URBAN GREENING IN THE GLOBAL SOUTH: GREEN GENTRIFICATION AND BEYOND

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EDITORIAL
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Editorial: Urban Greening in the Global South: Green Gentrification and Beyond

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Editorial on the Research Topic

Urban Greening in the Global South: Green Gentrification and Beyond

INTRODUCTION

The BiodiverCities initiative, which is a roadmap for sustainable city development that shifts traditional gray infrastructure to more natural-based solutions, was presented at the World Economic Forum, 2022. Another report that was released on the same day by the non-governmental organization Oxfam pointed out that during the COVID-19 pandemic, 99% of people's income fell, among other negative developments (OXFAM, 2022). As a result, more than 160 million were pushed into poverty, while a new person became a billionaire every 26 h. The wealth of the richest, all of whom are white men, grew by $5 trillion in the same period.

This Research Topic is about environmental inequality. While solutions and innovations to mitigate environmental damage are discussed, another fraction exposes the face of perverse and unequal impacts, which disproportionately affect the most vulnerable populations. The objective of the Research Topic was to contribute to fill the gap in environmental inequalities studies by presenting empirical research that focuses on the Global South. In our view, this gap perpetuates a limited understanding of the relationship between urban greening, unequal and uneven development, and growth, which includes the provision of ecosystem services and social equity.

With this, the organizers sought to expand both the repository of Global South case studies and South-South or North-South comparisons. Therefore, the main goal of this Research Topic is to develop scientific dialogue on approaches to greening cities in the Global South that exacerbate green inequalities and gentrification, as well as those that create greener and healthier cities for all. Within this Special Issue, we intended to receive papers on (1) concrete cases of green inequalities and (2) good practices and interventions.

After being reviewed by experts, a notable aspect was the sheer variety of articles that were published: original research, policy briefs, systematic reviews, mini-reviews, and policy and practice reviews. Eleven articles were approved from a total of 30 authors, most of whom came from Brazilian institutions. This can be explained by the fact that two special issue editors are based in Brazil, while the others authors are from Germany, the Netherlands, and the United States. Articles represent different kinds of expertise and areas of knowledge, including environmental sciences, architecture and urbanism, history, biology, urban planning, sociology, and political science, among others.

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We would have liked to have more contributions from the Global South, although territories in Brazil, Chile, Indonesia, and Barbuda were included. Two possible factors contributed to this: language constraints and the costs associated with open access publications.

Forty-six keywords are mentioned in the 11 articles, highlighting each text's particularity. Of these, only five mention "global south" (four times), "environmental justice" (three times), "green gentrification" (three times), "green infrastructure" (three times), and "gentrification" (two times). As such, the current set of articles published here should be seen as the starting point of an intellectual exploration that exposes global contradictions and environmental inequalities. Based on the authors' references and different theoretical perspectives, it became clear that most of the articles take the approaches of classic studies on environmental justice and political ecology. This is evidenced by the frequency with which authors such as Acselrad, Agyeman, Bullard, Pellow, and Schlosberg are cited. Additionally, central references to the theme of green gentrification, such as Gould, Lewis, and Anguelovski, were also frequently invoked.

In a 2008 paper, Budd (2008) used the term "green gentrification" to change cultural sources concerning urban sustainability in the United States, and in 2009, studies on green gentrification gained ground with the work of Gould and Lewis. The case studies revolved around New York or other locations within the United States. From 2013, with studies by Anguelovski (2013) the theme solidified in Europe and other countries. The year 2016 was an important one given the publication of *Green gentrification: Urban sustainability and the struggle for environmental justice* by Gould and Lewis (2016), which quickly became the most cited work on green gentrification (it currently has more than 400 mentions). This paved the way for many other researchers to test the limits, applicability, and challenges of using the notion of green gentrification in different realities, particularly in the Global South (Torres et al., 2021).

But what is Green Gentrification?

The gentrification process is commonly defined "as a process of neighborhood change through which the demographic, real estate, and business characteristics of a place reveal a transition toward a more educated, wealthy, whiter population, able to afford new or renovated pricier properties while also fomenting new cultural and consumption practices" (Cole et al., 2019, p. 3). Green Gentrification, in turn, can be defined as a process "which is facilitated in large part by the creation or restoration of an environmental amenity. Rather than cases where already gentrified neighborhoods develop constituents for local environmental amenities (where gentrification leads to greening)" (Gould and Lewis, 2012, p. 12). Gould and Lewis (2016) presented three questions in their studies related to race, class, and housing, which were central elements of their approach to green gentrification processes: (1) does sustainability whiten an area? (2) does greening enrich an area? (3) does greening increase rent and housing prices? These questions seem fundamental to urban greening in historical realities of the colonial past and present, such as in the Global South.

Concerning these contexts and particularities, Anguelovski and Irazábal-Zurita (2019) showed the roots of low-income populations' double dispossession process in urban areas of Medellín in relation to rural-to-urban migration, violence, land grabbing, and agricultural modernization. This same approach could be applied to several other territories in the Global South, which is hugely heterogeneous.

Perceiving these specificities is a challenge for scholars from the Global South, as is decolonizing (Anguelovski et al., 2021) and understanding how international agendas travel and impose themselves from north to south. A recent case study from the so-called Nature-Based Solutions (Kotsila et al., 2020; Tozer et al., 2020) centers around deciphering the narratives that create and recreate the process of greening cities. Is it true that polluting companies and large corporations are now sustainable? Who will profit from investing the billions of dollars cited in the initiative launched at The World Economic Forum's BiodiverCities? How many more millionaires will be produced by the time the next Oxfam report is published?

As shown by the different authors whose texts are published in this volume, it is always necessary to question the intentions of these processes (Meerow and Newell, 2016): for whom, what, when, where, and why?

The presence of a mini-review and a systematic review in the special issue contributes to a more systematic reading of this area of study. In *Greening and Just Cities,* de Souza and Torres presented a brief overview of the field covered by the Research Topic. The authors undertook a systematic review of research published in international peer-reviewed journals that analyzes environmental justice issues within the deployment of urban green amenities. Since most studies focus on the Global North, the authors' goal was to outline the similarities and differences regarding the nexus of justice and the greening of cities in both contexts to identify knowledge gaps in Global South studies. For this mini-review, de Souza and Torres chose to work with two descriptors, "green infrastructure" (GI) and "nature-based solutions" (NBS). Both notions, which were considered by the authors to be "leading concepts for cities' greening agendas," are analyzed in combination with "justice" and "green gentrification." Results show a need to better delineate a research agenda that addresses such issues in a heterogeneous Global South context, while also gaining insight from the advances made by research on the Global North. As the Global South will show the most rapid urban growth with numerous informal settlements and vulnerable places (Bai et al., 2018), it is essential to consider how Global South cities will use and take advantage of GI and NbS projects to address social and environmental inequalities. The authors further argue that future research ought to make proposals toward creating a just and resilient future for the Global South within an interdisciplinary agenda that should tackle climate justice and sustainable urban planning.

Urban Greening for New Capital Cities, by de Vries, aims to shed light on the contemporary discussion on relocating the capital city of Indonesia to a new location in Kalimantan and creating a new green capital city—this could possibly become the first capital relocation due to climate change effects of this century. For the Systematic Review, the article applies a meta-analytical approach by connecting the basic tenets of the proposed 8R framework of responsible land management to

assess the pros and cons of a selected set of global capital city relocations and green cities. The findings reveal that each of the selected cases falls short in one or more aspects of the 8R framework. In all cases, constructing green capitals requires mixed and integrated land use planning, a transparent regulatory framework toward land use control, extensive consultation with both local, national, and international stakeholders, as well as the participation of local residents. de Vries' research also aims to support having more choices in the design and implementation processes of relocating the Indonesian capital city. Determining how such intentions should become reality, and what they imply, are the key objectives of his article. The author concludes that new capital city designs and the implementation of construction and planning activities inevitably require a fundamental and explicit framework when choosing to be green and responsible. Acknowledging aspects of spatial justice and inclusion in the design and execution processes is crucial. Furthermore, the design of greening should not be at the expense of existent tropical forests or cultural landscapes or designed in isolation of spatial justice and affordable housing strategies.

The Research Topic has five Original Research Articles. The themes explored by the authors include water, urban river interventions toward a just sociotechnical transition, decoloniality, coastal climate disasters, green inequality concerning industrial area renovation, using Google Street View for research, and Green Amenities. In *Infrastructure in the Ruhr,* Zimmermann and Lee examined the extent to which green infrastructure planned at the regional level can contribute to environmental justice within a city-region. They analyzed the context of this region with regard to the rehabilitation of environmental damages that occurred after more than 100 years of coal mining and steel production, investment in green infrastructure, and the creation of regional landscape parks as one of the main pillars of the economic and physical transformation of the region. The study examines the extent to which green infrastructure planned at the regional level can contribute to environmental justice within a city-region, and indicates that there is a need for a multi-scaled governance approach when it comes to green infrastructure. In terms of institutional design for environmental justice, this calls for a stronger coupling of regional and local initiatives and emphasizes that green infrastructure should also be planned at the local level. They argue that environmental justice is a question of scale, also in terms of politicization. Within this approach, the authors emphasize that actors from different disciplines must work together with the aim of developing and maintaining green infrastructure across all scales within a multi-scaled governance approach for green infrastructure.

In *Emancipatory Urban Greening in the Global South,* Porto et al. discussed theoretical, methodological, and political issues related to urban greening in the Global South, as well as emancipatory alternatives to envision more inclusive, democratic, sustainable, and healthy cities. The article emphasizes the idea that the concept of urban greening has its own specificity in the context of the Global South. In the Brazilian context, this involves understanding the complex relationship between traditional peoples and communities, as well as families and peasant agriculture; the existence and different forms of mobilization or social struggles experienced by these groups represent a vast pluri-verse of hues and hybridizations. As a synthesis of different experiences presented in the article, they represent emblematic expressions of ongoing social struggles at different levels, scales, and regions of the planet that can contribute to articulating the emancipatory agendas of the Global South and the Global North.

In *Using Google Street View to Examine Urban Context and Green Amenities in the Global South* Haddad et al. evaluated the use of virtual, human-interpreted, field observations from Google Street View (GSV) to examine the presence of conditions that may be used to analyze green gentrification in the Global South. Using a sample of four parks in two Chilean cities, they analyzed how green amenity indicators and urban contexts (explored *via* virtual field observations) represent the potential for green gentrification. The outcomes indicate that virtual field observations can provide a promising method that may facilitate the identification and investigation of the effects of green gentrification in the Global South, thus broadening the scope and application of this type of research in heterogeneous urban landscape, especially in cases with unreliable or unavailable data. The study highlights the importance of understanding the local context to develop relevant indicators based on street-level characteristics and that local knowledge about neighborhoods needs to be incorporated into the interpretation of indicators; thus, engaging local experts to guide greening decision-making is essential.

In *Resilience Gentrification,* Gould and Lewis argued that responses to climate events often result in greater inequality through a process they call "resilience gentrification." They emphasized that from the three possible resolutions to the coastal resilience dialectic—*managed retreat, denial,* and *structural mitigation*—the last one has become the most popular response in the Anthropocene. The authors illustrate the post-disaster recovery of two different communities: Gowanus, Brooklyn, New York, and the Caribbean island of Barbuda. They argue that these examples show that government responses did not consider and address the equity impacts of climate change resilience policies, and that current processes lead to resilience gentrification, whereby less wealthy coastal residents find themselves unable to remain in place, and public policy fails to adopt equity-based climate adaptation strategies. They recommend *managed retreat* and de-growth strategies for climate resilience through public policies that separate resilience from wealth and offer greater potential for a more just kind of sustainability.

In *Urban River Interventions in São Paulo Municipality,* Travassos and Momm discussed the sociotechnical transitions regarding urban rivers policy in São Paulo Municipality by focusing on programs and projects conducted since 2000. For the authors, policies and projects concerning the relationship between rivers and urban spaces—specifically through linear parks and other open spaces for leisure—have not been able to be configured as a new socio-technical regime. They emphasized the need to consider the context of two different cities with two different socio technical landscapes regimes. Inequality remains a relevant factor in peripheral and precarious areas and there is

a need for a sociotechnical transition and the implementation of a new paradigm in the relationship between infrastructure and existing urban rivers. It is necessary to strengthen the link between the sociotechnical transition literature and that of justice, since an important part of the advances and setbacks are strongly related to the territorial inequalities of large cities in peripheral countries, which makes the analysis of the transition more complex.

Finally, the Research Topic presents some policy-oriented contributions for the discussion—one *policy brief* and three *policy and practice review*s authored by academics and practitioners. The Policy Brief *Green Gentrification and Environmental Injustice* from Alves et al. is a contemporary and essential contribution as it directly engages with the themes of the Research Topic: both the issue of green gentrification itself and the use of greening narratives—or green makeup—in government programs, plans, and policies, such as the case of the Pinheiros River Depollution Program. Through the analysis of the River Program, environmental inequalities are exposed, thereby showing that vulnerable neighborhoods will receive only basic infrastructure, whereas Marginal Pinheiros, a rich area, will be equipped with additional leisure, sports, and cultural facilities. The policy brief focuses on current practices of producing and reproducing urban environmental inequalities, while also exposing and unmasking ongoing issues in the program.

Opening the final three articles on *policy and practice review*, *Construction of Sustainable Territories and the Multiple Dimensions of Sustainability,* Marques and Alvim explored the relationship between legal frameworks, urbanization, and the environment in the context of metropolitan fringes focusing on the Juqueri-Cantareira sub-basin: a strategic territory for the ecosystemic balance of the São Paulo Metropolitan Region (SPMP), Brazil. The study sought to determine how these instruments articulate and incorporate these dimensions to promote strategies that contribute to sustainable development and address socio-spatial inequalities in the region. The results revealed that although the instruments analyzed did address the dimensions of sustainability defined for the study, a sectoral fragmented view prevailed, as did the model of a sprawling city. As a policy contribution, the article concludes that the planning process should be reviewed to provide an integrated vision of regional scope that values the territory, environmental heritage, and local communities.

Caetano et al. discussed São Paulo's *Environmental Quota (EQ),* which is a wide range of principles developed between 2013 and 2016 associated with environmental services and the consideration that green areas in this megacity are unequally distributed. This is the main contribution of authors at *The City of São Paulo's Environmental Quota.* This paper details the political-institutional context in which the EQ and its guidelines were established and implemented, and provides a general overview of the tools and theoretical frameworks within which it was developed; finally, it discusses the complex social decision-making process of its legal constraints. Moreover, it analyzes the implementation and application of the EQ to examine its effectiveness and how it relates to the city's gentrification. The replicability potential of the EQ to expand both the supply and distribution of green infrastructure and environmental services throughout the urban environment is considered, thereby contributing to the mitigation of intricate problems within urban environments in the Global South.

Another article on São Paulo, or its Metropolitan Region, *Socio-Ecological Conflicts in a Global South Metropolis* by Moreno et al. explored the greenways concept as a measure of environmental remediation within a broad framework aimed at promoting urban greening and adaptation to climate change. This *policy and practice review* examines the socioeconomic and environmental processes that shaped this potential urban greenway between Santo André, Mauá, and Ribeirão Pires, which are part of the São Paulo Metropolitan Region. The authors state that the implementation of green infrastructure should be based on local needs. Their findings indicate that the performance of green infrastructure in informal settlements may support the evolution of "slum upgrading" through local parameters, which will promote ecological and economic benefits for the region and expand the total green coverage of the municipalities. At the same time, the authors scientifically aim to contribute to research on urban greenways, green infrastructure, and ecosystem-based adaptation in cities within the Global South, therefore seeking to demonstrate the value of implementing green infrastructure solutions to planners and decision-makers.

Undoubtedly, there is still much research to be conducted in this area, as the relevance of urban greening, green gentrification, and critical paths toward just sustainabilities continues to grow. We hope this special issue inspires more research on these issues from the perspective of the Global South or with a view to create a South-North dialogue.

AUTHOR CONTRIBUTIONS

PT: conceptualization. PT, PJ, and CI: writing—original draft preparation. All authors contributed to the article and approved the submitted version.

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Construction of Sustainable Territories and the Multiple Dimensions of Sustainability: An Assessment of Urban and Environmental Instruments in the Juqueri-Cantareira Sub-basin of the São Paulo Metropolitan Region

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This article explores the relationship between legal frameworks, urbanization, and environment in the context of metropolitan fringes. The focus of study is the Juqueri-Cantareira sub-basin, a strategic territory for the ecosystemic balance of the São Paulo Metropolitan Region (SPMP), Brazil. This region is also home to critical natural remnants and watersources protected by Law and encompasses smaller cities undergoing intense urbanization out of step with prevailing instruments of urban and environmental planning. The article examines the limits and challenges of the urban and environmental instruments proposed for a section of the Juqueri-Cantareira sub-basin, particularly those lying within the protected area for Spring recovery (Alto Juquery). It is assumed that municipal Master Plans and the Specific Law for Protection and Recovery of Springs (State Law 15.790/2015) should be within the framework of an integrated planning process, in which sustainability is systemic and has multiple dimensions. A qualitative assessment methodology was adopted that covers four dimensions of sustainability (political, environmental, territorial, and socioeconomic) in an analysis of the urban instruments of the cities of Caieiras, Franco da Rocha and Mairiporã, and of the environmental instrument—the Specific State Law for the Protection and Recovery of Springs. The study sought to determine how these instruments articulate and incorporate these dimensions to promote strategies contributing to sustainable development and addressing socio-spatial inequalities in the region. The results revealed that, although the instruments analyzed addressed, to a greater or lesser extent, the dimensions of

sustainability defined for the study, a sectoral fragmented view prevailed, as did the model of a sprawling city. The planning process should be reviewed to provide an integrated vision of regional scope to value the territory, environmental heritage and local communities, favoring their sustainable development.

Keywords: sustainable development, sustainability dimensions, urban instruments, environmental instruments, spring protection zones, Juqueri-Cantareira sub-basin

INTRODUCTION

Currently, the intensity of the urbanization process has exerted tremendous pressure on protected areas, establishing a vicious circle of environmental degradation. In this context, the fringe areas of Brazil's major metropolises are equally affected which, while constituting ecological preservation areas, also present an opportunity for urban occupation, often without planning or control. In general, such regions comprise small towns or peripheral districts of large cities, and tend to have a higher population growth rate than their larger counterparts. Urban occupation processes threaten the natural remnants of the metropolitan fringes and, even though legislation at various levels (Municipal, State and Federal) provides for protection of these regions, a fragmented situation prevails (Alvim et al., 2018; Marques, 2019).

In the case of the Metropolitan Region of São Paulo (SPMP), Brazil's foremost and largest metropolis, its fringe areas endowed with significant natural remnants are invariably occupied by peripheral districts of the host city (São Paulo) and by smaller towns that have higher geometric population growth rates than those of the capital city.

In the northern portion of the SPMP (Juqueri-Cantareira sub-basin), the empirical focus of the present article, there is evident intense demographic growth with the presence of precarious settlements hand in hand with existing or planned major real estate, road and infrastructure projects for the region. Implementing these projects without considering socio-spatial inequalities or incorporating an integrated vision of environmental attributes can have dire consequences. These consequences impact the cities that make up the region and the metropolis as a whole, especially with regard to water resources (quality and quantity), since part of the sub-basin encompasses an area of regionally listed springs and other environmentally protected areas.

As part of a larger study[1], this article defends the importance of urban and environmental planning that considers social asymmetries in its scope and addresses the multiple dimensions of sustainability from a systemic perspective. It is assumed that urban and environmental planning instruments should be part of an integrated planning process.

This article aims to discuss the limits and challenges of the urban and environmental instruments proposed for a section of the Juqueri-Cantareira sub-basin. This study investigates the environmental instruments governing the Area of Protection and Recovery of Springs—Alto Juquery, especially its specific Law, as well as smaller cities, most notably, the Master Plans for Caieiras, Franco da Rocha and Mairiporã. A qualitative evaluation methodology is proposed that covers four dimensions of sustainability (political, environmental, territorial and socioeconomic) to determine how the selected instruments articulate and incorporate these dimensions to promote strategies that contribute to sustainable development and address socio-spatial inequalities in the region.

THEORETICAL FRAMEWORK

Sustainable Development: A Glance Over the Territory

Within the scope of the discussion on sustainable development of the planet, cities have come under the spotlight since urban environments are currently the habitat of most of the global population. According to the 2016 UNhabitat report (UN Habitat, 2016), 54% of the world population (approximately 4 billion people) live in cities. The projections presented by the United Nations indicate that the percentage of the world's urban population will rise to 66% by the middle of the century. In this perspective, and considering that urban population growth is set to continue in the years ahead, a scene is set in which cities play a crucial role in global balance and sustainability (Alvim et al., 2018).

A number of authors (Acselrad, 2004; Bellen, 2007; Magnaghi, 2011; Farr, 2013) argue that the concept of sustainable development has arisen in response to the crisis involving the traditional vision of growth and development. This idea, guided by the discourse of economic growth, treats the environment as a source of inexhaustible resources to be exploited. Several discursive matrices have addressed urban sustainability, predominantly after the Brundtland Report in the 1980s. Since then, the notion of sustainability has occupied increasing space in the international debate (Acselrad, 2007).

Although a growing number of studies indicate high levels of environmental degradation and the need for new development paths in several areas of knowledge, there is no consensus on the meaning of "sustainability." On the contrary, sustainability is a developing concept and the focus of a dispute encompassing authors from different spectrums.

The main lines of thought include theories that are more focused on the extreme protection of nature—which may often tend to a rigid determinism of the design of

[1]Master's dissertation authored by Andresa Lêdo Marques under the supervision of Prof. Dr. Angélica Benatti Alvim entitled "Franjas metropolitanas e as dimensões da sustentabilidade: o caso da sub-bacia Juqueri-Cantareira da Região Metropolitana de São Paulo."

the anthropic environment and not reproduce a radical critique of the socioeconomic system that drives environmental degradation, and definitions centered on a more functionalist and technocentric perspective—which sometimes fail to question the primacy of the economic dimension and reproduces a corrective logic with deep environmental injustices, transferring the consequences of ecosystem imbalances to more vulnerable countries and communities (Acselrad, 2004; Bellen, 2007; Magnaghi, 2011).

In the research that gave rise to this article, the concept of sustainability adopted was that addressed by two seminal authors: Sachs (2009) and Magnaghi (1999, 2011). Both these authors contribute to the idea of sustainability from an integrated and systemic standpoint, defending that sustainability has multiple dimensions beyond environmental aspects.

Sachs (2009), a Polish economist who lived and taught for many years in Brazil, takes a broad view of sustainability. According to the author, the term "sustainability" is often used to express "environmental sustainability;" however, the author holds that the term covers other aspects that should be seen as part of the same problem. Sachs (2009) defines eight dimensions of sustainability that provide support for the application and analysis of this important concept, namely: the social dimension, economic dimension, environmental dimension, territorial dimension, ecological dimension, national political dimension, and the international political dimension.

The architect Magnaghi (1999, 2011), one of the Italian territorialist school's leading theorists, contributes with a definition that is more focused on urbanism, understanding sustainability from an integrated perspective, valuing local development and the importance of territory. In his concept, Magnaghi establishes five sustainability dimensions: the social dimension, economic dimension, environmental dimension, territorial dimension and the political dimension.

Table 1 synthesizes the definitions of the authors for the multiple dimensions of sustainability.

The dimensions listed by Sachs (2009) and Magnaghi (2011) have several similarities and convergences. Although Sachs takes a broader perspective and Magnaghi a more applied approach to territorial planning, both authors view sustainability from a systemic and interdependent perspective. In this sense, "sustainability" is not seen as a mere environmental or sectoral issue, but as a relational problem with multiple dimensions.

Alvim (2003), corroborating with Magnaghi (1999), argues that redefining sustainability in the ambit of urban planning calls for the notion of territory as a living space for society and its pre-existences. The territorial approach seeks to address the problems surrounding territory with a multidisciplinary focus, considering environmental, territorial, cultural, and socioeconomic heritage in local dimensions through community empowerment.

When evaluating urban and environmental instruments in a water-producing region with rapid urban growth and marked socioeconomic inequalities, the valuing of the territory and the society residing within it based on democratic and citizenship practices should be considered determinants for the sustainability of these public policies.

The appreciation of the territory and its physical, environmental, and social pre-existence translates as an essential strategy to achieve sustainable development. This means that the quality of territorial production is an important indicator of ecological sustainability, since it is interpreted as a mixture of ecosystems. Territorialism approaches sustainability by focusing on the human environment (considering natural and built environments), thinking about sustainable development from the territory, understood as a neoecosystem produced by people, including the relations between culture, nature and history. From this integrated perspective, the territory's degradation has implications for multiple dimensions, promoting deterioration of natural, built and social aspects (Magnaghi, 2011; Alvim et al., 2019).

Rethinking the concept of sustainable development entails understanding and overcoming the dualistic view that divides the territory between areas with "economic" function and protected areas with "naturalistic" function. This involves a shift toward a systemic and integrated perspective, in which the whole territory (including the urban, built environment) is treated as a neoecosystem, seeking a concept of environmental, social, territorial, economic, and political sustainability (Alvim et al., 2019; Marques, 2019).

The sustainability concept that underpins the analysis in this article is aligned with this systemic vision and applied to territorial planning, aiming to construct sustainable territories. Despite recognizing the importance of each of the sustainability dimensions developed by the authors and their intersections, this article lists those elements that are potentially more adequate to support an analysis of urban and environmental legislation. The dimensions were listed according to major themes, seeking to pool elements (qualitative indicators) that corroborate an integrated analysis, namely, the political, socioeconomic, environmental and territorial dimensions.

In this systemic vision, it is understood that the construction of sustainable territories involves the incorporation of citizenship and participation principles in the planning and management process. In this sense, the political dimension of sustainability assumes a fundamental role because it must counter the culture of social polarization. Supported by democracy and participation, self-government and the strengthening of the local community should be encouraged, recognizing conflicts, complexity, peculiarities of the territories, allowing mediation and resolution of disputes, and collectively generating a future project for this society.

This type of organization does not extinguish the conflicting interests of the community. However, the mediation of its conflicts must be based on understanding and valuing collective interests over individual interests.

In this article, the social and economic dimensions will be addressed together. As outlined earlier, addressing the concept of sustainable development from a systemic approach is premised on understanding that environmental degradation is not a sectoral problem. Unsustainability is the product of a systematic process of man's distancing from his territory and an extractivism that generates socio-environmental injustices (Acselrad, 2004; Magnaghi, 2011). Therefore, when thinking

TABLE 1 | Dimensions of sustainability according to Magnaghi (2011) and Sachs (2009).

Dimension	Concept
Dimensions of sustainability according to Magnaghi (2011)	
Political	Based on building a robust, complex, and multicultural local community premised on the principles of citizenship, democracy, and participation. The community must have a high capacity for self-government and be encouraged to value the territory and heritage.
Economic	Entails a development model based on territorial valuing, capable of producing added value, seeking economic self-sustainability.
Social	The different social actors must have a high level of interaction and participation in decision-making. The growth of the social bond between the State and the market must be pursued.
Environmental	Derived from rules that aim to establish a good relationship between human settlements and the environment. The aim is to close the water, energy, solid waste, and food cycles at local and regional levels, minimize the movement of people and goods and encourage local consumption and redefine agricultural and forestry activities.
Territorial	Promote reterritorialization through virtuous production and reproduction rules. Territorial planning must prevent land consumption, reorganize built spaces, revitalize abandoned areas, promote the compaction of cities, create centralities, value the local heritage (environmental and cultural), and value public and multicultural spaces.
Dimensions of sustainability according to Sachs (2009)	
Political (International)	Guarantee of peace and international cooperation (United Nations), control of the international financial and business system, protection of natural resources, and protection of ecological diversity as a common heritage of humanity.
Political (national)	Defense of democracy and appropriation of universal human rights. Implementation of national projects by the State in partnership with the private sector and the guarantee of social cohesion.
Economic	Harmonious intersectoral economic development, food security, and the ability to modernize production instruments (a reasonable level of autonomy in scientific and technological research).
Social	Ensure social homogeneity and a fair income distribution accompanied by equal access to resources and services.
Cultural	Promote a balance between respect for tradition and innovation and the capacity for autonomy for an integrated and intrinsic national project.
Environmental	Respect and recognition of the capacity for self-purification of natural ecosystems.
Ecological	Limitation on the use of non-renewable resources.
Territorial	Balanced urban and rural settings, improving the urban environment, overcoming interregional disparities, and environmentally safe development strategies for environmentally vulnerable or protected areas.

Source: prepared by authors.

about the construction of sustainable habitats, the socioeconomic dimension should be considered, toward promoting a low-carbon economy and just income distribution, allied with equal access to resources and services, based on the participation and balance of forces of various actors in society. Thus, it seeks to strengthen the social bond between the State, civil society, and the market, aiming to value the territory and create job opportunities and income generation for the local community.

Under a systemic view, the environmental dimension of sustainability should not be based on a corrective logic but aim at establishing a healthy relationship between human settlements and the environment. In this respect, it is fundamental to seek territories from low carbon matrices and encourage the closing of water, energy, solid waste and food cycles at local and regional levels (Sachs, 2009; Magnaghi, 2011). Given the goal of reducing pollutant emissions, the movement of people and goods should be minimized and local consumption encouraged. In this view, the environment is not interpreted as a mere source of economic support. There is an attempt to establish virtuous relationships between the natural environment, built environment, and distribution of activities/functions within the territory.

The territorial dimension aims to promote the local community's "reterritorialization" with its territory by establishing virtuous production and reproduction rules. The fragmented city, dispersed and organized as a function of supporting the economic activities of circulation, consumption and accumulation, must be remedied. Given the level of deforestation and environmental degradation, city planning must prevent land consumption, reorganize the spaces already built, recover abandoned areas and value local heritage (cultural and ecological) and public spaces. The built environment should be based on multi-center systems, replacing the center-periphery logic and creating balanced urban and rural relations.

The State Water Resources Policy and Integrated Approach

In the political-institutional panorama, the State of São Paulo has some peculiarities, especially with regard to water resource policies. Since 1991, before the 1997 National Policy on Hydrological Resources (Federal Law 9.433/1997), the State of São Paulo had enacted its State Policy for Water Resources (State Law 7.663/1991), providing for a decentralized, participative and integrated management system, adopting the hydrographic basin as the physical-territorial unit for planning and management (Alvim, 2003). The administrative structure defined in the Law comprised the State Council of Hydrological Resources, formed by the State Secretariats or their representatives; by representatives of the cities within the hydrographic basins, civil society and universities, and by the Hydrographic Basin Committees, which have the same tripartite structure. The

Hydrological Resources Management Units (UGRHIs) of the State of São Paulo were derived from this landmark legislation.

In 1997, the new Law for the recovery and preservation of the springs of the State of São Paulo (State Law no. 9866) was implemented. This Law adopted a new planning and management model for the State's hydrographic basins, outlining the principles established by the State Policy for Hydrological Resources (State Law 7.663/1991) cited above. The new Law stipulated the devising of specific legislation for each springs area of regional importance in the State's hydrographic basins or sub-basins (São paulo, 1997).

Within the scope of the Upper Tietê Watershed, four specific laws were enacted between 2006 and 2016. These laws include State Law No. 15,790/2015, which defined the Area of Protection and Recovery of Springs—Alto Juquery (APRM-AJ), of the Juqueri-Cantareira sub-basin, which will be analyzed in this article. The specific legislation's approval required that the cities located within the spring preservation area make their Master Plans compatible with the guidelines set out in the Law and the new environmental zoning regulations of each sub-basin. However, to date, none of the Juqueri-Cantareira sub-basin cities that make up the APRM-AJ (State Law 15.790/2015) have made their Master Plans compatible with the Specific Law.

It is essential to highlight the impasses in coordination between Master Plans and specific laws to protect springs. Several authors (Saraiva, 1999; Muñoz, 2000; Alvim, 2003) consider the watershed a fundamental unit for planning and environmental management to ensure environmental quality, especially water resource availability. However, in Brazil, this territory is subordinated to planning and management processes that favor other sectoral logic and, therefore, it is a territory subject to disputes and conflicts (Alvim et al., 2008, 2015).

In the Brazilian case, following the precepts of the 1988 Federal Constitution, urban policy is the responsibility of the municipal authorities, and the Master Plan is the main instrument in urban development, and mandatory for cities with over 20,000 inhabitants (articles 182 and 183 of the Federal Constitution). At the regional level, Article 25 of the Federal Constitution stipulates that the States, through complementary Law, can establish metropolitan regions, urban agglomerations and micro-regions, composed of groups of neighboring cities, to integrate the organization, planning and execution of public functions of common interest. According to the constitution, environmental policies are the joint responsibility of the three federative entities (Union, States, Federal District, and Municipalities) that must promote the protection of the environment and water resources (article 20 of the Federal Constitution).

According to Alvim et al. (2008), although the Brazilian legislation governing environmental, urban and hydrological policies is considered advanced, the challenge of building paths that equate the main conflicts to render this integration feasible prevails. The integration of principles with a view to promoting sustainability in a given territory depends on effective articulation with other policies that affect it, i.e., a negotiated process between government bodies, institutional sectors and players that arbitrate conflicts and multiple interfaces.

CONTEXT: THE JUQUERI-CANTAREIRA SUB-BASIN

The empirical focus of the present article, the Juqueri-Cantareira sub-basin, is a hydrological sub-region comprising the Upper Tietê Hydrographic Basin (UGRHI-6) and is situated in the northern portion of the São Paulo Metropolitan Region, covering part of the city of São Paulo, principally the districts of Anhanguera, Jaraguá and Perus, and the smaller cities of Caieiras, Cajamar, Franco da Rocha, Francisco Morato, and Mairiporã, as shown in **Figure 1**.

This sub-basin is located in an area of very uneven topography and encompasses significant natural remnants on a metropolitan scale, such as state parks and environmental protection areas, which are part of the São Paulo Green Belt Biosphere Reserve (Instituto de Pesquisas Tecnológicas do Estado de São Paulo, 2008, p. 52). Besides the ecological heritage, the region also has a very relevant historical heritage. **Figure 2** illustrates the listed sites protected by the Council for the Defense of Historical, Archeological, Art, and Tourist Heritage (CONDEPHAAT). These sites constitute an extensive group of important works, which tell part of the State's history and that of the Metropolitan Region of São Paulo. Many of these sites are linked to the railroad or the industrial development period of the cities.

The sub-basin is home to 848,593 inhabitants (IBGE, 2010) and has undergone significant population growth. The average population growth rate of the Juqueri-Cantareira sub-basin between 2000 and 2010 was 2.60% per year. In the same period, the average for São Paulo city was 0.76% per year and 0.97% per year for the metropolitan region. The cities of Mairiporã (3.04%), Cajamar (2.36%), and Caieiras (2.01%) stand out with the highest rates, besides the districts of Jaraguá (2.39%) and Anhanguera (2.6%), located in the extreme north of São Paulo city. This migratory population movement causes population pressure which, if not adequately tackled and controlled by integrated inclusive public policies—Urban and Environmental—can lead to a disastrous scenario, especially from an environmental perspective.

As defined by the IBGE, the precarious settlements, or Subnormal Agglomerations, have been expanding in the region, especially in the cities of Franco da Rocha and Francisco Morato and in the districts of Perus, Anhanguera, and Jaraguá. The amount of settlements in Risk areas is alarming, especially those located in Francisco Morato and the central region of Mairiporã, near the Paiva Castro reservoir, as evident in **Figure 3** based on georeferenced data from IBGE.

With regard to social vulnerability, georeferenced data for the São Paulo Social Vulnerability Index (spatialized in **Figure 4**) shows that the areas corresponding to vulnerability grades 6 and 7 (high vulnerability) correspond to the outskirts of Mairiporã (within the protected springs area), and the outskirts of Franco da Rocha and Francisco Morato. The areas rated as grade 1, with very low vulnerability, correspond to high standard condominiums. The most vulnerable municipalities in the sub-basin are Francisco Morato, Franco da Rocha and Cajamar because a significant part of their territory is rated as

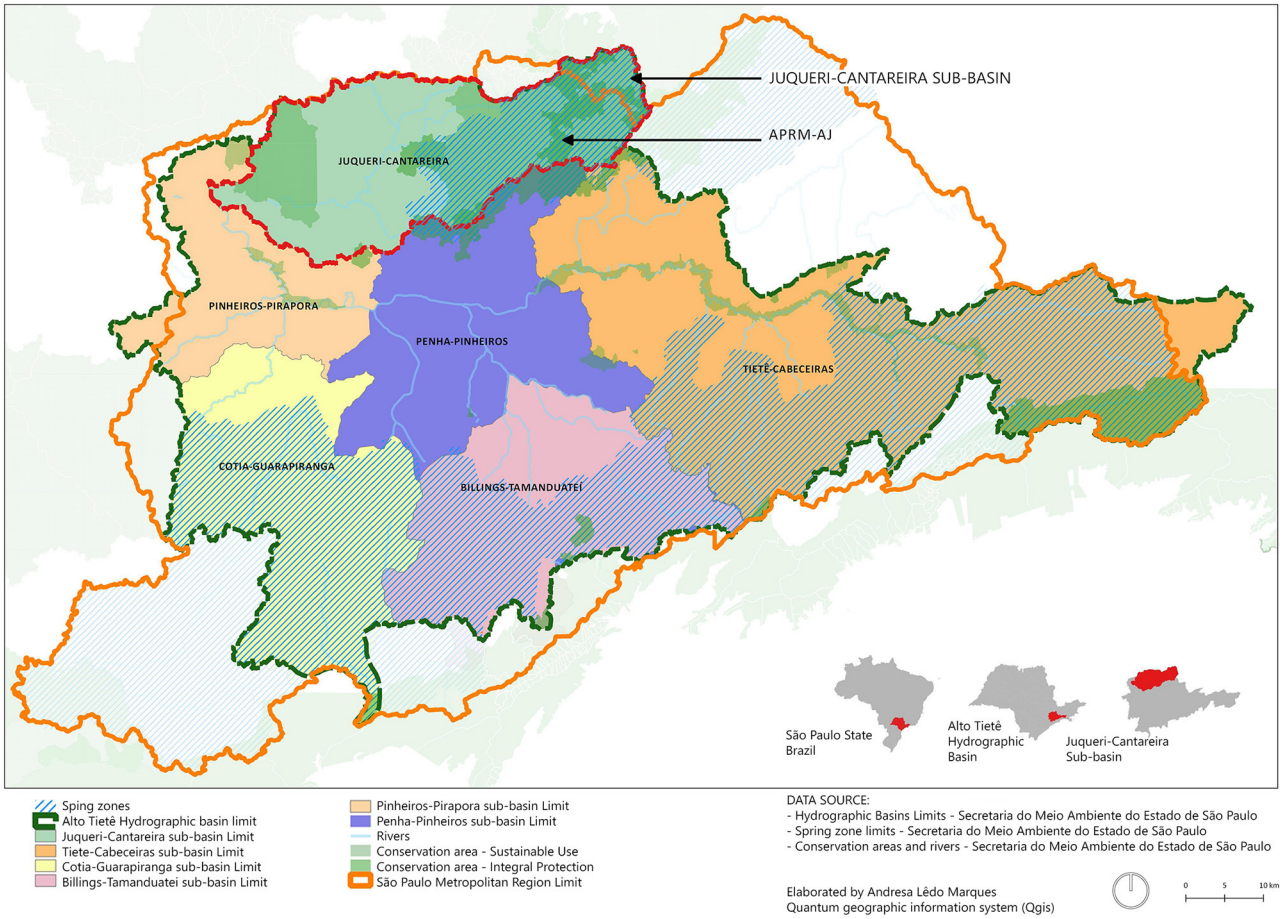

FIGURE 1 | Hydrographic sub-basins of the Alto Tietê Hydrographic Basin highlighting the Juqueri-Cantareira Sub-basin. Data source: São Paulo State Secretariat for the Environment. Available at: http://datageo.ambiente.sp.gov.br. Accessed: July 2018. Produced by: Andresa Ledo Marques.

medium and high vulnerability. The other districts and cities have high/medium vulnerability, where most of this territory has a low degree of social vulnerability.

The synthesis of some data from this sub-region, although not reflecting the full Construction of sustainable territories and the multiple dimensions of sustainability complexity of its problems, help highlight the central issues that should be dealt with in an articulated manner by the set of urban and environmental planning instruments proposed, within the overarching perspective of sustainability of the territory. Subsequently, albeit briefly, an evaluation is provided of the main urban and environmental planning instruments in effect within the region, along with the Master Plans of the cities of Caieiras, Franco da Rocha and Mairiporã, and the Specific Law of the Alto Juquery Springs Protection and Recovery Area (APRM-AJ).

MATERIALS AND METHODS

The Multiple Dimensions of Sustainability

The premise that sustainability has multiple dimensions is based on the theories of Sachs (2009) and Magnaghi (1999, 2011), as summarized in the previous section. Both scholars argue that sustainability is systemic and complex, recognizing the complexity of the discussion on sustainable development and providing contributions that go beyond the classic tripartite of sustainability of social, economic and environmental dimensions. These authors extended the concept by also incorporating cultural, territorial, and political aspects.

In the study of Marques (2019), a qualitative evaluation matrix was built for the analysis of Master Plans and Specific Legislation derived from articulation of the dimensions addressed by Sachs (2009) and Magnaghi (1999, 2011). The sustainability dimensions elected were: political, environmental, territorial, and socioeconomic (**Figure 5**). From these dimensions, elements (**Table 2**) of analysis were listed based on the literature review that correspond to each group and tare compatible with the study of urban and environmental policy, as follows:

Political Dimension

Political dimension involves the degree of participation in decision-making, representativeness of different groups of society (including those historically marginalized), valuing

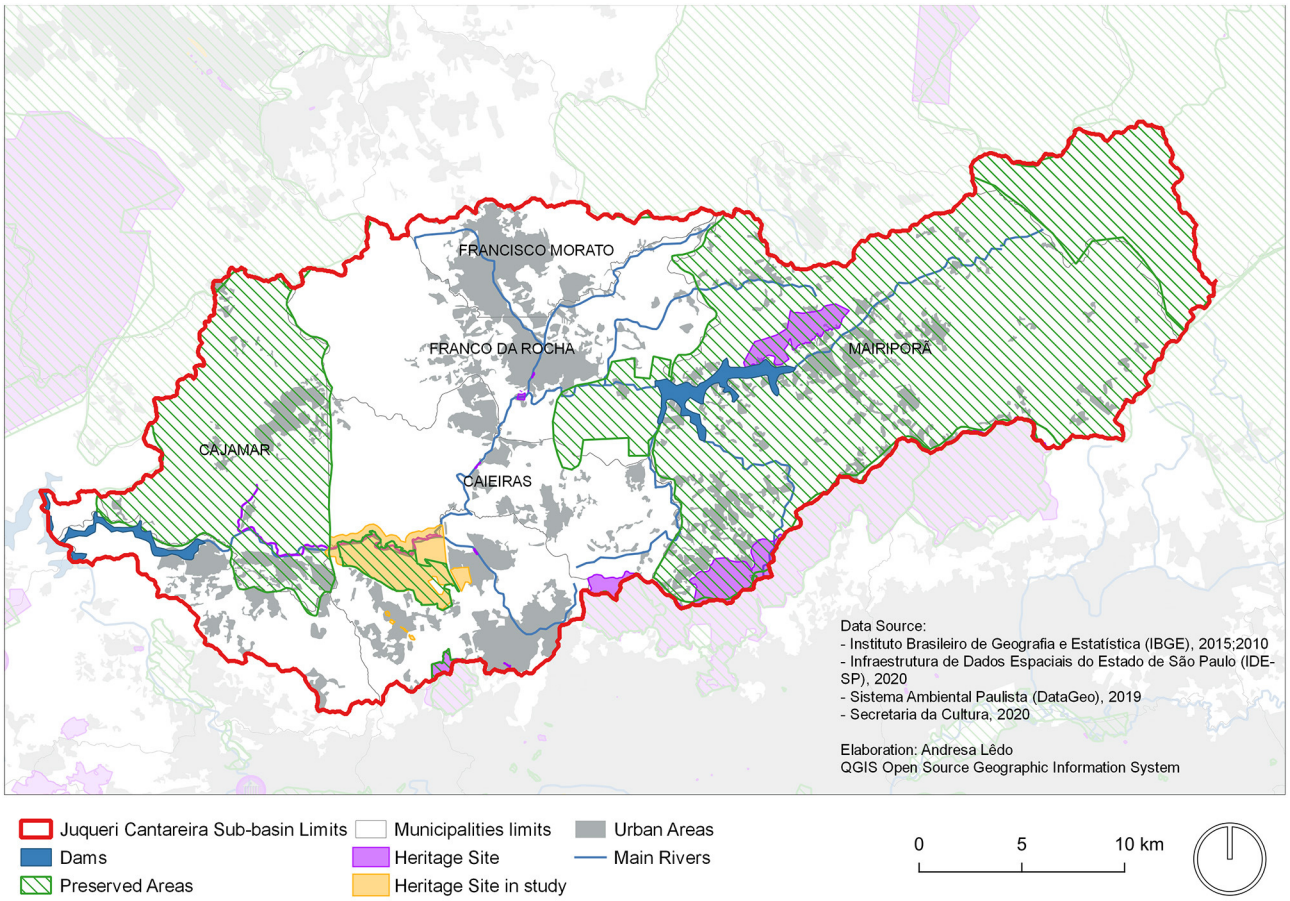

FIGURE 2 | Juqueri-Cantareira Sub-basin: APRM-AJ, heritage sites and those under consideration by CONDEPHAAT and environmental preservation areas. Data source: São Paulo State Secretariat for the Environment and EMPLASA. Available at: http://datageo.ambiente.sp.gov.br. Accessed: December 2018. Produced by: Andresa Ledo Marques.

and strengthening of the local community. The following components were listed for instrument analysis: participation of the population, representativeness, valuing the territory and strengthening the communities.

Environmental Dimension

Environmental dimension evaluates how strategies established in the analyzed legislation have considered the components of environmental science, especially ecology, in its scope, while addressing environmental recovery/protection and balance of ecosystems. The following elements were considered in the analysis: Environmental Preservation/Recuperation Areas, Recuperation of Degraded Areas, Environmental Preservation, Parks and Green Areas, Green Corridors, Forest Fragments Connection, Sustainable Tourism, Agriculture, Resources, Basic Sanitation (water, sewage and solid waste), River/Creek Treatment, Environmental Education, and Biochemical Cycle Closure.

Territorial Dimension

Territorial dimension aims to understand what strategies the Municipal Master Plans and the Specific Law have devised to establish a balance between the natural and built environments, between society and nature, and to promote reterritorialization of the local community into its territory. To this end, the following components are analyzed: cultural equipment, leisure equipment, health equipment, transportation (regional and municipal), active mobility, micro-accessibility, street tree planting, mixed-use, centralities/centers, urban sprawl planning, housing, redevelopment of abandoned areas/urban voids, valuing of heritage (historical and environmental), retrofit of historic buildings, integration of ecological and historical heritage, heritage education, and maintenance of heritage sites.

Socioeconomic Dimension

Socioeconomic dimension deals with fundamental components to the population's socioeconomic dynamics, seeking to understand how the urban and environmental instruments solve or mitigate the main social and economic problems of the region, aimed at promoting its sustainable development. The proposed analysis components are: local economic development, Generation of jobs and local income, Basic

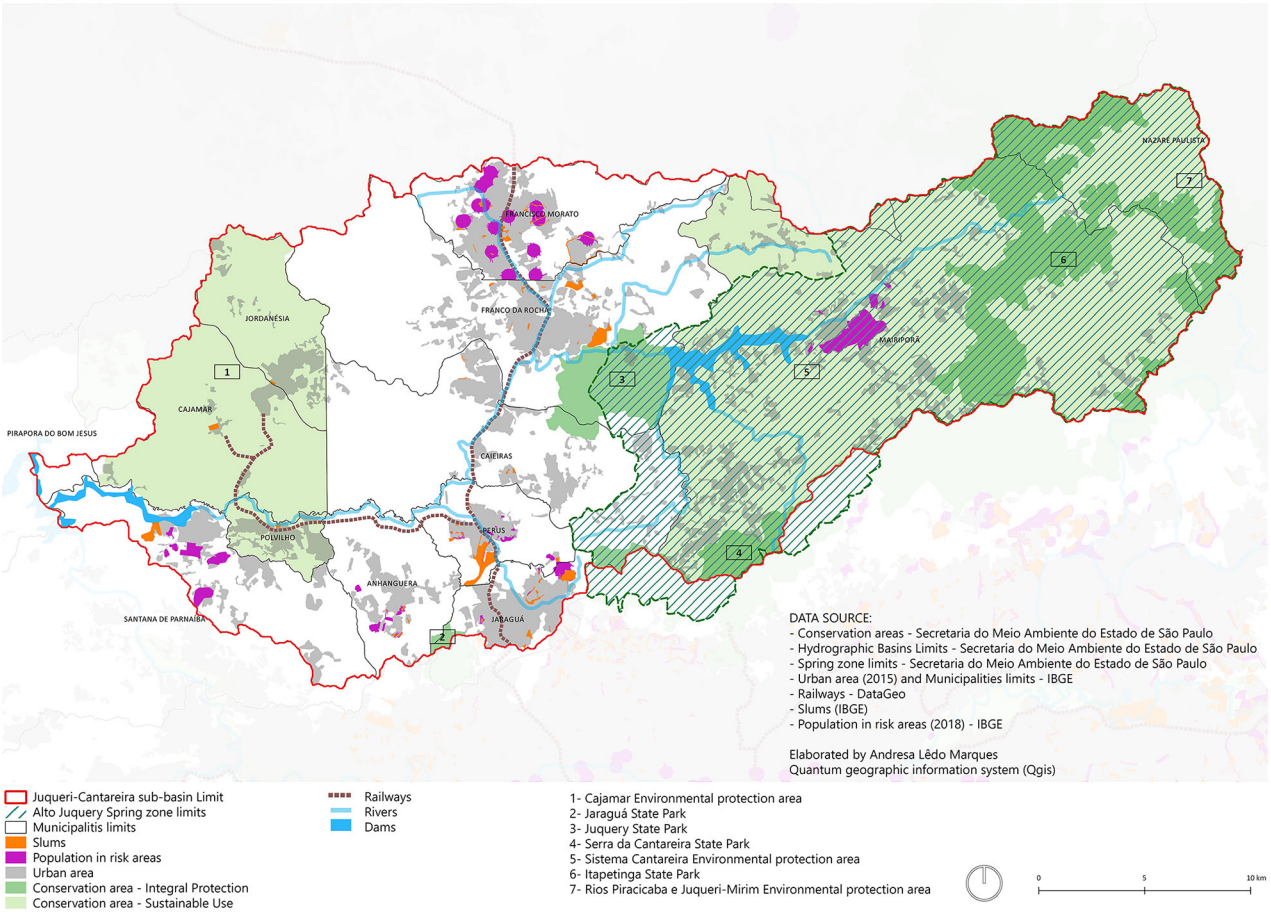

FIGURE 3 | Juqueri-Cantareira Sub-basin: APRM-AJ, urbanized areas, subnormal agglomerates (slums), and population at risk. Data source: São Paulo State Secretariat for the Environment, EMPLASA, and DataGEO. Available at: http://datageo.ambiente.sp.gov.br. Accessed: July 2018. Produced by: Andresa Ledo Marques.

education, Technical/vocational education, Higher education, Social vulnerability, Slums, and precarious settlements.

Study Period and Empirical Context

The present article reports the analysis of the Master Plans of the cities of Caieiras, Franco da Rocha and Mairiporã, carried out between 2005 and 2018. These cities are located on the outskirts of the São Paulo Metropolitan Region, more specifically in the Juqueri-Cantareira sub-basin, and were selected according to the following criteria:

- Small cities relative to São Paulo city and, therefore, with a lower degree of complexity in terms of urban and environmental policies;
- Cities that have undergone marked population growth to the detriment of preserved areas;
- Cities situated within the Area of Protection and Recovery of Springs—Alto Juquery, since the environmental issue, such as water production, among other ecosystem services, are central to this study.

The list of cities located within the Juqueri-Cantareira sub-basin and their respective percentage of the catchment area is given in **Table 3**. Mairiporã has 80% of its territory within the APRM-AJ, Caieiras has 20%, Franco da Rocha 5% and São Paulo 1.5%. The Master Plan of São Paulo will not be discussed in this article because the study objective was to address cities that lie fully within the fringe area.

Considering the criteria listed above, the strategies/guidelines of the following urban and environmental instruments were analyzed:

- Mairiporã Master Plan: Complementary Law No. 297/2006 (Mairiporã, 2006)
- Caieiras Master Plan: Supplementary Law No. 4538/2012 (Caieiras, 2012)
- Franco da Rocha Master Plan: Supplementary Law No. 618/2007 and amendments contained in Supplementary Law No. 244/2015 (Franco Da Rocha, 2007, 2015)
- Specific Law for the Protection and Recovery Area of Alto Juquery Springs—APRM-AJ: Law 15.790/2015 (São paulo, 2015)

Data Collection

The qualitative analyses of the instruments listed according to the criteria set out in the previous item were performed based

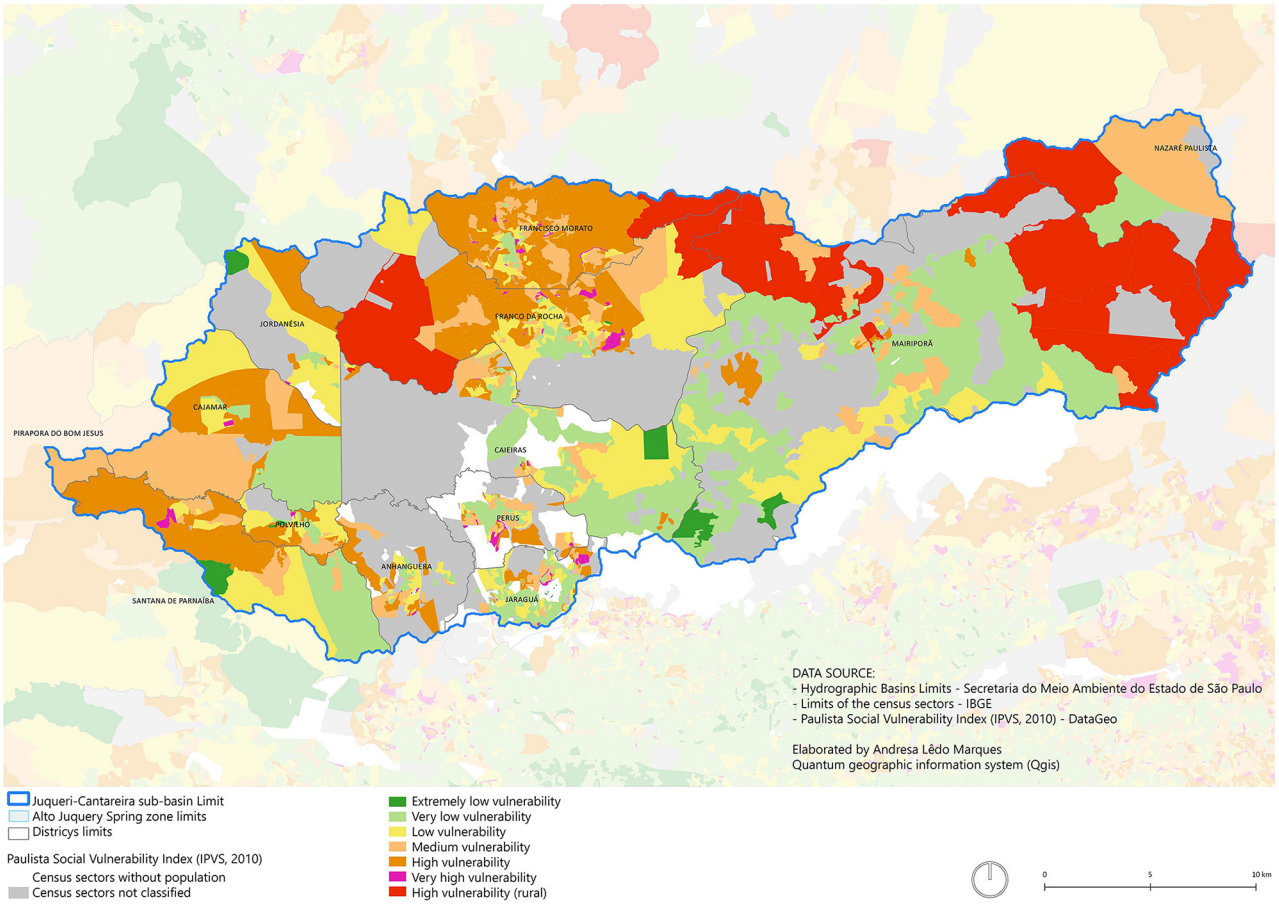

FIGURE 4 | Juqueri-Cantareira sub-basin—São Paulo social vulnerability index, 2010. Source: Fundação Seade (2013) and IBGE. Produced by: Andresa Lêdo Marques.

on the four dimensions of sustainability, namely: the political dimension, socioeconomic dimension, environmental dimension and the territorial dimension. These dimensions of analysis were established from the articulation of the sustainability dimensions devised by Magnaghi (2011) and Sachs (2009), as noted in the theoretical framework. From these dimensions, elements of analysis were listed that correspond to each dimension and were compatible with the study of urban and environmental policy.

The matrix was completed with information gathered from the reading and analytical transcription of the articles of the Master Plans and Specific Legislation corresponding to each element in the evaluation matrix. After filling out the matrix and comparing the laws, a synthesis of each instrument's strategies was produced outlining the dimensions of sustainability addressed. Finally, to aid comparison of the instruments analyzed, scales (grades) were assigned to measure the elements making up each dimension, as follows:

- 0 = no guideline/strategy in the instrument addressed the element of analysis;
- 1 = the element of analysis was addressed in a minimal and/or superficial way;
- 2 = the element of analysis was addressed partially or not satisfactorily;
- 3 = the element of analysis was addressed in depth.

This stage, considered exploratory, provided the basis of a comparative and relativized analysis of the cases addressed. The results obtained for each dimension were systematized into a matrix. The general grades assigned are based on the overall average of the elements analyzed. This average will be presented in a comparative Wheel Chart graph in the ensuing section.

RESULTS

Figure 6 depicts a comparative Wheel Chart graph of all the instruments analyzed according to the criteria and scales detailed in the previous item. Although the legislation provides for some elements of the sustainability dimensions, there are still a series of shortcomings in promoting the construction of more just sustainable cities. Indeed, some elements actually induce the processes of sprawl, monofunctional, and extractive urbanization.

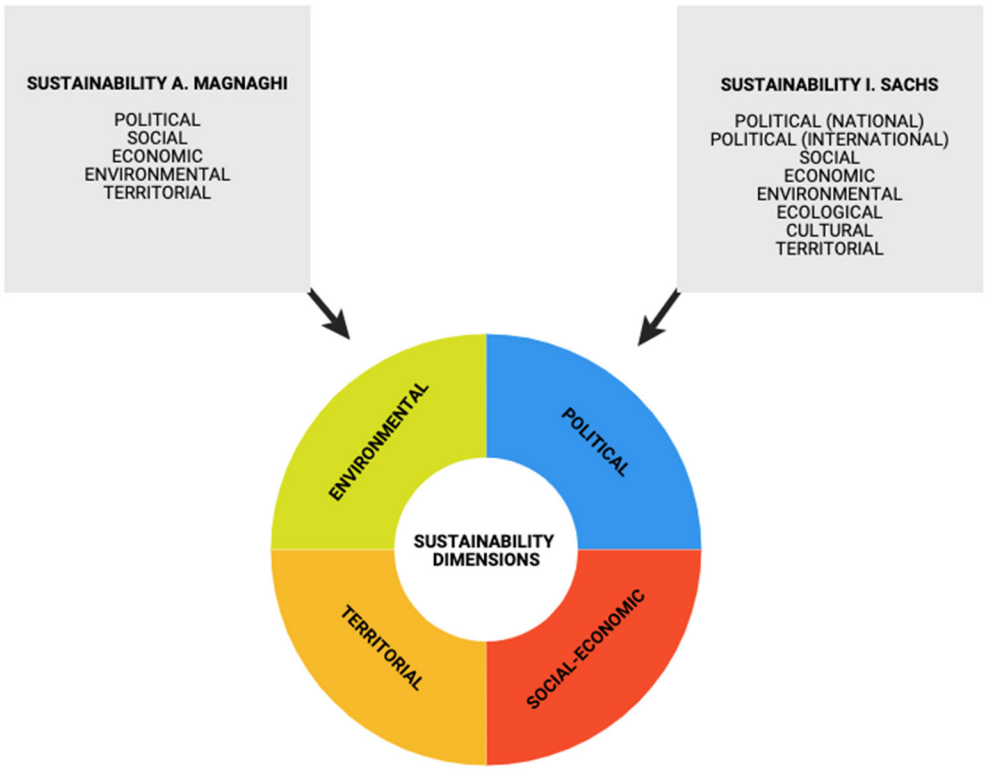

FIGURE 5 | Diagram depicting articulation of sustainability dimensions of Sachs (2009) and Magnaghi (2011).

TABLE 2 | Summary evaluation matrix containing elements analyzed, by sustainability dimension.

Analytical dimension	Elements analyzed, by dimension
Political dimension	Population participation, Representativeness, Valuing the territory, and Strengthening communities.
Environmental dimension	Environmental Preservation/Recuperation Areas, Recuperation of Degraded Areas, Environmental Preservation, Parks and Green Areas, Green Corridors, Forest Fragments Connection, Sustainable Tourism, Agriculture, Resources, Basic Sanitation (water, sewage and solid waste), River/Creek Treatment, Environmental Education and Biochemical Cycle Closure.
Territorial dimension	Cultural equipment, leisure equipment, health equipment, transportation (regional and municipal), active mobility, micro-accessibility, street tree planting, mixed-use, centralities/centers, urban sprawl planning, housing, redevelopment of abandoned areas/urban voids, valuing of heritage (historical and environmental), retrofit of historic buildings, integration of ecological and historical heritage, heritage education, and maintenance of heritage sites.
Socio-economic dimension	Local economic development, Generation of jobs and local income, Basic education, Technical/vocational education, Higher education, Social vulnerability, Slums, and precarious settlements.

Source: prepared by authors.

Although the legislation cites the concept of "sustainability," this concept should be addressed in an integrated way, allowing it to permeate several dimensions of urban and environmental policy and more effectively address today's dynamics and complexities.

The Political and Territorial dimensions attained the lowest overall averages among the instruments. This was due to the fact that they did not consider, or considered very superficially, issues related to the representativeness of different social groups in the process of planning and management of the territories and the strengthening of local communities, with regard to the political aspects. Other shortcomings included a lack of guidelines aimed at containing the sprawl of the urban area, redevelopment of urban voids, compacting of cities, active mobility and the integration of both environmental and historical heritage.

The socioeconomic dimension was better developed in the Mairiporã and Franco da Rocha plans, both addressing a series of elements in favor of local economic development and dealing with the social vulnerabilities present in the cities. Franco da Rocha stood out for emphasizing education at different levels (primary, vocational and higher education) in its plan. Caieiras, on the other hand, failed to meaningfully address the issue of higher education or tackling social vulnerability. The

TABLE 3 | List of cities with areas within Juqueri-Cantareira sub-basin.

City	Population	Growth rate 2000/2010 % per year	% included in protection and recovery of Springs Alto Juquery APRM-AJ
Mairiporã	80,956	3.04%	80%
Caieiras	86,529	2.01%	20%
Franco da rocha	131,604	1.99%	5%
Francisco morato	154,472	1.48%	0%
Cajamar	64,114	2.36%	0%
São paulo	11,253,503	0.76%	1.5%
Perus District	80,187	1.3%	0%
Anhanguera District	65,859	5.6%	0%
Jaraguá District	184,818	2.39%	0%

Source: prepared by authors based on data from 2010 Census (IBGE, 2010) and DATAGEO.

Specific Law did not address elements related to education and social vulnerability.

The elements of the Environmental dimension were, in general, well-provided for by the legislations, especially in the case of the Specific Law and Caieiras Master Plan. The most neglected aspect in the analysis in all cases was the intention of closing the water, energy, solid waste, and food cycles at local and regional levels; this issue did not feature in any of the instruments.

DISCUSSION

Taken together, the results reveal the limits and advances of the urban and environmental instruments analyzed, especially the Master Plans and the Specific Law for Protection and Recovery of Springs. We pose questions about paths for a planning process favoring the sustainability of the region in its multiple dimensions. Is it possible to devise a planning process that reconciles local community needs, economic development, and the preservation of a territory rich in environmental and historical heritage? What is the vision of "sustainability" addressed by the instruments?

The Political Dimension

The Political Dimension was less prominent in all cases, especially for aspects related to the representation of different groups of society in the planning process and management of territories. Although the legislation analyzed cites population participation in the planning process, in accordance with the precepts established by the Federal Constitution of 1988 and by the City Statute, this issue remains a major challenge for the cities assessed.

Multicultural representation featured only superficially in the instruments analyzed. This reveals a certain weakness of the legislation in promoting the strengthening and valuing of the local community, in building a solid and aware community capable of valuing the local territorial and environmental heritage and promoting its self-sustainability. It is important to emphasize that the weakening of the political dimension systematically jeopardizes the commitment and effectiveness of the other dimensions of sustainability, since society's participation and engagement are central elements to implementing a more sustainable development model. How can sustainable territories be built without the effective participation and engagement of local communities?

Despite the weakness of the political dimension, some strategies present in the plans—albeit incipient—seem to indicate the beginning of a process of valuing this dimension. Mairiporã's Master plan establishes procedures that promote the valuing of local community and territorial goals, recognizing the need to strengthen the economic bases identified as a city goal. Another example is the Franco da Rocha Master Plan that outlines the importance of creating a municipal memory and cultural identity and appropriation of public spaces by residents.

The Environmental Dimension

Specific Law 15.790/2015 was the legislation which best addressed the environmental issue among all the other legislations analyzed. The Law provides for the creation of several areas for preservation, leisure, tourism, recreation, and valuing of the scenic-landscape attributes of the region and areas for environmental recovery and protection. Several strategies stand out in the Specific Law, such as the creation of incentive, support, and advisory programs for the ecological management of the land, sustainable use of agriculture and non-impacting rural activities in Low-Density Sub-Areas (SBD) and the reduction of the effects of diffuse pollution: use of appropriate agricultural management practices, prioritizing organic agriculture and bans on the use of biocides.

Mairiporã stands out among the Municipal Plans by addressing local agriculture, which is not destined only to a small portion of the territory, as is the case of Caieiras. The Mairiporã Master Plan states the importance of reviving local agricultural farming and creating stimulus programs for sustainable agricultural activities, offering technical support to local producers so that they can adequately manage the land.

Regarding regional planning, the Inter-Municipal Consortium of Municipalities of the Juquery Basin (CIMBAJU) played a key role in incorporating urban-environmental planning strategies on the sub-basin scale, i.e., on the regional scale. Because of the committee's action, Caieiras and Franco da Rocha's plans include the implementation of a linear park along the embankments of the Linha 7 Rubi railroad, which would form a large regional park. In the same vein, the city of Caieiras furthered this with a system of parks and green areas that permeates the whole municipal territory, connecting large environmental preservation areas, the Cajamar Environmental Protection Area and the Environmental Protection Area of the Cantareira system.

None of the instruments analyzed addressed the closing of the water, energy, solid waste and food cycles at local and regional levels. In general, consistent with the precepts of the Brazilian legal framework, the scope of the instruments included the universal provision of basic sanitation, the creation of environmental education programs and actions for preservation

FIGURE 6 | Comparative wheel chart graph illustrating instruments analyzed and degree to which they address each sustainability dimension. PD, master plan; LE, specific law.

ecological recuperation, with an emphasis on protected areas. Although the Master Plans analyzed, up to the time of data treatment, had not yet been made compatible with the Specific Law, all recognized the importance of the water catchment areas' metropolitan nature and defined protection strategies for them.

In this sense, the defining of areas of regional importance under the State Water Resources Policy led to the creation of preservation strategies for these areas. However, the cities still have an extractive vision for the areas not yet occupied and unprotected by Law.

The Territorial Dimension

In the instruments analyzed, actions concerning the territory were more linked to environmental and urban aspects and failed to address socioeconomic and political issues. A development perspective based on traditional industries, highways and urban sprawl predominated in the Master Plans.

The highway model still plays a central role in the territorial planning strategies concerning municipal and regional transport. Road widening and plans for new highways and viaducts were common, to the detriment of encouraging quality public transportation, among other modes with less environmental impact. The issue of active mobility (bike lanes, sidewalks, pedestrian walkways) was addressed only in the Caieiras and Franco da Rocha Plans.

An advance is a fact that all the Master Plans cite the importance of integrating (in terms of fares and physically) of metropolitan transportation, proposing articulations with

the State Government and transportation companies. This is a central point for improving public transport in the São Paulo Metropolitan Region, since there is fare integration is only available for trains and buses, which come under State Government jurisdiction with no integration for municipal transportation. This issue makes it more expensive and difficult for the population to access public transport.

Except for Mairiporã, the Master Plans analyzed did not value local development and still promoted urban sprawl and fragmentation of the city. This can be exemplified by the case of Caieiras, which has no mixed zones in its zoning regulations, only a few areas of diversified use, reaffirming the fragmented city logic. All the commercial use zones of the city are located along the main highways. The urban expansion areas head toward the Cajamar Environmental Preservation Area, with predominantly residential and industrial uses. **Figure 7** clearly shows the large number of predominantly residential zones compared to other uses.

It can be noted that Caieiras and Franco da Rocha, in particular, consider the eastern region (toward Cajamar) as an urban expansion vector, encouraging urban sprawl in this region, with industrial and residential uses. It should be highlighted that the Caieiras Master Plan establishes a Special Zone of Metropolitan Interest (ZEIM 1 and 2) for this region, in which a forestry area is currently located. The plan defines this area for high and medium population density residential use or structuring projects of metropolitan scope and interest. There is a project commissioned by the Companhia de Concessões de Rodovias (CCR) to build the New São Paulo Airport in this area.

The Socioeconomic Dimension

With regard to the socioeconomic dimension, the strategies adopted did not focus on the sustainable development of the region or on a vision of economic self-sustainability that considers regional aspects or activities potentially appropriate for a water-producing region, with a historical and environmental heritage of great importance.

The Franco da Rocha and Caieiras Plans present employment and income generation strategies centered on industrial development (potentially polluting or otherwise), attributing to the cities the same vision and strategy of economic "development" implemented in other areas of the Metropolitan Region, such as the ABC Paulista, with no emphasis on low-carbon and ecological, economic activities.

In general, the cities promoted strategies aimed at local development and valuing of the environmental heritage only in Spring areas; ecological processes were not an integral part of the city planning. The case of Caieiras exemplifies this issue by

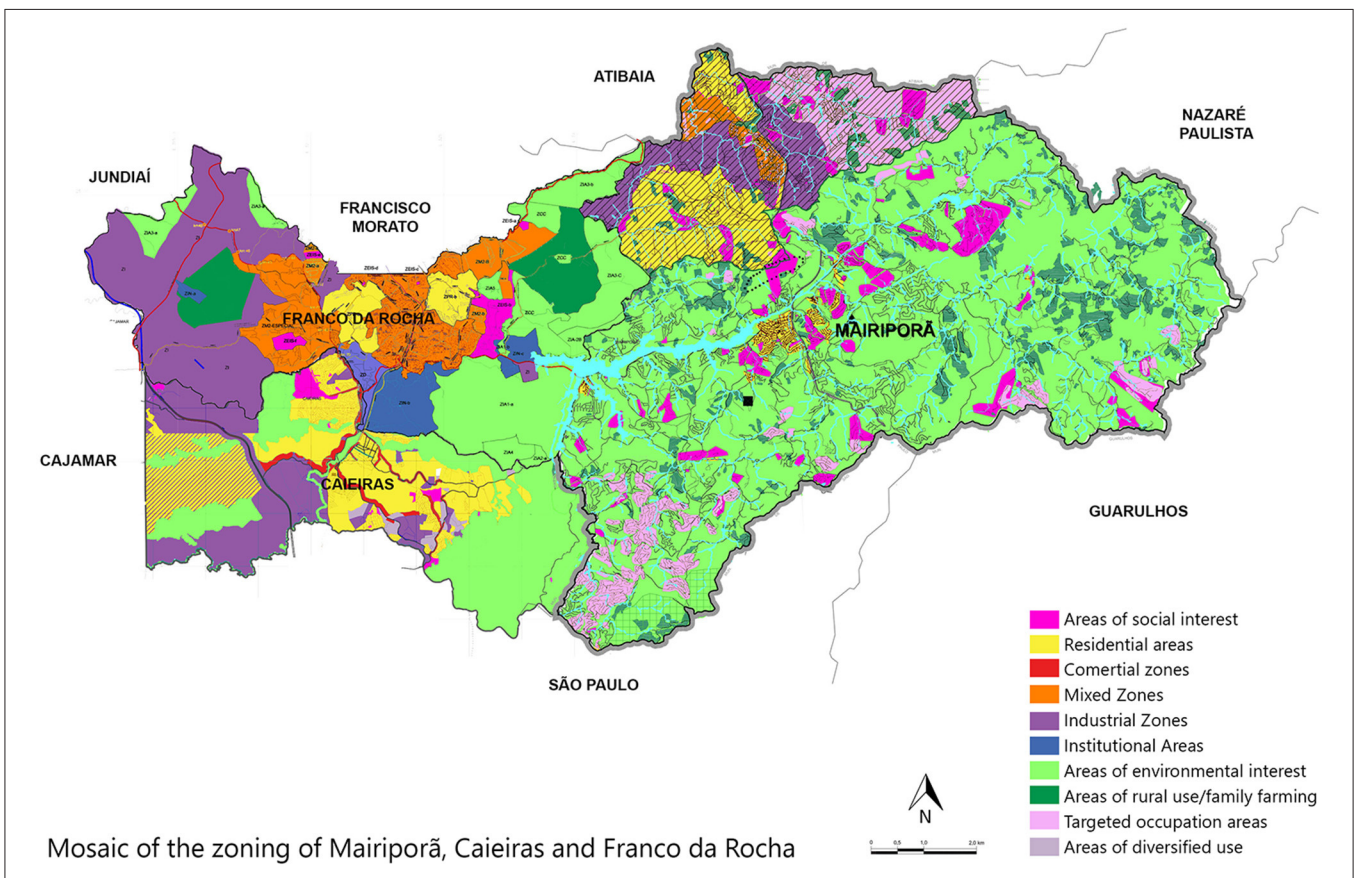

FIGURE 7 | Mosaic of municipal Zoning of Mairiporã, Caieiras, and Franco da Rocha. Data source: municipal authority of cities of Mairiporã, Caieiras and Franco da Rocha. Produced by: Andresa Lêdo Marques.

encouraging sustainable tourism activities as an alternative to economic development that generates employment and income only in a small part of the city consisting of the water springs area protected by State law. Other areas endowed with significant natural remnants are destined for industrial development.

The Mairiporã Master Plan is noteworthy for containing economic guidelines focused on the territory's environmental goals, emphasizing sustainable tourism, the implementation of low impact and high added value industries, sustainable agricultural activities and cooperatives as forms of employment and income generation.

Regarding the aspects related to education, all the plans analyzed cited the implementation of new school units to meet municipal demand and the creation of technical schools. However, only Franco da Rocha outlined the implementation of a University Campus for Higher Education, which was not mentioned as a priority for the other cities.

Regarding the strategies aimed at precarious settlements, slums and areas with high social vulnerability, the Master Plans and Specific Law emphasized the importance of ensuring the social function of property and decent housing and promoting land regularization, urbanization projects, and removal of the population from high risk areas and basic sanitation. However, some strategies stand out. For example, the Master Plan of Mairiporã adopts the neighborhood or census sector scale as the territorial unit of reference for the implementation of social welfare policies. In addition, the plan includes the promotion of self-defense practices and environmental education for risk management.

ACTIONABLE RECOMMENDATIONS

The urban and environmental instruments analyzed in this article focus on a complex territory that is home to critical natural remnants and protected areas, while marked by profound social and economic asymmetries and pressured by different demands and actors. The analysis shed light on the advances and challenges of integrating urban and environmental policies, albeit in a limited fashion. Application of the methodology showed that, although the Municipal and State Urban Policy touches on the dimensions of sustainability, there are still many flawed and superficial approaches. The main shortcomings that appeared recurrently in the instruments are described below, together with recommendations.

Effective Integration Between Public Policies

Although the State Policy framework stipulates compatibility of municipal Master Plans with the Specific Law for Protection and Recovery of Springs, this proved not to be the case for the plans analyzed. This process is not address in an integrated way, and the timing of the legislations differs. Moreover, in the Brazilian reality, the smaller cities often do not have technical experts available to carry out the compatibility process with the competent state organ.

This lack of compatibility creates a series of obstacles for the cities, which depend on the state agency for environmental licensing, involving a series of extensive and bureaucratic processes that, coupled with the lack of inspection in these areas, often leads to a devaluing of the importance of watershed areas and irregular occupation of these areas.

The public policies designed for these essential natural remnants should yield benefits for the population in different spheres. To this end, it is necessary to carefully examine the territory, considering its features and particularities, involving other agents in the process. The State and Cites must work together to safeguard the preservation of areas that provide important environmental services and have a systemic impact on a network of cities connected in different dimensions. Thus, there is a pressing need for convergences and synergies regarding natural resource sustainability and sustainable development of the region analyzed.

The Production of Fragmented Constantly Expanding Cities Must Be Overcome

Except for the Specific Law, a vision of development based on industries, highways and urban sprawl prevailed in the Master Plans. The Plans reaffirm the logic of the fragmented constantly expanding city organized to support economic activities, circulation of people and goods, consumption and accumulation. The cities analyzed must radically change this vision of planning and devise strategies that prevent urban sprawl and promote reorganization of existing built areas, reduction of movement of people and goods and incentives for local consumption.

Establishing a planning process based on an integrated vision aimed at sustainability calls for multidisciplinary efforts and a cultural shift, which is at the same time complex and involves multiple authors. The region's problems must be tackled and the value of its environmental potential and local communities appreciated, incorporating the various dimensions of sustainability in its territorial management from a systemic vision of integrated planning embracing urban and environmental aspects at municipal and regional levels.

Sustainability Should Not Be Regarded as a Sectoral Problem

As discussed in the theoretical framework, it is argued here that the construction of sustainable territories requires a systemic vision that considers not only environmental aspects but also social, economic, cultural and territorial aspects. However, in the policies analyzed, sustainability is still regarded as a sectoral, merely environmental problem, as if the preservation and recuperation of a small proportion of natural remnants were enough to construct "sustainable cities." Effective participation of different actors, valuing of the community, and environmental awareness of the structural changes needed to build fairer and more sustainable cities are lacking.

Without the construction of a solid and aware local community, it is impossible to value the local heritage with access to education and job opportunities or to promote the

construction of sustainable territories. Furthermore, incentives in different areas are necessary to reduce pollutant emissions, change the energy matrix, and close the water, energy, solid waste, and food cycles at local and regional levels.

CONCLUSIONS

The analysis presented sought to discuss how the Specific Law for Preservation and Recovery of Springs—Alto Juquery (APRM-AJ) and the Master Plans of the cities within a section of the Juqueri-Cantareira sub-basin have proposed actions and guidelines for sustainable development of this region in the formulation of their respective legislation.

The results show that the vision of "sustainability" contained in the urban and environmental instruments analyzed has a sectoral perspective and fails to address its various dimensions in urban and environmental policies. In general, the political and territorial dimensions were overlooked in the scope of the instruments. However, the construction of a participative process of effective planning and management prevails. The vision of city production focused on land consumption that prioritizes the economic dimension to the detriment of social and environmental aspects.

Citing the environmental protection of a small portion of natural remnants does not mean building sustainable cities. Clear strategies are needed that do not focus solely on the recovery and/or protection of a particular area, but aim to integrate social, economic, environmental, territorial and political aspects into the planning process based on citizenship principles.

Cities and State government should embrace sustainability, incorporating its multiple dimensions into territorial management adopting a systemic vision of integrated planning that involves urban and environmental aspects and municipal and regional levels. Sustainable and innovative alternatives should be explored for the region, to promote sustainable territories capable of providing employment and income generation, quality of life, and a balanced environment for this region and for future generations.

AUTHOR CONTRIBUTIONS

ALM and AA conceptualized the study and performed the data analysis presented in the paper. The manuscript was written by ALM and reviewed by AA. ALM produced the maps and tables. Both authors were involved in collecting data and discussing the results and methods presented in the manuscript.

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MINI REVIEW
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Greening and Just Cities: Elements for Fostering a South–North Dialogue Based on a Systematic Literature Review

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The design and deployment of green amenities is a way to tackle cities' socio-environmental problems in the quest for urban sustainability. In this study, we undertake a systematic review of research published in international peer-reviewed journals that analyzes environmental justice issues within the context of the deployment of urban green amenities. Since most studies focus on the Global North, where this scholarship first emerged, our goal is to link the literature focused on the North and the South. This study aims to outline similarities and differences regarding the nexus of justice and the greening of cities in both contexts as well as to identify knowledge gaps in this scholarship in the Global South. "Green infrastructure" and "nature-based solutions," as the leading concepts for cities' greening agendas, are used as descriptors in combination with "justice" and/or "green gentrification" in searches undertaken of two bibliographic databases. Our results show there is a need to better delineate a research agenda that addresses such issues in a heterogeneous Global South context while gaining insights from advances made by research on the Global North.

Keywords: global south, global north, environmental justice, green gentrification, green infrastructure, nature-based solutions

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INTRODUCTION

An increasing number of studies have investigated and demonstrated undesirable side effects of implementing green amenities in cities to promote more resilient territories and better quality of life. "Nature-based solutions" (NbS) and "green infrastructure" (GI) are well-established concepts that generally outline the agenda and orientations followed by cities in their quest for urban greening. The undesirable side effects resulting from GI and/or NbS implementation reported in recent scholarly research are related mainly to environmental injustice and the deepening of economic inequalities, which are mostly linked to green gentrification processes (Anguelovski et al., 2020). Therefore, environmental justice has been increasingly recognized as a crucial investigatory approach within the context of the new urban agenda for green spaces (Silva et al., 2018; Liotta et al., 2020; Mabon, 2020). Studies in environmental justice since Robert Bullard's classic "Dumping in Dixie" (Bullard, 2008) have exposed the uneven distribution of environmental harm in the territory, with greater exposure to black and more vulnerable populations. Contemporary authors

have observed the widening of the scope of themes linked to mapping environmental inequalities, related to privileges and power imbalances (Acselrad, 2010), as well as agendas associated with the unequal destruction of green areas in cities (Park and Pellow, 2013; Anguelovski et al., 2019), or the impacts of climate change (Mohai et al., 2009). The deployment of GI and NbS can trigger increased land prices, leading to displacement of local communities that cannot afford higher living costs (Safransky, 2014; Miller, 2016; Shokry et al., 2020). In that sense, the notion of "green gentrification" addresses the social consequences of urban greening from environmental justice and political ecology perspectives. Green gentrification can be defined as a process triggered by the creation of a green amenity or green renewal of an urban area, which results in changes in the residents' pattern and whitening of the territory due to removals and rising of land prices (Gould and Lewis, 2012).

Other lenses of justice concern unequal spatial distribution (Venter et al., 2020) and unequal sharing of financial investments in green amenities, since wealthier social groups tend to be more favored than disadvantaged ones (Bockarjova et al., 2020). Injustices related to how nature is framed and certain narratives and cultural practices are endorsed to others' detriment (Anguelovski et al., 2019).

The starting point is scholarly evidence that research on this topic is further advanced in the context of the Global North and still in its initial stages in the Global South. For instance, there is a significant number of literature reviews on the topics of Green Infrastructure and Nature-based Solutions primarily focusing on the Global North context (Tzoulas et al., 2007; Ferreira et al., 2020; Oral et al., 2020; e.g., Chatzimentor et al., 2020), while a lack of such studies centered on the Global South or the North-South connection is noted. For the Global South context, it is necessary to recognize the social processes behind the space production, and the specifics of the colonial, extractive, and unequal formation of these territories that contribute to a long-lasting perpetuation process of social inequalities and injustices (Rolnik, 2011). It is essential to observe the limits (or barriers) that this material reality imposes on the capacity to react against this process from an institutional and social viewpoint.

In this sense, this study has two objectives. The first is to verify the assumption described above concerning the distinct stages of that research topic on the Global South and the Global North. The second is to understand how the theme is addressed in the international scholarly debate and how it can be explored in future research agendas as well as within mobilizations of social struggles, mainly in the Global South.

METHODS

For our systematic literature review of peer-reviewed articles, the search was carried out using two prominent electronic bibliographic databases, Scopus and Web of Science. The descriptors GI or NbS were used in combination with the terms "green gentrification" or "justice" appearing in titles, keywords, or abstracts (see **Figure 1**). The concepts of GI and NbS were chosen—despite the existence of other terms related to urban greening (e.g., green spaces, green areas etc.)—due to both their connection to the special issue's scope and tests carried out with other descriptors within the bibliographic databases. These concepts showed the highest incidence in research agendas and scholarly publications in recent years. It should be noted as well the growing interested for these concepts and their adoption by global and local NGOs, scientific reports, economic agencies, and multilateral organizations. Subsequently, a filter by subject area was applied to the resulting list of papers to exclude those that unrelated to social and/or environmental sciences (e.g., medicine, energy, and chemical engineering). Then, we searched for the descriptor "cities" in the results to exclude papers focused on non-urban areas. Next, the term "Global South" was applied as a filter to identify which of the papers applied to this context. These steps were applied in both search databases, and the results were merged. Following this, all papers' abstracts were screened in order to exclude those that did not have "justice" and/or "green gentrification" as central topics of analysis.

Full papers of the final list were appraised by the authors for data extraction. In that phase, papers that did not properly meet the study goal were still identified and excluded (e.g., papers that did not analyze green amenities under the conception of GI or NbS, or papers focused on best practices without centrally addressing justice or green gentrification issues). Each of the remaining papers was then appraised to identify (1) the approach (e.g., qualitative and/or quantitative), and (2) the type of study (theoretical or case study-focused), (3) the focus of analysis, and (4) the addressed dimensions of socio-environmental justice. Data were then extracted and organized, following these categories, in an Excel spreadsheet. Finally, it should be noted that shortcomings in such a systematic review are unavoidable, as such publications as books, dissertations, and non-English regional journals were excluded from the review.

RESULTS

Our search in the bibliographic databases resulted in 64 papers after applying filters described in the methods, of which 20 met the scope of this study after abstract and full text screening (for a synthetic view of the 20 selected papers, see **Appendix 1**). Among these, it was found that seven papers address the Global South context, of which four (Anguelovski et al., 2019; Zhu et al., 2019; Sultana et al., 2020; Venter et al., 2020) focus exclusively on case studies in the Global South and three (Tozer et al., 2020; Woroniecki et al., 2020) investigate multiple cases, including cities in the North and South. Out of this sample of articles, it is important to note here that one paper, produced by Anguelovski et al. (2020), does not specifically address either the South or the North (see indication in **Appendix 1**), as it is a theory-oriented study; however, it updates boundaries related to justice issues within urban greening of special interest to the Global South, presenting ideas of extreme relevance to this review (please see indication in **Appendix 1**).

Anguelovski et al. (2019) were the first to address the Global South context, while Safransky (2014) was the first to focus on the Global North. This indicates that the connection between

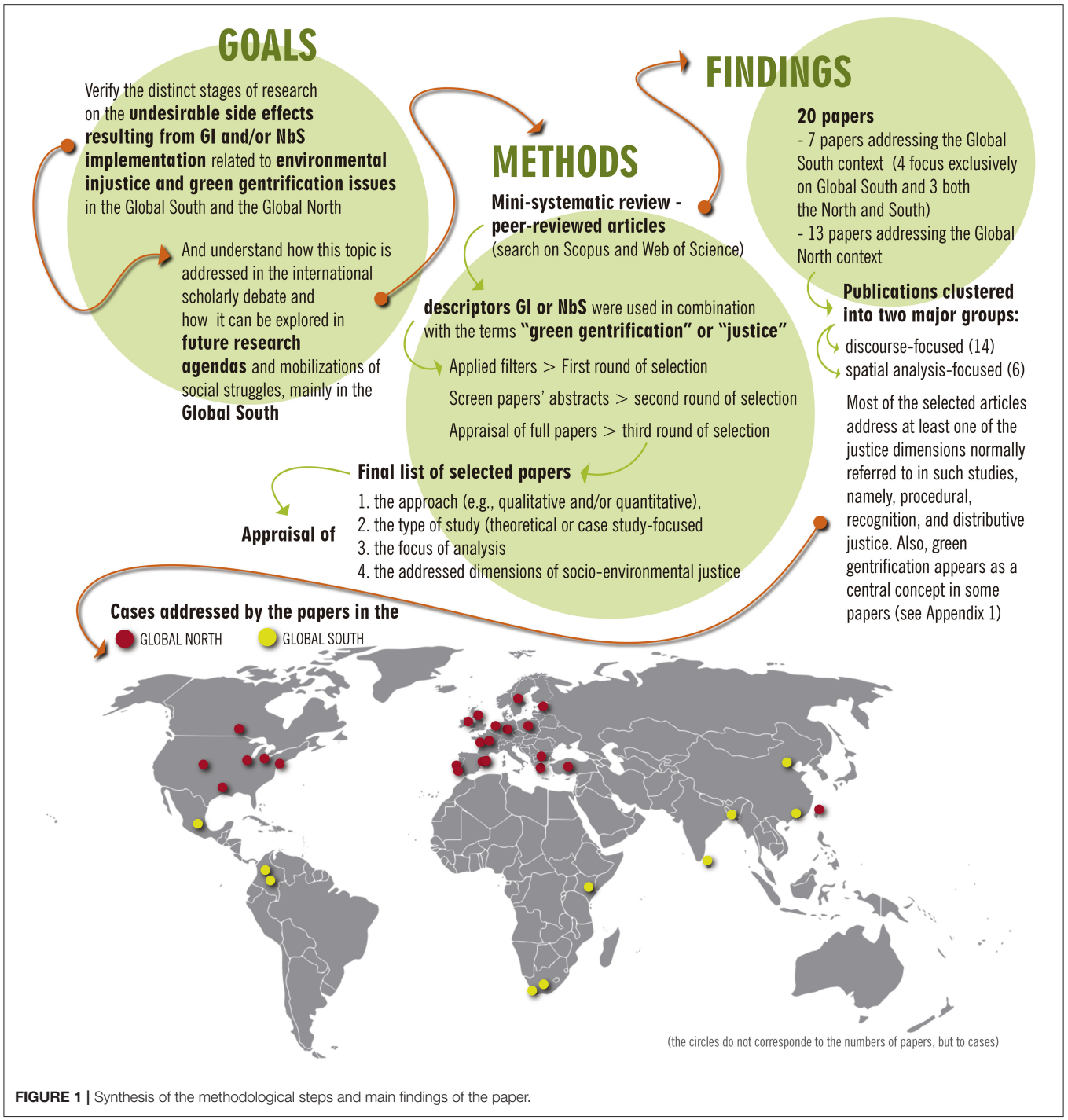

FIGURE 1 | Synthesis of the methodological steps and main findings of the paper.

justice issues and the implementation of an urban green agenda in the South is still in its initial stage in the international debate. Although heterogeneous, the Global South has more socially vulnerable territories in which access to justice and rights are still under construction. The contemporary right to the city claims for a better quality of life, just sustainability, and different justice dimensions (Coolsaet, 2020). In this sense, it is a contradiction that such approaches are not coined from this reality, as the Global South has a strong transforming potential in contributing with this topic. On the contrary, research indicates that GI and NbS agendas in the Global North reinforce neoliberal global capitalism expansion (Kotsila et al., 2020).

Our appraisal of the 20 papers suggests that publications can be clustered into two major groups, namely, discourse-focused (14 papers) and spatial analysis-focused (6 papers)—see **Appendix 1** and **Figure 1**. The former is predominantly focused

on qualitative approaches and mainly analyzes discourses, actors' perceptions, power relations, and how these topics relate to socio-environmental justice aspects in the design, implementation, and use of urban green amenities. These papers are either supported by case studies or present theoretical approaches. The latter are essentially quantitative studies that analyze the inequality in spatial distribution of the green amenities of whole cities or countries according to different socioeconomic status of citizens as well as the lack of prioritization of marginalized communities due to racial, economic, and social aspects in projects of GI and/or NbS. In addition, most of the selected articles address at least one of the justice dimensions normally referred to in such studies, namely, procedural, recognition, and distributive justice. The first two prevail in papers classified as discourse-focused, while distributive justice is the main focus of the spatial analysis-focused papers. Green gentrification appears as a central concept in some papers, either as the only focus of analysis or associated with one or more dimensions of justice.

Among six papers focusing on the Global South, four were classified as discourse-focused. From this set of publications, the most cited is Anguelovski et al. (2019) about a case of green infrastructure planning in Medellin, Colombia. This paper reinforces the need for more empirical research and cases in the region, and helps to affirm the urban greening agenda entry more as a neoliberal discursive agenda (Kotsila et al., 2020) than a bottom–up process with particularities, demands, and local dimensions.

DISCUSSION

The Global North and South have clear differences in social, economic, political, and cultural dynamics as well as institutional structures. The four aspects identified on how justice issues are related to implementation of urban green amenities—procedural, recognition, distributive justice, and green gentrification—appear as broad frames of analysis applied to both contexts; however, each reality has particular dimensions. In this section, we outline the main issues observed in each of these aspects for both the Global North and South realities to capture similarities and differences. This would help to identify the specific needs of the research agenda in the Global South; concurrently, scholars focused on the Global North can also benefit from emerging questions and proposals in the Global South concerning this topic. However, although the Global South has historical socio-economic structural similarities, it is still rather heterogeneous, with distinct processes of city production, which requires further critical analysis. The historical formation and production of inequalities in cities of Latin America, Africa, and Asia are very different. Thus, we need more empirical-based analyses (local and regional) to understand each place's specifics.

Procedural justice is fundamentally related to how the participation of various actors involved in GI or NbS projects is structured and conducted with the aim of producing spaces that meet the needs of communities effectively in a fair way (Haase et al., 2017; Amorim et al., 2020). Top–down GI or NbS projects, with limited involvement of diverse actors (mainly excluding disadvantaged communities) (Anguelovski et al., 2019), are widely recognized as directing the urban green agenda to the most privileged social groups (Toxopeus et al., 2020; Verheij and Nunes, 2020), thereby producing unequal distribution of environmental improvements within cities (Venter et al., 2020). However, participation alone does not guarantee desired procedural fairness (Woroniecki et al., 2020). The research in the Global North highlights the effects of power structures on the definition of who is included or not in participatory processes (Miller, 2016; Verheij and Nunes, 2020) or what discourses are most/least endorsed and accounted for in participation (Safransky, 2014; Woroniecki et al., 2020). These papers emphasize the need to hold a critical perspective on how dialog is implemented, facilitated, and delivered within participatory processes to effectively include the various ontologies and epistemologies of different participants (Woroniecki et al., 2020; e.g., Verheij and Nunes, 2020). In the Global South, this seems rather challenging given the pronounced disparities between social groups. Residents of informal settlements or marginalized communities have less voice and access to decision-making arenas than privileged groups with greater political power and influence, as illustrated by the Greenbelt project in Medellin (Anguelovski et al., 2019). In such context, Anguelovski et al. (2020) argue that an environmental justice perspective is needed that takes an anti-subordination stance and an emancipatory approach toward autonomy as well as respect for marginalized communities, which requires the transformation of institutions and practices that reproduce such systems.

The articles in our review reveal a strong interplay between recognition and procedural justice, since the way participation is conducted is key to the effective incorporation of the plurality of values, goals, and practices of a given community in a GI or NbS project (Tozer et al., 2020; e.g., Toxopeus et al., 2020). The critical scrutiny of how structural inequality and hegemonic worldviews—usually those aligned with a neoliberal agenda and technical discourses to the detriment of peripheral, marginalized voices and traditional knowledge—shape GI and NbS projects, come into focus (e.g., Safransky, 2014; Toxopeus et al., 2020). Safransky (2014) remarks that the hegemonic and technical discourses of nature as "infrastructure" have paved the way for discrediting alternative approaches to how green spaces should be praised or planned. This is in line with Woroniecki et al. (2020), who stress that the instrumental use of nature reflects dominant frames underpinned by ideas of economic development and extractivism (resulting in more environmental deterioration), while marginalized knowledge and subjectivities are more likely to associate nature with intrinsic values. It follows that a more critical appraisal of GI and NbS approaches is required, toward a broader appropriation of place-based knowledge and subjectivities throughout a project's deployment (Woroniecki et al., 2020). For example, it would include the views and demands of traditional indigenous communities and so-called first nations (Lyons et al., 2017; Jelks et al., 2021), as well as community strategies to resist agendas that not favor disadvantages groups (Apostolopoulou and Kotsila, 2021). Anguelovski et al. (2019) uses the case of Medellin to show how a large GI project is promoted by the municipality through

a top–down approach focusing on control and rationalization of green spaces for use by privileged social segments and tourists; this leads to a conflicting notion of nature with those of local communities, as it neglects the community's existing forms of relationship with nature and local practices (e.g., urban farming practices).

The selected articles focusing on distributive justice mainly address, in both the Global North and South, issues regarding whether GI is prioritized in areas inhabited by disadvantaged communities and the extent to which GI projects tend to be concentrated in wealthier areas (Venter et al., 2020; Verheij and Nunes, 2020). This aspect also encompasses methodological approaches to address this problem, such as indexes to identify sites with greater demand for green amenities (Zhu et al., 2019; Liotta et al., 2020). Such research, however, highlights that indexes alone do not guarantee environmental justice as a whole, and it is essential to consider ways to address the other justice dimensions holistically. In addition, GI or NbS projects in locations deprived of green areas where disadvantaged communities reside may involve gentrification processes or evicting these populations (Mabon, 2020; Shokry et al., 2020), rendering distributive justice particularly complex. In the Global South, special emphasis is placed on how the implementation of GI or NbS is intertwined with the eviction and relocation of disadvantaged communities in informal settlements (e.g., *favelas*)—in many cases located in risky areas (e.g., hillsides or riverbanks); this not only leads to the erosion of the social fabric of these communities but also puts them in a less favorable geographical location than before where it becomes increasingly difficult for them to make a living (Anguelovski et al., 2019; Sultana et al., 2020). This raises critical questions for the Global South. If GI reaches these most deprived communities and qualifies the areas where they live, how can gentrification of these places be prevented? If removal has occurred, was it necessary? What is the social cost to these populations and is the remedy provided for them just?

Finally, the selected papers focused on green gentrification, mainly in the Global North, explore this aspect from various perspectives. Most studies are largely concerned with understanding the dynamics of valorization of a given urban area as a function of implementing a green amenity (Silva et al., 2018; Bockarjova et al., 2020; Shokry et al., 2020). Amorim et al. (2020), with a focus on Barcelona, show how intangible values and features set by cultural ecosystem services increase the level of gentrification produced by a green amenity, noting that less gentrified parks placed more emphasis on social and cultural activities. Bockarjova et al. (2020) identify a means of predicting market dynamics, establishing links between property values and different types of urban nature, to help overcome undesirable gentrification trends. Garcia-Lamarca et al. (2019) analyze several cities in Europe and North America, and shows that rebranding a city as more ecological, through intense green rhetoric, over a long period of time leads to increased living cost in these cities. Similarly, Anguelovski et al. (2019) point out that the number of Global South cities branding themselves as "green" seems to be growing; the rhetoric is aimed at attracting international capital investment for the implementation of large GI projects. The influx of private capital and the progressive dependence of municipalities on public–private partnerships tend to favor wealthier areas of a city (Sultana et al., 2020). This generates ecological enclaves and reinforces the image of a sustainable city tied to the hegemonic neoliberal discourse, eventually validating and stimulating such greening initiatives backed by international and private capital, and exempting local governments from pursuing effective responses to structural issues that could effectively tackle poverty and promote environmental justice (Anguelovski et al., 2019).

CONCLUSIONS

The Global South will show in the coming decades the most rapid urban growth with numerous informal settlements and vulnerable places (Bai et al., 2018). Thus, it is essential to consider how those Southern cities will use and/or take advantage of GI and NbS projects to address social and environmental inequalities simultaneously. Further research is required to propose responses for creating a just and resilient future for the Global South within an interdisciplinary and multidisciplinary agenda that should tackle climate, inequalities, and sustainable urban planning.

Little was gleaned from the systematic literature review regarding resistance to the effects of GI and NbS implementation in the Global South. Some clues are evident, however, including the anticipation of ongoing non-desired outcomes provided by the Global North experience. One key highlight is the importance of acknowledging the need of participatory processes from projects conception, in a community-based oriented action toward a decolonial perspective to face present and future problems in the Global South. Finally, it is important to remark that the emergence of this research agenda in the Global South, on the one hand offers lessons and recommendations hitherto focused from the Global North, and on the other, points to further challenges, gaps, and specificities to be posed by future studies, thus expanding knowledge on urban justice and green cities worldwide.

AUTHOR CONTRIBUTIONS

DdS and PT: conceptualization, formal analysis, methodology, writing—original draft preparation, review, and editing. DdS: data curation. All authors have read and agreed to the published version of the manuscript.

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Environmental Justice and Green Infrastructure in the Ruhr. From Distributive to Institutional Conceptions of Justice

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Over the last 50 years, the Ruhr region experienced a remarkable transformation from an industrial to a post-industrial region. With regard to the rehabilitation of the environmental damages of more than 100 years of coal mining and steel production, investment in green infrastructure, and the creation of regional landscape parks constituted one of the main pillars of the economic and physical transformation of the region. However, little is known about the social effects of this green transformation. Many observers state that the Ruhr area is sharply divided by an east–west line (the A40 Highway) and in fact the Emscher zone was hit most by environmental degradation. We argue that environmental justice is a question of scale. While on the regional scale, the investments made in the Emscher zone can be seen as a trial to balance and repair a long-standing unequal provision with environmental qualities (not least parks), on a smaller scale (i.e., cities and neighbourhoods) we can demonstrate that in the cities of the Emscher zone environmental inequality is still observable. Some neighbourhoods benefit stronger from investment in regional parks and green infrastructure than others. The paper will describe the Emscher green regeneration programme and will give detailed insights into two cities of the Ruhr (including maps and data analysis).

Keywords: green infrastructure, post-industrial region, Ruhr region, governance, environmental justice

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INTRODUCTION

The health and well-being of citizens is largely influenced by the environment they live in. The impact of urban environment on humans has been widely studied, but it was only recently that the racial and socio-economic dimension is included. Starting as a social movement in the 1980s in the US, environmental justice has become a global movement and a concern in many cities (Stephens, 2007). Environmental justice in the procedural sense refers to "the fair treatment and meaningful involvement of all people regardless of race, colour, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (EPA, 2021). Inequality in the access to environmental benefits as well as the exposure to air pollution, noise or contaminated soil and water are the main environmental justice concerns (Stewart et al., 2014). In addition, climate change has become central to the environmental justice discourse as "it has been shown to create unequal impacts on communities of colour, indigenous people, the poor, and on developing countries" (Mohai et al., 2009, p. 425). Against the background of this special issue, we discuss environmental justice with reference to the balanced distribution *of* and access *to* green infrastructure. Equitable access to green infrastructure not only provides economic, social and health benefits but it also addresses the impact of climate change for the residential population.

The empirical case that we are presenting in this contribution is the Ruhr region in western Germany. This region, once the biggest polycentric industrial urban agglomeration in Europe, experienced a remarkable change, in particular with regard to the environmental conditions. The revitalisation of a deteriorated landscape has been an essential element of the economic and physical transformation of this area. Urban green spaces, green corridors, or to use more recent notions such as green infrastructure or eco system services are seen today as a major asset of this post-industrial region (Reimer and Rusche, 2019). The evaluation of the past and present regional planning strategies is mostly positive as the overall environmental quality is much better than it used to be. The Emscher Landscape park, a large system of green spaces and corridors in the north of the Ruhr region, stands out in this regard. However, a closer look and evaluation from the perspective of environmental justice reveals unbalanced access options to green spaces in some cities (Zepp, 2018). Some of the green corridors also shrunk over the last decades. Furthermore, our quantitative research on city level revealed that the supply of green spaces varies considerably across the cities in the Ruhr region. In order to bridge this gap between the perception of a green region on the one side and the limited access to green infrastructure on a smaller scale, we argue that a re-scaled approach is needed when discussing environmental justice in city-regions. This perspective of scaling of environmental policies and discourse has been introduced by Keil and Debbané (2005). Outcomes of environmental policies differ depending on the geographical and institutional scale of implementation.

While on a city-regional scale there is a much higher visibility and provision of green spaces, in particular in an area called Emscher Landscape Park, accessibility to green spaces is more difficult in some neighbourhoods of the Ruhr cities. The Emscher revitalisation programme had beneficial effects for some municipalities but by far not for all. What seems to be a green region shows a high variation of environmental qualities on the level of cities and neighbourhoods. In Bottrop, for instance, the southern parts of the city (Wellheimer Mark) are still waiting for improvements (as envisioned in the Masterplan Emscher Park and the Masterplan Future Emscher: Projekt Ruhr GmbH, 2005; Emschergenossenschaft, 2006). In the south of Dortmund, the Lake Phoenix regeneration project demonstrates a significant increase of blue and green infrastructure. At the same time, this intervention reproduced the north–south divide that characterises the city and raised serious concerns because of an eventual gentrification (Frank, 2021). This raises the normative question of evaluating environmental justice (beyond the questions of methodological measurement). As a result of our study, we argue that the discourse on environmental justice will benefit from a stronger acknowledgement of the theoretical debate on spatial justice (Moroni, 2020).

This paper is written based on the results of a research project called "Future of the City-Region Ruhr" (Zukunft-Stadt-Region-Ruhr, ZUKUR)[1], whose overarching goal was to increase climate resilience and reduce socio-ecological inequality in the city-region[2]. The paper is structured as follows: it first describes the rise of environmental justice as a social movement and a topic in the academic literature. We review a number of key studies that discuss various aspects of environmental justice to create an analytical framework. The green transition in the Ruhr area and some of the issues regarding environmental justice within the area are introduced. The findings of a quantitative environmental justice analysis of two cities in the Ruhr region are presented, followed by a discussion and conclusion.

THE NOTION OF ENVIRONMENTAL JUSTICE

The notion of environmental justice first emerged as a social movement in the 1980s in the US when civil rights activists organised to stop the state of North Carolina from dumping 120 million pounds of soil contaminated with PCB in Warren County, which has the highest proportion of African Americans (Mohai et al., 2009). The protests in the county soon received national attention and raised public awareness about the environmental concerns of African Americans and other people of colour (Bullard, 2000; Roberts and Toffolon-Weiss, 2001; Pellow and Brulle, 2005). The term environmental racism was first coined in 1982 by Benjamin Chavis to refer to "any policy, practice, or directive that differentially affects or disadvantages—whether intended or unintended—individuals, groups, or communities based on race or colour" (Bullard, 1996, p. 451). In this tense atmosphere, subsequent events were followed which increased the visibility and momentum of the environmental justice movement (Mohai et al., 2009). The movement was an attempt to respond to environmental inequalities, threats to public health, unequal protection, differential enforcement of environmental regulations, and disparate treatment received by the poor and people of colour (Bullard and Johnson, 2000).

In close relationship with this social movement, environmental justice arose as a topic in the academic literature and found increasing attention in the global south in recent years (Agyeman and Evans, 2004; Travassos et al., 2021; Irazábal, 2021). Starting with a study conducted by the U.S. General Accounting Office in 1983, a series of studies was released that investigated the racial and socioeconomic composition of the communities near hazardous waste sites in the US. Among others, a study by United Church of Christ Commission for Racial Justice (Chavis and Lee, 1987) documented the unequal and discriminatory siting of waste facilities across the US. This study also found out that the percentage of people of colour was the best predictor of where waste sites would be located. In 1990, sociologist Bullard published his now classic book, *Dumping in Dixie*, which chronicled the convergence of social justice and environmental movements into an environmental justice movement. Since the 1990s, an extensive amount of literature on this topic has been produced by scholars worldwide.

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Today, hundreds of studies conclude that, in general, there is a significant relationship between the racial and socioeconomic characteristics of a community and levels of exposure to environmental risk (Mohai et al., 2009).

While, traditionally, the environmental justice movement focused on pollution issues affecting the health of population living near toxic sites or infrastructures, more recently, it focuses also on the distribution of environmental amenities (De Sousa Silva et al., 2018). So, for instance, Gould and Lewis (2017) emphasised the importance of analysing the full spectrum of distribution from environmental burdens to environmental benefits such as green infrastructure. Green infrastructure is defined as "an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations" (Benedict and McMahon, 2002, p. 12). The European Commission provides a long list of benefits of green infrastructure in its report *Building a green infrastructure for Europe* (European Commission, 2013). According to this report, which was an essential back-up for EU funding programmes (i.e., the Green Deal), green infrastructure and nature-based solutions contribute positively to the environment, for instance, by removing pollutants from air and water, protecting against soil erosion, and retaining rainwater. It also has various positive effects on social aspects that range from promoting human wellbeing and health to enhancing tourism and the local economy. Green infrastructure is considered as an effective tool for climate change adaptation and mitigation as well. Lastly, it contributes to biodiversity as it, for example, provides improved habitats for wildlife and ecological corridors.

Green infrastructure is essential to improve the population's wellbeing. Yet, it has been documented that its distribution is uneven across a city or city-region and that some demographic groups have less access to it (De Sousa Silva et al., 2018). It is an environmental justice issue as socio-economically disadvantaged communities are most affected (Byrne et al., 2009; Curran and Hamilton, 2012). A definition of environmental justice includes the right of the entire population to live in a clean and healthy environment (Gould and Lewis, 2017). Hence, priority should be given to areas with highest proportion of vulnerable groups (Gill et al., 2007). Interestingly though, the implementation of green infrastructure to rehabilitate degraded neighbourhoods and, thus, improve wellbeing and environmental justice can have the opposite result, i.e., the increase of the value of land, increase in cost of living and, as an eventual result, displacement of the existing community (Curran and Hamilton, 2012; Pearsall and Anguelovski, 2016; De Sousa Silva et al., 2018). Hence, the concept of "just green enough" emerged; the idea is that neighbourhoods of low environmental quality are improved, but not to the point where gentrification takes place (Curran and Hamilton, 2012).

The concept of environmental justice has been expanding and it is applied to several different topics, from transportation to disaster management (Schlosberg and Collins, 2014). Climate change is not an exception. Climate change is a threat to physical and mental health, and vulnerable communities often face the greatest risks as they live in flood zones or areas exposed to heat (Travassos et al., 2021). According to a report released by Black Congressional Caucus (2004), although African Americans are less responsible for climate change than other Americans, they are disproportionately burdened by the adverse health effects of climate change as evidenced by, for instance, the number of deaths during heat waves. Indeed, climate change reflects social inequality in several ways, including who causes the problem, who suffers most, who is expected to act, and who has the resources to do so (Mohai et al., 2009). The Hurricane Katrina in 2005 helped to expand the consideration of climate-changing environment in the environmental justice movement (Schlosberg and Collins, 2014). Today, climate change is central to the environmental justice discourse (Travassos et al., 2021).

All in all, the discussion of environmental justice focuses on maldistribution of environmental resources, i.e., marginalised communities experience fewer environmental benefits, more environmental burdens, and less climate change related protection (Schlosberg, 2007). A question now arises as to how environmental injustice can quantitatively be measured, monitored, and evaluated. The City of Berlin was one of the first local governments to develop an environmental justice concept (Köckler, 2017), thereby providing for a detailed description of the environmental quality in each of the city's 447 planning areas (SenSW, 2015). The city used a two-stage process to examine environmental justice, including five core and a number of complementary indicators. Noise exposure, air pollutants, bioclimatic burden, access to green and open spaces, and social hardship belong to the core indicators. Complementary indicators provide for a more in-depth understanding of the situation in various neighbourhoods throughout the city. The available data were aggregated and multiple-load maps created. Berlin's approach served as a model for the environmental justice analysis carried out within the research (Bakunowitsch et al., 2019).

GREEN INFRASTRUCTURE AND ENVIRONMENTAL JUSTICE IN THE RUHR REGION

From the perspective of environmental justice, the Ruhr area is an interesting object of study **Figure 1**. The period of rapid industrialisation and urban growth (1870–1970) had a range of adverse effects for the residential population. Air pollution, loss of green spaces, contaminated soil, a degraded river system, and a scattered settlement structure were the main impacts. Environmental damages were, however, not spread evenly all over the region. Due to improvements in mining technology and geological conditions, mining and steel production activities went northwards over a period of 50–60 years. As a result, at the end of the age of mining, the northern parts of the Ruhr region display the highest density of industrial land use and transport infrastructure (Zepp, 2018). The southern parts of the Ruhr area, in contrast, were less affected by environmental damages than the northern parts. This north–south divide is mirrored also in social hardship indicators as well-of communities usually live in the southern parts of the region while disadvantaged

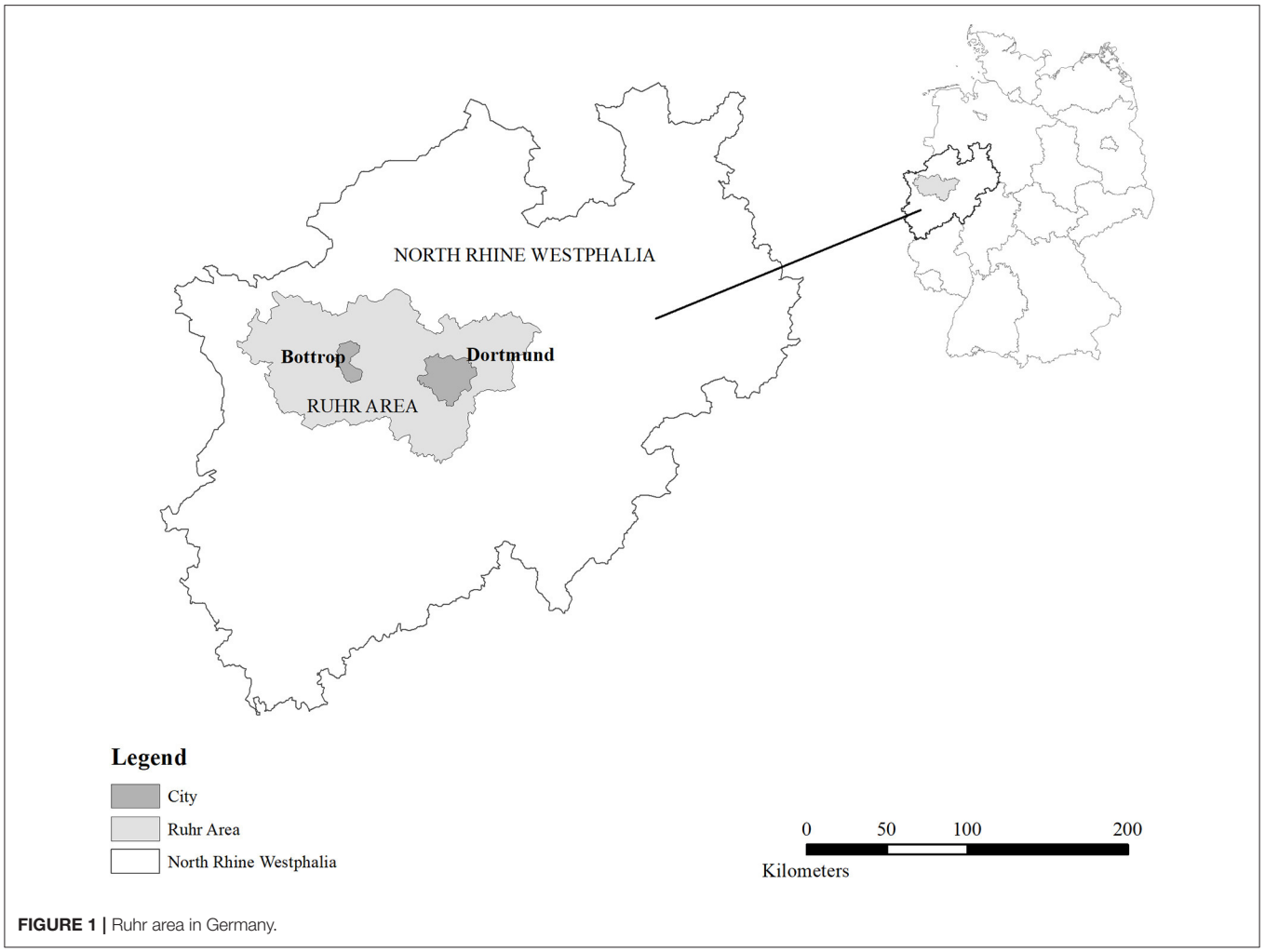

FIGURE 1 | Ruhr area in Germany.

neighbourhoods are more likely to be found in the northern parts (see analysis in section Findings).

The area that was affected most was certainly the Emscher zone in the northwest of the Ruhr area. The Emscher river and its many tributaries were used as an open sewer for industrial and household waste water for a period of more than 100 years. In fact, it is not totally misleading to call this area the dump site of the region, with a highly contaminated river and a degraded landscape being the main result. At the same time the area was densely populated, with many workers and their families living in so called industrial villages (i.e., dense working-class settlements next to the mines and steel works but out of the major cities). Measures to prevent the worst to happen were taken in the first decades of the 20th century. Suggestions to create a system of green corridors were made in 1912. In 1920, a regional planning association was founded and one of its main functions was the separation of settlements through green corridors and the maintenance of green spaces and agricultural land (Regionalverband Ruhr/RVR, 2015). Already before, in 1899, the Prussian government established the Emscher Association, a special purpose body that took care of flood prevention and sanitation. Obligatory members of this association were cities and the large waste water producing firms (mining companies, steel factories). It's important to note that both associations were cross-municipal initiatives.

In the following decades, the idea of green corridors turned out to have a perseverance in city-regional politics. In particular in the 1960s, when the above-mentioned regional planning authority was granted the role of statutory regional planning, the institutionalising of the seven green corridors took shape. The first statutory regional plan was published in 1966. Based on a technical study from 1960, a system of seven green corridors in north–south direction was granted a formal status (Zepp, 2018). In this period, industrialisation was still ongoing, although first signs of crisis became visible (with the closure of mines, restructuring of steel mills). Apart from air pollution and water sanitation, the protection of existing green spaces was the main element of regional environmental policies. This rationale changed in the late 1980s when the revitalisation of industrial brownfields and the river system became one of the main relevancies in the process of transformation of the post-industrial region.

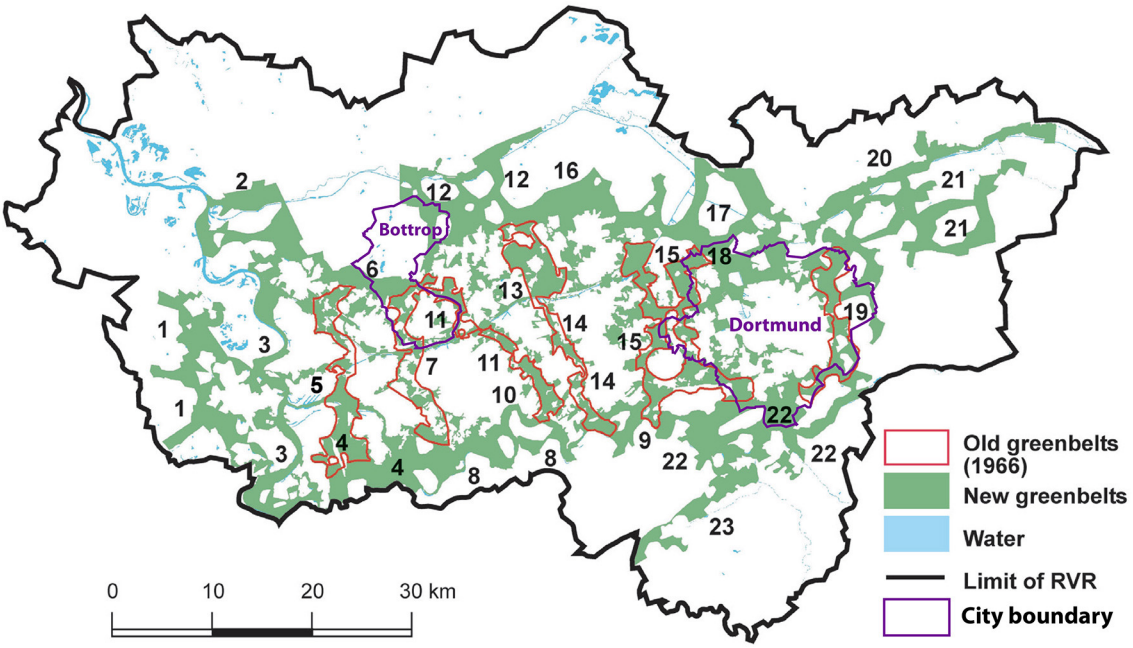

FIGURE 2 | Greenbelts in the Ruhr (modified from source: Zepp, 2018, 7).

A widely acknowledged regional initiative was the International Building Exhibition Emscher Park that was launched in 1989 (IBA-Emscher Park). The IBA was a 10-year intervention with the ultimate goal of transforming the region in many dimensions (economically, environmentally, culturally, and urban design). Hence, protection of existing green spaces was no longer the main driver but was combined with (if not replaced by) regeneration and transformation of no longer used industrial sites and the revitalisation of the river system. The creation of a regional system of green spaces with major land marks, heaps re-designed as tourist attractions, urban wilderness and industrial forests (as a result of succession on industrial waste land), parks, and bicycle paths were the main design elements. Often, this was done in combination with new settlements and the creation of office spaces and light industry on reused industrial sites. In fact, "working in the park" was one of the slogans of the IBA Emscher Park. Many of the ecological and environmental improvements in the period of 1990 until 2014 were financed by the Emscher-Lippe Ecology Programme (co-financed by the European Commission's programme to support former coal fields and industrial transformation). Note that the IBA was an initiative of the state government of North Rhine-Westphalia which met scepticism of the municipalities and counties as the state government used a state led agency in order to secure the implementation of the programme.

From the 2000s onwards, the strategy changed again and this became visible in the master plan Emscher Park (Projekt Ruhr GmbH, 2005). On the one hand, the green belts of 1966 shrunk significantly in the dense urban environments of the industrial core because of the extension of commercial developments and transport infrastructures (Zepp, 2018, **Figure 2**). The provision of green spaces in the Ruhr turned out to be comparatively low (Dosch and Porsche, 2008). As a result of this loss of open green spaces, environmental quality and access to green spaces in some of the cities was precarious (Dosch and Porsche, 2008). The main purpose of the master plan Emscher Park was to stop this loss of green infrastructure, to extend the system of green corridors and to improve the quality of existing green spaces in cities (Projekt Ruhr GmbH, 2005; Zepp, 2020). Again, it was the state government of North Rhine-Westphalia that supported the master plan. In fact, the Project Ruhr Agency, being in charge of elaborating the master plan, was an agency paid by the state government in order to continue with some of the initiatives of the IBA Emscher Park. Since 2004 the regional planning authority (Regionalverband Ruhr) is in charge of the Emscher Landscape Park. It owns quite a lot of the land (forests in particular) and is responsible for the maintenance and further development of the park. This task, however, needs close collaboration with the municipalities and the Emscher Association.

As a result of the regional park policy and the implementation of the master plan, in terms of numbers, the increase of green infrastructure in the Ruhr region was 137 km^2 so that the new territory of the Emscher Landscape Park is a total of 457 km^2 (Projekt Ruhr GmbH, 2005). This increase happened largely at the fringes while the situation in the inner parts of the city-region is still problematic (**Figure 2**). Besides the green corridors in north–south direction there is a new green corridor in east–west

direction. It is called the new Emscher Valley and existed more or less before but receives increased attention as this corridor coincides with the river Emscher (Emschergenossenschaft, 2006). The Emscher regeneration is another element in the green space strategy of the Ruhr and its current implementation is defined in the masterplan Emscher Revitalisation (Emscher Umbau) (Emschergenossenschaft, 2006). Although its main purpose is the regeneration and re-naturalisation of a degraded and polluted river system there is a significant spatial and functional overlap with the green infrastructure strategy of the regional planning authority RVR (Regionalverband Ruhr/RVR, 2016; Zepp, 2020). Hence, today the two regional associations (regional planning authority + Emscher Association) have taken over the leadership while the direct influence of the state government is now limited to funding (channelling also EU funds in the direction of green infrastructure).

This initiative is also a result of the change of the debate on green infrastructure and nature-based solutions. The rather new emphasis on ecosystem services makes the overall contribution of urban green for human well-being clear as it gives a monetary value to green spaces. The societal benefits of ecosystem services increased the relevance and allowed for the estimation of the monetary impact of loss of green spaces. Recent policy documents show a high commitment to the economic benefits of green infrastructures (Regionalverband Ruhr/RVR, 2016).

Although the master plans and policy documents of the regional planning authority RVR and the Emscher Association indicate an extension and qualification of green infrastructure, there is also criticism. This criticism refers to a significant loss of green spaces in specific areas so that the accessibility to green infrastructure is low for some segments of the residential population. Criticism was also made with regard to the quality. The green corridors are not nicely designed landscapes and parks, at least not everywhere. There are isolated buildings, power lines, agrarian land, roads, etc. (Regionalverband Ruhr/RVR, 2015; Zepp, 2018; Zepp et al., 2020, p. 81). The extension of the green corridors was planned in the east–west as well in the north–south direction but as a result of the losses the concept is now split up into 23 elements (the seven corridors are still visible but some of them are fragments, **Figure 2**). There is also a significant difference with regard to the size and coherence in the subregions. While in the east of the Ruhr (surroundings of Dortmund) we find large connected parts of forests and agricultural land, in the mid-west the structure of the green corridor is rather fragmentary and the lots are on average smaller.

While the uneven distribution of green infrastructure in terms of size and quality did result only in low levels of politicisation, the preparation of the new statutory regional plan in 2019 opened the ground for some controversies. While the plan proposal clearly accentuated the functional relevance of the green corridors, some municipalities were asking for more zones for commercial development and due to partial treatment of subareas and cities conflicts of land use are likely to emerge (Regionalverband Ruhr/RVR, 2015). This makes clear that there is gap between the overall acceptance of a regional green infrastructure strategy and the articulation of interests in some cities and municipalities.

It needs to be stated that the green infrastructure strategy is also not primarily thought to balance the unequal provision of high-quality green spaces for the citizens. It is rather a mix of attracting tourists and increasing the overall attractiveness of the region. Reimer and Rusche (2019) stress that the essential element of landscape planning in the Ruhr is an event-led strategy or festivalisation. The creation of land marks, the use of events such as cultural capital of Europe in 2010 or the planned international garden exhibition (in 2027) are the main building blocks of this strategy. Green infrastructure is not considered as being part of a territorial politics of welfare and we can also say that green infrastructure provision is not a result of bottom-up processes but rather led by the regional associations and local governments in connection with incentives given by the state government and the European Commission. This situation contrasts with scholarly descriptions of civic movements having a strong influence on green infrastructure initiatives (Agyeman and Evans, 2004). This is not the case in the Ruhr region.

The two cities of Dortmund and Bottrop benefitted from the regional green infrastructure strategy and the investment into the Emscher Landscape Park. However, the location of these two cities demonstrates the variation of green infrastructure development in the city-region. Bottrop is situated in the core of the industrial zone with dense industrial areas in the south just next to the river Emscher. So far only a few projects in this area have been implemented but the Masterplan Emscher Landscape Park foresees interventions here (Wellheimer Mark) (Projekt Ruhr GmbH, 2005). The transformation of these areas in the south of Bottrop is under way (see below and **Figure 4**).

Dortmund developed a large area in the south in the 2000s. The area of the former steel mill Phoenix has been transformed into a residential zone with an artificial lake of 24 ha and high-quality housing (Frank, 2021). The lake is part of the Emscher Landscape Park and also used as a rain water retention facility. The implementation provoked discussion on the reasonableness of this investment. Although the transformation of the area, that was once said to be the dirtiest place of the Ruhr, showed significant improvement in terms of landscape quality and environmental condition, the Lake Phoenix project created a very peculiar social situation as upper-middle class houses and villas were placed next to an old working-class neighbourhood. A city-wide discourse on gentrification emerged but until today there is a lack of accurate data. Certainly, the neighbourhood changed a lot but residents evaluate the process not totally negative as they see the benefits of the upgrade of the area (including the rise of house values) (Frank, 2021). As we will show later, the need for a green intervention is much higher in the northern parts of the city. In any case, the Lake Phoenix project, being part of the Emscher regeneration scheme, displays the ambivalence and selectivity of green infrastructure interventions. The following two sections will introduce an environmental justice analysis for the two cities of Bottrop and Dortmund in order to demonstrate that, despite the above-mentioned interventions, a lack of green infrastructure is still an issue.

TABLE 1 | Indicators used for environmental justice analysis.

Category	Indicator [acronym]	Definition	Threshold [>0.5 normalised value]
Environmental benefit	Supply of public green and open space [GSup]	Size of public green and open space per inhabitant	<6 m² of public green and open space per inhabitant within a statistical district
	Accessibility of public green and open space [GAcc]	Percentage of inhabitant living near public green and open space	<50% of residents per district who have access to public green and open space within a distance of 500 m (for ≥1 ha spaces) and 1,000 m (for ≥10 ha spaces
Environmental burden	Noise pollution [NOI]	Percentage of area having a noise impact	>50% of statistical district area covered by >55 db(A) LDEN
	$PM_{10}/PM_{2,5}$ pollution [PM]	Percentage of area having emission of $PM_{2,5}$, PM_{10}	>50% of statistical district area covered by >78 kg/a
	NO_x pollution [NO_x]	Percentage of area having emission of NO, NO_2	>50% of statistical district area covered by >700 kg/a
Climate-related extreme event	Hot days [HD]	Number of days whose temperature is above 30°C	>11 hot days per statistical district
	Tropical nights [TN]	Number of days whose temperature is above 20°C	>2.4 tropical nights per statistical district
	Flood risk [Fld]	Percentage of residential area, mixed use area, and area with critical social infrastructure that are at risk of flooding	>50% of flooded residential area, mixed used area, and area with critical social infrastructure on a flooding with a return period of more than 500 years per statistical district
Socio-economic status	SGB II and SGB XII recipient [SGB II/XII]	Percentage of SGB II and SGB XII recipient	–

METHODOLOGY

The data used in this paper were gathered from Bottrop and Dortmund—two cities in the Ruhr region that differ in size. The territory of both cities is part of the Emscher River system and hence both cities are beneficiaries of the Emscher Landscape Park and the Emscher regeneration process. Bottrop and Dortmund are obligatory members of the regional planning authority and the Emscher Association and both mayors have taken leading roles in these organisations. Hence, both cities are part of a multi-level governance arrangement that they share with several other cities, towns and counties. Bottrop is situated in the north-western part of the Ruhr region. It covers nearly 101 km^2 with a population of 117,000 inhabitants. Bottrop has meadows and agricultural land in the northern and central part as well as a large forest area in the western part. The southern part of the city is densely populated and urbanised (with a harbour, coal depots, former mining areas, and a coking plant). Dortmund, which is located in the eastern part of the Ruhr region, covers 280 km^2 and is home to 600,000 inhabitants. As part of the Ruhr region, Bottrop and Dortmund share the history of coal mining and steel production, thus have been undergoing a long-lasting transformation. Like other cities in the Ruhr region, Bottrop and Dortmund are increasingly exposed to climate-related extreme events such as heat waves, heavy rainfalls and flooding. For example, heavy rain in 2008 reached the highest intensity measured so far in Dortmund, and led to the overflow of a rain water retention basin in Dortmund-Marten with remarkable damages. Likewise, storm Ela in 2014 and Elvira in 2016 caused enormous damage on cities.

Environmental justice analysis was carried out for Bottrop and Dortmund in order to figure out how, among others, sufficient and accessible green infrastructure is in both cities and whether there is an environmental inequality. A broad set of geodata was used, largely from the existing open geodatabases of North Rhine-Westphalia. Altogether nine core indicators were established in four categories, i.e., environmental benefit, environmental burden, climate-related extreme event, and socio-economic status (see **Table 1**). The analysis involved several steps. First, indicators were selected based on the precedent studies and the availability of data in the existing database. After indicators were quantified by setting adequate thresholds, Bottrop and Dortmund were spatially analysed at the statistical district level based on each indicator. The analysis was carried out using ArcGIS 10.4 software and its Network Analyst extension. The results passed through a Boolean overlay and were finally visualised in a multiple-load map. Throughout the process, local stakeholders were involved via living labs in order to discuss interim results and optimise the process. It was an iterative process with learning effects for both the scientific and practical side. In the following, each indicator used for the analysis is explained.

As mentioned in the acknowledgment Kristina Ohlmeyer, Mathias Schaefer, Madeleine Kirstein, Dietwald Gruehn, and Stefan Greiving conceptualised and conducted the environmental justice analysis for Bottrop and Dortmund (Bakunowitsch et al., 2019; Ohlmeyer et al., 2021, 91–145).

Environmental benefit takes into account two indicators, i.e., supply as well as accessibility of public green and open space. When it comes to the supply side, the size of public green and open space per inhabitant is the determining factor. The actual

situation was compared by referring to a value proposed by the Deutscher Städtetag (German Association of Cities) in Berlin, namely 6 m^2/person (SenUVK, 2017). The ultimate goal was to find out if there was an oversupply or shortage in the provision of public green and open space. Concerning accessibility, public green, and open spaces were first divided into two categories: (1) those larger than or equal to one hectare but <10 ha; and (2) those larger than or equal to 10 ha. The distance thresholds for each category were set at 500 and 1,000 m, assuming that larger spaces imply a higher degree of centrality to visitors. Next category is environmental burden consisting of three indicators related to noise and air pollution. Noise is the result of a variety of sources, each with a varied duration and intensity. For this analysis, all noise pollution isotopes were combined and the spatial share of noise isotopes per statistical district was calculated using intersection processes. Concerning air pollution, the percentage area per statistical district was calculated by using the 1 × 1 km emission raster.

Another category is climate-related extreme events; it includes hot days, tropical nights and flood risk. A mean value was determined for each statistical unit using vector data of hot days and tropical nights from 1989 to 2010. The flood hazard mapping gave crucial information on the spatial scope of a potential flooding event. The percentage of residential area, mixed use area, and area with critical social infrastructure that are at risk of flooding was calculated for each statistical district. Lastly, the percentage of welfare recipient is used as an indicator for the category of socio-economic status. Percentage of SGB II and SGB XII recipient was calculated for each statistical district. Since the availability and accessibility of social and health data is rather limited, partly due to the data privacy, diversity of indicator is not achieved.

FINDINGS

Bottrop and Dortmund were spatially analysed based on the selected indicators at statistical district level. The result was first presented separately for each indicator (see **Figures 3**, **5**). Then they were overlaid and presented in a multiple-load map (see **Figures 4**, **6**).

Figure 3 shows the result of spatial analysis for each indicator in Bottrop. First, deficits regarding the supply of public green and open space [GSup] are present in the north and south of the city. Accessibility [GAcc] is high across the city due to the overall high proportion of public green and open space in Bottrop. The map for noise pollution [NOI] reveals that there is high noise pollution around superordinate roads and motorways. Air pollution [NOx, PM] is especially high in the south of the city where industrial plants are agglomerated. Also, there are isolated cases in the north where the A2 and A31 highways are. Concerning climate-related extreme events, the southern part of the city, and in particular within and around the old town, is characterised by a high number of hot days [HD] and tropical nights [TN]. What is more, high proportion of residential area, mixed use area and area with critical infrastructure in the south are affected by flood events [Fld] with a return period of 500 years. This is due to the proximity to the Emscher river. Lastly, there is a high proportion of welfare recipient [SGB II/XII] in the south of the city.

The multiple-load map of Bottrop (**Figure 4**) shows multiple-stressed areas in Bottrop. According to the analysis, there are more multiple-stressed areas in the south compared to the north. Indeed, 5–7 times stressed districts are concentrated in the south, close to the river Emscher. This can be partly explained by the fact that the south is densely populated and has many industrial sites (including a coking plant and former mining sites) and is crossed by railway lines and a highway. The result shows that this is also where high proportion of welfare recipient resides. Finally, a correlation analysis was conducted using the SPSS statistical program in order to determine whether there is a correlation between (1) the supply of public green and open space and the share of social welfare recipient; and (2) environmental stresses and the share of social welfare recipient. Spearman's rank correlation was used. Significance level was defined $\alpha = 0.05$. Furthermore, the data set was limited to inhabited areas. A significant negative weak correlation ($r = -0.266$) was found between the supply of public green and open space and the proportion of welfare recipient with 8% the explanatory power. In contrast, a significant positive moderate correlation ($r = 0.508$) was found between environmental stresses and the proportion of welfare recipient with 26% explanatory power (Bakunowitsch et al., 2019).

Figure 4 also shows the areas of intervention that have been initiated so far (planning started in 2018). The red dotted line indicates the area of the cross-municipal development zone and the intervention of the Emscher Masterplan. The project is called "Emscher Freiheit" (Emscher Freedom), a business zone on a former industrial site that is planned in cooperation with the neighbouring city of Essen with high proportions of green space. Another recent intervention is the requalification and extension of a park in this neighbourhood ("Wellheimer Lückenschluss," i.e., connecting interrupted green corridors). A coking plant still is active in this neighbourhood. Although meeting the standards of EU environmental legislation, air pollution is an issue here. The map also shows the inner-city green belts. The blue line demarcates an area where initiatives to increase the energy efficiency of buildings have been taken (called "Innovation City").

Figure 5 shows the result of spatial analysis for each indicator in Dortmund. First, deficits concerning the supply of public green and open space [GSup] are mainly found in central part of the city. Accessibility [GAcc] is very high in almost all statistical districts except for the city centre. In fact, 91% of residents live in average 300/700 m away from the next public green and open spaces. The map for noise pollution [NOI] shows that there is high noise pollution around superordinate roads and motorways. Air pollution [NO_x, PM] is concentrated mainly in the central part of Dortmund. Regarding climate-related extreme events, and in particular a number of hot days [HD] and tropical nights [TN], the central area reveals to be relatively higher than other parts of the city. In terms of flood events [Fld], western part of the city has a risk to be affected. Lastly, there is a high proportion of welfare recipients [SGB II/XII] in the central and northern part of the city.

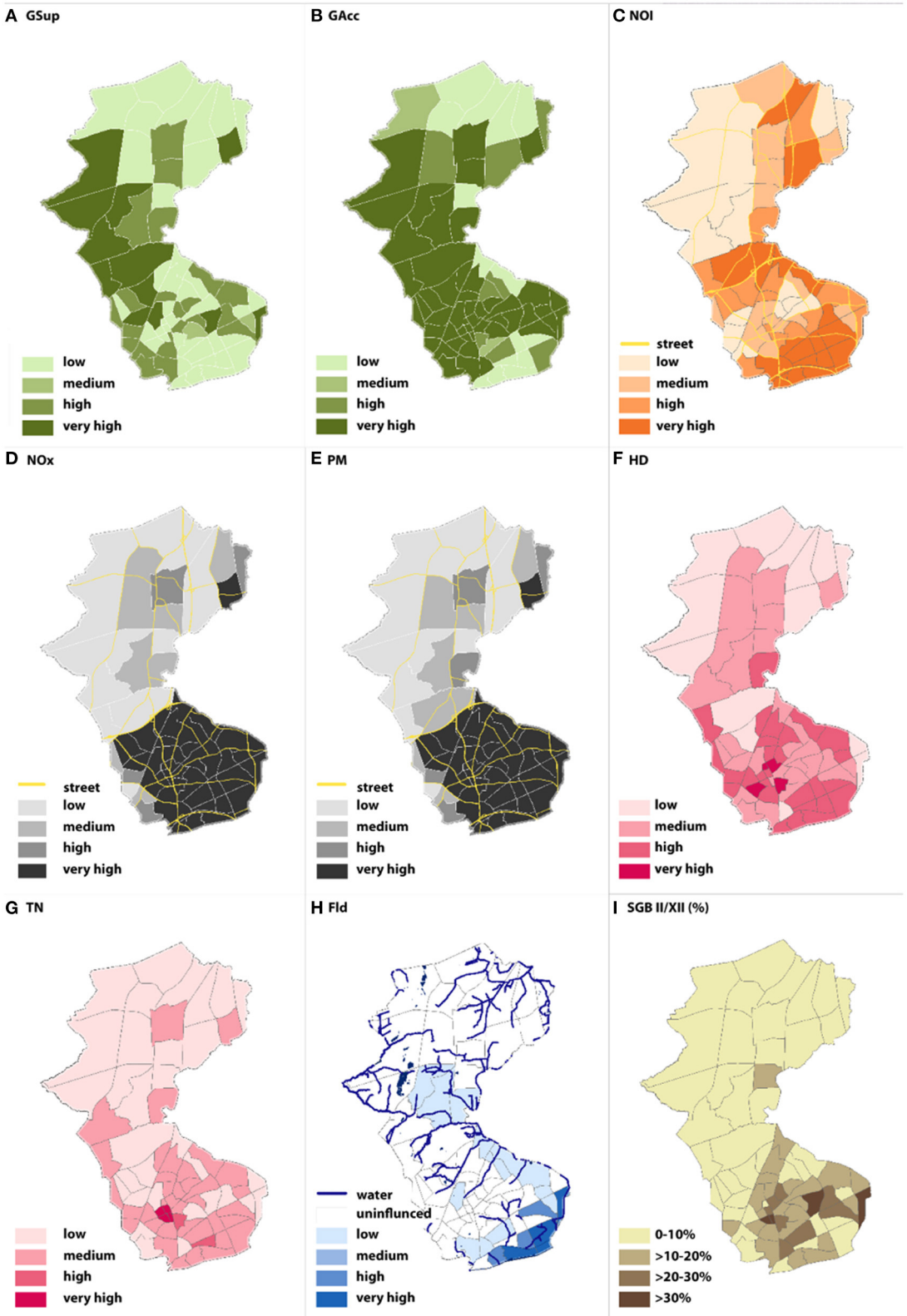

FIGURE 3 | Result of spatial analysis for each indicator (Bottrop) (source: Bakunowitsch et al., 2019, 120).

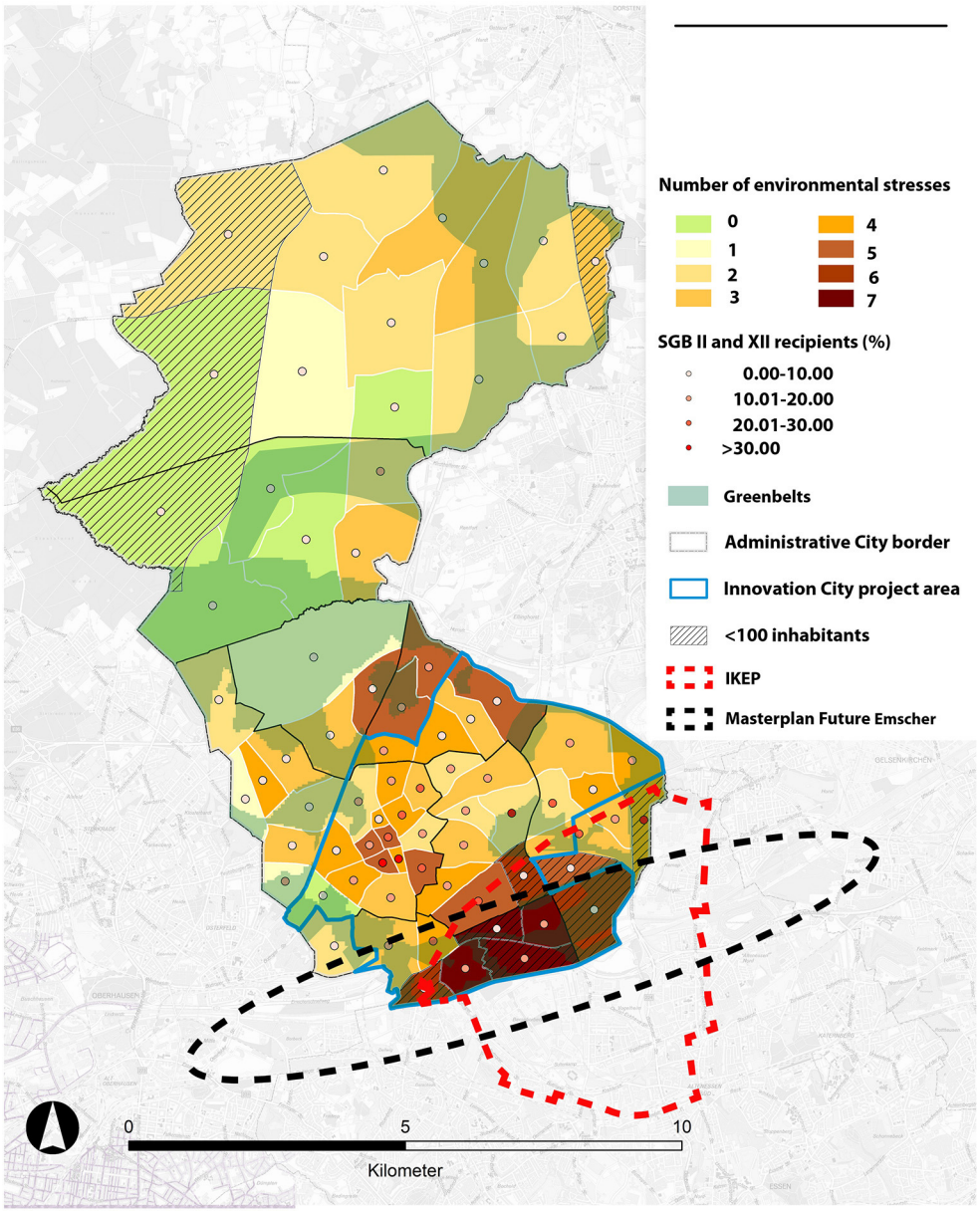

FIGURE 4 | Multiple-load map for Bottrop (modified from source: Bakunowitsch et al., 2019, 117).

The multiple-load map of Dortmund (**Figure 6**) shows multiple-stressed areas in Dortmund. According to it, there are multiple-stressed areas in the central part of the city. Five to six times stressed districts are concentrated in the area. As the result shows, this is also where high proportion of welfare recipient live. For Dortmund, a correlation analysis was conducted as well to determine whether there is a correlation between (1) the supply of public green and open space and the share of social welfare recipient; and (2) environmental stresses and the share of social welfare recipient. A significant negative weak correlation ($r = -0.239$) was found between the supply of public green and open space and the proportion of welfare recipient with 6% explanatory power. In contrast, a significant positive moderate correlation ($r = 0.44$) was found between environmental stresses and the proportion of welfare recipient with 20% explanatory power (Bakunowitsch et al., 2019).

All in all, the environmental justice analysis carried out in Bottrop and Dortmund reveals that, in both cities, there is environmental inequality as evidenced by a negative correlation between the supply of public green and open space and the share of social welfare recipient as well as a positive correlation between the environmental stresses and the share of social welfare recipient. The result of spatial analysis for environmental benefit shows that the accessibility to public open and green

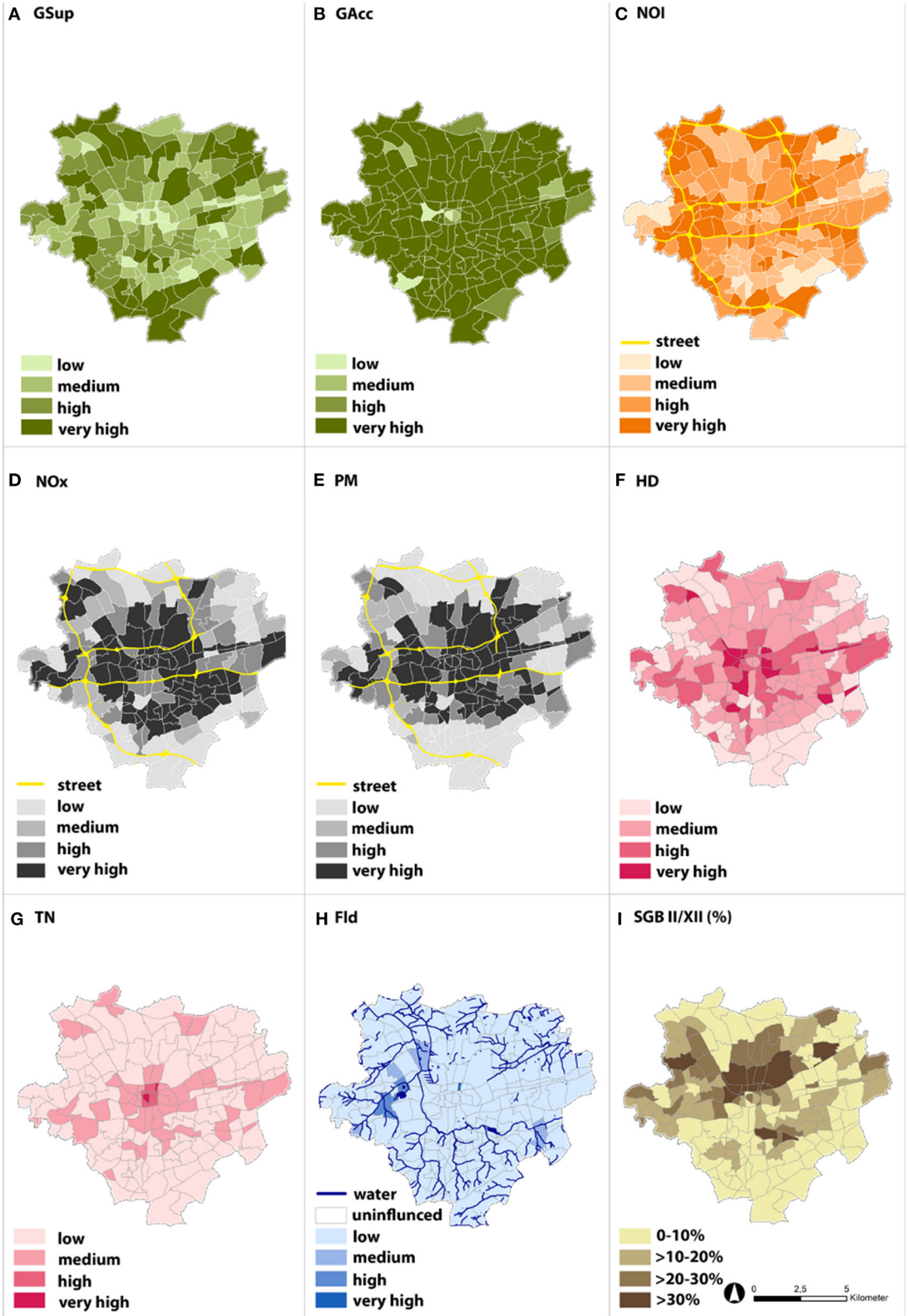

FIGURE 5 | Result of spatial analysis for each indicator (Dortmund) (source: Bakunowitsch et al., 2019, 124).

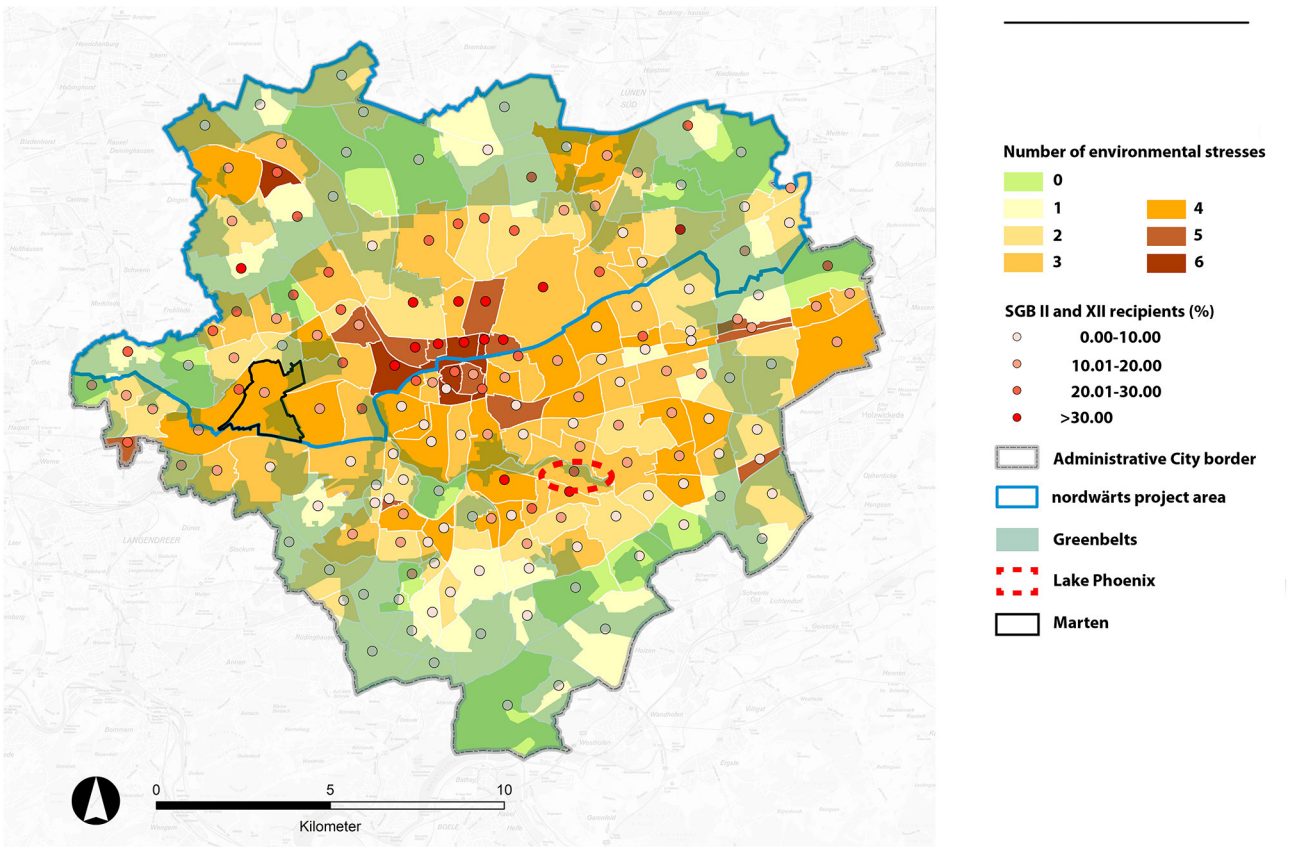

FIGURE 6 | Multiple-load map for Dortmund (modified from source: Bakunowitsch et al., 2019, 121).

space in both cities is less an issue, whereas its supply varies considerably across the cities. While on the regional scale, the investments made in the Emscher zone can be seen as a trial to balance and repair a long-standing unequal provision with environmental qualities, on a smaller scale (i.e., cities and neighbourhoods) we can demonstrate that in the cities of the Emscher zone environmental inequality is still observable. The Emscher revitalisation programme and the Emscher Landscape Park had some beneficial effects for some municipalities but by far not for all. Some neighbourhoods benefit stronger from investment in regional parks and green infrastructure than others. What seems to be green region shows environmental injustice on a smaller scale in cities and neighbourhoods.

DISCUSSION AND CONCLUSION

This paper examined to what extent green infrastructure planned at the regional level can contribute to environmental justice within a city-region. Without a doubt, regional planning for green infrastructure is well established in the Ruhr. The process started in the 1920s, became part of statutory regional planning in the 1960s, found strong operational support of the state government in the 1990s and early 2000s and is now in the hands of to two regional associations that share the characteristic of inter-municipal membership. However, analysis of data by Zepp (2018) demonstrates that the old green corridors of 1966 have shrunk significantly in the core zone of the Ruhr (see also Regionalverband Ruhr/RVR, 2015). The extension of the green corridors at the fringes of the city-region does not compensate for this loss from an environmental justice perspective. In addition, our quantitative research on city level revealed that there is a direct correlation between the supply of and accessibility to green infrastructure and environmental justice. Yet, the Emscher Park interventions did not intervene in these areas or began to do so only recently (i.e., in the south of Bottrop). It seems that advocacy for green infrastructure on the regional level is not enough to secure environmental justice on a smaller scale.

At the same time, investments in green infrastructures are made for many reasons and environmental justice does not seem to be the most important one. Functions that found strong recognition are water retention, flood control, eco system services (biodiversity), climate adaptation (fresh air circulation), recreation, and control of land consumption. Only recently guidance and policy documents proclaim that the park will be brought closer to the citizens (Regionalverband Ruhr/RVR, 2019, 2015). In fact, recent planning documents indicate that this

weakness of the regional approaches will be tackled. RVR as well as Emscher Association discovered this weakness and proclaimed to go into the cities. The city administration of Bottrop did go even a step further and now employs a "climate justice manager" in the planning department. She is in charge of the green infrastructure projects in the south of the city. The Emscher regeneration programme and the detailed insights into two cities of the Ruhr suggest that green infrastructure should be planned not only at the regional but also at the smaller scale (i.e., cities and neighbourhoods). Hence, we argue that environmental justice is a question of scale, also in terms of politicisation. While it is highly valuable to give an emphasis to green infrastructure as an amenity of regional relevance with respective lighthouse projects (such as Lake Phoenix and other landmarks), we demonstrated the need to think green infrastructure as a coherent network from the regional level, to the city and the quarter. Actors from different disciplines must work together with the aim of developing and maintaining green infrastructure across all scales. Accessibility and quality differ a lot due to the unbalanced provision of green space. There is a need for a multi-scaled governance approach for green infrastructure. In terms of institutional design for environmental justice, this implies a stronger coupling of regional and local initiatives.

With regard to the conception of environmental justice the implications are significant. As Moroni points out (2020), there is a variety of ways of how to define justice. In the debate on environmental justice a focus on distributive justice is very influential as many studies show empirically the unequal distribution of green amenities and/or environmental burdens. This assumes that environmental quality is a scarce good that provokes conflicts of distribution and access. We would like to add the perspective of institutional justice as green infrastructure strategies clearly are the result of a specific governance regime. As Moroni puts it:

"It is the basic urban institutional framework which must satisfy criteria of justice. Considered in these terms, if we speak, for example, of the injustice of certain urban situations—for example, the state of certain peripheral neighbourhoods or the inaccessibility of certain basic urban services—we are actually assuming implicitly that what is unjust in reality are the urban institutions that have allowed such situations to arise and do not intervene in order to right them" (Moroni, 2020, 254).

This applies to the local as well as to the city-regional dimension. Many of the positive results of green infrastructure development in the Ruhr region are the result of institutional design that goes back to the period of the industrialisation (i.e., the creation of regional associations) or the implementation of the post-war planning system (1966). The intervention of the state government in 2003–2005 was also an important step (Masterplan Emscher Landscape Park). The strong position of local governments in Germany, however, sometimes poses a threat to this city-regional policy.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work and approved it for publication.

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CORRECTION
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Corrigendum: Environmental Justice and Green Infrastructure in the Ruhr. From Distributive to Institutional Conceptions of Justice

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Keywords: green infrastructure, post-industrial region, Ruhr region, governance, environmental justice

A Corrigendum on

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A change in the acknowledgment has been made. The updated version is inserted below:

Special thanks to Kristina Ohlmeyer, Mathias Schaefer, Madeleine Kirstein, Dietwald Gruehn, and Stefan Greiving for conceptualising and conducting the environmental justice analysis for Bottrop and Dortmund. The analysis was done in Working Package 3 as part of the research project ZUKUR and its result was invaluable for writing this paper. Their work is published in Ohlmeyer et al. (2021) and Bakunowitsch et al. (2019), 91–145. Prof. Harald Zepp deserves thanks for allowing us to use **Figure 2**.

In the original article, there was an error. A correction has been made to THE NOTION OF ENVIRONMENTAL JUSTICE, Paragraph Number 6. Also, a citation (Bakunowitsch et al., 2019) has been inserted to this paragraph. Corrected paragraph is inserted below:

The City of Berlin was one of the first local governments to develop an environmental justice concept (Köckler, 2017), thereby providing for a detailed description of the environmental quality in each of the city's 447 planning areas (SenSW, 2015). The city used a two-stage process to examine environmental justice, including five core and a number of complementary indicators. Noise exposure, air pollutants, bioclimatic burden, access to green and open spaces, and social hardship belong to the core indicators. Complementary indicators provide for a more in-depth understanding of the situation in various neighbourhoods throughout the city. The available data were aggregated and multiple-load maps created. Berlin's approach served as a model for the environmental justice analysis carried out within the research (Bakunowitsch et al., 2019).

In the original article, Ohlmeyer et al. (2021) was not cited as it has been accepted only recently for publication. A text correction has been also made to this paragraph. Corrected paragraph with new citation is inserted below: A correction has been made to METHODOLOGY, Paragraph 3, 4, and 5 as well.

The section should start with:

As mentioned in the acknowledgment Kristina Ohlmeyer, Mathias Schaefer, Madeleine Kirstein, Dietwald Gruehn, and Stefan Greiving conceptualised and conducted the environmental justice analysis for Bottrop and Dortmund (Bakunowitsch et al., 2019; Ohlmeyer et al., 2021, 91–145).

Environmental benefit takes into account two indicators, i.e., supply as well as accessibility of public green and open space. When it comes to the supply side, the size of public green and open space per inhabitant is the determining factor. The actual situation was compared by referring to a value proposed by the Deutscher Städtetag (German Association of Cities) in Berlin, namely 6 m^2/person (SenUVK, 2017). The ultimate goal was to find out if there was an oversupply or shortage in the provision of public green and open space. Concerning accessibility, public green, and open spaces were first divided into two categories: (1) those larger than or equal to one hectare but <10 ha; and (2) those larger than or equal to 10 ha. The distance thresholds for each category were set at 500 and 1,000 m, assuming that larger spaces imply a higher degree of centrality to visitors. Next category is environmental burden consisting of three indicators related to noise and air pollution. Noise is the result of a variety of sources, each with a varied duration and intensity. For this analysis, all noise pollution isotopes were combined and the spatial share of noise isotopes per statistical district was calculated using intersection processes. Concerning air pollution, the percentage area per statistical district was calculated by using the 1 × 1 km emission raster.

Another category is climate-related extreme events; it includes hot days, tropical nights and flood risk. A mean value was determined for each statistical unit using vector data of hot days and tropical nights from 1989 to 2010. The flood hazard mapping gave crucial information on the spatial scope of a potential flooding event. The percentage of residential area, mixed use area, and area with critical social infrastructure that are at risk of flooding was calculated for each statistical district. Lastly, the percentage of welfare recipient is used as an indicator for the category of socio-economic status. Percentage of SGB II and SGB XII recipient was calculated for each statistical district. Since the availability and accessibility of social and health data is rather limited, partly due to the data privacy, diversity of indicator is not achieved.

A correction has been made to FINDINGS, Paragraph Number 3 as well. The reference must be **Figure 4**.

The multiple-load map of Bottrop **(Figure 4)** shows multiple-stressed areas in Bottrop.

A citation (Bakunowitsch et al., 2019) has now been inserted in the section on FINDINGS, Paragraph Number 3.

A citation (Bakunowitsch et al., 2019) is missing in the section on FINDINGS, Paragraph Number 6.

The source Bakunowitsch et al., 2019 needs to be added in the captions of Figures 3–6.

Figure 3. Result of spatial analysis for each indicator (Bottrop) (source: Bakunowitsch et al., 2019, 120).

Figure 4. Multiple-load map for Bottrop (modified from source: Bakunowitsch et al., 2019, 117).

Figure 5. Result of spatial analysis for each indicator (Dortmund) (source: Bakunowitsch et al., 2019, 124).

Figure 6. Multiple-load map for Dortmund (modified from source: Bakunowitsch et al., 2019, 121).

The authors apologize for this error and state that this does not change the scientific conclusions of the article in any way. The original article has been updated.

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SYSTEMATIC REVIEW
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Urban Greening for New Capital Cities. A Meta Review

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In light of the discussions on relocating the capital city of Indonesia to a new location in Kalimantan, and create a new green capital city (referred to as IKN), the purpose of this meta-review paper is learn from experiences from other relocations of capital cities and creations of green cities in the world. Specific emphasis is hereby given to urban greening and gentrification. This article applies a meta-analytical approach by connecting the basic tenets of the 8R framework of responsible land management to assess the pros and cons of a selected set of capital city relocations and green cities. From the comparison, it is possible to generate general recommendations for Indonesia's new green capital city. The comparison reveals that each of the selected cases falls short in one or more aspects of the 8R framework. In all cases, constructing green capitals requires a mixed and integrated land use planning, a transparent regulatory framework toward land use control, extensive consultation with both local, national and international stakeholders, and participation with local residents. Only under these conditions, one can ensure ownership, respect and trust in the decision. The quandaries highlight the complexity of capital city relocation and green city creation. The originality lies in the specific land management framework perspective and discursive analysis of documented discourses on constructing new capital and green cities. This provides new options for devising and extending regulatory guidelines and for assigning responsibilities for such new mega-endeavors. Given the conceptual and discursive character of the paper, a limitation of the approach may be that there are no specific empirical data collected, yet several recommendations for further research include expanding the boundary work between the land management, the spatial planning and governance domains.

Keywords: urban greening, land management, Indonesia, capital city, responsible land management, gentrification

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INTRODUCTION

History shows that capital cities play an important role in the image, representation and identity of a country (Lazar, 2005). In most cases, these capital cities are also the largest and/or most populated cities of these countries, but there are also remarkable exceptions, such as Canberra in Australia, Washington in the USA, The Hague in the Netherlands and Ottawa in Canada. When the designation of the capital city needs to be changed, for example after a major revolution or when aiming to establish a new political ideology, countries tend to embark on relocating and re-establishing their capital city. This process has taken place in multiple parts of the world, and recently especially in developing countries and countries in transition. In the western world, a notable example of relocations of capital cities include the relocation of Berlin to Bonn, and more recently back to Berlin again. This obviously has to do with political and ideological changes,

but also with the establishment of a new meaning and alternative self-image both nationally and internationally (Cochrane and Jonas, 1999; Eckardt, 2005). Additionally, Brazil for example embarked in the late 1950s on establishing their new capital Brasilia based on a modernist, technologically driven ideal that one could construct a new town based on rigid plans and the idea of shaping a new future from scratch (Rawat, 2005; Rossman, 2018). Many other countries followed since then in relocating and reconstructing their capital city ideals, such as Pakistan (Karachi to Islamabad), Nigeria (Lagos to Abuja), Malawi (Zomba to Lilongwe), Tanzania (Dar Es Dalaam to Dodoma), Kazakhstan (Almaty to Astana). Post-independent countries often decide to re-locate their capital city to a new location in order to reflect independence, reflect a new social representation of all peoples of the country, and to create a new national symbolic location whereby the center of power is in the center of the country.

All these justifications come with serious counter-arguments given documented empirical evidence. The new capitals suffer frequently from non-organic spatial designs, biased and non-harmonic social representations and either uncontrolled expansion (e.g., Abuja) or extremely limited expansion (e.g., Dodoma). In both cases, such capitals face serious development and livability problems. One of those problems in particular concerns different forms of gentrification and social segregation. Momoh et al. (2018) and Momoh and Benachir (2018) list gentrification as one of the emerging challenges in Abuja as a direct result of the inability to align the rural-urban migration to the design and monitoring of an urban development master plan. Lauriano (2015) reports that gentrification in Brasilia is largely the result of its original design for inhabitants with cars, and limited attention for public transport for those with more limited budgets. The direct consequence of this is a serious housing problem, which do not relate to land scarcity, but to property and income scarcity. Kampamba et al. (2018) describe the process of gentrification in Gaborone due to growing demand for middle-income housing leading to increasing eviction of lower-income residents. Seitzhanova and Nagy (2018) argue that some form of gentrification was in fact a necessary requirement for the new capital city Astana to grow and attract tourist for both the city itself as well as the surrounding region. In all these cases of capital city development, gentrification is primarily related to housing and new construction developments and not so much to environmental concerns.

A relatively historically new justification for a relocation of a capital city is to create a green city, or even the greenest city of the country, as a representation for new ecologically and environmentally friendly policies. Such contemporary knowledge and insights in responsible and sustainable city development are for example noticeable in contemporary reports on Malaysia's Putrajaya (Abdullah et al., 2020), South Korea's smart energy city Sejong (Yoon and Shin, 2019), or a "biophilic" capital city – one "full of nature" for Egypt (Nasreldin and Abdelfattah, 2020). Such greening visions are also playing a role in Indonesia's ambition for its new capital city – designed to be located in Kalimantan – which should become the greenest, smartest and sustainable capital city in the world. There are currently various designs for this new capital city, but it remains relevant to assess how and when such an ambitious goal is achieved.

This research should thus support the further choices in the design and implementation of the relocation of the Indonesian capital city, referred to as IKN (Ibu Kota Negara). As the current capital Jakarta is highly populated and is frequently suffering from environmental problems, such as floods, seeking an alternative locations for the administration has long been on the Indonesian agenda. How such intentions should become reality and what such intentions imply is the key objective of this article. We hypothesize that previous examples contain a certain degree of similarity, which can derive recommendations for future capital and green city designs. We further hypothesize that inclusion and diversity of such cities are vital. The main aim was not to judge the rightness or wrongness of the relocation of the capital in Indonesia specifically, but to support the decision makers in Indonesia in deducting which possible problem might arise, so that they could prepare for this.

This article starts by evaluating the variations in definitions and concepts of what constitutes either a capital city or a green city and what a number of design criteria are for green capital cities. The subsequent section explains the so-called 8R framework of responsible land management, which allows an assessment and comparison of capital and green city development. We apply this framework on evaluating and assessing 3 new capital cities and 3 awarded green cities, with the aim to generate recommendations for the plans of Indonesia. The Conclusion section provides a synthesis of the findings and recommendations for further continued research on this topic.

DEFINING CAPITAL AND GREEN CITIES

The fundament for this research lies in defining what actually constitutes both a capital city and green city. There are differing concepts related to both of these terms, which are dependent on location, ideology, culture and strategic planning. These differences influence the choices for the construction of a new capital city, which needs to be green and/or smart. The investigation relies on evaluating previous examples of both previous capital city relocations and designs and of evaluating characteristics of other cities that are supposedly green or perceived as green. The comparison of these examples relies on both the theoretical concepts combined with practical and professional choices made in different locations. The goal of this comparison is to derive recommendations for future designs and assessments of capital and green cities.

Varieties of Capital Cities

There are various ways to look at what constitutes a capital city. The pragmatic definition of Rossman (2018) is the location which represents the ideal image of the country and country's history. It is for example for this reason that a number of capital city names are the same as the country names (e.g., Mexico City, Panama City, Brasilia, Tunis). Hall (2006) distinguishes 7 varieties of capital cities. First, Multi-functional capitals (such as London, Paris, Madrid) combine and host all possible national-level

functions besides hosting the seat of the government. Usually they represent centralized public administrative and commercial systems, and are locations for performative functions, such as national ceremonies, event and parades. Secondly, the category Global capitals (e.g., Tokyo) represent cities, which conduct supra-national functions in politics and commercial life. Thirdly, political capitals (e.g., The Hague, Bonn, Canberra), established as locations where government conduct their activities, yet not necessarily the centers of commercial life. Fourthly, former capitals, being cities (St. Petersburg, Rio de Janeiro) which still maintain an international visibility and appearance as de facto capitals, yet having lost this official status. Fifthly, ex-empirical capitals (e.g., Vienna, Lisbon). Despite having lost the status of imperial centers they still act as cultural and commercial centers. Sixtly, provincial or State capitals (e.g., Munich, Sydney, Toronto). These are often cities, which function as metropolitan areas with large territorial influence both regionally and nationally. Lastly, super capitals (e.g., Brussels, Geneva, New York), which host international and multilateral organizations and thus act as capital cities with international diplomatic representations. Finally, large, federal and unified countries can have multiple capitals represented in historical and culture. For example in India the city Shimla represents the Himalayan hill station that was the "summer capital" of British India; Kolkata, earlier known as Calcutta, was the former capital of the British empire in India; New Delhi was the capital of several Islamic dynasties that ruled Northern India, including the Mughals, until it became the imperial capital in 1911 - when Calcutta lost that status - and was then developed as independent India's capital; and Chandigarh is a provincial capital with major post-Independence modernist implications:

From a critical spatial economic perspective one could also define capital cities as those cities where financial capital accumulates, usually in the form of urban real estate, and often at the expense of peripheral areas, combined with relocation and/or eviction of poorer people.

Varieties of Green Cities

As diverse as capital cities are also labels and characteristics of green cities, also associated with the labels of eco-cities, sustainable cities, climate-neutral cities, car-free cities or even smart cities. The qualification "green" can relate to various types of ideals and norms. According to Breuste (2019), the green can relate to ecological alternatives, and/or the technical improvements, such as the reliance on renewable energy. A city with low greenhouse gas emissions is furthermore considered green, as well as a city with plenty of green spaces (Kahn, 2007, Glaeser and Kahn, 2010). In addition, a city with dense and highly accessible public transport systems, bicycle paths and car-free pedestrian areas are also seen as green (Beatley, 2012). Albino and Dangelico (2013) refer to a Green Cities Practices Matrix to compare the greenness of cities, based on the characterization of green urban practices, and connected to green economy principles. Hereby green relates to three types of environmental foci: material (such a use of recyclable, biodegradable, environmentally neutral materials), energy (use and production of renewable energy; reduction of fossil fuels), and pollution (does not pollute or reduces pollution). In her book LO–TEK Design by Radical Indigenism, Watson et al. (2020) argue that tribal communities, seen by many as primitive, are highly advanced when it comes to creating systems in symbiosis with the natural world. Green cities in this book are seen as cities designed in such a way that they make better use of the natural qualities in terms of ecosystem services. Finally Breuste et al. (2020) provide the following working definition of green cities: *the Green City is a city, where all forms of nature—living organisms, biocoenosis, and their habitats—are highly significant components of green infrastructure. In a Green City, these forms of nature are preserved, maintained, and extended for the benefit of city residents. Urban nature is an ideal provider of services, and a key concept for city development.* To a large extent this makes a green city a metaphorical vision for preserving existing nature while adapting it optimally for residents in cities. Such a city design must ensure that the quality of life improves.

Green Capital City Awards

Globally there are various kinds of greenest or most-eco-friendly award lists, which are arguably also biased toward the interests and the economic or political ideals of the designers of such lists. Although the word "capital" is used in a different sense as described above, the European Commission has a so-called "European Green Capital" award[1], based on predefined environmental criteria. Awarded yearly since 2010, it is an incentive for European cities to adapt to greener practices and/or to design new area, which better fit the awards' criteria. Although also aimed symbolically as uniting Europe under one green flag, the award practically judges and assesses air and water quality, noise emissions, production and handling of waste, biodiversity, use and production of alternative and renewable energies, and mobility. The subsequent European green capitals have been Stockholm (2010), Hamburg (2011), Vitoria-Gasteiz (2012), Nantes (2013), Kopenhagen (2014), Bristol (2015), Ljubljana (2016), Essen (2017), Nijmegen (2018), Oslo (2019), Lissabon (2020), Lahti (2021), Grenoble (2022). The subsequent awards reflect certain design principles and blueprints for other cities to commit to further action, to showcase and encourage exchange of best practices. In this way, such examples might also be useful for the capital design of Indonesia amidst a tropical forest area.

The C40 is a network of the world's megacities committed to addressing climate change. C40 supports cities to collaborate effectively, share knowledge and drive meaningful, measurable and sustainable action on climate change. The Arcadis Sustainable Cities Index ranks 100 global cities on three dimensions, or pillars, of sustainability: People, Planet, and Profit. These represent social, environmental, and economic sustainability to offer an indicative picture of the health and wealth of cities for the present and the future. Australia's Sustainable Communities – Tidy Towns and Sustainable Cities awards programs encourage, recognize and reward local communities, councils, businesses and schools for their outstanding efforts to reduce litter, increase recycling and beautify and improve their local environment. All-in- all such

[1]https://ec.europa.eu/environment/europeangreencapital/

TABLE 1 | Selected cities for researching character of capital green cities.

Capital cities	Green cities
Brasilia – Brazil	Lahti – Finland
Putrajaya – Malaysia	Vancouver – Canada
Sejong – South Korea	Masdar – UAE
Berlin – Germany	Birmingham – UK

awards also reflect best practice and guidelines for further greening of cities.

There are also lists of the worst and least green city. One could argue that most of these lists are also not completely neutral, and often reflect certain interests. According to the IQAir ranking Hotan, China ranks as the most polluted city in the world, and Orzesze in Poland as the most polluted in Europe[2] Research conducted by Good Move ranked cities across the UK based on the degree of eco-friendliness, and lists Birmingham as the least eco-friendly[3]. The degree to which this is true is somewhat subjective. Criticasters would argue that many of these competitive lists are often also marketing tools for cities itself as well as for normative of political (mostly neoliberal, western) ideas (Angotti and Irazábal, 2017). The least green city may not reflect the ideal global city in the exes of some, despite perhaps having some other positive qualities of cities, such as being democratic, authentic or independent. It is therefore that one has to include a critical evaluation in the use of comparative frameworks.

Review of Documented Cases

The analytical and conceptual investigation relied on comparing and synthesizing documented experiences and learning lessons from previous examples of both previous capital city relocations and designs. Unlike a full systematic review a meta-review relies more on a justified sampling and selection strategy based on qualitative rather than quantitative grounds (Timulak, 2014). Hence, there was an investigation of characteristics of other cities which were supposedly green or perceived as green. The comparison of these examples relied on both the theoretical concepts combined with practical and professional choices made in different locations. The goal of this comparison is to derive recommendations for future designs and assessments of capital and green cities. **Table 1** presents the cities which were reviewed.

The choice for Brasilia was because its characteristics of its choice of re-location is similar to the planned location of the new capital of Indonesia, given its territorial centrality and its surrounding tropical rainforest. The current location had originally only some 1,000 indigenous residents, but the current population is estimated at more than 4,7 million (figures of 2021)[4]. The relocation of the capital from Rio de Janeiro to this location drew on several arguments, including developing and colonializing the hinterland, providing more security for administrator and residents and creating a new identity reflecting independence (Grimes et al., 2016; Bravo, 2019; Faria and Pescatori, 2019).

The choice for Putrajaya is its similarity in culture, geography and history. The location was on former oil palm and rubber plantations. Moreover, similar to the new capital of Indonesia, the Malaysian government created an idea to develop a capital primarily for an administrative function, aimed to host all of Malaysia's federal government ministries and national level civil servants, and all diplomatic activities for the country. Gradually the idea also developed into a more symbolic capital reflecting independence, modernization and Muslim culture.

Since 2012, South Korea accepted to allocate Sejong as the administrative capital, with a plan to relocate government functions outside of Seoul. Until today, South Korea has a two-capital model. Seoul has long been the official capital and the economic and cultural center of the country, but Sejong City is now the administrative capital where many of the government's most important agencies are located. The choice for looking at Sejong in view of assembling recommendations for Indonesia is 3-fold. Firstly, the governments has generated experience in the relocation process. Since 2012, the government of South Korea has relocated numerous ministries and agencies to Sejong, even though a number of organizations still reside in Seoul. Secondly, the character of the city as administrative center instead of creating a multi-functional city may resemble the phased-based approach in Indonesia. Thirdly, Sejong has especially become well-known internationally as one of the first ICT-driven smart city called Ubiquitous Cities (U-City), and one of the full-scale greenfield development models of a future city armed with cutting-edge ICTs (Leem et al., 2019). This is an ideal, which is also aspired by the Indonesian government. How this turns into practice may be insightful.

Berlin is a relevant case in the context of the IKN because of its recent transition as the new capital combined with enormous investments. Although the choice of Berlin as capital of the country has never been seriously disputed, not even before the fall of the wall, the image of Berlin suffers from its past. Konrad Adenauer, the first chancellor of West Germany after the Second World War, chose Bonn as temporary capital, assuming that it would be possible to relocate in case of a reunification (Leadbeater, 2016). After the "Hauptstadtbeschluss," the formal decision to opt for Berlin as new capital, the city faced however two major problems (Báčová, 2012; Rossman, 2018). First, the city's clear connection Germany's national-socialist past, reflected in the once again centralized structures (Campbell, 1999). A Germany with Berlin as its capital can be matched with the Germany from the Nazi-past as it again represents a strong and centralized state, that was the basis for quick takeover of power by Adolf Hitler (Campbell, 1999). Secondly, there was a tremendous pressure on ensuring the construction of appropriate symbolic artifacts representing the identity and memory of the city (Campbell, 1999; George et al., 1999; Rossman, 2018). Many buildings from the Nazi and communist past were destroyed and provided space for adequate memorial buildings, but most of these were equally praised and criticized.

[2]https://www.forbes.com/sites/emanuelabarbiroglio/2020/02/29/cities-in-poland-and-italy-among-europes-100-most-polluted/?sh=490b662c58fd
[3]https://goodmove.co.uk/britains-green-cities/ (last date of access 23 March 2021).
[4]https://worldpopulationreview.com/world-cities/brasilia-population (last date of access 21 February 2021).

New Berlin differs from its past states: German federalism has decentralized the city and stressed institutional separation (Campbell, 1999). Second, was the high expectation on appropriate culture of memory in the city (Campbell, 1999; George et al., 1999; Rossman, 2018). Many buildings from the Nazi and communist past left plenty of space for adequate memorial building. Germany, obviously, wanted to erect a capital that well-cared for its past, and even hoped to integrate a combination of western capitalism and eastern socialism in the cityscape and the whole country after reunification (Campbell, 1999). For many the city ever has been the symbol of reunification (Cochrane and Passmore, 2003). It is well-located and can serve for the country's economic rebalancing by attending to east-German unemployment rate, and pan-European unification (Bedford, 1992; Faggio et al., 2018). Without disregarding Bonn, where six out of 10 ministries have remained, also for fear that the city would otherwise perish, the reintroduction of Berlin could contribute to the reconstruction of an entire nation and demonstrate solidarity between East and West (George et al., 1999; Leadbeater, 2016; Rossman, 2018). However, the decentralization measure alone, and the associated communication between Bonn and Berlin, is estimated to cost around 5 million euros annually (Rossman, 2018).

The most recent green European capital (of 2021) is Lahti in Finland, the capital of the Päijänne Tavastia region of Finland, has a population of 119,068. Lahti lies approximately 100 kilometers to the northeast of Helsinki, the capital city of Finland on the southern bay of Lake Vesijärvi. The rapid industrialization in Lahti in the last decades led on the one hand to significant economic growth for the region, but also to significant environmental challenges, such as the eutrophication of Lake Vesijärvi and a higher dependency on cars in the city center. This prompted the city government to come up with more comprehensive green policies, involving multiple stakeholders, directly affected by the negative ecological impacts, such as the Lake Vesijärvi project, where university research groups, residents, local companies and the City work together to improve the lake's condition. Despite the relatively small size as compared to most major European cities and country capitals, the experiences of Lahti are highly relevant for the construction of a new city in a forest area. Additionally, since the current plan of the IKN is an upgradable growth, in different phases, it will need to start with a relatively small starting territory. The description on the website of the European Green Capital states that in Lahti, 99% of people live within 300 m of green urban areas. The city enables its inhabitants to enjoy nature in many different ways, offering leisure activities such as skiing, fishing and wild berry and mushroom picking. The city has a clear vision for green growth and eco-innovation. The Lake Vesijärvi and the Grassroot projects, for example, promote the reuse and sharing of public spaces in the city, making these spaces available to rent. These kinds of ideas enable the development of new projects with strong citizen involvement.

Vancouver's greenest action plan (GCAP) of the City of Vancouver, originating from 2009, is comparable to the IKN in the sense that the plan aimed at becoming the greenest city in the world by the year 2020. Such high ambitions together with the action items in the plan may be relevant in constructing larger metropolitan areas. Vancouver has approximately 600,000 inhabitants. Remarkably enough Vancouver, the largest city in British Colombia is not the capital of that Province, which is the less populated Victoria (∼335,000 citizens), but there were plans to move the capital from Victoria to Vancouver[5] In any case, the greenest action plan led for example to winning the C40 cities award at the 2015 Paris Climate summit[6] The GCAP outlines the following 10 discrete goals: green economy, green buildings, green transportation, zero waste, access to nature, lighter ecological footprint, clean water, clean air, local food.

Abu Dhabi, one of the emirates of the United Arab Emirates, initiated the construction of Masdar City. The location is 17 km from Abu Dhabi International Airport, in the middle of severe desert conditions. To build an environment with many greenfield conditions seems therefore at first extremely ambitious. Launched in 2006, Masdar City aimed to be a model of sustainability and of urban planning itself (Cugurullo, 2013). Developed by the state-owned Mubadala Development Company, the aim has been to combine smart technologies with ecologically-balanced integrated urban development, including self-generated energy availability through solar, energy efficiency and other zero-carbon features in subsystems such as transportation, civic utilities, physical infrastructure, water management, waste management (Sankaran and Chopra, 2020). The carbon-neutrality is remarkable in a country which is rich in fossil fuel, and whose GDP depends for 70% on the export of oil and gas. Nevertheless, the city should become home for 40,000 people and 50,000 daily commuters. The choice to look at Masdar City as an example for the IKN is relevant because it is also a city built from scratch aiming to be energy neutral and not depending on natural resources from the vicinity.

To understand if the greening policies of highest and lowest ranked green cities are essentially different we also add Birmingham as the least eco-friendly city in the UK. The question hereby is if not being green also corresponds to not being participative, democratic or socially just for example, or whether not being green in the eyes of the ranking is instead a political branding issue. In fact, the city council of Birmingham developed a "green living spaces plan" in 2013 (Birmingham City Council Development Directorate, 2013) based on the greening principles of prosperity, fairness and good health, a city in which to work, live and enjoy by being more efficient with scarce resources and a city for the delivery of green finances and business – so-called green urban entrepreneuralism.

8R Framework of Responsible Land Management

The analytical lens of the investigation was the 8R framework of responsible land management (De Vries and Chigbu, 2017). The 8R framework was derived from international

[5]https://dailyhive.com/vancouver/bc-capital-victoria-vancouver-legislature-move

[6]https://www.straight.com/news/591306/vancouvers-greenest-city-action-plan-wins-c40-cities-award-paris-climate-summit

TABLE 2 | 8 R aspects of the 8R framework of responsible land management.

	Looking at questions such as …
Responsive	Including needs, requests, long-term views of stakeholders Addressing urgency of need
Resilient	Ensuring or creating the sustenance of societal structures Avoiding major disruptions
Robust	Based on solid mechanisms Not leading to fundamental change or disruptions
Reliable	Decisions are trusted or are based on trust or creating trust by stakeholders and directly affected citizens
Respected	Decisions and actions are valued positively by stakeholders and directly affected citizens Decision makers are seen as appropriate leaders or managers
Retraceable	All steps are documented, so history can be reconstructed At all times it is possible to see which steps have been taken by whom, and what still needs to occur
Recognizable	People can identify with the decisions; there is ownership of the project or intervention
Reflexive	At regular points in time there are moments at which the rightfulness or appropriateness is re-evaluated or re-assessed

TABLE 3 | The aspects against which the 8Rs are reflected.

	Looking at questions such as …
Structures	Validity and functionality of institutional structures to manage the project or intervention Validity and functionality of technical structures needed for the interventions
Processes	Logic of process sequence Appropriateness of individual steps Need for parallel processes / steps
Outcomes and impacts	Appropriateness of results, changes Visibility and proof of results, changes

literature and multilateral conventions and guidelines on what is considered "responsible" public administration, land governance and spatial planning (Bourgon, 2007; Cooper, 2012; FAO, 2012). The resulting assessment framework aims at analyzing and classifying differences among cities and to derive practical recommendations for improvement. This 8R framework uses 8 aspects which qualify land interventions, evaluating whether these are responsive, robust, respected, recognizable, resilient, reliable, reflexive, and retraceable. These aspects are largely self-directed, but during the evaluation, one can also combine these if certain artifact or manifestation justify this. During an 8R assessment, one evaluates for each aspect the degree to which these are present in either the structure, processes or impact generation of the associated land intervention. Such an assessment can be both qualitative and/or qualitative (Amekwa et al., 2018). Part of then assessment also include elements of being participative, inclusive or democratic, which are crucial for spatially just urban planning (Caldeira and Holston, 2015). Specifically, the aspects of responsiveness, respect and reliability address the extent to which these values are present in the preparation, execution and maintenance of such interventions. **Tables 2**, **3** list the type of questions, which are relevant for each of the 8 R aspects.

Like any assessment, an 8R assessment cannot be fully neutral, or free from any assumed epistemology and axiology. It is best to clarify this from the start in order to position the assessment in this context. To a large extent the 8R framework is an engineering heuristic rooted in an engineering epistemology (Grimson and Murphy, 2015), aimed at practicality, experience and iterative revision of old and new interventions. The ultimate goal of the 8R assessment is not to rank the chosen case cities in a list of good and bad, or to compare cities in develop or developing countries but to derive practical suggestions for spatial interventions, prevention of technical and social conflicts, and planning of early mitigation measures.

RESULTS AND DISCUSSION

The analysis of the abovementioned-documented cases relied on the 8R framework. The assessment involved reflecting on the degree to which each of the 8 R's were present and/or significant (positively or negatively) in each of the respective cases. This was a qualitative assessment in view of the questions for each of the 8 R's (summarized in **Table 4**). More detailed questions could be added.

The discourse on the pros and cons of Brasilia as a novel city developed from scratch is broad. An often-framed critique is that the design of the city followed a now outdated image of what a city should look and feel like. An overall impression of emptiness one of the expressed critiques, whereby all of the government buildings were similar and located based on geometric principles. The residential "superquadra," or superblocks, intended for government workers and their families were outside of the government areas. Each superquadra looked alike, containing six-story residential towers in a park-like setting as well as a school, playgrounds, shops, recreation fields, and community spaces. Its original conception was egalitarian, providing equal opportunities to all citizens, without any preferences or differences. This vision intended to foster social change, in particularly handling the Brazilian socio-economic segregation (Rezende and Heynen, 2020). Various scholars have however highlighted that segregation continued in all sorts of forms. The original plan for Brasilia did not anticipate low-income housing for example, suggesting that the city would not host and reflect all classes of society. Expansion of the city into peripheral areas of the region due to Rapid population growth however, enhanced the unplanned and informal character of the region. More generally, top-down land governance led to socio-spatial fragmentation (Costa and Lee, 2019). From an 8R perspective, one could say that the original design was not in accordance with needs of citizens, or at least not in line with consultative processes, hence not responsive. The subsequent continuing critique on land use planning and land use control, lack of multi-functional use of space suggests problems regarding the robustness of the design and subsequent policy measures. In addition, the continuing socio-spatial segregation coupled with

TABLE 4 | Summary of 8R, urban greening and gentrification findings for each selected city.

City	Did well on aspect	Concerns exist with aspect	Concerns with greening and gentrification	Recommendation for IKN
Brasilia	Retraceability (many of the earlier plans are preserved and documented). Resilience (new societal activities emerge beyond the original design and societal ownership and belonging emerges with time).	Responsiveness (due to lack of participation), Recognizability (segregation and crime have increased), Robustness (too rigid land use planning processes).	Spatial design and associated land use control applied too rigidly, leading to car-biased/favored urban structure.	Enhance reflexivity in subsequent spatial decision making and implementation phases. Create sufficient public transport for all levels of society. Provide space and time for bottom-up new socio-economic initiatives and a sense of ownership.
Putrajaya	Respect, recognition and reliability (society supports and trusts the decision to relocate and people can identify themselves with the decision).	Responsiveness (limited direct involvement of citizens). Robustness (given the side effects of rapid uncontrolled property price increases).	Eventually it turned into a car-favored city design. Given its close proximity to the old capital, similar types of gentrification emerged.	Carefully plan and control unintended socio-economic side effects of the relocation. Seek broad public support.
Sejong	Respect (as there was both political and societal support)	Resilience. (legal) robustness (as the legal foundation for the relocation was declared unlawfull and the ICT-supported processes did not increase efficiencies.	(unvoluntary) displacement is likely to occur.	There is a need to create more functions and facilities in order to attract a critical mass of people and increase its livability. A new capital will have to accept having to deal with the collaborating with functions and processes from the old one. Redundancies may emerge. Displacement must be taken seriously.
Berlin	Recognition, because most Germans agreed with the relocation.	Robustness and respect are at stake given the high costs for the reconstructions and the emerging gentrification. Responsiveness, because Bonn actually had an operational government infrastructure.	Gentrification arises if costs for upgrading are not equally distributed spatially.	Maintain existing infrastructure from old capital which is operational in order to reduce immediate costs. Carefully reflect on costs for monuments.
Lahti	Respect and retraceability (given the documented evidence needed for the award). Recognition and resilience (given the high number of citizen initiatives). Reflexiveness given the commitment to lessons learned and proposed modifications for the future.	Robustness may be a concern if the city expands and/or if certain unforeseen inequalities arise.	Upgrading and greening close to the waterfront may lead to gentrification. New types of businesses and SMEs may be required to reduce the spatial economic inequalities.	Greening implementation work best when applying a reflexive and upgradable strategy supported by a variety of citizen initiatives. Broaden the spectrum of business and SMEs.
Vancouver	Respect and recognition structures (citizens agree with the overall goals).	Resilience and recognition processes and outcomes (people do not live by the goals).	Gentrification occurring in multiple ways especially in re-development and transit oriented development strategies.	Ensure that ambitions and reality remain in sync. Do not strive to be the best only for the international rankings. Align redevelopment strategies by creating more equal access to housing for all.
Masdar City	Reflexivity (given the changed approach over time) Resilience (as the developed technologies have become profitable and bankable over time).	Responsiveness (as no clear need was addressed at the start). Recognition and respect (as at the project is primarily for profit and not for people).	Risk of inequality and inaccessibility (given that most of the town still empty).	Rethinking the original approach after a number of years of construction is crucial.
Birmingham	Responsiveness derived from the greenerbirmingham people's manisfesto.	Resilience and robustness are at stake because social and environmental justice and equity are not aligned.	Social housing policies are still insufficient to deal with spatial inequalities.	More holistic approach which aligns greening and social and spatial justice approaches is necessary.

the uncontrolled migration suggests a lack of recognition of structures and processes. Furthermore, from a land management perspective there were strict limitations on building height, land use, and rooflines. Transportation was centered around cars, which was at the time of its design the new, exciting mobility technology. This suggests limited space for redesign, renovation and hence limited reflexivity.

On the other hand, a number of authors also highlight positive elements of Brasilia. Lara (2010) notes that despite the inequalities, spatial exclusions, and frustration with the slow pace of necessary transformation, Brazilians have adapted to these challenges, and have brought Brazilian traditions with them while developing new urban practices. He specifies that after 50 years of development in Brasilia *The superquadras are thriving with busy restaurants and bars every few blocks and noisy with children playing on the interstitial green spaces. What caused the change? The main factor is time. The small young trees planted at the city's inception have grown into large shady canopies. Stores that address the specific needs of the local inhabitants have thrived and multiplied. These changes highlight the fact that no city can be judged at its beginning. Instead, Brasília, like all cities, needed time to develop and evolve* (Lara, 2010). This suggests a high degree of resilience, be it perhaps unplanned. Furthermore, the ethnographic work of Marques et al. (2021) suggests that regardless of in which neighborhood of Brasilia children grow up they show a similar sense of belonging to the places in which they live. This would indeed reflect a sense of ownership of their location, which obviously can only emerge with time.

The construction of the capital Putrajaya also did not come without any critique or adversaries. Despite the public appearance of highly criticized deforestation to make way for the new capital, the design of Putrajaya aimed at using the available green to establish an ecologically friendly city with large green spaces and a big artificial lake in the center (Moser, 2010). Yet, soon after the inception, the national oil company Petronas took over a large part of the financing and planning, which resulted in a situation where the ecological focus was quickly vanishing. Instead, the resulting spatial design reflects the preference for a car-based city (Omar, 2004). In terms of the 8Rs one could argue that the relocation was not a bottom-up initiative and limited consultation with broader groups of stakeholders took place. Hence, the aspect of responsiveness in the design and construction has been limited.

In terms of spatial development Kozlowski et al. (2017) warn that the current urban regeneration and transformation of Kuala Lumpur Metropolitan Region, which includes the axis to Putrajaya, has the potential to lead to gentrification in a similar fashion in the entire region. Such a development would call for measures of closer connections to communities and more community participation in the urban regeneration process. In addition, the development of the metropole as a whole is positive for the economic power of the region, yet will also reinforce urban gentrification and a rapid increase in property prices. Both have a potential socio-spatial segregation effect. Reflecting from the 8R framework one could argue therefore that the development may lack a certain degree of robustness. It may lead to unintended and uncontrollable side effects, such as the price increases of properties.

Contrastingly, the public support for the relocation to Putrajaya is considerable. A large-scale survey executed and reported by Betria and Raju (2018) confirms this public support despite the fact that many respondents indicate having congestion problems having to travel to their new work place. Yet the decision of the Malaysian government is both trusted and respected. Hence, the relocation scores high on the aspect of respect, reliability and recognition as people also identify with the new capital as their symbolic center.

In South Korea, the development and growth has been slow in Sejong and it has not attracted many residents to relocate from Seoul. Sejong has a population of 351,007 as of 2020 and covers a geographic area of 465.23 km^2, making it the least populous and smallest administrative division in South Korea. It has remained largely mono-functional, suggesting that any aim to create a lively city atmosphere will require a broad spectrum of development incentives, including opportunities for jobs and provision of cultural and educational facilities. Hence, in terms of self-sustainability and resilience it scores low.

Secondly, the ubiquity and smart nature of the capital remains contested. Hur et al. (2019) posit that the relocation has created bureaucratic inefficiencies simply because of the two-capital model. Despite ICT-enabled solutions, dubbed "Smart Work," these inefficiencies have actually remained intact and have not solved the challenges of information and ICT-based administration. Therefore, the relocation is not sufficiently robust in its processes, as organizational redundancies and cooperation problems persists. The result is that Sejong only functions as a "mini-capital." From a greening perspective the abundant presence of green areas instead of a polluted and congested city center, the presence and functionality modern and sustainable transportation systems, and an optimal social mix within the neighborhoods make the city quite liveable and identifiable, and can ensure that the city can function sustainably (Kang, 2012; Choi and Reeve, 2014). Hence, the aspect of recognition scores high.

Regarding the gentrification in Sejong one has to look at the existing studies of characteristics of gentrification in Seoul. Multiple type of gentrification exist: commercial gentrification (Ryu et al., 2020), housing gentrification (Kwon et al., 2017), restoration related gentrification (Lim et al., 2013). When gentrification requires displacement of people Lukens (2020) demonstrates the consistent relationship between metropolitan-scale redevelopment and the process of repeat and chronic displacement in Seoul. Hence, it is very likely that displacement is a feature which occurs for the development of Sejong as well, be it however a rather hidden or undocumented feature.

Berlin's modernization has suffered from robustness and respect, given the high costs for the reconstructions and the emerging gentrification. The degree of participative approaches and direct benefits for stakeholders and affected citizens was not always sufficiently taken into account. The degree of responsiveness can also be critically evaluated, because Bonn actually had an operational government infrastructure and there was no immediate need to reduce or replace this. With regard

to gentrification, there is an abundant amount of literature suggesting that Berlin's urban renewal policy since the unification (Siemer and Matthews-Hunter, 2017; Döring and Ulbricht, 2018). Its gentrification also often comes with involuntary displacement (Helbrecht, 2018).

Lahti's green strategy has a number of characteristics, which are remarkable in terms of the 8R framework. Besides having well-respected and well-documented strong aims regarding air quality, waste, green growth and eco-innovation, the governance strategy brings together brings together several programmes and plans including those focusing on smart, clean and circular economy, mobility, environment, energy, urban regeneration and citizen science. The central theme and vision for Lahti's 2018 city strategy is "Bold Environmental City," which did not come out of nowhere. It was built on several earlier pilot projects, with built-in reflexivity. Effects of the air quality plan of 1997 were closely monitored, and only after evaluation led to air quality regulations for the entire city. Such a reflexive and upgradable strategy is meaningful for the development of IKN as well.

With regard to gentrification there are various in-depth studies on gentrification and spatial inequalities in Finnish towns, such as (Jauhiainen, 1997; Ehrström, 2016). Specifically for Lahti the dissertation of Airas (2016) provides some general description in direct relation to upgrading of certain parts of the town, such as the waterfront area. Yet, the work of Hyötyläinen (2019) provides specific historical and socio-economic context for why gentrification has occurred only recently. Until recently OECD had listed Finland as the country with the least inequality. This changed however with the emergence of new technologies and industries, in particular related to telecommunication and ICT. The 2019 OECD statistics[7] indicate an income inequality of 0.269 for Finland (OECD, 2021), where it used to be 0.211 in 1992 (reference: 0= complete equality; 1 = complete inequality). According to the European statistics (EURES) in 2020 the region in and around Lahti has an employment rate which is below the national average, while the unemployment rate is above the national average, being one of the highest among all regions in Finland. Part of this may be due to the age structure as the share of those over 64 is above the national average. These kinds of statistics are no worrying *per se*, but suggest that certain types of businesses, such as family businesses, may be at risk, which may lead to spatial inequalities. New types of economic activities, such as tourism may thus be required to decrease the economic disparities.

With respect to Vancouver overall the greening efforts are highly praised and recognized globally. Yet, Affolderbach and Schulz (2017) also provide a critical note to this image. The argue that perhaps too much emphasis has been laid on becoming the first ranked city on international ranking schemes and performance indicators, at the expense of staying close to participatory approaches and changing the behavior of its citizens to meet the targets. So, whilst the political ambitions regarding participation are very visible in the policy process and setting the goals they are not always lived in reaching and monitoring the goals. In fact, citizens have expressed a certain level of disappointment in the leadership and action, despite the overall support for the GCAP. For the 8R framework this translate in a relatively high score for respect and recognition structures, but a lower value for the resilience and recognition processes and outcomes. O'neill and Affolderbach (2018) add that there may still be a large gap between the image of the city as leader of radical change toward greening and the actual reality which is not so radical.

Regarding gentrification, Mösgen et al. (2019) remark that privatization and demolition of the public housing complexes not only are a withdrawal of the state in securing equity in access and use of property, but also lead to direct and exclusionary displacement, and the forms of contestation and protest. Additionally, Jones (2020) describes displacement and gentrification because of transit oriented development strategies in Metro Vancouver. The transit oriented development strategies indeed create more opportunities for more energy-neutral mobility, yet also lead to gentrification because the rapid redevelopment of low-income rental housing follows the opening of a new rapid transit stations. Access to low- cost rental housing near public transit is important for the settlement process of refugees, making these newcomers particularly vulnerable to this form of gentrification.

Masdar City's original plans had to be scaled back due to lessons learned from continued assessments of the original concept (Griffiths and Sovacool, 2020), which altered the initial goals for reduction of CO2 and waste and drastically changed the manner in which the city aimed to develop. More specifically this meant only a 30% reduction in the embodied carbon of construction materials used in the construction of its buildings (relative to comparable buildings in Abu Dhabi), 40% reduction in the energy consumption of its buildings (relative to comparable buildings in Abu Dhabi) and 40% reduction in the use of interior water (relative to comparable buildings in Abu Dhabi). Although not ideal, one has to remember that Abu Dhabi is the country with one of the highest greenhouse gas emissions per capita in the world. Yet, the stepping back and re-assessment of the rightfulness or appropriateness of the approach is a clear sign of reflexivity (Griffiths and Sovacool, 2020). Therefore also conclude that re-thinking the original goals given the current and upcoming changing realities *may turn out to be the best outcome for Masdar City if it is truly to become a model for "eco-cities" of the future.*

On the other hand, one could also question whether there was an explicit need for the construction, and whether this project was actually a particular response to this need. Desouza et al. (2020) describes the pathway and some difficulties with Masdar city. Masdar relied on a top-down planning approach, faced many economic struggles and did not attract as many as innovative industries as was hoped. Moreover, the city itself is still rather empty. Therefore, in terms of responsiveness the project would score low. On the other hand, since its inception the UAE has been able to gradually build research and development on renewable energy, which is now an internationally requested community. Hence, paradoxically, the initial non-economic project may turn into a profit making industry. From the 8R perspective this has an (perhaps unintended) built-in resilience.

[7]https://data.oecd.org/inequality/income-inequality.ht

Cugurullo (2013) reflects on the, development of Masdar city as a manifestation of the nexus between eco-cities and sustainability ideology and shows how and whether such ideologies actually emerge in the manifestations of the practical development of new settlements. The conclusion of his critical reflection is that at the end of the day the Masdar City project turns out to be one with profit maximization, whereby the "social," component is not part of the agenda. He concludes therefore that despite image of the city being portrayed as constructed according to a broader sustainability ideology, project is covered is essentially dominated by economic logic.

The assessment of greening and gentrification of Birmingham is not overwhelmingly positive. Despite that fact that other rankings are currently referring to Birmingham as one of the greenest city based on the amount of green space, Mckendry (2017) argues that gentrification, a prioritization of the green consumption preferences of the middle class and use of scarce public funds for green amenities all remain serious concerns. Also, the critique on the implementation of the greening plans often refer to lack of progress, proper measuring indicators and the need for urban regeneration and revitalization. Hence, the struggles in Birmingham to make the city greener have also highlighted that greening cannot be isolated from making the city more socially equitable. Hence, a more holistic understanding of the relationship between social and environmental sustainability is necessary. In terms of the 8Rs one can therefore state that resilience and robustness of the greening polices are clearly at stake. The fact that the initiative www.greenerbirmingham.com emerged also provide evidence of more responsiveness and calls for more inclusion in the greening strategy.

CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

Especially post-independent countries often decide to relocate their capital city to a new location. This re-location comes often together with new ideas of what this capital city should present symbolically and with contemporary knowledge and insights in responsible and sustainable city development. Indonesia has also recently embarked on this strategy. The intentions for its new capital city – designed to be located in Kalimantan - are that it should become the greenest, smartest and sustainable capital city in the world. There are currently various designs for this new capital city, but it remains relevant to assess how and when such an ambitious goal is achieved. This research should thus support the further choices in the design and implementation of the relocation of the Indonesian capital city. How such intentions should become reality and what such intentions imply is the key objective of this article. We hypothesize that previous examples contain a certain degree of similarity, which can derive recommendations for future capital and green city designs. We further hypothesize that inclusion and diversity of such cities are vital. The fundament for this research lies in defining what actually constitutes both a capital city and green city. There are differing concepts related to both of these terms, which are dependent on location, ideology, culture and strategic planning. These differences influence the choices for the construction of a new capital city, which needs to be green and/or smart. The 8R analysis derived that the requirements for a relocation and a design for a capital and green city are multiple. Key requirements include the participation and inclusion, recognition of diversity, sustenance of cultural and landscape identity, sustainable balance of original and novel green and equal appreciation for both national and local needs and practices.

The conclusion is that new capital city designs and implementation of construction and planning activities inevitably require a fundamental and explicit framework when choosing to be green and responsible. Recognition and acknowledging aspects of spatial justice and inclusion in the design and execution processes is crucial. Furthermore, the design of greening should not be at the expense of existent tropical forest or cultural landscapes, or designed in complete isolation of spatial justice and affordable housing strategies. Concerning the specific nature of capital cities there are still additional requirements. Some of these are taking care of symbolic elements in the design of monuments, shapes and structure of the city representing national identity. Additionally there are functional elements, in order to preserve and maintain attractiveness and livability. Finally, there are social and cultural requirements, such as securing land tenure and land rights, securing diversity and relying on indigenous and local diversity and identity of cultures. This research and these findings is relevant for urban planning and design and for the wider field of land management.

Further research could extend the comparative assessments into additional capital and green cities, and also on the links between greening and social justice. The political realities of greening and capital relocations are often different from the more ambitious strategies and innovations in urban greening designs, such as those from Watson et al. (2020). In the greening design of the Indonesian capital city, the first indications are that the politicians are purposely opting for this more radical greening alternatives, but instead rely on more traditional or conventional greening strategies. This is however not to say that these options and choice may change in the future. It is exactly for this reasons that the last aspect of the 8R framework, reflectiveness, is crucial and why the development of the new capital city in Indonesia will need to be followed closely. Hereby the key interests are which socio-spatial decisions the Indonesian government will make in the process of city development, how and where local and (inter)national stakeholders will be involved and how fast the development and migration to the city will go. Following the experiences of other cities a gradual process with regular moments of reflexivity and close consultation with local and regional authorities is advisable in order to avoid regional disparities and inequalities. Of course, the new capital will be more than just symbolic. It also needs to be a liveable city where all kinds of citizens can enjoy their own quality of life and where national and international travelers will be happy to travel to. The experiences of Brasilia and Berlin amongst others has shown that gentrification is likely to occur if the development will be mono-functional, i.e., primarily focusing on

the administrative capital requirements, or erecting monumental symbolic buildings only. Instead, the developments in Sejong and Lahti have shown that a gradual development with considerable involvement of public and private parties which develop multiple functions and services based on smart and green concepts is likely to be more successful.

An additional critical note may be that the choice for this 8R assessment framework, with the associated questions, might be biased toward favoring western or Eurocentric ideologies of how to govern cities. Some of the questions within the framework might be seen as favoring bottom-up governance structures and western types of new public management systems and associated discourses. On the other hand, the main aim was however not to critique non-European countries or administrations in particular countries wanting to change their capital city, or pointing to the problems of their greening strategies. Instead, the application of the framework provides more transparency in the so-called "responsible" land management or governance claims, and derives inductively practical planning and governance problems which may occur, irrespective of the location of administration.

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.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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The City of São Paulo's Environmental Quota: A Policy to Embrace Urban Environmental Services and Green Infrastructure Inequalities in the Global South

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In 2013 the urban authority for São Paulo city, Brazil, was interested in incorporating environmental aspects into the urban licensing process of diverse urban developments. To overcome concepts related simply to soil sealing, the initiative gave rise to a wide range of principles associated with environmental services and the consideration that green areas in this megacity are unequally distributed. Given the costs involved in analyzing each case and the legal uncertainty among entrepreneurs, it has become a tradition in Brazil for authorities in charge of urban licensing to follow general regulations rather than case-by-case studies, except in high-impact developments. In response, the São Paulo municipal government developed during the period from 2013 to 2016 a governing instrument to deal with these issues, known as the Environmental Quota (EQ). For that, the following guiding principles were established: (a) it should have a solid theoretical basis, with incentives for consistent public participation; (b) it should be flexible in such a way that it can provide a general framework within which a project designer can make decisions, rather than a set of rigidly determined solutions; and (c) it should consider inequalities in the availability of urban green infrastructure throughout the city. This paper will first detail the political-institutional context in which the EQ and its guidelines were established and implemented, then provide a general overview of the tool and the theoretical frameworks within which it was developed, and, finally, discuss the complex social decision-making process of its legal constraints. Moreover, it analyzes the implementation and application of the EQ to examine its effectiveness and how it relates to the city's gentrification. Furthermore, it is considered the replicability potential of the EQ to expand both the supply and distribution of green infrastructure and environmental services throughout the urban environment and, thus, contribute toward mitigating the intricate problems of urban environments in the Global South.

Keywords: urban greening, urban land use, environmental services, gentrification, Environmental Quota, Biotope Area Factor, exergy, Quota Ambiental

INTRODUCTION

Contemporary large-scale urbanization has been exacerbating the global environmental crisis. In this context, cities throughout the world centralize the high demands for environmental and ecosystem services, characterizing the locus of fundamental mitigation actions for ongoing environmental changes (Seto et al., 2017). When it comes to mitigating and adapting to the impacts of climate change, for example, local governments face critical political and governing challenges (Di Giulio et al., 2019). Indeed, cities are both a cause of climate change, by way of the emissions of greenhouse gases, and victims of its consequences, given that urban inequalities exacerbate the negative impacts of climate disasters, such as floods, hurricanes, and droughts (Kjellstrom et al., 2007; Bulkeley, 2010; Prieur-Richard et al., 2019).

Green urban infrastructure has been recognized as a key element of any strategy to deal with climate change issues, given its potential to mitigate greenhouse gas emissions and, therefore, reduce the contribution of cities to global climate change, as well as improve the environmental health and quality of life of its residents and reduce their vulnerability to global climate change impacts. However, the process of greening urban spaces has been characterized by the gentrification paradox, whereby poorer and more vulnerable populations have become isolated and pushed out to locations far from these urban improvements (Cole et al., 2017; Haase et al., 2017; Staddon et al., 2018; Andersson et al., 2019).

Cities with high population densities and poor planning, particularly those in the Global South, face worrisome conditions regarding the risks of heavy rainfall associated with poor green infrastructure, deep social inequities and housing built on extensive areas susceptible to flooding and landslides. Moreover, the vulnerable urban populations who live in these cities face constant difficulties due to increasing urban population density, high soil sealing, and insufficiency of environmental services, such as the provision of healthier environments (Anguelovski et al., 2016; Prieur-Richard et al., 2019).

In this paper, it is explored the parceling, use and occupation of land in the city of São Paulo, Brazil, concerning the implementation of the Environmental Quota (EQ), an innovative public policy tool designed to render ecosystem benefits by implementing green infrastructure and flood mitigation on private[1] lots in a city that is highly vulnerable to climate effects and has deep social inequities. Furthermore, it is described the process that led to the development of the EQ and its subsequent institutionalization as an alternative regulatory policy to deal with urban environmental services, urban drainage, and urban microclimates.

This paper is organized as follows, after this introduction: section Environmental Quota Development and Institutionalization summarizes the process that led to the development of the EQ and the principles and legal institutionalization of it in the context of the municipality of São Paulo; section Stakeholder Engagement explores the role of the stakeholders involved in the development and implementation of the EQ; section Effectiveness and Provision of Environmental Services examines the effectiveness of the EQ for the provision of environmental services from private urban plots; section The Environmental Quota and Gentrification discusses the relationship between the EQ and gentrification; section Replicability of the Environmental Quota analyzes the replicability of this initiative in other cities; and, finally, section Final Considerations presents the final considerations. The methodology used in this paper, and which forms the basis of discussions, is descriptive, especially concerning discussions surrounding the replicability of development analogous to the EQ in other cities.

This paper is developed from the empirical evidence through participant observation (Yin, 2015) made by the first four authors, which are career technicians working for the city of São Paulo and played prominent roles in proposing, developing and implementing the EQ. Therefore, as a review of policy and practice, this paper was developed by compiling, analyzing and discussing the process of environmental innovation within the context of development and implementation of local government policy. It relates to the public processes and is also dedicated to highlighting the relevant dialogue between various stakeholders, and reflections on issues inherent to the challenges of urban greening and urban sustainability.

ENVIRONMENTAL QUOTA DEVELOPMENT AND INSTITUTIONALIZATION

São Paulo city[2] is the capital of the state of São Paulo and is the most populous municipality in Brazil, with about 12 million people (IBGE—Instituto Brasileiro de Geografia e Estatística, 2021). Although the city only occupies 0.02% of Brazil's total landmass, it concentrates 12% of the country's GDP (Seade apud EMPLASA, 2019). São Paulo is characterized by high population density in the outskirts, social inequalities, housing deficits, informal and unplanned urbanization, occupation of risk areas, high rates of soil sealing, and unequal distribution of green areas and environmental services. Any innovation implemented in the greater cities of these regions has the potential to reverberate through to the surrounding municipalities and, thereby, further contribute to the regional dilemmas of unsustainable urbanization.

In order to implement the most recent São Paulo Municipality Strategic Master Plan, which came into effect by way of law 16,050 on July 31, 2014, it was required that several laws should be updated, among which was the law concerning the parceling, use and occupation of land, i.e., the zoning law. During the

[1]Our discussion also applies to developments in public lots, but in this text, we highlight the perspective of private lots that represent the vast majority of permits.

[2]In this paper, the words "city" and "municipality" are used interchangeably. Officially, the word municipality is more representative of the territory and its administrative structure, i.e., its executive power, the mayoral office ("*Prefeitura*"), which in Brazil is called the municipal administration. Brazilian municipalities also have legislative power, which is represented by a City Council ("*Câmara Municipal*"). The Brazilian Federal Constitution (CF) considers municipalities as federated entities. According to Fernandes (2013), it is the only country in the world that gives this status to municipalities.

preliminary works for the formulation of the new zoning law, the city administration decided to create a legal clause making mandatory for anyone seeking a license to build or renovate buildings to consider the environmental aspects of doing so, in addition to the environmental licenses already required by the National Environmental System (SISNAMA). It was agreed that this tool, unprecedented in the various Brazilian legal bodies, would be called Environmental Quota (EQ).

Internal seminars were held within the municipal administration to determine the guidelines to steer the development of the EQ. It was decided that the research being carried out by Caetano (2016) for his PhD thesis at the School of Public Health within the University of São Paulo would be used as a theoretical starting point to develop the EQ. Next, an *ad hoc* working group (WG) made up of four technicians from the São Paulo City Hall was created. These technicians are the first four authors of this paper.

Caetano initially sought to adapt Berlin's Biotope area factor (*Biotopflächenfaktor*, in German) (Landschaft Planen Bauen, 1990; Pobloth, 2008)[3] to the São Paulo context. In addition, the WG also considered Seattle's Green Factor (Hirst et al., 2008; Stenning, 2008), Malmö's (Sweden) Special Green Factor and Green Point System (Skärbäck, 2007; Kruuse, 2011) and Singapore's Green Plot Ratio to develop the São Paulo EQ. Given the idiosyncrasies and complexities of the city of São Paulo, the WG understood that the EQ should be more than a mere adaptation of the above cited experiences. Therefore, the EQ took on a shape of its own, with its particular characteristics. More details of the process to develop the EQ and concepts can be found in Caetano (2016).

Since the WG's activities began, it has been led by the following conceptual guidelines: first, that the purpose of the EQ is to insert an environmental clause in the legislation about the parceling, use and occupation of land; and second, that the insertion of such a clause must occur by way of institutionalizing the EQ into the zoning law with the same status as pre-established urban parameters, such as the occupancy rate, the land use coefficient, the building height and the floor area coefficient.

Three working guidelines were also established by the WG at the onset:

- Flexibility: the designers–for any submitting proposal–should not compose their projects from stereotypical solutions imposed by legislation, but from a relatively broad menu of environmental measures provided by the EQ legislation;
- Simplicity for the designer and the licensing body: a challenge to developing the EQ was to create a simplified process to assess complex issues. This was made possible with a set of powerful indicators, specifically eco-exergy, as shown in the following text. The result of this simplification is an electronic spreadsheet that facilitates the elaboration of each project considerably for the user. However, as a result of the urban, environmental, and political complexities inherent to the city of São Paulo, the EQ, during its development, was losing its desired simplicity;
- Solid theoretical basis: this guideline was never intended to deny the political nature of the decision-making process for the development and approval of EQ. On the contrary, the aim was to facilitate the decision-making process by developing a solid theoretical basis. Such a basis would allow any changes requested by the decision-making entities involved in the approval of EQ to reverberate throughout the EQ framework in order to provide a level of consistency and conceptual integrity of the EQ given these requested changes. Caetano's (2016) research provided fundamental support in this regard.

As the work progressed, it was deemed appropriate to add another guideline:

- No retrogression when it comes to environmental matters: for the EQ to be politically viable, it should not repeal any previously established legal municipal environmental protection provisions. Without such a clause, it would have been possible for any parties interested in relaxing previously established environmental provisions to maliciously take advantage of the EQ development process to do so. Moreover, were it not for this directive, groups who have fought hard and successfully over time to advance environmental legislation would not feel secure about EQ and they would oppose it.

The guidelines that were followed throughout the development of the EQ, concerning public consultation and compatibility with general and sectorial principles, plans and programs at the municipal, state and federal levels, did not need to be made explicit by the WG as they had already been contemplated in the Organic Municipal Law (the city's "Constitution"). The WG also sought to determine operationalization criteria (**Box 1**) and the environmental objectives of the EQ (**Table 1**).

The solid theoretical basis ensured that the indicators related to these environmental goals (**Table 1**) had cardinal character. Other environmental goals were implicitly considered in the choice of such goals. However, the indicators chosen for the implicit environmental objectives are merely ordinal in nature.

Drainage is one of several rainwater management measures that can occur on three levels: macro drainage, micro drainage,

BOX 1 | EQ operationalization should be as follows.

- The EQ is an index that aggregates several indicators to evaluate the environmental performance of an urban built-up plot;
- A given designer develops the lot coverage from a menu available in the legislation of surfaces of environmental relevance in the project (for example, green cover, vertical greenery, green roofs, greened surfaces, semi-permeable floor, arboreal specimens, palm trees), here called biotopes. Using an electronic spreadsheet provided by the municipality, the area covered by these biotopes is processed to generate a number. This number is the project's EQ (EQproj). The project must be such that the EQproj is either equal to or greater than the minimum established by the legislation (EQmin), which is determined according to the location and area of the lot.

[3]SENATSVERWALTUNG FÜR UMWELT, VERKEHR UND KLIMASCHUTZ STADT BERLIN. BFF Biotopflächenfaktor https://www.berlin.de/sen/uvk/natur-und-gruen/landschaftsplanung/bff-biotopflaechenfaktor/ (accessed February 14, 2021).

TABLE 1 | Environmental objectives and indicators.

Environmental objectives considered in the EQ*	Environmental measures	Associated indicators	EQ index
To promote lot drainage	Lot detention reservoir (default solution adopted) and unconventional lot drainage measures(for instance, detention basins, retention ponds, inlet devices, infiltration trenches, permeable sidewalks)	D v. **Figure 1**	$QA = V^{\alpha}.D^{\beta}$
To promote ecosystem quality** To improve the microclimate	Garden areas, existing trees and palmtrees, trees and palmtrees to be planted, existing tree clumps, green roofs, green facades, green walls, permeable and semi-permeable floors	V (simplified eco-exergy calculated according to the vegetation associated with the different biotopes)	

Source: produced by the authors.
**Other environmental objectives were indirectly considered.*
***V has been formally shown to be a good indicator of both ecosystem quality promotion and microclimate improvement.*
α and β are weighting coefficients.

and lot drainage. The EQ is concerned with the latter. To obtain the indicator for lot drainage, each lot is considered to be a watershed wherein the outlet corresponds to the pipes through which stormwater flows from the lot to the micro drainage system.

In a given basin with an area on the order of magnitude of an urban lot, it is perfectly adequate to use the rational method to determine the maximum outflow. To consider storage aspects, it is best to use the modified rational method (Chow et al., 1988). Hence, in the EQ method, each surface element of the constructed lot is assigned a runoff coefficient value (the surface elements chosen by the landscaper which are the called biotopes). An increase in the runoff coefficient can lead to the following outcomes: (a) the peak of the outflow hydrograph increases, (b) the lag time of the outflow hydrograph decreases; (c) the volume of water drained tends to increase. These are undesirable situations as they overload micro drainage systems.

It was decided that the EQ should only address the abatement in the peak of the outflow hydrograph. It was also decided that any measures aimed at abatement should be classified into one of two categories, as follows: (a) conventional measures (detention and retention for reservoirs) or (b) non-conventional measures (e.g., infiltration trenches, porous sidewalks, grassed trenches, infiltration wells). Finally, a decision was made to adopt the detention reservoir as the paradigmatic situation to develop the EQ, given that this is the measure that the technical community and licensors are most familiar with. Non-conventional measures will be subjected to regulations that are currently being elaborated.

The D indicator is a measure of how well the lot performs for promoting lot drainage. If the detention reservoir system succeeds at lowering the peak outflow hydrograph value of the plot to the pre-development value of the peak outflow hydrograph, then $D = 1.0$ (the so-called "zero impact"). If the placement of the reservoir succeeds at reducing the difference between the pre-developed and developed hydrograph peaks by 80%, then $D = 0.8$. **Figure 1** can better clarify the concept.

The EQ procedure is currently as follows: first, a given designer chooses the detention reservoir volume, then D is calculated according to the spreadsheet. A possible reversal of these procedures is currently being studied whereby the designer would first choose a D-value and then, based on that value, the spreadsheet would calculate the minimum reserve volume needed to obtain this D value.

Additionally, the EQ establishes detention reservoir outlet structure requirements, without which the mere requirement to a minimum detention volume would be innocuous.

The objective of the EQ is to improve ecosystem integrity based on a solid theoretical foundation through representative and powerful indicators. Ecosystem integrity has been well-documented by Kay (1991, 2000), and Schneider and Kay (1994), being integrity the ability of a given ecosystem to maintain its structure while self-organizing and dissipating energy. Xu and Tao (2000) point out that some ecologists prefer the expression "ecological integrity" to "ecological health." Furthermore, they state that these expressions are used in official documents in the USA to refer to long-term policies associated with environmental conservation objectives. There is a debate in ecology as to whether health and integrity are equivalent, and whether equivalent expressions can be assumed a priori. Jørgensen (2006) argues that the concept of eco-exergy is an excellent indicator of ecosystem health.

The exergy of a system is the maximum amount of work required to bring that system into equilibrium with its environment. Jørgensen (1992) postulated that ecosystems maintain themselves out of thermodynamic equilibrium with the environment. It occurs with a high degree of organization and information about that environment. Ecosystems do so in such a way that maximizes their exergy. Mejer and Jørgensen (1979) proposed that the content of the so-called eco-exergy of an ecosystem component can be calculated as the probability of producing such a component at thermodynamic equilibrium. For a component of an ecosystem, it consists of the probability of producing organic matter (classical exergy term)

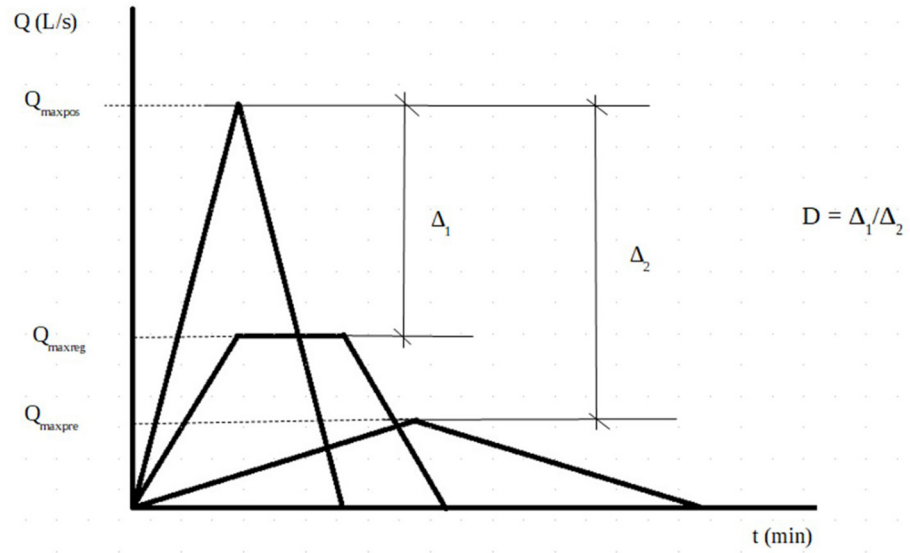


FIGURE 1 | Diagram of indicator D. Source: produced by the authors. Q_{maxpre}, maximum lot output flow in the pre-developed condition; Q_{maxpos}, maximum lot output flow in the post-developed condition; Q_{maxreg}, maximum lot outlet flow with regulation through the chosen detention reservoir; The lines of the hydrographs are presented as straight for the sake of simplicity.

and the probability of finding the genetic code, i.e., the correct sequence of DNA nucleotides (informational exergy term) of this ecosystem component (Bendoricchio and Jørgensen 1997; (Jørgensen et al., 2005; Silow et al., 2011a,b). Note that this calculation does not consider the information inscribed in the structure of the ecosystem. In practical terms, eco-exergy in a building project will relate, for example, to the diversity of tree strata and the types of vegetation cover rather than just the number of square meters of vegetation.

Thus, the V indicator of the EQ corresponds to the ratio between (a) the sum of a simplified Jørgensen's eco-exergy associated with the different surface biotopes of the per unit plot area and (b) a reference value that is intended to normalize the indicator. **Table 2** clarifies how the V indicator is calculated, demonstrating some possible landscape solutions listed in the EQ menu.

For calculating the existing trees and palms on a given plot of land, the V indicator uses a single variable allometric equation, namely the diameter at breast height (DBH), as it provides a quick assessment of the trees and palm trees already on the plot. For trees and palm trees to be planted, V should be estimated based on catalogs published by the São Paulo Municipal Secretariat of Green and Environment [São Paulo (City), 2005] with a considerable safety coefficient included to account for the probability that seedlings will not thrive. For other biotopes, literature reviews were conducted regarding their biomass, and the values used were judiciously chosen.

Caetano (2016) argued that eco-exergy also serves as a microclimate indicator and is frequently associated with urban greening and related environmental services. Thus, the V indicator seeks to describe how a built lot performs to improve both ecosystem integrity and the surrounding microclimate.

Given that a set of general rules regulates the EQ for licensing purposes, rather than on a case-by-case basis, it is essential to emphasize that mere compliance with its requirements does not guarantee, in of itself, a good landscape or lot drainage project (OBSERVASP, 2015; Cioni and Passos, 2018). This task is up to the landscape architect and the hydraulic engineer.

Once the values of the D and V indicators have been obtained for the project, the EQ indicator is, in turn, obtained by taking the weighted geometric mean of both. The WG opted to adopt the geometric mean instead of the arithmetic mean to limit the possibility that a designer could compensate excessively poor performance by promoting lot drainage with good performance to promote ecosystem quality and microclimate improvement, and vice versa.

Table 1 presents a summary of the intertwined relationships between the environmental objectives considered in the EQ, environmental measures, indicators, and the formula to calculate the EQ index. Values for EQmin (environmental standards) were set as a function of lot area and lot position in the city.

Considering that the city of São Paulo has rigorous legislation regarding tree management, development of the EQ provided a glimpse of a very auspicious environmental possibility. The paradoxical effect of excessive legal protection of an environmental good, such as protection of a given tree species, is well-known. The procedures to manage trees on land in the city of São Paulo are so difficult and complex that real estate developers argue the presence of trees on a given plot of land tends to devalue the property. Since trees that already exist in a given plot of land considerably increase the numerical value of EQ as it is calculated in its spreadsheet, the EQ goes against this trend.

TABLE 2 | Calculation of indicator V.

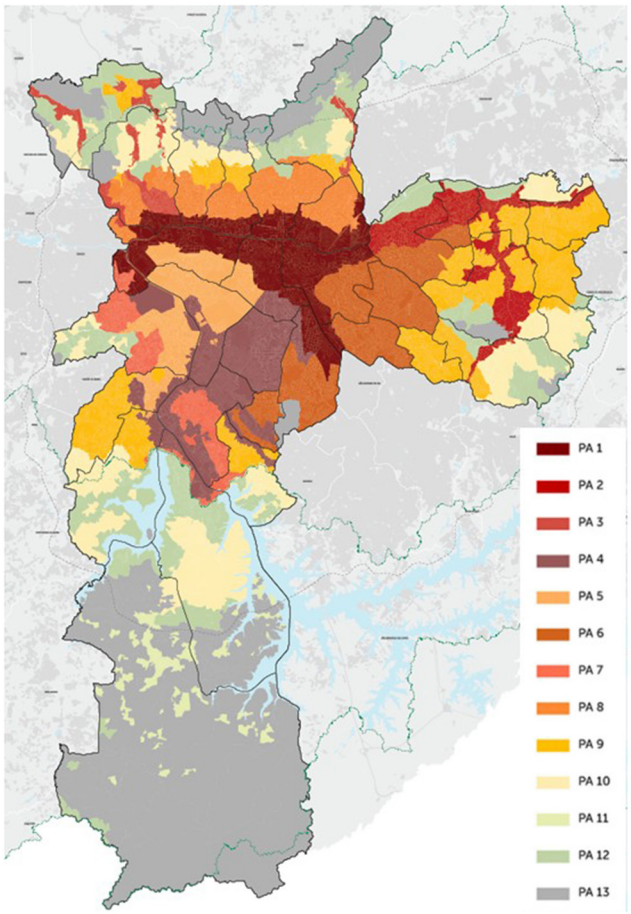
#	Picture	Biotope description	Factor	Ecoexergy related to the biotope (e.u./m²)
1		Landscaped areas connected to the soil below	0.25	$Ex_i = \Sigma_j\ 0.25.a_j(m^2)/A(m^2)$
2		Landscaped areas with a soil depth of 40 cm or greater	0.20	$Ex_i = \Sigma_j\ 0.20.a_j(m^2)/A(m^2)$
3		Permeable paving with vegetation	0.10	$Ex_i = \Sigma_j\ 0.10.a_j(m^2)/A(m^2)$
4		Green roof	0.20	$Ex_i = \Sigma_j\ 0.20.a_j(m^2)/A(m^2)$
5		Vegetated walls	0.10	$Ex_i = \Sigma_j\ 0.10.a_j(m^2)/A(m^2)$
6		Preserved small trees	80	$Ex_i = 80.nt_j/A(m^2)$
7		Preserved medium trees	180	$Ex_i = 180.nt_j/A(m^2)$
8		Preserved large trees	400	$Ex_i = 400.nt_j/A(m^2)$
				Total eco-exergy = $Ex = \Sigma_i\ Ex_i$
				$V = Ex/rv$

Source: produced by the authors; column two ("picture"): São Paulo City Hall.
(a) The complete table for calculating indicator V can be found in the annex to law 16402/2016 table III.B item II. The table presented here is considerably simpler than that found in the law.
(b) e.u., environmental units.
(c) A_i, lot area (m^2).
(d) a_j, area (m^2) of each element of a given "i" biotope.
(e) nt, number of tree specimens.
(f) rv, reference value, adopted as 0.38 e.u./m^2 = 7.1 JG/m^2.

The EQmin values as a function of lot area were set according to a logistic curve. To set EQmin as a function of the position of the lot in the city, environmental zoning (the set of "environmental qualification perimeters") was developed using a method analogous to that of McHarg (1969) (see also Yang and Li, 2016), and environmental qualification perimeters were set from there. This zoning has considered the environmental situation of the regions inside the perimeters and also its transformation potential. **Figure 2** shows the environmental qualification perimeters in the São Paulo municipality territory. From this figure, it is clear that the peripheral regions of the city received the worst scores in terms of their environmental situation and also in terms of the potential for change. This corresponds to more evidence of environmental inequalities in the city's structure, especially in its aspects of greening, which impacts the environmental comfort of its residents and their leisure possibilities.

It was determined that developments that exceeded their EQ score by a certain amount would receive urban incentives. The zoning law in effect establishes two potential types of non-cumulative EQ incentives (see **Table 3**). The first corresponds to a discount on the financial contribution of the onerous grant for the right to build[4] or the additional non-computable

[4] An onerous grant for the right to build, which establishes that property owner can build beyond the percentage of lot area pre-established by law, is issued by the São Paulo municipal government to the property owner upon payment of a financial consideration.



Environmental Qualification Perimeters	Microclimate + Biodiversity	Drainage	Transformation Potential	Ranking (mean)	Ranking (sum)
PA 1	4	4	4	4.0	12
PA 2	3	3	4	3.3	10
PA 3	3	3	3	3.0	9
PA 4	3	3	3	3.0	9
PA 5	1	2	3	2.0	6
PA 6	3	3	2	2.7	7
PA 7	2	3	2	2.3	7
PA 8	3	3	3	3.0	9
PA 9	4	4	1	3.0	9
PA10	2	1	1	1.3	4
PA 11	2	1	2	1.7	5
PA 12	2	2	1	1.7	5
PA 13	na	na	na	na	na

Classification Microclimate, Biodiversity, and Drainage	
GOOD	1
MIDDLE	2
BAD	3
TOO BAD	4

Classification Transfomation Potential	
GOOD	4
MIDDLE	3
BAD	2
TOO BAD	1

FIGURE 2 | Environmental Qualification Perimeters in the São Paulo municipality territory. Source: São Paulo City Hall; adapted by the authors. Environmental Qualification Perimeters (EQPs) are, in practice, environmental zoning. The territory of the municipality of São Paulo was divided into homogeneous regions into environmental terms, with 13 types of regions being defined. For each of the 13 types of EQPs, requirements are presented in the law in terms of minimum permeability (even for the lots dispensed from the EQ) as well as the minimum numerical values of the EQ score as a function of the lot size. To define EQPs' degrees of rigor, each homogeneous region was evaluated in terms of indicators for (a) microclimate plus biodiversity, on a scale of 1–4, with 1 corresponding to the best state and 4 the worst; (b) drainage, idem; (c) transformation potential, on a scale of 1–4, with 4 corresponding to the best potential and 1 the worst. The indicators were then added together in order to be ranked. The higher the ranking, the greater the legal requirements of each EQP. The idea of including state indicators and a potential transformation indicator and providing them with values on an opposite scale rests on the following: an EQP with a good environmental state and very bad transformation potential receives the worst grades, having, therefore, the minor legal requirements in terms of EQ; on the contrary, an EQP with a deplorable environmental state and a good transformation potential receives the best grades, therefore having the highest legal requirements in terms of EQ.

built area and can be claimed when EQproj exceeds EQmin at a certain level. The second corresponds to a discount on the financial contribution to the onerous grant for the right to build, which is calculated according to the sustainability certification level that the developer obtains for the property, i.e., the lot's environmental performance. The municipality itself does not grant environmental certifications. This task is delegated to environmental certifiers who have registered and been approved by the municipality. The certification can be, for example, LEED® (GBC Brasil, 2021), AQUA-HQE (Fundação Vanzolini, 2021), Selo Casa Azul CAIXA (Caixa Econômica Federal, 2021) or EDGE (IFC, 2021). After an environmental certifier is registered with the municipality, different levels of its certification are scored according to EQ legislation, being the EQ incentive provided according to that score. The certification incentive is only valid for either residential developments or non-residential developments associated with residential use.

The development of the EQ also took into consideration climate factors potentially related to global climate change. The severe water crisis between 2014 and 2016 in the state of São Paulo (Soriano et al., 2016; Moraes, 2020) contributed to determining that the EQ should include a requirement for buildings to have rainwater harvesting systems. This requirement is aligned with the idea that big cities should jointly manage alternatives to mitigate and adapt to climate change. Traditionally, there has been a scarcity of efforts to create synergies between them (Ürge-Vorsatz et al., 2018).

STAKEHOLDER ENGAGEMENT

In 2013, at the start of a new municipal administration, it was well-known that the then-mayor had formed a comprehensive coalition that included politicians from both the right and left sides of the political spectrum.

TABLE 3 | Incentives.

Incentives	Type of incentive	Requirements
EQ incentive	Discount on the financial contribution to the onerous grant for the right to build*	Relationship between EQproj and EQmin
	Additional non-computable area	
Certification incentive	Discount on the financial contribution to the onerous grant for the right to build*	Level of environmental certification

Source: produced by the authors.
**An onerous grant for the right to build is a grant issued by the municipal government that permits to a property owner to build above the proportion of the lot area established by law upon payment of a fee.*

Although the mayor did not receive unconditional support, negotiations occurred in such a way that made it possible for the executive branch to pass their bills comfortably, provided, of course, that it was willing to spend its political capital. This also explains why the WG was pressured to make the EQ self-applicable, i.e., to leave little for future regulations, such as decrees, ordinances and other administrative acts, that could easily amend the EQ under future administrations.

Institutionalization of the EQ would not have been possible without following eminently political processes. As for developing the EQ, it is worth discussing how the relationship between politics and technique is established. Decision-makers responsible for weighing costs against benefits and accepting and dealing with risks and uncertainty when it comes to scientific, technical, social, political and, especially, legal concerns. Yet, it is up to technicians to ensure that any solutions presented to decision-makers are contained within a trade-off surface This is sometimes very difficult given the various degrees of uncertainty surrounding technical decisions (Scoones and Stirling, 2020). In that sense, it is the responsibility of the technique to assist politics. **Table 4** presents more detailed information about the stakeholders' engagement during the EQ development process.

TABLE 4 | Stakeholder involvement in EQ development and implementation.

Stakeholder	Mode of involvement	Role played by the stakeholder
Municipal government	Relationship with city council	- Maintained a comfortable relationship with city council. - The municipal government has pushed for the EQ to be self-enforcing for fear that the subsequent governments would substantially change it through infra-legal legislation. This is not feasible for a law of this size and complexity. - Arbitrated conflicts between environmental and housing interests through zoning.
WG	Carrying out technical work and supporting other stakeholders	- Career civil servants do not work for the municipal government, however, they maintain a hierarchical relationship with it. - Anticipated and evaluated interests in the development phase to enable and facilitate approval. - Focus of stakeholders, even though the WG is not a political body.
Social housing movements	Pressure on the government and direct actions	- Strong influence on the municipal government. - Little interest in the EQ during the formal public participation process.
Designers	Commissioned by entrepreneurs	- Feasibility studies became more complex and their work as designers was more recognized. However, some were against the EQ for fear that it would make their relationship with developers more difficult.
Entrepreneurs	Produce most of the built space in the city	- They were not in a position to oppose the EQ. - They showed no hostility to the *ad hoc* group or to the EQ even though feasibility studies would become more complex and the costs of undertaking the developments would rise slightly. Their focus was on zoning.
Groups within the public service sector		See **Box 2**.
Academics	Call for contributions to workshops. Production of articles	- In general, the reaction was positive. - Some academics complained that the EQ would lead to bad designs and expressed a preference for studies to be carried out on a case-by-case basis. However, there was never a claim that mere compliance with the EQ alone would guarantee the quality of landscape designs, given that EQ is only a minimum minimorum. That is the responsibility of the landscape architect. - It was pointed out that requirement for mandatory compliance with EQ to be limited to plots larger than 500 m², even with more stringent permeability rate requirement, would limit its effectiveness in the city's periphery, which is the area of the city that is most in need of environmental services. Especially considering that the EQ operates only in the formal city.

Source: produced by the authors.

Parameters are necessarily suggested or imposed by the technique. These parameters, when institutionalized and having defined mandatory thresholds, become standards. Setting standards is necessarily a policy task. Private entities, research institutes, universities and the literature suggest threshold values for the parameters, thresholds that are called criteria (Porto, 1991; Förstner, 1995). Political decision-making entities, when defining standards, should consider not only the suggested criteria but the social, economic and cultural issues associated with that definition, taking risks and deciding in a situation of uncertainty (Scoones and Stirling, 2020). In the case of EQ development, parameters were successfully defined. What involved considerable difficulty was to define criteria to be suggested to the decision-making entities. This implied the need to perform several simulations to obtain reasonable values for the parameters, being oft tricky even to know possible values for the parameters, let alone for their criteria. In the face of scarce data, how to decide? To use the mean, the median, the mode, a characteristic value? Are they available? Often this process involved the suggestion of criteria in a somewhat arbitrary but in reasonable and responsible way. Such is the realm of producing new socially robust knowledge, whereby social actors corroborate the quality control of science and technology used to make decisions (Gibbons, 1999).

Career civil servants have sufficient autonomy not to be obliged to compromise with the political options of the government[5]. Its role, ideally, is to maintain the possible neutrality and assist the government, doing so in the form of suggestions for alternatives for government officials to make their political decisions. Nevertheless, in producing alternatives to submitted to government political agents, public career civil servants in the early stages of their work should have in mind the political preferences of their hierarchical superiors and all stakeholders, also evaluating the power relations between them. This was observed when developing the EQ. It is not a good technique to produce proposals that are not politically viable or are not likely to be easily adjusted according to the political negotiations conducted between the stakeholders. That is why it can happen that career civil servants still in the development phase of their jobs are subject to direct pressure from stakeholders outside the public administration, as was the case with EQ development. The government itself is also not homogeneous, nor does it always know exactly what it wants. This can lead government officials to give contradictory or empty directives that must be taken into account by the career civil servers. Since the early stages of the development of the EQ, the WG considered political backgrounds and proceeded with negotiations involving stakeholders. The WG had always kept in mind that the government itself is not homogeneous, and this can lead government officials to give contradictory directives.

BOX 2 | Situations of EQ development in the public service sector.

1) The group that was developing an update of the Building and Construction Code hardly opposed the EQ, alleging that the drainage concepts proposed in the development of EQ were not aligned with those that they had been adopted, mainly the concept of specific flow [Tucci, 2000; São Paulo (City), 2012].
2) Some public employees who had been developing academic studies were pleased to incorporate these studies into the EQ proposal.
3) The staff responsible for approving tree management expressed strong opposition to the final, approved version of the EQ.
4) Some staff with excellent academic credentials complained that they had not been asked to contribute to the EQ. This was due to the urgency with which the process was carried out.
5) Career civil servants involved in licensing hardly opposed the first decree proposal when it was being written. This opposition had to do with the legal uncertainty surrounding the activity of these servants.

In the public service sector, five significant situations occurred as the EQ was being developed, as reported in **Box 2**.

When the EQ was being developed by the WG, the São Paulo municipal government was widely sensitive to the demands of social housing movements. For the most part, these demands were not directed at the WG. The municipal government established a clause into law that stated the EQ parameters for social housing would be subject to specific regulation. Moreover, the municipal government arbitrated these interests by establishing in the urban zoning areas specifically intended for low-income housing developments and other areas of environmental interest.

As the EQ was being elaborated, some design entities took a keen interest in it and the new possibilities it provided. Before the institutionalization of the EQ, feasibility studies for real estate developments were relatively simple. Implementation of the EQ meant that many landscape design decisions would need to be made at the feasibility study stage. This situation obviously displeased entrepreneurs. Some designers considered it a valorization of their profession due to the EQ opening up. In addition, designers realized the prospect for a new market with more possibilities and more plasticity to their projects, especially concerning green infrastructure; others demonstrated being displeased and pressured by their clients to respond to the new requirements. For some designers, it became impossible to oppose the idea of incorporating environmental aspects in the zoning law.

[5]The purpose of the group of career civil servants (*servidores efetivos* in Portuguese*)* is to provide a permanent structure for the Public Administration due to the sudden changes in the government in office. They are hired from public tenders and are not appointed or elected. In order to protect themselves from undue or illegal coercion, they are given job stability after a three-year probationary period. They have criminal, civil, and administrative liability for their decisions or opinions issued. There is great legal uncertainty in its activity, which tends to paralyze the public administration. The first four authors of this paper, as careen civil servants, are employees of the executive branch of São Paulo city. They are not government employees in power, although they maintain a hierarchical relationship with it.

Perhaps it was precisely due to this unfeasibility to publicly oppose the EQ that some members of the real estate developers sector, which is quite powerful economically and politically, did not demonstrate any objections to the EQ. It is worthy to reinforce that more elaborate projects tend to be of better quality, offering benefits to buyers that developers will know how to use. **Table 5** summarizes some criticisms of EQ and the responses to those criticisms.

EFFECTIVENESS AND PROVISION OF ENVIRONMENTAL SERVICES

Two elements are fundamental to guaranteeing the effective implementation of urban planning guidelines: licensing and inspection. For several reasons, when it comes to overseeing urban works, the municipality of São Paulo faces some challenges.

TABLE 5 | Criticisms of the EQ.

Criticism	Response
The number of environmental objectives considered in the EQ is small.	Were the EQ to increase the number of environmental objectives it would become overly complex. Moreover, other objectives have been considered indirectly.
The runoff coefficients do not consider the local infiltration capacity.	The runoff coefficient is associated with the rational method, which has a margin of error of around 40% (Tomaz, 2002).
The EQ does not require zero impact for source drainage control measures.	Consistent with the guideline to provide freedom to the designer, a choice was made to allow designers to off-set different environmental objectives, especially considering that the EQ index is an aggregate of two indicators, calculated by taking the geometric mean rather than the arithmetic mean.
It is difficult to understand that the reservoir volume is arbitrarily defined and then the indicator D is calculated.	A technical primer would have been useful in the EQ debates. At the moment there are studies underway to determine whether this order should be inverted, i.e., whereby the D indicator would be chosen first and then the minimum reservoir volume to control lot drainage would be calculated.
The EQ established a "minimum volume" for stormwater reservoirs, which led to confusion.	This "minimum volume," which was perhaps an unfortunate choice of term, corresponds to the guideline of not regressing in terms of environmental legislation. This is because prior to the EQ there was already a requirement to build rainwater reservoirs, albeit of modest minimum volumes.
The concept of "specific flow rate" was not used.	This concept presupposes linearity between flow and drained area. In the theoretical conditions considered, this is not possible. Regardless, simulations performed by the WG showed that in the design range of the D-indicator both approaches lead to close results.
Leaf area is a better indicator of microclimate than eco-exergy.	This consideration would be an unnecessary complication. Studies carried out when the EQ was being developed showed that both indicators have a proportionate relationships and, therefore, that either would produce close results.
EQ is only required for plots larger than 500 m².	See **Table 4**.
The minimum volume of reserve water for non-potable uses is very small.	In fact, although the norm NBR 15527 (ABNT, 2007) has been observed, methods such as Rippl's (Tomaz, 2003; May, 2004; Annecchini, 2005; Carvalho et al., 2007; Mierzwa, 2007; De Amorim and Pereira, 2008; Matos et al., 2013; Giacchini, 2016) lead to invariably large volumes.
It is not acceptable to jointly consider the stormwater control reservoir and rainwater harvesting reservoir volumes.	This criticism stems from a misunderstanding of how these two types of reservoirs operate. Roughly speaking, reservoirs for stormwater control must remain empty, whereas those for rainwater harvesting must remain full.
The required outflows from the stormwater control reservoir are very small.	This is due to the calculation assumptions considered. Since there are often no pumps available on the market for such low flow rates, a way out is to use intermittent pump runs to obtain the average flow rate recommended in the EQ.
It is impractical to supervise the EQ.	With respect to the EQ, a bi-annual report is required on the status of its implementation and maintenance, specifically when it comes to landscaping solutions. The inspection of these reports should be carried out by random sampling by the public inspection office.
Compliance with the EQ does not in of itself guarantee good quality landscape designs.	See **Table 4**.
The EQ is a technocratic requirement.	The EQ has never lost sight of its political nature. The goal of the tool is to ensure that the alternatives presented are on a trade-off surface (BRAGA 1987). There is no optimum point in this set.
The EQ ignores the legal uncertainty of public servants.	Public administration oversee structures (for example, prosecutors, court of auditors, judicial police, and internal affairs) are not obliged to adhere to the hermeneutics and doctrine used to base the decisions of career civil servants. Consequently there is a great legal uncertainty in its activity, which tends to paralyze the public administration. The WQ, as far as possible, tried to minimize the problem. However, this is a structural issue in the public service in Brazil.
EQ approval and supervision procedures are not in line with the municipal government's organizational culture.	According to Handy's (1987) simplified classification for organizational cultures, the São Paulo City Hall has a culture centered on people and not on rules, which, in fact, created significant difficulties. There is no way to change this culture in the short term.

Source: produced by the authors.

Licensing of the EQ occurs within the scope of the general process to request an urban license for a given development. Roughly speaking, in São Paulo, the process to request an urban license for a "large-scale" development is overseen by a central department (currently the Secretariat of Urbanism and Licensing, SMUL), whereas the process to request a "small-scale" is overseen by decentralized units.

A sample of 83 non-residential developments was extracted to carry out an initial assessment of the EQ. Obviously, a complete assessment of these effects would require further study in much greater depth and comprehensiveness, which has yet to be done. Therefore, the results presented here must be carefully considered. The total area consumed by each of these developments varies between 551 m² and 66,041 m², with an average development area of 4,333 m². The total area consumed by all of these developments combined is 34.7 ha.

The municipality of São Paulo is located in the Atlantic Forest biome, a biome similar to that of the Amazon concerning biodiversity. Based on data from Jørgensen (2010), Lima (2010), and Forster and Melo (2007), the eco-exergy of fragments of secondary Atlantic Rain Forest in the initial/intermediate succession stage was roughly estimated at 1.7 e.u./m² or 32 GJ/m² (see **Table 2**). The weighted average simplified eco-exergy of the 83 developments considered here was found to be ∼0.8 e.u./m², that is approximately half of the value above, which demonstrates good environmental performance in promoting ecosystem quality and improving the microclimate. The exergy of the analyzed enterprises amounted to 4.8 PJ (petajoules).

Wall (2009) showed that the relationship between physical exergy and the amount of information at room temperature corresponds to 2.9×10^{-21} J/bit, and the exergy per unit of information of a protein synthesis process in a cell is 4.6×10^{-21} J/bit. Assuming that one unit of eco-exergy corresponds to the same amount of information as one unit of physical exergy (which, in the best case scenario, would provide only one order of magnitude given that they use different concepts and references), the amount of information stored in the vegetation of these 83 developments would be in the order of 4.7×10^{30} bit/m², and the total amount of information stored would be in the order of 1.7×10^{36} bit.

The weighted average of indicator D, which relates the performance of the development to the plot drainage, is 0.67. This result would disappoint those who advocates of zero impact measures. The weighted average of the runoff coefficient is 0.65. This runoff coefficient corresponds to that used by the rational method to estimate the flow corresponding to a precipitation of duration equal to the time of concentration of the basin; thus, it does not consider the effect of the reservoir. It is important to note that the simplifications made in the QA to estimate the runoff coefficient were such that they tend to increase the numerical value of this coefficient.

This raises an interesting question: if a detention reservoir were built to have zero impact on a given fictitious basin and the volume of this reservoir was the sum of the lot's detention reservoir volumes, what would be the numerical value of this fictitious basin area? Canholi (2014) extracted some expeditious methods from the literature to estimate the volume of detention reservoirs. It was used the United States Conservation Service method (SCS 1986 apud Canholi, 2014). After adopting some assumptions to simplify the calculation, it was concluded that such an area would be ∼300 ha. This result is remarkable since the sum of the lot areas corresponds to 35 ha.

Only a more complete study could test the validity of the adopted hypothesis and analysis. Above all, it is essential not to lose sight that the average of a function (correct method) does not always come closer to the function of the average (the method used here). In short, these are only preliminary calculations that are intended to provide a starting point to the structure of future evaluations.

THE ENVIRONMENTAL QUOTA AND GENTRIFICATION

Based on what has been presented so far, one might consider that, given the enormous environmental and social sustainability problems engendered by São Paulo city, the EQ is a relatively modest instrument. Such a conclusion would be proper whether the municipal government had abdicated its efforts toward urban sustainability and outsourced them to the private sector. However, in reality, nothing could be further from the truth. What the São Paulo city did was to determine the real estate sector to make its share of sacrifices (in the form of a not so significant costs increase) in pursuit of sustainability based on the social function of properties principle, an innovative concept from the field of urban studies, consolidated in the 1988 Brazilian Federal Constitution[6].

Indeed, the Municipal Secretariat of Green and Environment is engaged in the so-called green plans, which include, as determined by the Strategic Master Plan for the City of São Paulo (Municipal Law No. 16,050 of July 31, 2014), the Municipal Plan for Protected Areas, Green Areas and Open Spaces, the Municipal Plan for Conservation and Recovery of Areas Providing Environmental Services, the Municipal Plan for Urban Afforestation, and the Municipal Plan for the Atlantic Forest. These plans and actions were established through participatory, complementary, and harmonious work, and considerable human resources were allocated toward them.

It is essential to keep in mind that these plans prioritize concerns over gentrification by establishing mechanisms to minimize it. Thus, the EQ constitutes an unprecedented and well-liked by-product of these established priorities.

The EQ does, in effect, cause gentrification, but to a small degree. In coordination with the plans outlined above, the EQ could be used to improve its parameters to mitigate the processes that cause gentrification. The literature on urban greening and gentrification has demonstrated the paradox related to improvements in urban green infrastructure and

[6]It cannot be overlooked here that the cost increases implied by EQ are partly passed on to consumers and partly reduce the profits of developers. Quite simply, it can be said that the proportion between the transfer of costs and the decrease in profits will depend on the relative elasticity of the supply and demand curves for housing. There is a particular generational injustice involved in this process since younger generations will bear the costs of EQ while all will enjoy the benefits.

making poorer and vulnerable people migrating from these areas (Cole et al., 2017; Haase et al., 2017; Andersson et al., 2019). The EQ can be argued to make a different effect since it dedicates to improvements on environmental services from green infrastructure to private and public urban plots. It characterizes environmental services provided by the private and public developments and also operates from urban plots in urban outskirts and poorer neighborhoods, even with compensation on urban areas with lower degrees of green infrastructure. In that sense, it is assumed that the EQ can assist in lowering the inequalities on the green in urban spaces. That is to be considered a perspective of improving urban resilience to climate change impacts and encompassing deep urban inequalities (Yang and Li, 2016; Staddon et al., 2018).

Even lots smaller than 500 m², for which the EQ provisions do not apply[7] (Nobre et al., 2015; Da Silva et al., 2018), must comply with a minimum permeability rate. The EQ not only established a significant increase to the minimum permeability rate compared to the previous requirements. It also modified the concept to become more rigorous, whereby only garden areas on natural soil are accepted and there cannot be slabs under them.

REPLICABILITY OF THE ENVIRONMENTAL QUOTA

The EQ is very customized to the complexities inherent to the city of São Paulo, the political situation at the time it was being developed, and the time that it took to elaborate. Nevertheless, some of the experience gained in developing the EQ in São Paulo could serve as a starting point to discuss specific issues when developing an instrument analogous to the EQ in other cities.

A prior assessment is obviously needed, at least, to address the city's real estate market, environmental situation, the local political context and how public administration oversee structures affect it (for better or worse), the state and municipal government guidelines and, finally, to assess the decision making processes and survey the main stakeholders. A timeline is necessary, but it is also important to remember that political processes are complex and unpredictable, and this timeline will need to be adjusted continuously.

Next, the mode of operation must be defined. A small group of career civil servants with experience in public administration, composed of members from different backgrounds and, above all, a history of working together is desirable. How public participation will take place must be defined a priori. It has been proven to be adequate to convene specialists and allow a small degree of intervention among stakeholders in the development phase, all under the political tutelage of the municipal government. Seminars can be held with the Academy, research institutes, civil servants, including from other spheres of government, slightly more technical stakeholders, consultants, developers and designers. In the final stage, the public should be encouraged to participate, i.e., any citizen with interest in the subject. A careful strategy must be defined to handle this phase, for example, making primers for citizens to participate in public hearings, among other forms of participation.

It is important to remember that, although public participation is a mandatory requirement of any public policy, program or project, dialogue does not solve everything. The government has to assume the burden of the decision in the event of a deadlock. Issues related to representativity and proportional representation among the entities who will act on behalf of the public are complex.

Anyhow, decisions surrounding the environmental objectives and their magnitude must be made. There is a fine line between "ensuring the legal instrument remains simple" and "ensuring its regulatory power." For example, concerning lot drainage, the desire to include issues related to infiltration, interception, and diffuse pollution can be assessed; however, this would make the instrument more complex. It can have a vital role in cities located in tropical zones that are highly vulnerable to climatic events (Canil et al., 2020; Travassos et al., 2020), as in São Paulo and in many Global South cities. Nevertheless, the experience of the EQ in the municipality of São Paulo provides an alternative, as it aggregates three different environmental objectives within a plausible framework.

Any government considering adopting a similar tool to the EQ should consider whether it is more convenient to establish a single index or to separate the indicators when determining different environmental objectives. Architects tend to have spatial vision and are, therefore, more comfortable with the V indicator. On the other hand, engineers tend to have a more functional vision; therefore, more in tune with the D indicator.

The choice to establish weighting factors related to an indicator analogous to V through the Delphi method, for example, should be studied, as Berlin did to develop the Biotope Area Factor (Keeley, 2011). On the one hand, weighting factors would be easier to understand, yet, on the other hand, this would come at the expense of scientific rigor and political legitimacy.

The convenience provided by establishing mandatory adherence to the principle of zero impact on lot drainage should be studied. The convenience of adopting the concept of specific flow should also be considered (Tucci, 2000). The convenience of establishing regulations concerning the definitive lowering of the water table by buildings with subsoil, which implies the need for permanent pumping, should also be considered. Additionally, the convenience of repealing existing environmental legislation should be analyzed, assuming the political burden of doing so in case of contradictions.

The legal framework and the control mechanisms and institutions must be studied very carefully to not hinder licensing and inspection. If enforcement mechanisms are not carefully considered, the effectiveness of the regulation tool will be seriously compromised. The degree of administrative discretion for licensing should be carefully considered. The relationship of EQ with other environmental regulation tools must be

[7]The restriction of the mandatory application of the provisions of the EQ to lots smaller than 500 m² was a political requirement, against which the WG unsuccessfully opposed. It should be noted that to a development in a lot smaller than 500 m² is allowed the application of EQ so that it can enjoy the incentives of EQ, without prejudice, of course, to the requirements presented above in terms of minimum permeability rate and all other urban and environmental legislation.

considered. Everything should be consistent with the culture of the involved organizations.

It is mandatory to proceed in a multi- and interdisciplinary way when it comes to environmental matters in complex urban contexts. Even with such open approaches, there will be several difficulties demanding careful prior assessments and political work.

Incentives to complement previously established environmental objectives are an exciting strategy that may be worth replicating. One could also think of extending EQ requirements, for example, by including considerations to install photovoltaic panels on buildings with large roof areas, such as supermarkets and shopping centers. Any measures will also depend on the regulations established by the electricity authority on the sale of energy. The use of high thermal performance paints (Gartland, 2010) and other similar strategies can also be considered in this context.

Given these arguments and considerations, we believe that the EQ can be replicated and adjusted to other cities or metropolitan areas[8]. This is particularly true for cities and metropolitan areas located in the Global South, where improving environmental services makes sense given the unequal division of urban territories. In that direction, it is worthy to remark that the development of the EQ can be understood by encompassing five dimensions on the necessary ability of local governments to advance in adaptation to climate change. These dimensions are presented by Di Giulio et al. (2019) through cognitive factors, resources, organizational factors, political aspects, and urban planning. Furthermore, EQ operationalized a principle of public function for the private properties, what in the case of Brazil set out in the Federal Constitution. For the Global North, the EQ experience can provide insights into how to promote urban greening from private developments in a way that benefits the whole city.

FINAL CONSIDERATIONS

The decision made by the municipality of São Paulo to introduce an environmental element to its land parceling, use and occupation legislation arose, in part, from a desire to overcome some of the limitations imposed by the National Environmental System (SISNAMA), in which São Paulo acts as a local agency. These limitations have to deal with federal legislation's formal rigidity, which reflects the previous experiences of some state agencies in approving pollution control legislation and Environmental Impact Studies. Additionally, it was in the City's interest to capillarize and universalize environmental measures at the lot level for either new developments or renovations.

This solution was inspired, in part, by other cities that have undergone similar processes, such as Berlin, Seattle, Malmö and Singapore. However, the development of São Paulo's tool (the EQ) differed substantially from its predecessors. The EQ explicitly states its three environmental objectives. Two of them, which relate to ecological and microclimatic aspects, are solved by lot occupation and development. The other, which is related to lot drainage, depends on hydraulic structures. The number called EQ is an aggregate of indicators that seek to evaluate the environmental performance of a given lot. Given that these indicators are grounded on a solid theoretical foundation, an assessment of the environmental performance of a given plot can be objectively measured and compared with other measures and indicators.

A very expeditious analysis showed possible aspects of the effectiveness of EQ in non-residential buildings. By this analysis, EQ had a good ecological and microclimate performance and a somewhat disappointing but good enough performance in lot drainage. These conclusions need to be ratified by a more comprehensive and in-depth study. In particular, it would be interesting to compare these results with those to be obtained for residential buildings.

Development of the EQ was centered mainly around a small *ad hoc* WG formed by four municipal government employees who have decades of experience working in this area and are, thus, well-versed in its formal and tacit norms, culture, and decision-making processes, and have considerable knowledge of the city. These professionals formed this group based on their individual expertise and their previous experience working together. This group developed the EQ over hundreds of hours of work, received suggestions, sought feedback from both outside and local experts, held seminars, provided information, attended to the (sometimes conflicting) demands from the local government and mediated interests between stakeholders and local government. Moreover, the group anticipated the different interests that would converge in the EQ and sought to develop compromises to accelerate political convergence. Above all, and even though the EQ is an unprecedented tool to insert environmental aspects into the legislation governing land parceling, use and occupation, the group strived for reasonableness so that the EQ would be respected by the diverse interest groups, even those who were opposed to it.

Several stakeholders have sought to influence the EQ during its development. Prominent among them is the powerful real estate development industry. Naturally, any given legal initiative that implies an increase in costs, even relatively modest ones, such as those contemplated in the EQ, is bound to face opposition. For the most part, these additional costs are absorbed by buyers and developers according to the relative elasticity of the supply and demand curves for new real estate. It is essential to say that the municipal government dared to take a chance such a new proposal as the EQ, even though it could have weakened its political capital given that such a measure was unprecedented.

Given that it is the center of a large peripheral capitalist megalopolis, São Paulo city has enormous social, environmental, landscape, economic, and urban planning problems, especially in terms of unequal access to the city's infrastructure and quality of life. Given these enormous problems and environmental imbalances in the city, even if a stakeholder were to disagree with the EQ, it would be difficult for them to publicly position

[8]For example, the municipality of Campo Grande, capital of the state of Mato Grosso do Sul, Brazil, created through complementary law n. 341, of December 4, 2018, the Environmental Relevance Rate (TRA), clearly inspired by the EQ (see also Campo Grande, 2021). The municipality of Ribeirão Preto is also studying an urban instrument in part inspired by the EQ.

themselves against it, no matter how much they disagreed. This is what was expected from the real estate development sector. Indeed, this sector showed relative small resistance to the EQ, despite the economic crisis of unprecedented magnitude that had engulfed the country. Perhaps the incentives contributed to this lack of resistance, especially the certification incentives, which are pretty usual in compliance processes. Moreover, it is remarkable the acceptance of the EQ among designers who were happy to see the diverse alternatives that the EQ made possible.

The interests of popular urban housing movements ignored rather than positioned themselves in front of EQ. It was a positive convergence considering their good organization and influence due to the city's huge housing deficit.

The commitment of municipal (local) governments is of decisive importance to enable a tool like EQ. Also remarkable is the municipal government's willingness to mobilize its political capital to make a tool like EQ politically viable, and supporting its approval in the city council. This is a key element for any other city that wishes to successfully develop a tool similar to the EQ.

It is important to note that the EQ does not imply that addressing the city's environmental and landscape issues will be delegated to the private sector. It merely requests that this sector contribute, within the framework of the social function of property, enshrined in the 1988 Federal Constitution. Given the city's severe environmental problems, the EQ would be modest in isolation (since it would only apply to the formal sector of housing developments). Thus it must be accompanied by a diversity of landscape and sanitation plans.

If, in principle, EQ is modest in its effectiveness in the face of serious environmental problems in the city, it is also modest in its capacity to produce gentrification. In addition, the aforementioned green plans work explicitly with the issue of gentrification and are committed to reducing inequalities in access to urban green infrastructure. It cannot be forgotten that if EQ had its application limited to lots smaller than 500 m², having limited its effects on the fringes of the city, the minimum permeability rates remain not only valid for any lot size, but have had a its requirements increased, both from a quantitative perspective (the minimum rates are higher) as a qualitative one (to be considered a permeable area, it cannot be inscribed in a semi-permeable area or have a slab under it).

Finally, considering the need to better understanding the potentialities of EQ, we suggest three lines for further studies. First, on physical and urban effects of the application of EQ considering properties of adaptation on climate change. Second, perspectives of refinement of EQ in terms of how to make concepts into better applications. Third, comparative studies on São Paulo's EQ with the experiences of Berlin, Seattle, Malmö, Singapore, and Campo Grande. Now, the Secretariat of Green and Environment of the São Paulo City is conducting studies in the first and second lines. This and more in-depth comparisons on similar policies can give more comprehensive guidelines for the replicability of these innovative alternatives to contribute to urban sustainability in the face of climate change.

AUTHOR CONTRIBUTIONS

PC, HP, LF, and PS contributed in the process of implementation of the EQ and as so provided relevant information produced through participant observation. PC and LG worked collaboratively in proposing and writing the first draft, organizing data, including tables and figures, and reviewing the final version. HP and LF reviewed the paper, included data, and writing inputs. PS made inputs of data and reviewed the final version. All authors contributed to the article and approved the submitted version.

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Emancipatory Urban Greening in the Global South: Interdisciplinary and Intercultural Dialogues and the Role of Traditional and Peasant Peoples and Communities in Brazil

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This article discusses theoretical, methodological and political issues related to urban greening in the Global South, as well as emancipatory alternatives to envisioning more inclusive, democratic, sustainable and healthy cities. We sustain that the role of traditional and peasant peoples and communities – including indigenous, quilombolas and others - is strategic for thinking about alternatives and actions aimed at the paradigmatic transition that surpasses the vision of Eurocentric modernity. It generates artificial barriers that divide countryside and cities, society and nature, life and economy, as well as subjects and objects in producing and sharing knowledge. These peoples and communities designates a diversity of social situations that have as a common denominator conditions of existence considered to contrast with "modernity," situated on the margins of the representations of "development" and "progress" of the hegemonic economic and political powers. Our arguments are empirically based on experiences developed in Brazil with interdisciplinary and intercultural dialogues carried out in recent years. The events called "Meetings of Knowledges" brought together academic groups and different social movements and community organizations involving social struggles and topics such as health, environmental conflicts and justice, food security and sovereignty, agroecology, among others. These meetings intend to enhance intercultural and interdisciplinary interactions between agents working together in different territories with concrete knowledges and experiences. The contents generated by the debates held at these events and their developments depict social experiences that reinforce the underlying hypothesis behind this article: the social struggles involving the interaction between traditional and agricultural populations with urban spaces in the Global South provide important evidence for research agendas about emerging emancipatory processes related to urban greening. In the first part of the text, we analyze the historical, social and epistemological meaning of indigenous, *quilombola* and peasant peoples in the Brazilian context, analyzing both recent contradictions and threats, as well as their role in the emergence of ongoing emancipatory agendas, including interaction with cities. Finally,

we show examples related to social struggles, first of an indigenous ethnic group in the Amazon region, and then in two big Brazilian cities, involving social movements and community organizations that integrate actions for decent housing, sanitation, health care, and food along with the rescue of ancestral knowledge.

Keywords: emancipatory urban greening, Brazil, intercultural dialogue, Global South, traditional and peasant peoples

INTRODUCTION: RETHINKING URBAN GREENING IN THE GLOBAL SOUTH

This article aims to contribute to the theoretical, methodological and political issues related to urban greening in the Global South, as well as emancipatory alternatives to envisioning more inclusive, democratic, sustainable and healthy cities. The research is based on interdisciplinary and intercultural dialogues carried out in Brazil in recent years between academic groups and different social movements and community organizations involving social struggles and topics such as health, environmental conflicts and justice, food security and sovereignty, agroecology, among others. This involves both populations that live and politically act in typically urban spaces, as well as in the territories where the countryside, forest and the waters' populations live, which include the so-called traditional peoples and communities such as indigenous and *quilombolas* populations, and family and peasant agriculture. This terminology has been used in Brazil since 2008, when the National Policy for Comprehensive Health of Countryside, Forests and Waters Populations was created by the Ministry of Health (Souto et al., 2016), and subsequently also incorporated into documents from the environmental area that address Biodiversity protection. From the viewpoint of sustainability, these populations are related to different groups that have, due to their specific knowledges and ways of life, a strategic role throughout history in biodiversity conservation and the promotion of sovereignty and food security through the sustainable use and management of natural resources.

We consider it interesting using Brazil as example to discuss urban greening, as it is a country in Latin America with continental dimensions and where characteristics of the Global South and Global North coexist and collide in extreme ways. Brazil, as well as in other Latin American countries, has typical metropolitan regions of the Global North, guided by the modern State-Law-Science regulatory tripod, and whose populations are, in part, relatively more protected by the institutions and included in the formal market, either as elites and privileged classes, or as workers and citizens who fight for their rights, although the current context of deregulation and precariousness of labor laws are unfavorable to them. However, the persistence of the strong social inequalities in Brazil, which leaves unprotected a significant part of the population, cannot be exclusively justified by the capital-labor conflict in times of neoliberalism, or theories such as that of the dependence developed by Latin American intellectuals (Sunkel, 1969; Dos Santos, 1970). These perspectives place inequalities as the result of exclusions caused by the incomplete development of productive forces, from the market operations and from more sovereign social and development policies to the country's possible rise to the group of so-called developed countries. However, racism and other forms of violence express a particular form of exclusion, the so-called radical exclusions, which ignore or despise other forms of being, living and knowing that are typical of peoples who lived in the former European colonies, established and later self-declared independent between the 16th and the 20th centuries (Santos and Meneses, 2014).

One important way to explain the existence and continuity of radical exclusions is reflected in the idea of a Global South that remains mainly in regions such as Latin America, Africa and Asia as an active construction of social and political non-existence. More than a geopolitical definition, it is a metaphor for the human suffering caused by radical exclusions resulting from colonial inheritances that affect not only the exploited workers, but all groups who are ontologically disqualified by the Eurocentric and capitalist modernity (Santos and Martins, 2021). The radically excluded groups encompass indigenous populations, Afro-descendants, agricultural workers, and even entire fractions of the racially and socially dominant groups, such as women and the LGBTQI+ community, although these latter two groups also suffer intersectional violence and discrimination in the context of the Global North, which are confronted through social struggles and agendas that are sometimes quite different in relation to the Global South. The Eurocentric modernity associated to the concept of the Global North imposes a radical exclusion, of an ontological and epistemological nature, which is related to cognitive injustice (Visvanathan, 2009), being simultaneously radical, invisible and ostracizing. This dimension of injustice is subtly combined with others and is behind phenomena such as racism, xenophobia and other types of violence against peoples and social groups considered ontologically inferior by Eurocentric modernity.

Therefore, the concept of the Global South is a complex one and corresponds to geographical, political and symbolic spaces, both in the countryside and cities, in which institutions that correspond to modernity are replaced by acts of plunder, violence and racism without the effective protection of laws and the State, even if these exist and are depicted as democratic. As Santos (2018) proposes, there is an abyssal thinking that separates the protection zones of the Global North from those that operate out of the violence and plunder that affect the populations and territories of the Global South. This idea is not exactly the result of irrationalities to be overcome by economic development,

social inclusion and education. The abyssal thinking result from conceptions of the world, values and rationalities that are considered superior in their ontological and epistemological dimensions; for this reason, other ways of being, knowing, living and connecting to nature are denied, despised, and made invisible by modernity.

Paradoxically, despite the historical violence that includes genocides and epistemicides, innumerable groups that have other forms of being, knowing and living still resist – such as indigenous, *quilombolas* populations, and agricultural workers – and are organized in social movements and community organizations. They currently preserve and reproduce values and conceptions of life, work, nature, sense of community, and spirituality that are typical of the Global South. Their social struggles and emancipatory processes cannot be delimited or understood only through social and health justices, or even by the defense of the environment, which constitute the idea of well-being of modernity aimed at a longer and more pleasurable life. To advance the dialogue with emancipatory resistances from the Global South, we believe it is necessary to incorporate other conceptions of justice to understand the current crisis as a broader civilizational crisis and to articulate agendas and processes. And that includes a greater dialogue with traditional and peasant peoples and communities who continue to be active in numerous social struggles, including in the urban context, beyond the critical agendas of urban greening typical of the Global North (Opitz et al., 2015).

The conceptual and methodological bases adopted by the authors and which support the article come mainly from the articulation of three interdisciplinary fields of knowledges: collective health developed in Latin America in the last 40 years to confront social and health inequalities in the region (Paim and de Almeida Filho, 1998); the political ecology that supports movements for environmental justice (or against environmental racism) through the understanding of social metabolism and environmental conflicts associated with the model of productivist and neo-extractive development (De Molina and Toledo, 2014); and finally, the post-colonial studies, especially the epistemologies of the South (Santos and Meneses, 2014), which expand the critique of capitalism by incorporating ontological and epistemological dimensions to the analysis of the continuity of colonialism (or coloniality) and patriarchy as axes of oppression and radical exclusion that affect mainly the populations of the so- called Global South.

These three fields provide the theoretical basis for proposing the four concepts of Justice (social, for health or sanitary, environmental, and cognitive) that we seek to promote aiming to confront social and ecological problems and propose actions together with social movements and community organizations, mainly in the Brazilian context (Porto, 2019a). The articulation of these four justices, as well as policies and actions that have social movements and community organizations as protagonists, provide the theoretical and empirical bases to envision utopian perspectives emerging from concrete social struggles, as well as the different knowledges that arise in the context of these struggles. The idea of emancipatory health promotion that has been developed is based on the reinvention of the very concept of social emancipation underway in many of these struggles (Porto, 2019b).

Therefore, modernity, seen as permanently incomplete in the so-called developing countries such as Brazil, paradoxically brings with it potentials and social experiments of reinvention that can support the civilizational and paradigmatic transition toward new socioeconomic, political and cultural arrangements that can overcome the injustices created by the current hegemonic capitalist system. Even with recent setbacks in public policies and the resurgence in practices of social fascism, innumerable emancipatory processes continue to emerge, which point to the rescue and updating of knowledges and practices of traditional peoples and communities with ontologies and values that are counter-hegemonic to the Eurocentric and capitalist modernity. This provides a fertile ground to envision other economies that are more solidary and sustainable, community relations that are more convivial and harmonious forms of connecting with nature. Many of them exist and flourish like seeds, in present situations that point to other post-capitalist and post-colonial futures. For this reason, we believe that an important clue to rethink urban greening from the perspective of the Global South is to strengthen ongoing experiences in cities regarding their interactions with traditional and peasant peoples and communities.

However, the perception and expansion of emerging alternatives require not only intellectual and analytical tools developed by science and its methods. They demand new forms of co-labor- action, of sensitive methodologies (Fasanello et al., 2018) that blur the boundaries between science, art and politics. In other words, a "corazonar" (Guerrero Arias, 2010) of science that transcends the barriers of its supposed epistemic superiority. We believe that the interactions and re-existences of various movements and experiences of intercultural dialogues can reorient the ongoing emancipatory processes and Academy itself.

From a critical perspective, certain authors may consider that the Global South only updates previously used concepts, such as the Third World, of which use has fallen into disuse with the collapse of the Socialist Bloc and the end of the Soviet Union, being equivalent (or even analytically inferior) to that of peripheral or semi-peripheral countries within the scope of the capitalist world-system theory as opposed to the central countries that would correspond to the Global North (Wallerstein, 1979). However, although of great relevance, we consider this analysis to be limited for several reasons. For instance, this perspective has difficulties in incorporating social struggles that involve ethnic-racial, gender, cultural, ecological, spiritual or ontological dimensions, which intersect issues mainly from the Global South related to traditions despised by the Global North. These issues include the role of nature, community and spirituality that bring with them quite different perspectives, eventually opposed to the conceptions of development, economy, work, and well-being built by the Eurocentric modernity.

The context considered to be the most complex and relevant for thinking about the Global South comes from a wide range of works by politically engaged intellectuals that flourished after the Second World War. They encompass and can articulate different

contributions from the anti-colonial movement in Africa and Asia, from the World System theory (Wallerstein, 1979), the Subaltern Studies (Spivak, 1988); from the Dependency Theory and intellectual movements in Latin America, including the modernity/coloniality program (Quijano, 2000; Escobar, 2007); and the Epistemologies of the South, a synthesis work by Boaventura de Sousa Santos that aggregates and dialogues with the different aforementioned schools (Santos and Meneses, 2014; Santos, 2018). These references allow the articulation of different social struggles and knowledges arising from them, reinventing possibilities of social emancipation in the presence of the several ongoing crises, which disclose the limits of the utopias that guided and continue to guide the Eurocentric modernity.

The idea of an abyssal thinking proposed by Santos (2007) allows us to understand how different forms of oppression can exist in the same region, a country, a city or even in the same place of work due to two realities that coexist, the Global North and the Global South. The modern and Eurocentric Global North is currently represented by the spaces in which globalized capitalism expresses both its benefits and its most visible contradictions, but which can dialectically institutionalize the accomplishments of workers and citizens resulting from their social struggles. These are the spaces on "this side of things" of the abyssal line guided by knowledge-regulation based on the tripod of Science, Law and the modern State along with its institutions.

The Global South, more than a geographical space, represents the metaphor of human suffering that results from radical exclusions and, one should add, based on the contempt for other ways of being, living and knowing that diverge from the Eurocentric world. It is in this sense, that the Global South refers not only to the complaints, but to the announcements that bring hope and alternatives for the paradigmatic and civilizing transition rooted in the recognition and dialogue with other possible worlds, not just one universe, but a pluriverse (De La Cadena and Blaser, 2018) of relationships between humans and non-humans, including those who are seen as coming from other planes of existence (Santos and Martins, 2021). In these spaces the institutions that correspond to modernity (State-Law-Science) predominantly give way to forms of plunder and violence without the protection of Laws and the State, even if they exist and are said to be democratic. Thus, for the epistemologies of the South, the social struggles of the Global South must necessarily be anti- capitalist, anti-racist, anti-colonial and anti-patriarchal, based on the resistance and alternatives that will confront all these types of oppression, being by definition struggles that point to post-colonial and post-abyssal societies. The importance of the class struggle and other emancipatory struggles of the Global North is recognized, mainly focused on democracy, sustainability, inclusion and social protection. However, the denial of the social struggles of the radically excluded peoples characterizes a Eurocentric structuralism, albeit critical, which delegitimizes and secedes several struggles of the oppressed populations of the Global South. This is one of the problems of the critical academy in countries such as Brazil, strongly influenced by Eurocentric academic schools. To "decolonize" it means connecting ontological and epistemological issues to social struggles, which also implies appreciating theoretical and empirical productions by intellectuals and social struggles from these regions, especially the historically most marginalized social groups and whose thinking's are daily delegitimized and ignored.

Therefore, the relations between the Global North and the Global South are complex and cannot be defined by geopolitical characteristics only. There are countries that represent stronger characteristics of the Global North by taking on a relevant role in defending the values of the Eurocentric Western modernity, as well as in the conduct and hegemony in the current globalized capitalism. However, at the same time, either because they were former colonies (such as the United States) or because they have undergone important migratory processes of populations coming from former colonies, they also have marked cultural and political characteristics of the Global South, with processes of radical exclusion that disregard and make invisible the ontological and epistemological dimensions of these subalternized social groups.

In recent years, the authors of this article organized two events entitled "Meetings of Knowledges," to enhance intercultural and interdisciplinary interactions between agents working in Academia, in social movements and in different territories with concrete knowledges and experiences. The contents generated by the debates held at this event and its developments depict social experiences that reinforce the underlying hypothesis behind this article: the social struggles involving the interaction between traditional and agricultural populations with urban spaces in the Global South provide important evidence for research agendas around emerging emancipatory processes related to urban greening. We highlight some experiences involving intercultural and interdisciplinary dimensions that were discussed at the abovementioned meeting. They express countryside-city interactions of particular interest for research agendas connected to emancipatory processes: territory, food and care. More than strategic research topics, they all imply numerous social struggles in progress at different levels and regions of the planet that can help to articulate emancipatory agendas of the Global South and the Global North.

EMANCIPATORY STRUGGLES IN CITIES IN THE GLOBAL SOUTH CONTEXT

Paradoxes of Exclusionary Modernity in the Global South: Environmental Conflicts and Transformations of Urban and Rural Spaces in the Brazilian Context

In the colonial and capitalist context, the cities are guided by political and economic elites with their ideals of progress. Very often, the uncritical importation of urbanization perspectives ended up favoring the construction of artificial environments inappropriate for local climates, less resilient to the rain and insolation pattern that disregard "native" solutions. In general, they are built based on centuries of adaptations that generate better sanitation conditions and environmental sustainability. Therefore, it is to be expected that the construction processes of urban environments in these contexts are influenced by social agendas and struggles typical of the Global South, which

often present complex challenges not easily captured by critical theoretical approaches that are based on a modernization concept which excludes a significant part of sociodiversity.

Taking Brazil as an example, it underwent an intense expansion of urban areas, mainly throughout the 20th century. Much of this growth was due to the rural exodus to the cities, associated with a land concentration process, especially of public lands, by a small political elite, which was intensified with the Land Law of 1850 (Moreira, 2002). The latifundium remained the basis of the Brazilian agrarian structure ever since the first years of European colonization to the current days without the effective planning of social, economic, and infrastructure policies that would provide dignified and healthy circumstances for most Brazilian families.

Throughout the 19th and 20th centuries, with the "March to the West" (and also to the North, toward the Amazon region), historically excluded groups, such as indigenous people, people of African descent, and peasants were recurrently expelled from their traditional territories, sometimes remaining "islanded" in the midst of the growing urbanization. That is why from 1,900 to 2,000 the urban population became 4.3-fold larger and nowadays ∼85% live in urban areas (IBGE, 2017), mostly in the urban outskirts and slums with housing and sanitation deficits (Fernandes and Costa, 2012; IBGE, 2017).

This pattern continues up to the present day and is expressed in the presence of many social, environmental, and territorial conflicts in rural and urban spaces, with the latter increasingly expanding and influencing the first. In the countryside, the socio-environmental conflicts in recent decades are characterized by the export neo-extractivism of agribusiness, mining, and infrastructure projects, which face resistance from social and community movements linked to the agrarian reform and the demarcation of indigenous and *quilombola* lands. In the cities, real-estate speculation and gentrification driven by the finance, tourist, medical, and hospital capital or by major events (Olympics and World Cup) have intensified the socio-spatial processes of exclusion, with resistance organized by movements such as the Homeless Workers' Movement (*Movimento dos Trabalhadores Sem-Teto,* MTST) (Rocha et al., 2017). Their fight is not just for housing, transportation and sanitation, but also for more democratic and inclusive cities.

The subtle complexity that characterizes these conflicts is highlighted when one thinks of the differences in emancipatory projects in the Global South, which are not limited to social inclusion, production and distribution of wealth proposed by the utopias of modernity that characterize the Global North. Here, the relevance of environmental and cognitive justice increases, as important dimensions for understanding the differences and possibilities of ongoing emancipatory agendas.

People of the Fields, Forests, and Waters in the Countryside-City Interaction

Currently, many traditional, indigenous and *quilombola* populations coexist in the urban or peri-urban spaces of Brazil, in addition to those who insist on practicing family and peasant agriculture in areas increasingly threatened by a disorderly urbanization. Generally, they are families that in the past were expelled from their original territories, migrated and are currently once again being threatened by urban policies that disregard and submit them to dynamics involving what Brazilian political geography scholars call the deterritorialization and reterritorialization (Haesbaert, 2004, 2009). These families are considered non-citizens by the Brazilian society, in addition to being landless. That is why, although many regions show economic development based on extractive economies such as the production of rubber, gold mining, large-scale mining of iron and bauxite, the exploration of timber, cattle raising, the construction of hydroelectric power plants, highways and waterways, and more recently, the production of grains (mainly soy), these people remain subject to a situation of poverty and oppression. They have been banished to the most degraded areas of large and medium-sized cities, even in Amazonian metropolises, such as the cities of Belém and Manaus.

As for other Brazilian regions, such as the Southeast, the South and the Northeast, their intense urbanization process started after the end of slavery (which occurred only in 1888, when black people went from "slaves" to "landless") and mainly with industrialization process after World War II. However, even these regions also have traditional populations remaining in cities that, until a few decades ago, lived on family and subsistence farming, traditional fishing, seafood gathering and even hunting. Similarly to the whole of Latin America with its colonial heritage, the creation of cities in the region involves complex processes of a historical, political, economic, cultural, and environmental nature that are behind the violence, racism, and deep socio-spatial inequalities in the metropolises, including the creation of slums and the historical deficits of democracy and access to housing, sanitation, and health services.

At the same time that discriminated and marginalized populations in the Brazilian society were driven out of the countryside, in the last decades, entrepreneurial agriculture and, more broadly, the agroindustrial sector have become a strategic component of the Brazilian macroeconomic policy, becoming fundamental for the equilibrium of the trade balance and the stabilization of the economy, a position reinforced by the government of President Fernando Henrique Cardoso in the 1990s (Delgado, 2012). Agribusiness, favored by an international cycle of high commodity prices, has assumed a central role in the Brazilian society and economy, and has currently become the main obstacle to the agrarian reform, the recognition of traditional territories and the greening of cities, as well as the dissemination of an agroecological approach in the country (Caporal and Petersen, 2012). The maintenance of this configuration throughout the 2000s helps to understand how the country has become the largest international consumer of pesticides and the second in areas with transgenics crops, whereas, paradoxically, it has consolidated itself as an international reference in the construction of public policies in favor of agroecology (Schmitt et al., 2017). In this context, the country also ended up endorsing the maintenance of more than 4 million small and medium family production units, with a significant concentration of land, in which 0.91% of rural

establishments concentrate 45% of the entire agricultural area (Oxfam - Brasil, 2016).

Despite land possession restrictions and its historical marginalization in the scenario of Brazilian public policies, family, and peasant agriculture farming in the country has characteristics that comprise a wide mosaic of possibilities in different agroecosystems, with different degrees between subsistence farming and integration into the food market, as well as different levels of environmental degradation and preservation. This broad scenario includes agroecosystems in the northeastern semiarid region, in the *Pantanal* and in the *Cerrado* in the Midwest region, in the Amazon Forest in the North region, up to the remnants of the Atlantic Forest and *Pampas* in the Southeast and South regions, in the areas that comprise the bases of the Brazilian coast occupation between the 16th and 20th centuries.

Although surviving at increasingly adverse conditions, even with the growth of cities throughout the 20th century, green belts remained in their peripheries and surroundings, which were responsible for the supply of fresh food, since the focus of family farming beyond subsistence is, by definition, the internal market through the so-called "local and short food circuits," while agribusiness is mainly focused on the international commodity market. Several indicators point out that family and peasant agriculture is responsible for a large part of the foods that comprise the Brazilian diet, such as fruits, vegetables, beans, cassava, coffee, and milk, among others. More than 80% of the rural establishments is family-owned and about 70% declare that they do not use pesticides, although a much lower number, about 2%, is recognized as organic agriculture (Niederle et al., 2013, Lima et al., 2020; Porto et al., 2020). Although counter-hegemonic, these data show the potential of family and peasant agriculture as the basis for the agroecological transition in Brazil.

Moreover, a striking characteristic of the Global South and Brazil is associated with the influence of traditional practices related to different cosmologies that are found in the Brazilian rural world, which involve, with different nuances and syncretisms, indigenous traditions, those of African origin and those related to peasants of Indo-European origin. This characteristic may contribute, according to our evaluation, to the construction of important emancipatory agendas and processes for the paradigmatic transition, including the context of urban greening.

Recent Advances and Contradictions Related to Traditional Peoples and Communities and Peasants in Brazil

A relatively recent milestone of great importance for the traditional peoples and communities and peasants in Brazil was the constitutional reform carried out after the end of the military dictatorship. It officially ended in Brazil in 1985, although it was only in 1989 that Fernando Collor de Mello was elected president, the first president elected by popular vote since 1964, the year of the military coup that lasted more than 20 years. Indigenous peoples and *quilombola* communities had their rights guaranteed with the promulgation of the 1988 Federal Constitution, also called the "Citizen Constitution." It recognized indigenous peoples as full citizens for the first time in our history and put an end to the State tutelage that prevailed until then, simultaneously assuring them the right to exist, to subsist, to organize and to be represented autonomously and according to the traditions and social organization of each people. In the wake of the indigenous peoples' successes, *quilombola* communities were also included in the Constituent Assembly, which defined that the State would have to demarcate all traditional territories in up to 5 years. The traditional peoples' right to the land was considered an original right, that is, independent from the ratification by the State, which would only be responsible for the delimitation of indigenous lands and registering them as the collective heritage. It means that each people would have the right of usufruct, a timid component of the historical justice performed in Brazil considering its violent colonial past. After years of great effort by the black and peasant movements, *quilombola* communities were also included in the Constituent Assembly, but with a lower degree of legal security, as their land rights, unlike those of indigenous peoples, were subject to state recognition.

Unlike the advances for indigenous and *quilombola* communities, the results of the Citizen Constitution of 1988 were much less favorable regarding the possibilities of a broader and redistributive agrarian reform, which reflected the historical, economic and political power of the large landowners since the formation of the colonial Brazil and, later, in modern capitalist agriculture. This power remains to the present date, despite the several economic, political and technological cycles that were part of the Green Revolution and culminated in the power of modern agribusiness, which has established deep connections between agriculture and global industrial and financial capital in recent decades.

These factors are strategic to understand the weight of political conservatism and the bases of neoextractivism in the country's development model remains hegemonic, with the increasing weakening of the developmental and industrial model forged after World War II. For authors such as Maia and Oliveira (2017), there was even a setback in the agrarian reform compared to the existing Constitution during the military dictatorship period. The result practically made agrarian reform unfeasible in the country due to bureaucratic requirements that favored only the large landowners, such as the payment required for the indemnity due to expropriations for social interest, as well as other gaps in the infraconstitutional legal provisions that hindered its implementation. Since then, the main pressures and advances in agrarian reform in Brazil have been generated by the organization of social movements such as the *Movimento dos Trabalhadores Rurais Sem Terra* (Landless Rural Workers Movement - MST) and its strategy of occupying unproductive land. Their actions have always involved many conflicts and violence on the part of the police forces and the judiciary, as well as armed actions by large rural landowners. Therefore, despite the advances and the relative elation with the promulgation of the Citizen Constitution of 1988, the Brazilian society has remained profoundly unequal and violent, with the maintenance of privileges and the perpetuation of an exclusion system that

reinforces the presence of an "abyssal line," as proposed by Santos (2007).

The decades that followed the end of the military dictatorship in 1985 and the new 1988 Constitution brought about important changes, with the presence of some governments that implemented redistributive and inclusive policies in areas such as health, education, government programs to fight hunger and poverty, support for family farming, regularization of indigenous peoples and *quilombola* lands. At the same time, the cities started to develop housing and urbanization programs in slums and the outskirts, in addition to educational policies such as quotas for the poor and those of African or native indigenous descent. However, these were isolated accomplishments, although accelerated in the 21st century, during the years of *Partido dos Trabalhadores* (Workers' Party -PT) government.

Regrettably, there have been important setbacks in recent years after the political-institutional- media coup that removed President Dilma Rousseff from power in 2016, led to ex-president Luis Inácio Lula da Silva's imprisonment in 2018 and then reached its peak with the election of a far-right government at the end of the same year. Although important, the social inclusion measures developed between the end of the military regime and the fall of President Dilma Rousseff were insufficient to reverse structural social inequalities and different forms of racism, with countless social achievements in recent decades being quickly reversed in a few years of retrograde neoliberal and conservative governments.

To understand this process, it is important to indicate that the more conservative sectors of society, although without a clear political expression after the end of the dictatorship, had been growing during the years of PT's center-left coalition government. They were mainly driven by agendas such as the fight against crime, violence, and corruption, the defense of the traditional family values and religious intolerance and against the few advances related to the recognition of political minorities' rights. The symbolic and political void left by the Catholic Church regarding its impasses in the presence of internal disputes that clashed conservative groups linked to the so-called Catholic Charismatic Renewal Movement, with sectors whose pastoral action was based on the so-called Liberation theology, of a more progressive nature, came to be increasingly occupied by neo- Pentecostal evangelical churches. Herein, we highlight the prosperity theology that unites the Christian tradition, in a particular way, with capitalist modernity by associating, in a more explicit way, the spiritual and material success. This association is in the genesis of the analysis made by Max Weber in his famous book "The Protestant Ethics and the Spirit of Capitalism." Although he focuses on the work ethics and wealth as a symbol of those who were blessed by God, the underlying idea is similar to that of neo-Pentecostal churches. However, in the latter, the constructed narrative has a more popular appeal and includes symbols of opulence, whereas before it was associated with a certain asceticism.

These churches, together with agribusiness, mining, the military sector and the financial market, are at the basis of the current far-right government elected in late 2018 agglutinates a group of forces that, until recently, were part of the fragile center-left alliance and include sectors of great economic, political, and symbolic power, such as the hegemonic media. This strengthened a moral agenda of great appeal to the middle and popular classes, such as the selective fight against corruption by a conservative judiciary power influenced by the US geopolitical strategies that disseminated lawfare in the Brazilian judiciary (Santana, 2018).

In this complex context, some research groups have been working on the theoretical and methodological renewal to think about the construction of alternatives that articulate different fields of knowledge, social struggles, and movements. The present article is an expression of the search for this renewal.

The Meetings of Knowledge and the Development of Sensitive and Collaborative Methodologies in Intercultural Dialogues in the Global South

The systematization of social struggles and emancipatory processes expressed in the context of the Global South can offer interesting signs related to urban greening. To illustrate this idea, we used as reference two events organized by the authors of this article in 2018 and 2019, entitled the "Meeting of Knowledges of Neepes" (Neepes, 2020). The objective was to enhance intercultural and interdisciplinary interactions between subjects working in Academia, in social movements and in different territories with concrete knowledges and experiences, be they leaders, activists, researchers, technical advisors, among others. It was a strategy aiming at the shared construction of research agendas and topics, exchange of experiences and conceptual frameworks that can support social struggles and the emancipatory processes for health, dignity and territorial rights.

The Meetings are also thought of as spaces for the experimentation of dimensions that are simultaneously epistemological and communicational, involving the articulation between scientific, artistic and popular languages in the interaction and dialogue processes, in addition to strengthening the work in cooperation networks.

A central aspect of this proposal for the carrying out of intercultural dialogues is the dilution of boundaries between the theoretical-conceptual and methodological dimensions, aiming at producing knowledge, not *about*, but *with* the social subjects who are present in the social struggles. Contrary to what the dominant scientific canon of Northern epistemologies defends, based on the ideas of objectivity, neutrality and reproducibility that stringently separate subject and object, producing knowledge *with* is usually much more complex and challenging. This collaborative theoretical-methodological attitude implies processes of inter-knowledge and self-knowledge, fundamental to the ethical and political dimension of knowledge aimed at social and community transformation.

Therefore, we have relied on the concept of non-extractive collaborative research (Santos, 2018), which has been resignified as sensitive co-labor-active methodologies (Fasanello et al., 2018, Porto et al., 2021). Different languages, such as academic-writing, graphic-imagery, poetic-musical and audiovisual, have been used as strategies to create the conditions for an

intercultural dialogue that overcomes the limits of the scientific language logocentrism and facilitates communication with social movements and community organizations (Fasanello et al., 2018). It is a matter of connecting them to the spheres of feeling and thinking, reason and affection, also called by Guerrero Arias (2010) as "corazonar." By prioritizing the making of audiovisual documentaries together with articles, books and reports, we also rely on the theoretical-methodological proposal of the sociology of images by Cusicanqui (2015), in which the audiovisual emerges as a possibility for sensitive elaborations in the territories that simultaneously integrate the political, aesthetic and epistemological dimensions that make the alternative narratives visible. For the production of the Meetings, militant artists were invited to work with the discussion groups in the production of poetic-musical and graphic-imagery reports, including languages such as rap, *repente* and *cordel (cultural expressions from northeastern Brazil that use rhyming verses)*, poetry slam, indigenous visual and graffiti artists, among others.

The last event in 2019 was focused on a key topic for the article and was called "The Countryside in the City: resistances, (re)existences, and interculturalities in care and food" (Neepes, 2020). Its objective was to develop the countryside-city relationship based on the interactions of knowledges, experiences, resistances, and transformations involving traditional peoples and communities, whether indigenous, *quilombolas* or others of African origin, but also the populations of peasants and traditional fishermen. As previously discussed, the set of this vast pluriverse of social groups has been referred to in Brazil as populations of the countryside, forests and waters. Despite the intense rural exodus and the rapid industrialization and urbanization processes throughout the 20th century that characterize the socio-spatial inequalities in Brazil, these populations remain alive and participate in countless social struggles and political agendas in the country, which are often simultaneously anti- capitalist and anti-colonial, including inside or near growing urban spaces (Porto, 2019b; Neepes, 2020).

The choice of participants involved at least two of the following criteria: (i) being part of a social movement, community organization or academic group working on the central topic of the Meeting; (ii) being involved in one or more environmental conflicts involving traditional populations in urban contexts, having the "Map of Conflicts Involving Environmental Injustice and Health in Brazil" as reference, a project coordinated by Neepes (Fasanello et al., 2018); (iii) have partnerships with researchers from Neepes, based on research projects. The Meeting was attended by 67 people from several Brazilian regions, 23 of whom linked to academic groups and, of the remainder, 16 linked to community organizations and urban social movements, 11 from indigenous organizations, 9 from rural organizations, and 8 linked to the black and *quilombola* movements.

In this event, we sought to advance the debates on how to strengthen the co-presence of social subjects from social struggles that are often made invisible, with their knowledges, practices and languages, aiming at more effective dialogical processes. How can one build an ecology of knowledges with such different populations living in these territories of intercession (and exception) on the increasingly blurred borders between cities, fields, forests and populations living from their relations with the sea, rivers, and waters? Therefore, the conceptual and methodological consolidation of the emancipatory processes was sought, with the effective participation of subjects who bring their lives, values, knowledges and struggles and, respectfully, dialogue with other struggles and knowledges in the construction of this process of sharing their dilemmas, conflicts and the solutions developed by them, according to Freire (1998).

On the 1st day of the event, two tables were set up with speakers talking about territorial experiences, social and academic movements, aiming to present and discuss references that would inspire the collective debate on the day after the meeting. Under the title "The countryside in the city: contributions and resistances of traditional and peasant peoples and communities," the speakers at the first table presented their experiences, highlighting how urbanization affects the territories and how traditional peoples and communities have organized themselves to resist deleterious pressures as much as to establish interfaces with urban movements that fight for housing, the right to the city and more inclusive, healthy and democratic spaces. The second table, entitled "Care and food: challenges in the encounter between the countryside and the city," the speakers presented their experiences of care rooted in the knowledges found in the territories of traditional and peasant peoples and communities.

On the 2nd day of the Meeting, three Working Groups (WGs) aimed to share experiences and promote a debate around three axes: territory, care, and food. Aiming to promote an ecology of knowledges, there was a diversified distribution in all groups from the different social movements, community groups and academics present at the meeting. Each group received a set of questions that stimulated debate and sharing. In addition to the specific questions of each axis, the groups received four questions that were created based on conceptual, methodological, and political challenges considered to be strategic in the countryside-city relationship: (1) about the ecology of knowledges and interculturality in the relationship between academia and social movements, and between the countryside and the city; (2) about the enchantment, the spirituality, and relationship with nature found in the cities; (3) on the democratic challenge, coexistence, and tolerance involving sociodiversity in the interaction of populations such as indigenous peoples, *quilombolas* and peasants in urban spaces; (4) the identity challenge in the countryside-city interaction.

Based on these questions, debates emerged from the experiences related to the specific axis of each group (territory, care, and food) and the transversal topic of the Meeting (countryside-city relationship based on the interaction of traditional peoples and communities), which were partially recorded on video, with reports also being produced using three types of languages: poetic-musical, graphic-imagery, and written language, the latter made by people linked to academic groups. These recorded materials were used as the basis for the syntheses and analyses presented below.

Synthesis of the Debates in the Working Groups: Territory, Care, and Food

The Territory WG focused on the guiding question: how are the struggles for territorial rights carried out by peoples, communities and movements that are traditionally linked to the countryside, forests and waters in their relationship with the cities? Through the idea of territorial rights, the aim was to encompass multiple aspects regarding the concept of territory, from land demarcation, seen beyond its legal dimensions, to the right to share common goods and public spaces related to the production and access to healthy foods, housing, mobility, sacred spaces, and the performance of important rites for traditional groups. The importance of territories in recovering and valuing ancestral traditions and knowledges, crucial as reference action points in the presence of contemporaneity crises, was emphasized. Processes of deterritorialization that bring stress, in different ways, to these populations and their ways of life, which make the successful synergies in the construction of other possibilities in the countryside-city relationship unfeasible, were also denounced.

An important example are the struggles for the demarcation of indigenous lands as a strategy to rescue and value their tradition and ancestry, in a dynamic of resistance and counter opposition to the processes of accumulation through the spoliation of processes linked to agribusiness, agro-extractivism, and urbanization. These processes even threaten society as a whole, considering that the guarantee of indigenous territories allows the conservation of several common goods and the recovery and appreciation of an important framework of knowledges about how we can preserve them.

The main question for the Care WG was: What experiences of care do traditional peoples and communities bring, resist and reinvent in the proximity to cities? The aim was to promote a debate related to the knowledges and practices of health protection, attention and promotion, including care for specific and vulnerable populations such as children, pregnant women, the elderly, people with mental suffering, victims of violence and racism. A set of successful care experiences promoted in different territorial contexts by traditional peoples and communities was shared. Different concepts of care were shared, which reinforce its multidimensionality, extrapolating the hegemonic idea of treating diseases, disabilities or mental suffering, as seen in the following statements. To care is "…not letting anyone go hungry, it's putting yourself in someone else's shoes." "…have feelings together means strengthening relationships, each warrior who falls, all relatives cry." "…sharing, welcoming and building a world of respect, as opposed to the prevailing climate of competition."

In the different speeches, the idea of care was related to ancestry and spirituality, with intergenerational affective, gender, community, and intercommunity relationships (transscale, because they join the local and the global), involving resistance and struggles for land and housing rights. The affective and collective dimensions of care were also highlighted, in contrast to the individualistic and utilitarian logic that prevails in the Western and capitalist scientific medicine. The inseparability of care, territory, nature and food was highlighted. Additionally, tensions and conflicts that make traditional peoples and communities vulnerable in the face of the prevailing logic in biomedicine, which distance them from their autonomy, were denounced.

Finally, the following question guided the Food WG: how do the production, circulation and distribution of food, its quality and/or lack, contribute (positively or negatively) to the sovereignty and food security of traditional peoples and communities and the city populations? The aim was to reflect on food based on the experiences of traditional peoples and communities' movements, peasant family agriculture and agroecology, observing how they resist and create alternatives in their relations with cities. Moreover, we sought to discuss food from an intercultural perspective, related to the exchanges of knowledge and tastes, care, and spirituality.

The potential of territorialized experiences that seek food and nutrition sovereignty and security with ecologically sustainable and socially fair foods was emphasized. The need to guarantee that healthy foods are accessible to the most socioeconomically vulnerable people in cities and the countryside was highlighted, and not just another "market niche." In this sense, the experiences of the Movement of the Homeless Individuals of Bahia (MSTB, *Movimento dos Sem-Teto da Bahia*) in two occupations in the city of Salvador, state of Bahia, were highlighted; as well as the Serra da Misericórdia Integration Center (CEM, *Centro de Integração da Serra da Misericórdia*). These experiences unfolded into one of the research projects that are currently being developed by the authors of this article, which will be discussed later.

Also highlighted was the potential of interchanging and exchanging experiences between production and supply initiatives: "exchange is power!" was the motto of this discussion. At the same time, several concepts of food emerged, explaining its multidimensionality. Finally, threats to the experiences of food security and sovereignty were denounced, with the debate of urgent issues, such as the growing use of pesticides in agriculture, which directly impacts the health of those who work with agriculture and the production of organic foods; the threats to common goods and their importance to guarantee food security and sovereignty, especially access to land and water, and the issue of preserving and recovering traditional knowledges related to food.

On the 3rd day of the meeting, the three WGs shared the results of the debates. The presentations explained the potential of sensitive collaborative methodologies (Fasanello, 2018) in promoting intercultural dialogues between subjects from the territories and academic researchers through the use of other languages. In addition to written reports, graphic-imagery (drawing and painting) and poetic-musical (rap, *cordel*, and slam poetry) reports were made by artists with experiences with social movements. In this sense, the presentations showed that the current moment demands resistance and articulations between movements, organizations, academic and public institutions, at local, national and international levels. In a context of social, ecological, democratic, and institutional crisis, the participants showed that territory, care and food intersect at the material,

political, and spiritual levels. These synergies point to the strategic importance of continuing the successful experiences that celebrate and nourish with hope the democratic coexistence and the construction of utopias.

Below, a painting made at the Meeting by indigenous artist Denilson Baniwa is presented as an example, as well as an excerpt of the poem written by a rural and agro-ecological movement activist, Maicon Vieira, characterized by the cultural tradition of Northeastern Brazil. In the case of the poem, *cordel* is a folk-popular poetry often written in rhyme form, which originates from oral reports and is usually printed in pamphlets, although it can also be sung.

Graphic-imagery report by Denilson Baniwa

Excerpt from the poetic-musical report by Maicon Miguel Vieira da Silva
(Translated to English by Sonia Strong)

Brazil,
your time has come.
*To listen to Marias, Mahins, Marielles, Malês *,*
To look for a place to talk about interculturality.
In care, food and the countryside in the city,
The resistances, the existences and their diversity.
An open-sky place, with an indigo background,
Where we can look at ourselves, reporting what we felt.
We found this place at the Roots of Brazil (...)
So large are these reports, which make us reflect.
In each gesture, an action, making us feel,
reinforcing the need for us to (re)exist.
(Re)existing in art, (re)existing in culture, (re)existing in the food that comes from agriculture, (re)existing through the herbs that bring us so much cure.
What is science? What is revolution? Do we have the answers for this consideration?
For the answers teach us to walk with our feet on the ground.
On the ground of knowledges, on the ground of diversity, on the ground of resistance, on the ground of equality, on the ground of territories that guarantee liberty.
A point of balance,
we must find,
between academic knowledges and popular ones, too.
Because the inexistence of this meeting is a challenge I point out,
Which prevent us from advancing (...)
We must come together, walking side by side, academy and territory are allies in this fight, defending the right to life and food, which is sanctified.
Our writings and knowledges must talk to each other.

**Mahin was a tribe of the African nation Nagô; Malês was the term used in Brazil in the 19th century to designate African people of Islamic origin brought as slaves to Brazil who organized an uprising in 1835 in the State of Bahia; and Marielle Franco was a Brazilian politician, feminist, socialist, and human rights activist who was brutally murdered in 2018. In 2019 two former police officers were arrested and charged with the murder of Marielle Franco.*

Aspects that permeate the disputes in various territories, affected by transformations in the neoliberal and neoextractivist capitalism, were evident in the final evaluations of the Meeting by the participants. Conflicts over land are worsening, in a process of resistance against agribusiness, mining and energy production, as well as housing spaces and spiritual practices, injured by real estate speculation and intolerant and violent religious fundamentalism, with increasingly more fragile democratic institutions and policies. In this sense, the presentations showed that the current moment demands resistance and articulations between movements, organizations, academic, and public institutions, at local, national, and international levels. In a context of social, ecological, democratic and institutional crisis, the participants showed that territory, care, and food intersect at the material, political, and spiritual levels. These synergies indicate the strategic importance of continuing the successful experiences that celebrate and nourish with hope the democratic coexistence and the construction of utopias.

The Meetings of Knowledges have shown the importance of the territories where the rural and the urban interlace, resulting in fertile spaces for establishing dialogues around social and environmental conflicts, as well as ongoing experiences that indicate possibilities of knowledges and practices to be better investigated, and which have been changing into agendas and research projects that bring new perspectives to discuss urban greening. Below are some examples toward this direction.

The Case of Urban Expansion and the Challenges for the *Munduruku* People in the Middle Tapajós River in the Amazon Region

Regarding the *Munduruku* people of the Middle Tapajós River, whose representatives were present at the 2018 Meeting,

the cooperation was initially developed from the demand for institutional support to assess the impacts of mercury contamination associated with mining, as well as alternatives aimed at socio-environmental and cultural sustainability in order to promote health in the presence of the threats faced by them. In the project that was initially developed (Rocha and Porto, 2020), the interconnections between the processes that take place in the countryside and in the urban areas of the Amazon region became evident. They highlight how the economic dynamics based on the extraction of gold and forest products shape the economy of a city and put pressure on the villages closer to that people, limiting their social reproduction, territoriality, access to land, fishing and agricultural production activities. Based on the intercultural dialogue and interdisciplinary perspectives with this ethnic group, with the support of the reflections generated during the Meetings, new research questions were asked.

For instance, to understand the territorial and environmental conflicts surrounding gold mining and others existing in the Middle Tapajós river region, the question of the meaning of the value of gold for the *Munduruku* and non-indigenous people (called *pariwat* in their native language) is raised. Additionally, whereas the main problem in the villages farthest from Itaituba lies in the contamination of fish by mercury, in villages undergoing the process of urbanization they also face issues associated with real estate speculation, the disordered expansion of the urban area driven by the mining economy the appropriation of river banks for the installation of logistical terminals for the transportation of mineral, timber and grain farm (soy) production or the construction of roads and railroads that cut through the territory, preventing the continuity of traditional indigenous agriculture and fishing activities, submitting them to the same dilemmas of the peripheral populations of large metropolises.

Other important issues emerge to consider socioenvironmental topics influenced by the urban expansion. For instance, the meanings of food and fish in the *Munduruku* cosmology in comparison with the recommendations of the WHO and health research institutions about findings on mercury contamination, whose medical and toxicological recommendations impose rules that restrict the consumption of several important fish in different dimensions of that people's life. Because in the *Munduruku* cosmogony, fish have symbolic and spiritual meanings that cannot be disregarded based only on so-called technical-scientific recommendations.

The indigenous concept is not limited to a matter of access or exchange of animal protein sources. Just as it is not any piece of land that can be used by the Munduruku people to exercise their territoriality, and not all fish can be eaten, not by anyone, at any given time. The choice of what to eat, who eats it and when one does it, does not obey a utilitarian logic based only on the availability of animals in the river at certain times of the year, but also on a ritual logic that creates taboos about the consumption of certain fish species and encourages the consumption of others, including as part of self-care strategies.

The broth made of certain species is seen as imbued with curative powers, even for those situations during the life cycle in which people are subject to what they would call "diseases of the spirit." The care of parturients is also mediated by the choices of fish consumption, with some types of fish being considered as not recommended in this situation, while others help in the postpartum recovery period. In summary, the choice of whether or not to consume these animals cannot be mediated just by estimating how many milligrams of mercury are found in each kilogram of each species.

The relationship of the *Munduruku* people with rivers goes beyond mediating the health- disease-care process. The safety of the world itself would be associated with the relationships established with the beings that protect the river, as exemplified by the excerpt of a letter sent by them to the Brazilian government during the debates on the construction of a hydroelectric power plant in the municipality of São Luis do Tapajós:

> *"São Luiz do Tapajós (*Joropari kõbie*) [is] an ancient place of the Munduruku existence, who lived there at that waterfall. The white people know nothing about that place. There is a hole in the middle of the waterfall that some ancient residents, who are not* Munduruku*, say there is a huge hole there, called the "devil's throat"; anyone who is pulled down there, in that current, and is swallowed, will never appear and nobody will ever see them again. You can't touch the waterfall and disasters can happen. The mother of the fish lives there, in the shape of a river dolphin, and some people who live there have seen this animal. So, the fish are happy to see her and the tapirs usually fall into the water in that place, where the mother is. According to the spiritual leader, the shaman warned that there should be absolutely no changes in that place, and if someone changes anything or destroy that sacred place, which belongs to the mother of the fish, misfortunes can happen in people's lives, it is a risk for all societies. These things, the non-Indian will never understand."*

That is why, for the *Munduruku* people, it is so important to establish coexistence relations with the rivers, fish and animals. According to their cosmogony, the *Munduruku* world was created by the deity *Karosakayban,* as their people's inheritance. It is in this socio-environmental and cosmological context that food security and sovereignty alternatives have started to be thought of through an intercultural dialogue. This involves both fish farming activities, raising fish that are irreplaceable for them, under conditions that can protect them from mercury contamination, and the dynamization of traditional agricultural systems based on the promotion of indigenous agroecology in the region, which is seen by the main leaders as a desirable alternative to mining. For this purpose, a support network started to be built, involving agroecological and indigenous organizations, which have been working toward this direction at the regional and national levels. In addition to guaranteeing adequate food that respects the agroecosystems and indigenous culture, the idea is to create alternatives that generate income, considering the seductive idea of gold mining as a quick way to create wealth in villages that are increasingly impoverished and excluded from public policies; unable to maintain their traditional economic and subsistence activities. The economy of gold, soy and timber production, not only make the *Munduruku* way of life unfeasible in the end but is also paradoxically presented to them as an alternative to hunger and poverty.

This subordination is systematically stimulated by the government through educational, health or social security policies, which aim to integrate the villages into the non-indigenous way of life, especially through the concentration of the main public services in nearby municipalities. This encourages the migration of young people, both to study, to work or to have access to more complex health treatments. Thus, interethnic relationships are established, in which the traditional *Munduruku* knowledge is systematically despised, delegitimized and disregarded, starting with the loss of fluency in the language and signs learned in the forest, increasingly replaced by the predominant Portuguese language and by an urbanized way of life. Hence the importance that has been given to the indigenous school where the *Munduruku* language is spoken and taught, alongside Portuguese.

Two Experiences of Articulation Between Social Struggles for Housing, Sanitation, Health, and Urban Agroecology in Brazil

Another important initiative furthered by the Meetings was the construction of a research agenda, aiming to systematize the knowledges and practices led by the Homeless People Movement of Bahia (*Movimento dos Sem-Teto da Bahia*, MSTB), in two occupations in the city of Salvador, state of Bahia; and the Serra da Misericórdia Integration Center (*Centro de Integração da Serra da Misericórdia*, CEM), in a slum complex in the city of Rio de Janeiro. Both organizations have actions that articulate topics such as the right to housing, sanitation and health in conditions of high socio- environmental vulnerability.

Even in the context of the expansion of the Covid-19 pandemic over these territories, several actions are underway to investigate how these collectives' initiatives can have a protective effect in times of severe crises, such as the current sanitary one. These two territorial experiences connect innovative actions in agroecology, food sovereignty and food and nutritional security, popular housing, ecological sanitation, self-care and environmental preservation, seeking to increase community resilience and promote equity and sustainability.

In the context of the sanitary crisis caused by the pandemic, these actions, which have been ongoing for several years, have gained greater dynamism and public expression, indicating an important inflection in the debates related to health and food, by seeking to guarantee good-quality and enough amounts of food for the populations in peripheral contexts of further social, environmental and nutritional vulnerability. Moreover, these initiatives increase an intercultural and intergenerational view of health through alternative care practices that value indigenous, agriculturalist and African ancestral knowledges, including those preserved by *quilombola* communities, with the participation of women and young people.

The CEM experience involves food production in urban agroecological yards, the sale of healthy foods, donations and exchanges aimed at vulnerable individuals in the *Complexo da Penha* and *Serra da Misericórdia*, in the city of Rio de Janeiro. The organization has also supported a set of actions with the objective of promoting income generation, especially among women, and communication to disseminate its actions.

In the two popular occupations in the city of Salvador, in the state of Bahia, the MSTB has sought to articulate their efforts aiming at housing and health promotion with the production of healthy foods and medicinal plants. The community vegetable garden structured around the *Quilombo Paraíso and Quilombo Manoel Faustino* occupations encourages the production of herbal medicines and the rescue of their ancestral knowledges, giving rise to what they call the "Living Pharmacy," which has been an important alternative for the prevention and treatment of diseases. Currently, the movement has sought to promote the implementation of Agroforestry Systems in these occupations and in the surrounding *Bacia do Cobre,* an official environmental protection within the city. The actions seek to influence state housing policies that have historically been based on Cartesian urban planning, where popular housing projects are seen only as places to live, without spaces for leisure, commerce, production and other important situations for coexistence and the establishment of community bonds.

For MTSB and CEM, it is important that popular communities in cities or urban outskirts be seen as more than just apartment blocks or clusters of houses that reproduce a highly segregated city model that characterize the Global South. On the contrary, the popular territories are seen by these movements as spaces to rescue a certain rurality that was lost with the exodus, where families produced their own food or did it collectively, and their ancestral knowledges was valued. For this reason, the two organizations have promoted workshops with leaders who present their ancestral knowledges and offer the communities their indigenous values and practices, of African and agriculturalist origin, focused on health care and food.

Final Considerations

The article sought to support the idea that the concept of urban greening has its own specificity in the context of the Global South. In the Brazilian context, this necessarily involves the understanding of the complex relationship between traditional peoples and communities and family and peasant agriculture, and that their existence and forms of mobilization through current social struggles express a vast pluriverse of different hues and hybridizations. In general, we highlight three population groups that work through social movements and community organizations: the indigenous people, *quilombolas* and those who work in family and peasant agriculture.

Even though they are characterized as countryside, forest and water populations, the enormous expansion of urban spaces in the country has been promoting a growing countryside-city interaction. At the same time that it degrades ecosystems and traditional ways of life of these populations, this interaction provides countless experiences of resistances and re-existences that indicate new conceptions of nature, care and common goods inside the cities and in the surrounding ecosystems. In this sense, the intercultural dialogue can strengthen the inter-knowledge between the cosmological meaning of sacred spaces and the scientific recognition based on ecology of the vital importance of

certain landscapes or rivers. This makes it possible to strengthen conceptions and public policies that, in the field of Law, have come to recognize rivers as rights holders.

In this context, the Meetings of Knowledges work as strategic spaces that improve the action of academic groups engaged in the production of knowledge in the presence of multiple action fronts of community movements and organizations that are mobilized in social struggles. Ultimately, they aim to strengthen the acknowledgment of the countless possibilities of being, knowing and expressing themselves in the world, present in the cultures, worldviews and practices of indigenous people, peasants, *quilombolas*, workers and residents of slums, occupations and urban outskirts that characterize the emancipatory processes of the Global South.

It is from this perspective that we consider that the reduction of social, environmental, spatial, cognitive and health inequalities and vulnerabilities in populations living in peripheral spaces represents an extremely complex challenge for the thinking of urban emancipatory and greening processes. These are social contexts and struggles that are inherent to the Global South, characterized by models of housing, sanitation, education, health and environmental preservation that disregard the way of life of these populations and impose an exclusionary, territorial organization logic, orientedalmost exclusively toward the reproduction of international Capital and the expansion of the economic and political power of local elites. There is important evidence that, moreover, these contexts intensify ethnic-racial and gender inequalities, which make black and indigenous women and young people in these communities the main targets of violence, exclusion, poverty and even cooptation mechanisms, which disrupt the traditional social relations, with profound physical and psychological effects on families, which become fragmented and even involved in internal disputes.

In this sense, anti-hegemonic initiatives such as those carried out by CEM and MSTB, or under discussion by the *Munduruku* people, indicate instigating strategies for emancipatory health promotion together with urban greening. In common, regarding territorial experiences as ecologically and socially unique, as those in the basins of the Amazon river, in the northeastern coast and in the slums of Rio, they show the importance of agroecological approaches, popular strategies of health care, dignified housing and sanitation, while articulating knowledges and practices promoting sustainable and healthy urban, peri-urban or rural territories. Therefore, these are privileged cases of emancipatory health promotion as they integrate the reduction of vulnerabilities with four dimensions of justice: social, sanitary, environmental, and cognitive, the latter associated with radical exclusions involving anti-racist, feminist struggles for cultural-epistemic diversity and community autonomy. An additional important aspect, on which the authors have been working in different ongoing research projects is the support aimed at the strengthening and creation of Agroecology Networks, whether indigenous or urban ones.

We understand, therefore, that all the aforementioned experiences, more than strategic research topics, are the emblematic expressions of innumerable ongoing social struggles at different levels, scales and regions of the planet that can contribute to articulate the emancipatory agendas of the Global South and the Global North.

Finally, we also consider noteworthy the proposals that the Meetings of Knowledges end up generating for the social struggles that are expressed in the Global South, in addition to the debates around more concrete research actions. In this sense, we highlight the production of audiovisual records, with documentaries that can be used in different spaces and as a support element for collective debates; as well as in the production of research and academic works, which can provide greater visibility to territorial struggles and indicate research topics and methodological postures that are relevant to the individuals from the territories and the researchers. These documentaries, with subtitles in many languages, can contribute to the intercultural processes of inter-knowledge and the construction of counterhegemonic narratives through the sharing of values, knowledges, and experiences, thus helping the dialogue between emancipatory processes in the Global South and the Global North. This includes bringing the meaning of urban greening created in the contexts of the Global North closer to the complex processes that involve populations and communities of the countryside, forests, and waters in the interaction with urban spaces in countries such as Brazil.

DATA AVAILABILITY STATEMENT

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

AUTHOR CONTRIBUTIONS

MP initially conceived the proposal, the structure, and the main contents of the article. MF on sensitive collaborative methodologies. DdR in the field of political ecology and traditional peoples and communities, especially indigenous peoples. JP on the agrarian and peasant question, and on agroecology. All authors participated in the general review of the article.

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frontiers in Sustainable Cities

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Using Google Street View to Examine Urban Context and Green Amenities in the Global South: The Chilean Experience

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This study evaluates the use of virtual, human-interpreted, field observations using Google Street View (GSV) to examine the presence of conditions that may be used to analyze green gentrification in the Global South. We propose that green gentrification is characterized by the introduction or improvement of green amenities (such as parks) as well as corresponding changes to the urban context (such as facade materials). While virtual field observations have been used to examine neighborhood context for other applications, this method has not yet been applied to the study of green gentrification, nor in the Global South. Using one urban park located in Talca, Chile, and in three urban parks located in Santiago, Chile, we sought to address the following research questions: (1) How do *in situ* and virtual field observations compare as methods of evaluating green amenities and urban context? (2) What characteristics of green amenities and urban context must be addressed to investigate green gentrification in the Global South? (3) How do indicators of green amenities and urban context observed via virtual field observations indicate the potential for green gentrification? In order to observe the streetside conditions of the neighborhoods surrounding established, improved, and new parks, we utilize the ground-level 360° imagery through GSV as an alternative to *in situ* studies, which can be time-consuming, expensive, and logistically challenging. Features related to the land use composition, building materials used, and the presence of aesthetic improvements and pedestrian amenities were noted as potential indicators of gentrification, and the correspondence between the two methods of observation were evaluated. Results indicate that virtual field observations can provide a promising method that may facilitate the identification and investigation of the effects of green gentrification in the Global South, broadening the scope and application of this research. This comparison offers insight into the use and comparison of virtual and *in situ* observations for identifying green gentrification in the Global South and for the applicability of the virtual observation method in this heterogeneous urban landscape, especially in cases with unreliable or unavailable data.

Keywords: virtual fieldwork, Latin America, urban parks, Google Street View, gentrification

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INTRODUCTION

Urban greening has become priority for many cities around the world striving to become sustainable, resilient, and attractive places, and many municipalities explicitly seek to redress longstanding urban environmental injustices through urban greening programs (Pearsall et al., 2012). Latin American cities are also prioritizing greening because they generally have less green space per capita compared to cities in the Global North, because of the rapid pace of urbanization and the decision-making dynamics that exist between developers and public officials overseeing land use and zoning (Breen et al., 2020). With increased greening efforts, there is a need to acknowledge the burdens, disinvestment, and neglect that may span for decades prior to the new investment in a community.

Previous studies provide substantial evidence of environmental gentrification in many urban neighborhoods, with a few exceptions (e.g., Eckerd, 2011). However, these studies have often focused on single case studies of high-profile greening initiatives (e.g., New York City's High Line) in large cities in the Global North (e.g., Chicago, New York, Toronto). Further, the methods used by these studies largely depend on the multi-date comparison of official governmental statistics (e.g., Census data regarding education, income, and ethnicity) or on a survey or focus group of a subset of the population. While these studies reveal the limits of the "green is good" mantra (Connolly, 2019), the relevance of such findings to different urban contexts (both within and among cities) has only recently been explored (Anguelovski et al., 2018). Additional research is needed to understand green gentrification in different contexts and to critically examine the theories, methods, and findings of research efforts based on studies in the Global North.

Many studies of green gentrification developed in the Global North focus on how a new environmental amenity (like a park) or environmental remediation (like brownfield redevelopment) lead to gentrification because they increase the desirability of the neighborhood, subsequently increasing property values (e.g., Toronto's Don Lands waterfront: Bunce, 2009; Seattle's public green space planning: Dooling, 2009; Gowanus Canal, Miller, 2016). Yet, two dilemmas complicate the diagnosis of such classic cases of green gentrification in different contexts. First, there is a question of directionality. Which came first? Greening or gentrification? Does greening actually cause gentrification or are green environments a reflection of the desires of gentrifiers? The majority of green gentrification research draws on supply-side/market-led theories of gentrification premised on the idea of an "environmental" rent gap (Bryson, 2012, after Smith, 1979), or the idea that environmental disamenities (e.g., pollution) or the lack of environmental amenities depress property values, which rebound once environmental conditions improve. There is empirical support for this theory (e.g., Gamper-Rabindran and Timmins, 2013). However, some studies have found that environmental improvements do not lead to gentrification (e.g., Eckerd, 2011) or that demands for environmental quality are associated with the presence of gentrifiers (e.g., Mir and Sanchez, 2009) and their demands for more green amenities and improved environmental conditions. Additionally, there are limits to the rent gap theory to fully explain gentrification processes, particularly in the Global South (López-Morales, 2015).

Globalization and policies of neoliberalism are intertwined with gentrification in the Global South, flourishing in the absence of the state presence in urban planning (Betancur, 2014; Janoschka and Sequera, 2016). In Latin America, neoliberal urban regimes promote public-private partnerships (PPP), which are integral to gentrification, with the maximum return on investment as a deciding factor to allocate funding for new projects in areas of cities that are suitable for redevelopment. Seeking out the best investment segregates the population according to wealth, displaces residents in historic city centers, and impacts both immigration and emigration between countries. Irazábal (2016) illustrates how PPP can be harmful, using the city of Talca, Chile, inclusionary housing strategy, which was implemented after the 2010 earthquake and ended up promoting gentrification, not inclusion.

Previous research on gentrification in Latin American cities focuses on various causes of such phenomenon, but not specifically on the implementation of a greening or sustainability plan. Notable examples include: the presence of private educational institutions and universities in Santiago, Chile (Borsdorf and Hidalgo, 2013), the actions of a specific investor in the historic center of Mexico City's historic center (Delgadillo, 2016), and the housing demand for a transnational middle class in Panama City (Sigler and Wachsmuth, 2016), among numerous others. The latter illustrates what Sigler and Wachsmuth identify as "globalizing gentrification or transnational gentrification" (p. 706), showing globalization at its peak force wherein gentrification is occurring because of an international, not local, demand for real estate development—developments that may not be inhabited by a local population. Additionally, the 2010 earthquake in Talca was the motivation for Letelier and Irazábal (2018) to examine how the state, the community, and private actors were not able to avoid gentrification of the affected areas because of "neoliberalism type of urbanism," despite the existence of programs that heavily rely on participatory planning in the design of neighborhoods.

Second, there is a question of scale. How local or global are patterns of green gentrification across a city? This question is particularly pressing, as much of the work on green gentrification has been site specific and focused on one neighborhood or one green space (Checker, 2011; Bryson, 2012; Curran and Hamilton, 2012; Pearsall, 2013; Kern, 2015). The handful of studies that have examined citywide trends highlight spatially variable patterns (Pearsall, 2010; Abel et al., 2015; Anguelovski et al., 2018; Immergluck and Balan, 2018). Research on the Beltline, a large adaptive reuse project in Atlanta, Georgia, found statistically significant differences in cumulative appreciation in housing from 2011 to 2015 within a ½ mile of the Beltline and housing beyond ½ mile (Immergluck and Balan, 2018); however, changes in accumulation rates were not equal across the four neighborhoods. Rigolon et al. (2018) identified characteristics of parks that led to gentrification in the surrounding neighborhoods in 10 cities in the United States and found that the location and function of the parks were predictors of gentrification outcomes. These findings suggest that gentrification is not an

inevitable result of greening or park development and that certain contextual factors may accelerate or mitigate green gentrification.

Although there are few studies examining green gentrification in Latin America, there are multiple studies that have investigated access to urban parks in the region (Rigolon et al., 2018), focusing on proximity, quantity, and quality. There is evidence that higher-income people live closer to urban parks than lower-income people in cities such as Santiago de Chile (Krellenberg et al., 2014), Hermosillo, Mexico (Lara-Valencia and García-Pérez, 2015) and Bogotá, Colombia (Scopelliti et al., 2016). Moreover, quantitative studies on the quantity of urban parks per capita show spatial inequality, i.e., high-income residents have higher quantities of green space than low-income residents in cities such as Mexico City, Mexico (Fernández-Álvarez, 2017) and Curitiba, Brazil (Macedo and Haddad, 2016). Some studies suggest that best quality green spaces are in wealthier neighborhoods in Santa Cruz, Bolivia (Wright Wendel et al., 2012) and Bueno Aires, Argentina (De Mola et al., 2017). These park-related socio-economic inequalities may serve as symptoms of green gentrification and warrant further investigation. However, how the influence of the park relates to the physical and green amenities present in the surrounding neighborhoods is not apparent through the comparison of secondary data and would instead rely on *in situ* observations or, in the case of this study, virtual observations.

It is well-known that wealth inequality is rampant in Latin America. Amarante et al. (2016), reported that Latin American countries have been known for their inequality for as long as reliable statistics on income data has been available. The wealth inequality gives insight to how green gentrification may be evident in Latin America and how it differs from the Global North. According to Janoschka, Sequera, and Salinas, "the emerging discussions on gentrification in Latin America seem to proffer enough mounting evidence to make the claim that there are several types of gentrification to be found in this region that do not necessarily resemble the sort of gentrification previously found in the Global North" (López-Morales, 2016, p. 1110). Green gentrification is just one of the several types to be further explored, given increased attention to the aesthetic and health benefits of urban vegetation and its subsequent desirability.

In addition to exploring the contextual factors that may distinguish green gentrification in the Global South, researchers may also need to use different types of data and methods to detect gentrification. Gentrification research in Latin American cities has relied primarily on property sales data, governmental Census data, interviews, and policy analysis (see Delgadillo, 2016; Gaffney, 2016; Inzulza-Contardo, 2016). However, in many cities there may be either inconsistent or incomplete socio-economic data available (Hinojosa and Hennermann, 2012; Haddad, 2015). Additionally, census data and property sales data primarily capture changes in exchange value of land and may be inadequate for detecting changes in use value. When comparing the Global North and South, researchers in the Global North have better access to accurate and timely data (Musakwa and Van Niekerk, 2015; Arsanjani et al., 2016), which allows more effective analysis of changes in urban areas.

Cities that lack timely or complete data can greatly benefit from field observations, but conducting these *in situ* can be costly, in time and expenses, and may not be possible due to logistics, safety, or restrictions. Google Street View (GSV), a service available from Google with panoramic imagery stitched into a continuous scene, can be used as a proxy source of virtual field observations. The imagery is collected by Google's car-mounted camera and concurrently captures the location and direction of each image, allowing them to be browsed and queried as a comprehensive dataset. GSV has documented images from more than 100 countries spanning every continent (Houser, 2018). GSV has been applied to assessments of the built environment and natural amenities, including the study of gentrification in neighborhoods in Chicago (Hwang and Sampson, 2014) and Ottawa (Ilic et al., 2019). Hwang and Sampson (2014) emphasize that GSV is easily accessible and can provide visual indicators of gentrification, such as "the structural mix of an area," "visible beautification efforts," and "lack of disorder and decay" (p. 732–733). Moreover, Ilic et al. (2019) discuss the benefits of using GSV to reveal potential areas undergoing gentrification, especially because GSV updates its visual data approximately every 1–3 years, depending on location—more frequently than official Census data, which is often used to collect similar information. As Glaeser et al. (2018) argue, GSV has the potential to help evaluate income dynamics in developing countries, where this data might not be as readily available. Even though GSV is not comprehensive in every possible locale—there may be no data available within very low-income neighborhoods where car access proves to be challenging—still GSV can be an effective tool.

This study contributes to research methods on how to examine green gentrification in relation to park development by utilizing a GSV method applicable to most cities that face lack of official socio-economic data collected on a routine basis. This method provides potential for addressing the two green gentrification dilemmas described above because of the ubiquity and temporal scale of GSV imagery. Rather than using indicators from Census data, our approach incorporates more relevant indicators related to the built environment that can be derived from direct observation of the street-view imagery of a particular location or neighborhood, even through the virtual "lens" of GSV. Census data analysis provides a measure of demographic changes that reflect gentrification, and the use of GSV imagery may detect investments and improvements in the housing stock. Ilic et al. (2019) discuss how the visual expression of gentrification is an important yet under-addressed aspect of the process, yet it is also an important sign of gentrification (Hammel and Wyly, 1996).

We test our approach to detecting property improvements using GSV imagery in a set of case studies from two different cities in Chile, Talca and Santiago. Talca offered an opportunity to examine urban context using both *in situ* and virtual field collection surrounding an established park. Santiago was selected because within Chile, Santiago is the city that best depicts the effects of globalization and neoliberal policies in its territory and has both established and newly (re-)developed parks across a spectrum of neighborhood contexts. Both cities are experiencing

greening initiatives, in response to new development and urban renewal efforts.

To address the goal of understanding green gentrification in the Global South, we sought to address the following research questions: (1) How do *in situ* and virtual field observations compare as methods of evaluating green amenities and urban context? (2) What characteristics of green amenities and urban context must be addressed to investigate green gentrification in the Global South? (3) How do indicators of green amenities and urban context observed via virtual field observations indicate the potential for green gentrification? The study was conducted in two phases: phase I included a systematic comparison of *in situ* and virtual observation using GSV in Talca and an evaluation of the survey instrument; for phase II, in the Santiago Province using virtual observation only, we analyzed three buffer zones set around each of three parks with different socio-economic conditions, in order to identify patterns indicating green gentrification in the neighborhood surrounding each park and across the three neighborhood contexts. Our findings are twofold and inform future efforts to evaluate green gentrification in the Global South: (1) we demonstrated that variables that represent green gentrification in the Global South differ from previous studies in the Global North, and (2) our analysis using GSV indicates that street-level imagery provides a promising method that may facilitate the identification and investigation of the socio-economic impacts of green amenities (or green amenity investment) in the Global South.

MATERIALS AND METHODS

Study Area

Chile is a very urbanized country when compared to the world population: it had 87.5% of its population living in urban areas in 2018, compared to 55% of the world population (World Bank, 2021). Its urbanization process was particularly affected by the neoliberalization that started with the military dictatorship (1973–1990) bringing segregation and inequality to the urban fabric of several Chilean cities but most markedly Santiago (Otero et al., 2021). Like most countries from the Global South, urban informality is part of Chilean cities. Specifically for Santiago, Inostroza (2017) quantified the new urban peripheries, where most informality takes place, and found that the spatial patterns of development were "highly fragmented," and corresponded to 32.6% of the total built-up area, having 13% of overall informality (Inostroza, 2017). And to exacerbate this complex urbanization process, the lack of planning in Chilean cities is contributing to the formation of unsustainable built environments (Velázquez et al., 2021).

This study was conducted in two urban areas in Chile: phase I in the City of Talca primarily addressing research question 1 and contributing to research question 2, while phase II in the core of Santiago Province primarily addressing research questions 2 and 3. **Figure 1** displays the location of the areas in the country, and their territory. Talca, the largest city of the Maule region, had a population of 222,357 in 2017. The nation capital Santiago is the core of the province, divided into 32 comunas, with a total population of 5,613,982 inhabitants in 2017.

Like many Latin American cities, Talca does not have many urban parks. For the analysis, we chose a central park called Cuatro Norte, a corridor that runs the length of 14 blocks west to east of Talca (**Figure 3a**). Even though Cuatro Norte was established in 1742, in the original city plans, the intent of phase I was to compare results from the *in situ* and virtual field observations and to identify variables in a typical urban context that may relate to green gentrification. While the park is surrounded by stable neighborhoods that may not be experiencing gentrification, Cuatro Norte offered the opportunity to evaluate different variations of the built environment, especially related to the presence and visibility of green amenities on a block-to-block scale. **Figure 2** shows the location of Cuatro Norte within Talca, displaying a proxy variable to measure quality of housing per census tract for 2017 from Chilean national census. Low values mean that the area has very good quality housing stock, and high values mean that the quality of the housing stock has deteriorated. This indicates that the Cuatro Norte park had different levels of housing quality in its surroundings in 2017.

Talca has been the study area for a gentrification study, though not in relation to greening. Inzulza-Contardo (2016) conducted a study in four historic neighborhoods in Talca examining the reconstruction process, following the 2010 earthquake, using Cuatro Norte as a study area boundary. Their findings indicated the presence of gentrification caused by housing subsidies, allowing "urban plots and increasing land value rather than the protection of owner conditions and/or affordability for residents to keep living in the inner city" (Inzulza-Contardo, 2016, p. 2025).

For the Santiago Province we focused on three new or newly renovated parks: Andre Jarlán, Bicentenario, and Quinta Normal. These parks are located in three comunas with different socio-economic characteristics, as shown in **Figure 4**. Andre Jarlán, with an area of 320 thousand square meters, is located in the southern Pedro Aquirre Cerda comuna and is a historic park that was remodeled and reopened in 1997 (**Figure 3c**). Bicentenario, with an area of 314 thousand square meters, is located in the northeast Vitacura comuna and is the newest park out of the three we chose (**Figure 3d**). It was built in 2007 with anticipation that it would attract 75,000 new residents to the area (Lopez-Morales, 2011). Most parks are (in theory) designed to serve the public, yet with the rise of novel, high profile parks, such as Promenade Plantée in Paris or the High Line Park in New York City, city officials around the world are inspired to build similar world-class green spaces to generate economic development and attract global attention. Bicentenario is an example for this category, but in the Global South. Quinta Normal, with an area of 355 thousand square meters, is located in a western Quinta Normal comuna and is also a historic park that was also remodeled with new additions and more acres were added in 2008 (**Figure 3b**).

These are indeed very different comunas as Otero et al. (2021) described in their cluster analysis: Pedro Aquirre Cerda was classified as "lower-middle-class areas," Vitacura was classified as "affluent area," and Quinta Normal was classified as "urban

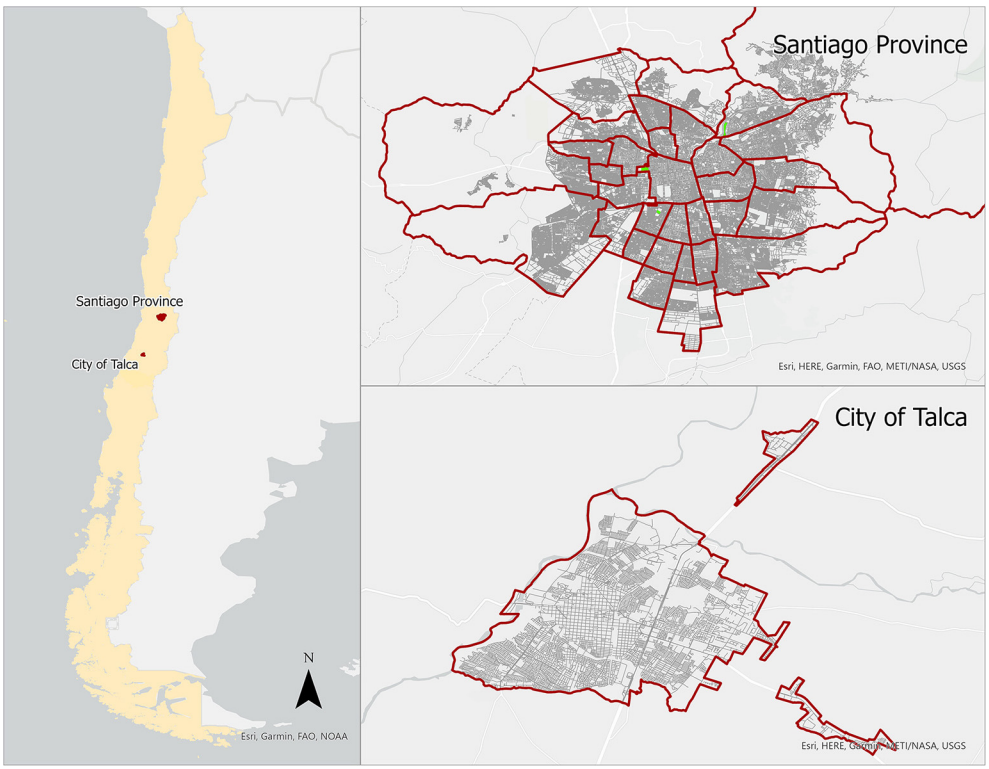

FIGURE 1 | Two study areas in Chile: City of Talca and Santiago Province.

crime area." Rental housing affordability varies greatly between the three comunas, as the study of Vergara-Perucich and Aguirre-Nuñez (2020) using 2017 data indicates: Pedro Aquirre Cerda and Quinta Normal are more affordable when compared to Vitacura, which has the highest rental housing price within the greater Santiago region. This illustrates what Macedo and Haddad (2016) describes as the process of ground rent accumulation on the part of private largest-scale real estate firms, and he argues that if this process remains untouched, segregation will not stop.

Furthermore, even the spatial distribution of the bicycling network in greater Santiago and its use by residents demonstrate how segregated the capital is, with most travels being generated at the east part, where Vitacura comuna is located (Mora and Moran, 2020). From an urban ecosystems services perspective, Dobbs et al. (2018) conducted a spatial analysis 1986–2014 and found that "Santiago showed a socioeconomic effect, where social inequalities matched environmental inequalities represented by lower provision of ecosystem services" (p. 1077). Based on their study, Pedro Aquirre Cerda and Quinta Normal would have experienced degraded ecosystem services during the period of study, and Vitacura, a more affluent comuna, would showed improved ecosystem services. Even though the city is implementing Smart City strategies with the goal to diminish this segregation, among others, Jirón et al. (2020) found that some of these strategies "are intended to have a placebo effect" (p. 615), i.e., they will not change the problem, but alleviate the perception for residents will connect Santiago with the "world-class city" concept.

Table 1 depicts characteristics of the three comunas, with different population density varying from 3,104 to 14,041. One can observe Vitacura had the largest amount of authorized square meters of new construction during 2015–2020, contrasting with Pedro Aguirre Cerda that had the smallest area of 33,366 m^2. These contrasting development levels may be related to the age of the neighborhoods located in these comunas: Vitacura has new neighborhoods on the edge of the province, and the other two are traditional established comunas with older neighborhoods.

Figure 4 shows location of the three urban parks and the percentage of population below the poverty line for all of the comunas in Santiago Province for 2017. The western part of the province was poorer than the eastern, direction to where the region is growing. The three parks are located in different gradients of poverty, being Bicentenario in lower poverty, Quinta Normal in medium poverty, and Andre Jarlán in higher poverty, when comparing the three. This figure illustrates López-Morales (2018) statement about gentrification in Santiago: the wealth distinction between comunas generates "material and symbolic exclusion" of the less affluent.

Data Collection

In this study, we utilized GSV to virtually observe locations and collect data based on human observation in Talca and Santiago, Chile, to investigate whether this technology can be effective in

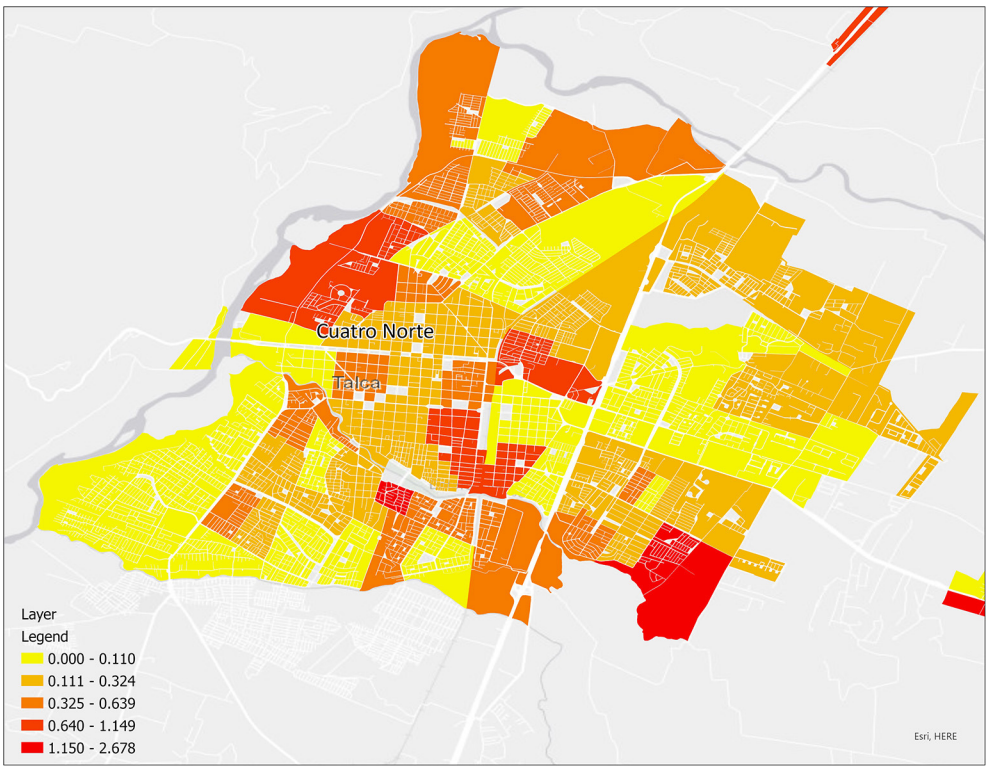

FIGURE 2 | Percentage of housing units in Talca with irrecoverable housing materials, an indicator of housing quality (2017).

FIGURE 3 | Photos of Quinta Normal **(b)**, Andre Jarlán **(c)**, and Bicentenario **(d)**, and Cuatro Norte **(a)** Sources: **(b)** Wikimedia Commons https://commons.wikimedia.org/wiki/File:Parque_Quinta_Normal,_Santiago_de_Chile.JPG; **(c)** FAHNEU https://fahneu.cl/imagen/parque-andre-jarlan-pedro-aguirre-cerda; **(d)** TripAdvisor https://www.tripadvisor.com/ShowUserReviews-g294305-d3236426-r329849129-Parque_Bicentenario-Santiago_Santiago_Metropolitan_Region.html; **(a)** MAPIO https://mapio.net/s/25908192/.

evaluating key characteristics of the built environment in diverse urban contexts. We aimed to determine whether GSV technology can serve as a reliable and cost-effective method of analysis compared to direct observation (Rundle et al., 2011; Kelly et al., 2013; He et al., 2017). We also aimed to determine if GSV is a viable and reliable method to investigate indicators of green

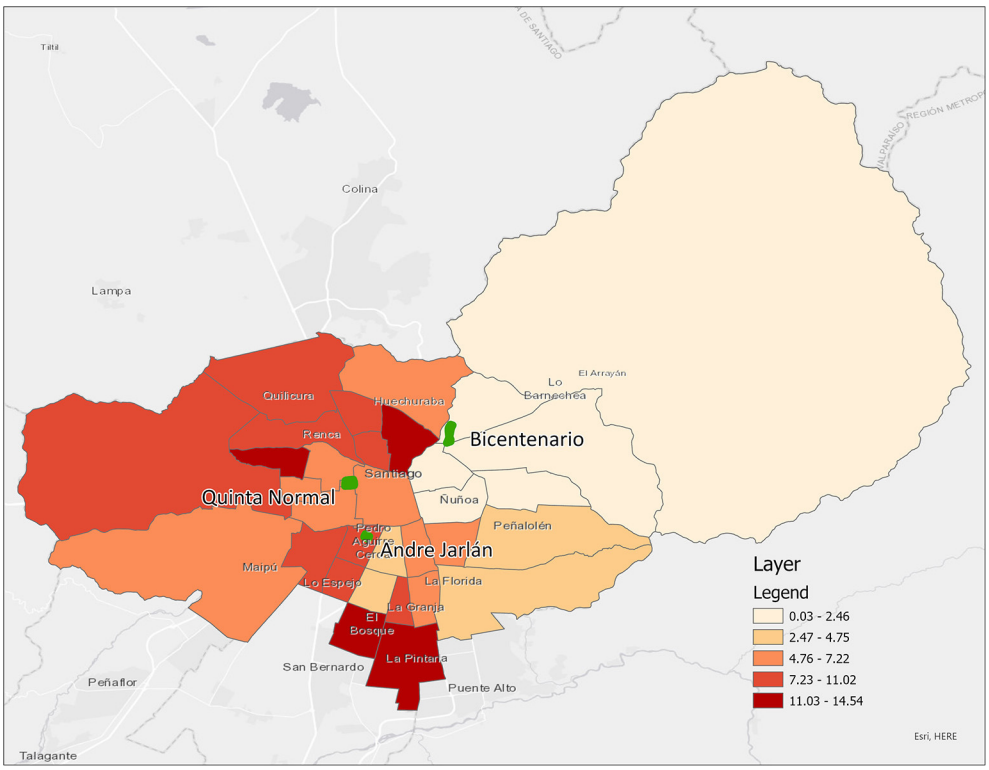

FIGURE 4 | Percentage of population below the poverty line per comuna in Santiago Province (2017).

TABLE 1 | Characteristics of the three comunas where Santiago parks are located.

Comuna	2017 population	2017 # housing units	Population density (2017)	Building permits 2015–2020	Authorized construction area 2015–2020 (m^2)
Pedro Aguirre Cerda	101,174	29,906	14,041	469	33,366
Quinta normal	110,026	38,989	9,849	9,149	528,332
Vitacura	85,384	31,777	3,104	5,392	1,211,601

gentrification. For *in situ* and virtual data collection, we designed a survey questionnaire. Questions about some notable features which may represent green gentrification in the Chilean urban context were included, such as land-use composition, materials used in the façades, the presence of aesthetic improvements, and pedestrian amenities. This survey was used in all four parks: one for *in situ* observation in Talca, and four for virtual observations: one in Talca and three in Santiago. The design of the survey was a continuous process that was finalized after four rounds of testing the instrument, by checking it with the *in situ* and virtual built environment, as described in the data analysis section.

When designing the questions, we considered the differences in the built environments between Latin American and North American cities. For example, we created a question in the survey about the type of façade material because in Latin America, buildings and homes use different materials depending on the socio-economic level of residents. For example, the presence of marble or glass as a building façade could indicate a higher socio-economic level. There were also questions about security features such as metal bars on windows and graffiti because this is a common occurrence in many neighborhoods in Latin America that indicates higher-socioeconomic and lower-socioeconomic levels, respectively.

The survey instrument used in both Talca and Santiago included 11 questions regarding neighborhood conditions and amenities (**Table 2**). Each question response varied on a scale, including Boolean, Likert (none, 0–25, 25–50, 50–75, over 75%), or a choice of relevant options. Visibility questions utilized this scale to indicate the proportion of the feature that was seen, and questions of prevalence applied the same scale to the coverage of the block surrounding the location under observation. The question regarding the condition of the street applied the Likert scale of prevalence to indicate the proportion of the roadway affected by features such as potholes, cracks, construction, or a continuous curb. Possible answers to questions had features

that could be present in higher socio-economic areas such as continuous curb along streets or in lower socio-economic areas such as presence of potholes—both for conditions of street.

For Talca, we defined 37 locations in a regular grid of navigable streets surrounding Cuatro Norte, using a stratified sample from the park, extending four blocks north and south, and along the park at two block intervals. **Figure 5** shows Cuatro Norte with the sampling locations: the 37 red points were used for the virtual observation, and the 18 blue circles represent the locations used for the *in situ* observation and comparison. Identical surveys were used in both the virtual and *in situ* observation. For *in situ* observations, looking ahead a block to the north, south, west, and east of the exact standing location, we recorded the precise longitude and latitude of the virtual observation. Using a smartphone, we recorded responses to the survey questions for the 18 locations. Independently, we conducted virtual observations of 37 locations, with complete overlap with the *in situ* observation. All imagery observed in Talca was collected by Google in 2013 and 2015.

In Santiago, the boundaries of each park were delimited from official shapefiles, and buffers of 500, 1,000, and 1,500 m were calculated using ArcGIS 10.6.1. Areas for which sampling was impractical or infeasible (e.g., due to coverage of military bases, conservation zone, golf course, a vacant lot, and museums) were excluded from the buffer zones. Ten target locations for observations were randomly calculated within each buffer with a minimum distance of 100 m between each point, for a total of 30 points surrounding each of the three parks (**Figure 6**). The yellowish areas show places where gentrification is not possible to occur (i.e., development not possible), including areas of parks, golf courses, military bases, conservation zones, and museums. Geographic coordinates were extracted from each point and converted into location-specific links to target each point in Google Street View for virtual observation. All imagery observed in Santiago was collected by Google in 2014 and 2015, except for 5 locations observed in 2012.

Data Analysis

Responses from the Talca *in situ* and virtual surveys data were compiled and summarized to address Research Question 1 establishing correspondence between the *in situ* and virtual observations. In the case of ordinal variables along a scale, results from each collection type were compared using direct agreement (responses identical) and adjacent agreement (responses varied ± one step on a scale). The direct agreement and the adjacent agreement were summed to yield a metric of total agreement between the *in situ* and virtual field observations. To illustrate, if the security feature metal fence in location x was 0–25% visible in both *in situ* and virtual observation, it was considered direct agreement. If the security feature metal fence in location x was 0–25% visible in *in situ* and 25–50% visible in virtual observation, it was considered adjacent agreement.

Next, we evaluated the response of each variable from Talca for potential inclusion in the resulting analysis. In locations of complete presence or absence, results were tabulated but not further examined, as they offered no metrics of comparison. For locations in which the responses differed substantially, the differences were noted and discussed in terms of varying conditions, timing of observation, or the feasibility of consistent observation between the two methods.

Research Question 2 addressed the response of variables that may indicate green gentrification and how they varied across three park contexts and over distance from each park. Using the three buffers (500, 1,000, 1,500), we conducted the GSV virtual observation in the neighborhoods surrounding three Santiago parks. Responses were summarized to presence vs. absence when possible to clearly demarcate the patterns across the three distance-based buffer zones. Variables for which the response was not static (i.e., unchanged in magnitude among the three buffers) were selected for increased examination. For example, the presence of single-family dwellings diminished in frequency over the three buffer zones surrounding one park, but increased in frequency over the buffers for the other two parks. Similarly, the presence of security window bars diminished with distance from one park, decreased with distance from another park, and were constant (i.e., consistently not present) surrounding a third park.

In summarizing the Santiago virtual observation responses to address Research Question 3, the proportion of presence of each variable was compared in summary across all parks and across the buffers between parks. These results were summarized in **Table 3**, and sparkline graphs were generated to illustrate the direction of the trend among buffers for each park, and the proportion of variable response among all parks, per buffer and in total (**Figure 6**). Line graphs among per park buffers indicate whether the presence of each characteristic rose, fell, or remained constant with distance from the park. For example, the presence of smooth sidewalks is a feature of higher socio-economic areas. If the line graph starts with high presence close to the park (500 buffer) and decreases presence in 1,000 buffer and even more so in 1,500 buffer, then a trend for green gentrification could be observed. Bar charts across all parks indicate whether a characteristic was more/less prevalent per park at each respective buffer or among all observations. To illustrate, the presence of decorative pavers is a feature of higher socio-economic areas. If the bar chart starts with high presence close to the park (500 buffer) and does not change its presence in 1,000 buffer nor in 1,500 buffer, then no trend could be observed.

RESULTS

Findings From RQ 1: Agreement Between *in situ* and Virtual Observations

In response to Research Question 1, the correspondence between the *in situ* and virtual observations in Talca was very high among all survey questions (**Table 3**). For the visibility of the park, all attributes were consistent via direct agreement. Streetside elements like billboards, graffiti, green amenities, and litter were observed with 100% total agreement, though direct agreement ranges from 56.3 to 87.5%, supplemented by adjacent agreement of 12.5–43.8%, likely due to the differing timing affecting the abundance of the element but not its prevalence. Similarly, the abundance of land use types was improved by the use of

TABLE 2 | Topics of questions included in the survey.

Indicator	Topics	Examples of possible answers	Scale
Higher property value characteristics	Park visibility	Yes, no	Choice
	Conditions of the park	Benches, trees, grass, sculpture	Presence/absence
	Number of blocks to the park	0, 1, 2, 3	Integer
	Stories of multi-family homes	<5, 5–10	Choice
	Conditions of the sidewalk	Smooth surface, construction	None, 0–25, 25–50, 50–75, over 75%
	Conditions of the properties	Poor, moderately well-kept	Choice
	Material of the façade	Marble, glass, wood	None, 0–25, 25–50, 50–75, over 75%
	Security features	Metal fence, security camera	None, 0–25, 25–50, 50–75, over 75%
Lower-value	Visible features	Billboard, graffiti, broken glass	None, 0–25, 25–50, 50–75, over 75%
	Conditions of the street	Potholes, cracks, construction	None, 0–25, 25–50, 50–75, over 75%
Mixed	Visible land use	Hospital, hotel, parking lot	None, 0–25, 25–50, 50–75, over 75%

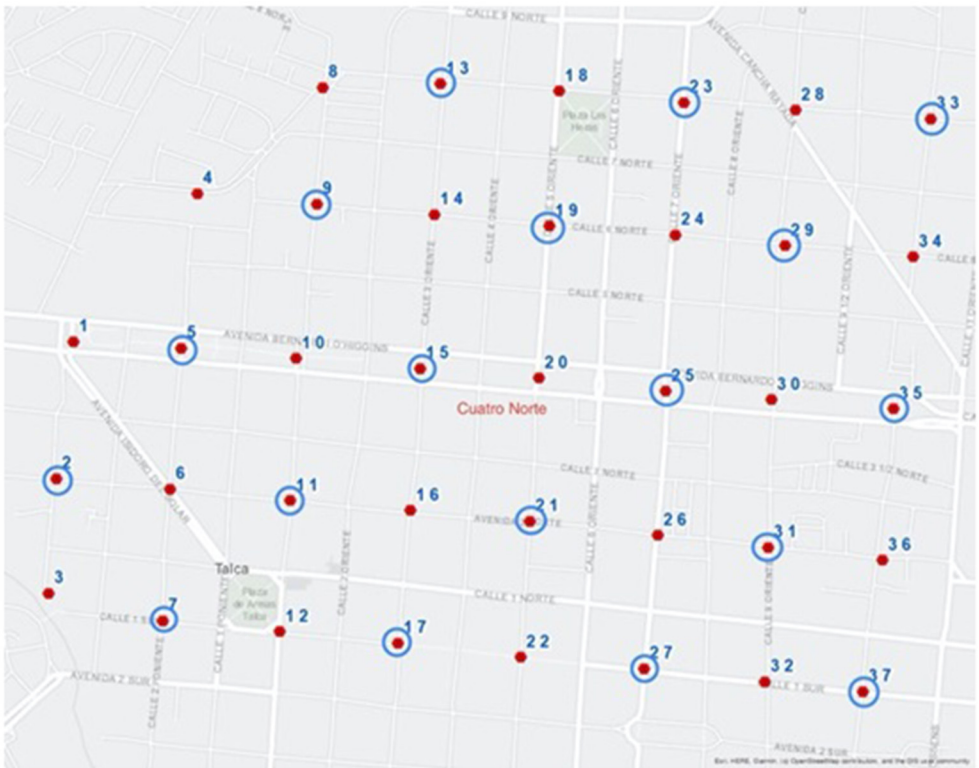

FIGURE 5 | Sampling locations surrounding Cuatro Norte, Talca.

adjacent agreement, which accounted for 11.1–38.9% of the observations, achieving 100% total agreement, except in the case of multi-family homes at 95%. This pattern of near-complete correspondence between the *in situ* and virtual observations continued for all observed variables.

Findings From RQ 2: Characteristics of Green Gentrification

Parsimony of observations aids in the detection of green gentrification in the Global South. While the same survey questions used in Talca were also used in the virtual-only observations of Santiago, a subset is reported here to reduce redundancy and highlight findings. The visibility of the park and park features did not necessarily serve as a reliable indicator of the presence of green amenities, due to the varying uses and compositions of surrounding blocks and also the lack of visibility from locations that were not adjacent or orthogonal to the park.

Similarly, many variables served as an indicator by a choice, in that a building may not be made of more than one facade material, so the use of a single choice served as an indicator that other types may or may not also be present, based on its proportion. In Santiago, the brick façade was more universally

FIGURE 6 | Map of study area in Santiago with buffers and observation points.

common than any other type, so its absence indicated some other type in use. Some variables were not mutually exclusive, such as the potential presence of Single- or Multi-family Dwellings and Businesses within a single block, or the different types of security features.

Hence, the full suite of questions used in the survey was reduced to include nine variables that may serve as indicators of green gentrification in this study: the presence of green amenities, the different types of land uses, the presence of security features, and the condition and composition of the facade and sidewalk materials. The comparative examination of the presence of these variables can enable cross-site comparison of green gentrification across a city, and the change of each variable over distance from a single park can give an indicator of the influence of the introduction or improvement of the park.

Findings From RQ 3: Evidence of Green Gentrification Near Parks in Santiago

For Santiago parks, results from the survey question responses of the 9 location characteristics, with 10 observations for each of 3 distance buffers, at each of the 3 parks are summarized in **Table 4**. Each of the nine variables illustrates an increasing, decreasing, or stable trend across the per-park buffers, and this trend gives insight into the characteristics of the urban context that may be indicative of green gentrification. Additionally, one can visualize the trend pattern of each of the variables with a linear sparkline.

For Andre Jarlán and Quinta Normal, there was a positive (increasing) slope with increasing distance from the park for Green Amenities, but Bicentenario exhibited an inverse relationship, with the prevalence decreasing with distance from the park.

Residential buildings (Single-family or Multi-family) also exhibited differing trends among the parks, with an increase in single-family dwellings with increased distance in the neighborhood surrounding both Bicentenario and Quinta Normal, but a decrease in single-family dwellings with increased distance from Andre Jarlán. Multi-family trends were more variable in response, with slightly v/n-shaped curves in all cases, indicating differing neighborhood composition with increased distance. It may be harder to see the effect of green gentrification surrounding an established park like Andre Jarlán and Quinta Normal because of the lag in improvements in an established neighborhood. Because of the neighborhood improvements following the introduction of Bicentenario, many distance effects are more pronounced, but also share similarities with the other two parks. For example, the increased prevalence of multi-family dwellings closer to Bicentenario may be reflective of increased land values closer to the park, thereby indicating green gentrification resulting from this introduction of this park. Security window bars and security metal fencing (such as a shop or garage

TABLE 3 | Agreement of survey responses between *in situ* and virtual field observations.

Survey question	Agreement			Survey question	Agreement		
	Direct	Adjacent	Total		Direct	Adjacent	Total
Is the park visible?	100%	0%	100%	**Landscape features**			
Grass well-maintained	100%	0%	100%	Billboards	72%	28%	100%
Trees	100%	0%	100%	Gardens	72%	28%	100%
Benches or other seats	100%	0%	100%	Graffiti	67%	33%	100%
Art Installation	100%	0%	100%	Trees	76%	24%	99%
Play equipment	100%	0%	100%	Bushes	59%	41%	100%
Material of benches	100%	0%	100%	Green amenities	56%	44%	100%
Blocks to the park	100%	0%	100%	Broken Glass	88%	13%	100%
Visible land use				Garbage	59%	41%	100%
Single-family homes	72%	28%	100%	**Conditions of streets**			
Multi-family homes	56%	39%	95%	Potholes	94%	6%	100%
Industrial or warehouse	81%	19%	100%	Pavement cracks	61%	39%	100%
Parking lots	83%	17%	100%	Visible construction	100%	0%	100%
Vacant lots	78%	22%	100%	Shoulder on side of the road	61%	33%	94%
Recreational facilities	89%	11%	100%	Continous curb	100%	0%	100%
Hotels	67%	33%	100%	Paved with asphalt	67%	33%	100%
Hospitals	83%	17%	100%	Paved with concrete	67%	33%	100%
Businesses	50%	50%	100%	**Sidewalk conditions**			
Premium businesses	89%	11%	100%	Smooth service	56%	39%	95%
Commercial buildings	56%	44%	100%	Visible construction	94%	6%	100%
Stories of multifamily homes				Paved with concrete	33%	67%	100%
<5	20%	n/a	n/a	Decorative pavers	44%	56%	100%
5–10 stories	60%	n/a	n/a	Cracks	50%	50%	100%
10–15 stories	50%	n/a	n/a	**On the sidewalk**			
Conditions of the properties				Wide enough for 2 people	78%	22%	100%
Residential	39%	61%	100%	Bicycle navigable	83%	17%	100%
Businesses	53%	47%	100%	**Material of the façade**			
Surrounding area	44%	56%	100%	Marble	100%	0%	100%
Security features				Painted concrete	100%	0%	100%
Metal bars on windows/doors	39%	61%	100%	Wood	61%	39%	100%
Metal pull-down gate	33%	67%	100%	Glass	56%	44%	100%
Security camera	94%	6%	100%	Plastic Sididing	67%	33%	100%
Concrete fencing panels	72%	28%	100%	Brick	72%	28%	100%
Metal fencing	28%	67%	95%	Metal	72%	28%	100%
Wood fencing	78%	22%	100%	Other	72%	28%	100%

door) also exhibited differing trends with distance, with window bars more common adjacent to the park in the neighborhood surrounding Andre Jarlán and increasing with distance from Quinta Normal; the security metal fencing exhibited the opposite pattern. Brick façades, smooth sidewalks, and decorative pavers offered another line of discrimination among the park characteristics, with differing trends for each of the parks.

Summarizing the buffers across all parks yields insight into the characteristics that may be most commonly recognized as influenced by proximity to the park. Green amenities and multi-family dwellings, along with security metal fences, brick façades, and decorative pavers were most associated with the newly-established Bicentenario park. By contrast, single-family dwellings, businesses, and both types of security features were emblematic of the neighborhood surrounding Andre Jarlán. Smooth sidewalks were present in both of the neighborhoods, surrounding Andre Jarlán and Quinta Normal, though this characteristic did not vary dramatically with distance.

At the furthest buffer from the park, the neighborhood composition has shifted, with green amenities most associated with Andre Jarlán, single-family dwellings with Quinta Normal, and multi-family dwellings with Bicentenario.

Across all observations, the neighborhood surrounding Bicentenario is most rich with green amenities, decorative pavers, brick façades, and multi-family dwellings, whereas businesses were most prevalent surrounding Quinta Normal and single-family dwellings (and security features) most associated with

TABLE 4 | Prevalence of selected characteristics surrounding each park, in total and by 500, 1,000, and 1,500 m buffers.

Park	**Andre Jarlán**				
Characteristics/Scale	**All points**	**Buffer**			**Trend**
		500 m	**1,000 m**	**1,500 m**	
Smooth sidewalks	97%	100%	90%	100%	
Security window bars	93%	100%	90%	90%	
Security metal fence	93%	90%	90%	100%	
Single-family dwelling	87%	100%	90%	70%	
Brick façade	50%	50%	70%	30%	
Multi-family dwelling	37%	50%	20%	40%	
Business	33%	50%	30%	20%	
Green amenities	30%	30%	20%	40%	
Decorative pavers	0%	0%	0%	0%	
Park	**Bicentenario**				
Characteristics/Scale	**All points**	**Buffer**			**Trend**
		500 m	**1,000 m**	**1,500 m**	
Brick façade	97%	90%	100%	100%	
Smooth sidewalks	97%	90%	100%	100%	
Multi-family dwelling	87%	70%	100%	90%	
Security metal fence	87%	90%	90%	80%	
Decorative pavers	53%	40%	80%	40%	
Green amenities	50%	70%	50%	30%	
Business	47%	40%	50%	50%	
Single-family dwelling	33%	30%	20%	50%	
Security window bars	0%	0%	0%	0%	
Park	**Quinta normal**				
Characteristics/Scale	**All points**	**Buffer**			**Trend**
		500 m	**1,000 m**	**1,500 m**	
Smooth sidewalks	97%	100%	100%	90%	
Single-family dwelling	70%	60%	60%	90%	
Security window bars	70%	60%	60%	90%	
Business	57%	30%	40%	100%	
Security metal fence	53%	60%	70%	30%	
Brick façade	50%	20%	60%	70%	
Multi-family dwelling	47%	50%	70%	20%	
Decorative pavers	30%	20%	30%	40%	
Green amenities	23%	10%	30%	30%	

Andre Jarlán. The responses to these variables helped to interpret evidence of green gentrification based on their patterns.

The Santiago analysis showed that virtual field observations can indicate green gentrification based on the spatial patterns seen from buffer to buffer. There was variation in the types of characteristics indicating gentrification among Bicentenario and Ardre Jarlán. Bicentenario's strongest indicators of green gentrification were green amenities and a security fence. Andre Jarlan's strongest indicators were single-family homes, businesses, and security window bars. Quinta Normal, arguably, did not demonstrate any strong spatial patterns of green gentrification across any indicators, potentially because it is difficult to attribute that change of the built environment to the parks if they have been there for many years.

DISCUSSION

One of the goals of this study was to assess how well GSV fared in surveying the built environment and to understand how this compared with an *in situ* study. Based on the comparison to an *in situ* observation, we learned that GSV has the ability to effectively capture conditions of the built environment and it may be a valuable tool to measure green gentrification. It is an interesting and potentially exciting approach to study green gentrification, and our findings support similar research on *in situ* and virtual GSV studies on gentrification in the Global North (Hwang and Sampson, 2014; Ilic et al., 2019).

This finding supports the use of GSV to complement and extend methodology previously used, which largely rely on

comprehensive secondary governmental or commercial data sources. In this way, GSV-based observations mirror the insights from *in situ* by offering precise locational information regarding a range of factors uncommonly captured by aggregated data. Further, GSV offers an advantage of being nearly comprehensive in coverage, with increasing potential for multiple observations over time. However, our results suggest that this approach must be used with caution because there are potential challenges.

From the Talca phase, two issues should be kept in mind as the methods presented here should be utilized in other studies: day of *in situ* visits, and year of the street-level imagery. Both issues are related to some features that were either not seen or did not appear in the virtual observation in comparison to the *in situ*, and vice-versa. First, the day of week chosen for *in situ* observations made a difference in what one could observe. The Talca *in situ* took place on different days. One day was Sunday when most stores and businesses were closed, making it easier to observe the streets, and more was seen in comparison to the other *in situ* visits not on Sunday. Second, if GSV images are older, then during virtual observations some features that were added to the built environment after the images were taken, will be present in the *in situ* but not in the virtual observations, which may mislead the results.

Concerning the survey questionnaire, there were questions such as the building façade that did not show a lot of variability. On the other hand, the survey question about multi-family and single- family homes gave us more variability, leading to meaningful information based on what was already known about the socio-economic background of that park. The results highlighted what key questions or variables should be used to address green gentrification in the Global South. For future survey questionnaires additional topics that could be included to bring more insights about green gentrification follow: the level of maintenance of the buildings, the presence and level of maintenance of landscape projects in the buildings surroundings, and the presence and conditions of electric poles in the sidewalks.

Our study highlights the importance of understanding the local context to develop relevant indicators based on street-level characteristics. Local knowledge about neighborhoods needs to be incorporated into the interpretation of indicators. Engaging local experts to guide the decisions about greening is essential for well-informed decision-making processes.

The results of this study suggest that there is a complex relationship between park investments and property upgrades, such that gentrification isn't an inevitable consequence of creating new parks or renovating existing ones. The data analysis showed some indicators of property upgrades in close proximity to the parks, but the indicators showing gentrification-related trends varied across all three parks, and multiple indicators did not show evidence of upgrades. These results complicate the park-gentrification relationship, similar to several recent citywide studies of green gentrification that show that gentrification isn't an inevitable outcome of park investments. Rigolon and Németh (2020) study of ten cities in the United States found that park function and location were stronger predictors of gentrification than park size. Similarly, Pearsall and Eller (2020) found that parks likely anchored gentrification in certain neighborhoods, but was not a driver of gentrification in others. Finally, Kim and Wu's (2021) study of parks in New York City revealed that park characteristics had an impact on gentrification outcomes over the medium- and long-term. While these three studies are all based on North American cities, our study contributes an additional line of evidence of the complexity of park-related gentrification based on a study in Latin America. Further, our study is one of the first that focuses on property upgrades, rather than demographic change, which provides a new perspective on neighborhood redevelopment linked to park investments. Given that our study did not show strong or consistent evidence of gentrification in proximity to the three parks, these parks might be an example of "just green enough" park development. This concept suggests that neighborhoods can be greened or improved, but not to the point that they attract substantial additional investment to become gentrified. We suggest that there is need for further research on neighborhood dynamics surrounding the three parks to understand if these park investments represent a "just green enough" example, or if other local or city processes are driving neighborhood investments that may result in gentrification over time.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

MH contributed to literature review, organization paper, and map design. ZC contributed to data analysis and table design. HP contributed to literature review and the editing. MS collected the data. All authors contributed to the interpretation of findings, to the article and approved the submitted version.

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Resilience Gentrification: Environmental Privilege in an Age of Coastal Climate Disasters

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Climate change is exacerbating storms at the same time that humans are increasingly settling in areas most affected by such storms. In theory, post-disaster recovery offers opportunities to rebuild for sustainable development. However, in reality, responses to climate events often result in greater inequality through a process we term *resilience gentrification*. Three possible resolutions to the coastal resilience dialectic are managed retreat, denial, and structural mitigation. Structural mitigation has become the most popular response in the Anthropocene. This response raises the cost of coastal redevelopment, giving capital greater access and control over development decisions. These changes make coastal areas more expensive and more exclusive. We illustrate this process in the post-disaster recovery of two very different communities: Gowanus, Brooklyn and the Caribbean island of Barbuda. In both cases, attempts to build it back "green"—using selective aspects of "sustainable development" as a guide—come at the cost of exacerbating existing housing inequality. In this way, "resilience" gets equated with wealth, thus reinforcing a cycle of climate injustice. To achieve a "just sustainability," government responses must consider and address the equity impacts of climate change resilience policies. Managed retreat and degrowth strategies for climate resilience offer greater potential for a just sustainability in the Anthropocene.

Keywords: resilience gentrification, green gentrification, sustainability class, climate justice, structural mitigation, coastal resilience dialectic

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A PARADOX OF OUR TIMES

By the end of the second decade of the twenty-first century it has become evident that one of the key impacts of climate change is the increased frequency and intensity of storms impacting coastal areas. In the United States, two major coastal cities have already experienced major infrastructural collapse resulting from climate-change enhanced hurricanes: New Orleans in 2007, and New York in 2012 (Gotham and Greenberg, 2008; Bullard and Wright, 2009; Greenberg, 2014a). The impacts of those megastorms were exacerbated by climate change induced rising sea levels, which increased the severity of the storm surges that devastated the levee structures of New Orleans and the subway and highway tunnels of New York. The economic losses and loss of lives in these types of disasters are on the rise globally (Yi and Yang, 2014; Cere et al., 2017). These disasters will become more regular over time. Steadily increasing precarity, a result of a set of social arrangements, is the ecological reality of coastal development in the Anthropocene (IPCC, 2018).

Paradoxically, at the same time that coastal development is facing increasing ecological threats due to climate change, there is a surge in human population in coastal areas. A global socioecological reality of the twenty-first century is a rapid expansion of both the number and percentage of people at risk on the coasts (While and Whitehead, 2013). From 1970 to 2010 the population of coastal counties in the United States increased by nearly 40% (NOAA, 2018). In 2020, 127 million people lived in coastal counties, accounting for over 39% of the total population (NOAA, 2021).

The United States is not unique in this regard. Roughly 40% of the global human population lives within 100 km of the coast, with that percentage rapidly increasing (Neumann et al., 2015). Two out of every three of the worlds' megacities are located on the coast, and coastal population worldwide continues to surge as rural populations migrate to those cities. Added to the global pattern of population redistribution to the coasts is the steady increase in tourism, both domestic and international (WTO, 2018). Coastal tourism development further densifies coastal development, as does vacation home construction. Through these coastal settlement and recreation patterns, communities are creating "disasters by design" (Mileti, 1999). In an age of climate change, a strategy to reduce the human and economic costs of storms would suggest settling farther from the coast. However, that is the opposite of what is occurring worldwide[1].

Given the facts that (1) climate change is exacerbating storms and storm surges, and (2) humans are increasingly settling in the areas most affected by such storms, post-disaster recovery processes will become an increasingly regular occurrence. This paradox is a microcosm that represents the broader challenges that communities face in resolving the contradictions between the social system and the ecosystem. On the coast, tensions exist between the demands of the social system (population distribution toward precarity) and the reality of the ecosystem (increasing precarity for human populations). We call this the coastal resilience dialectic to highlight the social system-ecosystem dynamic. The resolution of the contradiction can be played out in at least three ways: managed retreat from the coast, climate denial, or rebuilding using structural mitigation to protect capital investment.

Analyses of recovery efforts following disasters have historically focused on the catastrophic consequences. For instance, Kai Erikson's (1978) classic study of what happened after the Buffalo Creek Flood of 1972 documented the individual and "community trauma" that followed flooding. In the current era of climate change, this sort of work continues (see for example, Bullard and Wright, 2009). Studies of disaster recovery efforts in the United States have demonstrated that powerful institutional responses exacerbate pre-existing inequalities (Pais and Elliot, 2008; Greenberg, 2014b). Howell and Elliott (2019:465) summarize the findings of disaster researchers: "…Socially marginalized residents are vulnerable not just to damages from natural hazards but also to subsequent recovery efforts." The proliferation of disasters has led to recent calls by sociologists to mainstream the examination of "extreme events, infrastructure, and adaptation" caused by the climate crisis (Klinenberg et al., 2020: 655) and the consequent "climate-induced displacement and migration" (Dietz et al., 2020:146).

Post-disaster recovery is sometimes presented, at least theoretically, as an opportunity to rebuild for sustainable development; in other words, as a possibility for remaking communities in ways that promote equity and environmental sustainability. Agrawal describes "natural disasters as windows of opportunity…a natural 'reset button" (Agrawal, 2011: 291). This is manifest in calls to "build back better" and "build back green." However, the United Nations Office for Disaster Risk Reduction (2017) explains building it back better in this way: "the use of the recovery, rehabilitation and reconstruction phases after a disaster to increase the resilience of nations and communities through integrating disaster risk reduction measures into the restoration of physical infrastructure and societal systems, and into the revitalization of livelihoods, economies and the environment." The U.N. description is notable for two reasons. First, the description omits reference to equity impacts or outcomes, which is related to the second item of interest. It references the murky concept of "resilience." A growing literature seeks to define and operationalize the interdisciplinary concept of resilience (see for e.g., Olsson et al., 2015; Davidson et al., 2016; Meerow et al., 2016). In a critical analysis of the concept of disaster resilience, sociologist Kathleen Tierney describes both "sustainability" and "resilience" as "boundary objects" which "enable communication across disciplines and that can smooth the way for collaboration" (2015:1331). However, on the flip side, she argues, that these terms "can be used to legitimize the activities of groups with very different interests," which can in turn obscure tensions and power relations (1331). Geographers Popke and Rhiney (2019) examine the concept of resilience in light of the post-hurricane context in the Caribbean. They note, "The twin watchwords for this paradigm [of disaster preparedness and response] are 'resilience' (as a form of preparedness) and 'building back better' (as a means of response)…Ironically, the imperative to 'build back better' relies to a certain extent upon a normalization of climate disasters; its logic contains a built-in assumption that house-by-house, island-by-island, existing forms of infrastructure and the lives and communities that they bind together, must be destroyed in order for true resilience to be imported from abroad" (2019:4). Understood in that way, "building back better" is a neocolonial project. The work presented here aligns with these critiques by seeking to further uncover the meanings of "resilience" as carried out in post-disaster recovery.

To address post-disaster recovery in a way that prioritizes equity is extremely challenging in the face of existing social and economic structures. To disrupt historic structural inequality requires political will and intentionality; and to build it

[1]A further paradox inherent in this is that some attempts to live more "sustainably" actually exacerbate the process of coastal development. For instance, Sun (2011: 2,160) notes, "[O]ur current sustainability policies promoting urban living as a key method for decreasing greenhouse gas emissions may, in fact, be hindering efforts to adapt to the effects of climate change." Journalist Owen (2010) argues that environmentalists should move to the cities to cut down on their carbon emissions, based on lower transportation emissions, living with less, and the energy efficiency of dense building structures. Similarly, those who can afford to travel "sustainably," visit coastal eco-resorts built on at-risk shorelines.

back "green" is economically costly, especially in urban areas (Sabto, 2011). Nevertheless, the extent to which these goals can be achieved—greater equity and greater environmental sustainability—is important for disastered communities that must consider whether to relocate or how to rebuild post-disaster.

This paper has two main goals. The first goal is to contribute to the literature on post-disaster recovery, and specifically, the challenges to being able to build more equitable and sustainable communities. We examine and compare the post-disaster recovery and rebuilding processes of two very different communities: one in New York City and one in the small Caribbean nation of Antigua and Barbuda. We focus on how the recovery efforts affect housing equity of affected communities. Both cases represent explicit attempts to build it back "better" and in specific, to build it back in more "resilient" ways. However, the resilience is built into the actual physical structures rather than the communities and the outcome is that even building it back "better" comes at the cost of exacerbating existing housing inequality. Public-private partnerships, a sign of the neoliberal times, are key agents in producing and reproducing inequality in these sites.

Second, we elaborate on the concept of resilience gentrification to demonstrate the (mostly) unintended outcomes of (mostly) well-intentioned plans to build it back better/greener/more resilient (Gould and Lewis, 2018a). We argue that the most common path to recovery—namely, rebuilding with structural mitigation—leads to *resilience gentrification*. This parallels the process of green gentrification in terms of its (mostly) unintended effects: greening urban areas, while positive in an environmental sense, has had the consequence of exacerbating environmental inequality (Gould and Lewis, 2017; Anguelovski and Connolly, 2018). In this case, building it back "better" and more "resilient," also has the consequence of exacerbating environmental inequality and housing inequality. When building it back better and more resilient (structural mitigation) is prioritized in recovery, it leads to resilience gentrification. Resilience gentrification is the result of natural disaster recovery processes that prioritize policies promoting structural mitigation. Structural mitigation costs further bifurcate the haves and have nots, leading to a recovery in which "resilience" is by default defined by wealth. Structural mitigation inflates housing costs. Access to housing is distributed by wealth in capitalist economies. As rebuilt, structurally mitigated, housing is distributed upward to the wealthy, resilient housing becomes a form of environmental privilege (Park and Pellow, 2011). Resilience gentrification is a subset of green gentrification processes stemming from resilient construction as structural mitigation. Coastal resilience efforts thereby become engines of green gentrification (Gould and Lewis, 2012, 2016, 2017, 2018a; Anguelovski et al., 2019).

A sub-goal is to connect the discussion of gentrification to colonizing processes. Angotti describes gentrification as the "appropriation of economic value by one class from another" (Angotti, 2008: 108). That appropriation is facilitated by growth coalitions of state and capital actors seeking to generate public and private revenue increases (Molotch, 1976). We have defined green gentrification as the approporiation of the economic value of environmental resources by one class from another (Gould and Lewis, 2017). Resilience gentrification uses structural mitigation to displace local populations and replace them with wealthier settlers. As such, resilience gentrification (especially in the global south) is in some ways a greenwashed version of neo-settler colonialism.

RESOLVING THE COASTAL RESILIENCE DIALECTIC

We approach this specific tension—the clash between population distribution toward the coast and increasing coastal precarity for human populations—through the theoretical lens of the treadmill of production theory (TOP). TOP is a broader theory focused on how to resolve the clash between our political-economy and ecological systems. In brief, the treadmill of production theory argues that the logic of capital is both anti-ecological, routinely increasing ecological withdrawals and additions, and antisocial, routinely delivering fewer social gains per unit of ecological disruption (Schnaiberg, 1980; Schnaiberg and Gould, 1994; Gould et al., 1996, 2008). The result is that capital must constantly expand development (growth) in order to deliver the same level of social benefits (jobs). These processes are facilitated by the state whose economic and military power depend on growth, and labor whose access to employment depends on growth to counteract job displacing investment in labor saving technology. However, according to the TOP, this is not the necessary and inevitable outcome.

According to Schnaiberg (1980) resolving the dialectic between our economic system and our ecological system could be done in three ways (Lewis, 2016, 2018). The first, is through an ecological synthesis. In this formulation, the social system would accept the new ecological limits imposed by nature in the Anthropocene. The second, the economic synthesis, is chosen when economic values supersede environmental values, and ecological limits are ignored. In the third, the managed scarcity synthesis, ecological realties are recognized, and public policy is employed to facilitate some market adjustment to those realities (along a spectrum of less or more constraint on capital). These syntheses align with the three main resolutions of the coastal resilience dialectic of the last 20 years: managed retreat, climate denial, and structural mitigation. (1) Resolving the climate resilience dialectic through managed retreat from coastal areas represents Schnaiberg's ecological synthesis. (2) Resolving the climate resilience dialectic through climate denial represents Schnaiberg's economic synthesis. (3) Resolving the climate resilience dialectic through structural mitigation, the strategy preferred by both enlightened capital and pragmatic environmentalists, fits within Schnaiberg's managed scarcity synthesis. We elaborate on each scenario.

Managed Retreat

In the first scenario—managed retreat from coastal areas—the logic of ecosystems trumps the logic of capital, and the

social system adjusts to the unfortunate ecological conditions it has generated (through fossil fuel combustion, deforestation, etc.). Managed retreat includes a staged withdrawal from coastal development, and a consequent rewilding of coastal environments (sponge parks, wetlands, mangrove forests, etc.). Such an approach is consistent with broader degrowth strategies. Managed retreat could happen before or after a disaster. The idea of retreating prior to an event has made it into the popular consciousness as evidenced by news coverage of such concerns. For instance, *The New York Times* has published articles with headlines such as this: "Climate Change Insurance: Buy Land Somewhere Else: In case global warming makes their homes uninhabitable, some millennials have a Plan B: investing in places like the Catskills, Oregon and Vermont" (Nov 30, 2018). However, retreat is not a particularly popular option. Policy-making bodies do not regularly propose retreat as a viable option, in part due to opposition from real estate interests. For instance, in North Carolina, the Coastal Resource Commission's priorities for economic growth negated any proposal for retreat (Allen et al., 2018). When retreat has been a policy option, it hasn't been chosen by homeowners. For example, very few residents took the offer of buyouts in Staten Island after Hurricane Sandy (Koslov, 2016). In addition, a national study of buyouts of flood-prone homes found that buyout options are not equitably distributed (Elliot et al., 2020). Sun (2011) summarizes the barriers of retreat: "Unfortunately, retreat from hazardous areas is notoriously difficult to implement given pre-existing property rights, the costs associated with voluntary buy-outs, the likely disruption of existing community ties that relocation entails, and local political opposition to relocation efforts" (2157). From a TOP perspective, through managed retreat, social actors acknowledge the reality of climate change and adapt social arrangements in an ecological synthesis.

Climate Denial

A second resolution to the dialectic would be climate denial. In this scenario, the logic of capital trumps the logic of the environment, and the economy proceeds as if ecological limits are not a factor in social decision-making. This was the primary resolution to the climate resilience dialectic in the late twentieth century and early twenty-first century as both the evidence of climate change and coastal development mounted (Norgaard, 2011). Climate denial has been official policy in some vulnerable coastal areas. The state of Florida ordered it's Department of Environmental Protection to omit the terms "climate change" and "global warming" in official communications and reports (Korten, 2015). In response to a study by North Carolina's Coastal Resources Commission indicating that sea levels will rise 39 inches by the next century, the state legislature passed a law banning the use of the study in coastal policy decisions (Harish, 2012). Climate denial either rejects scientific evidence altogether, or exploits scientific uncertainty to argue that economic costs should not be incurred until all unknowns are resolved. Investments are made in manufacturing and promoting scientific uncertainty in order to delay policy intervention in markets indefinitely (Brulle, 2013; Farrell, 2016). In a climate denial scenario, coastal disasters are treated as "natural" and normal one-off events, with losses underwritten by federal emergency management relief and insurance claims. From a TOP perspective economic values trump ecological values, and a desire for short-term economic gains override concerns for longer term ecological, economic and social costs.

Structural Mitigation

A third resolution to the dialectic would be to "build back better/green/resilient," which could take a number of forms; the dominant one has been focused on structural mitigation. By structural mitigation, we are referring to what the United Nations calls structural measures: "any physical construction to reduce or avoid possible impacts of hazards, or the application of engineering techniques or technology to achieve hazard resistance and resilience in structures…" (United Nations Office for Disaster Risk Reduction (UNISDR), 2017). In practical terms, these are practices such as raising buildings, and placing heating, cooling and electrical systems on roofs instead of basements, for example. It often includes more stringent building codes and requirements to harden shoreline infrastructure. Structural measures are in essence an ecological modernization approach to addressing coastal resilience (Mol et al., 2009). With structural mitigation, the logic of capital is applied to the ecological reality of increasing coastal precarity. Capital-intensive technological fixes are employed to make a pattern of increasing coastal density less vulnerable to the pattern of increasing coastal climate risk (Carmin et al., 2015). While these measures may promote short- or medium-term economic growth, they also increase social inequality. As is often the case with technological approaches to climate mitigation, the unanticipated consequences of implementation undermine efforts at genuine socioenvironmental sustainability, which requires inclusion of strong ecological and equity components (Jorgenson et al., 2018). Structural mitigation raises the cost of redevelopment of coastal real estate. Those costs raise the price of coastal residency[2]. Despite these issues, this is the primary response to coastal precarity in the Anthropocene. From a TOP perspective, these processes are indicative of state intervention in markets (regulating capital through building codes) to manage the relationship between ecosystems and the treadmill, without fundamentally challenging the growth imperative of capital. Structural mitigation is also supported by state subsidies through higher public infrastructure costs (raised roads, hardened coastlines, resilient sewage and utility systems), the National Flood Insurance Program, and Flood Mitigation Assistance Grants. In this way those taxpayers who cannot afford to live in structurally mitigated coastal housing bear some of the costs for those who can, thus deepening climate injustice.

[2]Additionally, a problem with "structural solutions to disaster risk – such as strengthening building codes or building seawalls and levees-[is that it] can sometimes deceive communities into increasing their exposure to hazards by lending a false sense of security through the air of invincibility that surrounds much modern engineering and construction" (Sun, 2011: 2,158).

RESILIENCE GENTRIFICATION: WHEN STRUCTURAL MITIGATION IS THE RESPONSE TO CLIMATE CHANGE

All three responses to climate change on the coast are possible. However, climate denial and structural mitigation appear to be the dominant approaches, and structural mitigation is the one we focus on in the case studies. Even when the recovery goal is to build it back resilient, which is theoretically positive and logical, the outcome is still regressive and leads to increasing gaps in housing stock safety between the haves and the have nots. We will illustrate this in two very different processes.

Generally speaking, the process plays out like this: The impact of climate change on coastal real estate due to increased storm frequency, intensity, and sea level rise occurs in three stages following a disaster event. First, the disaster clears existing property and disperses residents, which frees the way for redevelopment. We call this stage of impact *climate demolition*. Climate demolition removes existing structures and populations, reducing political and economic barriers to the appropriation of coastal amenities. In the second stage, a response to the demolition, redevelopment designs are produced by governments and private capital interests that often include plans with resilient features to replace the climate-demolished structures. This phase may also include changes to policies that guide structural mitigation. In this phase, the cost of rebuilding is increased. In the third phase, the increased costs have the effect of distributing climate resilient structures to those with greater ability to pay, especially the sustainability class. We call this impact *resilience gentrification* (Gould and Lewis, 2018a). Resilience gentrification stems from more stringent building codes and requirements to harden shoreline infrastructure that are put in place in response to a disaster event. It allows the sustainability class, who are "well-educated, [hold] overt sustainability-oriented values, can afford sustainability themed consumption, and [tout] their green urbanism (such as living on the waterfront or near green space) to brand their lifestyle," to take advantage of coastal residency opportunities generated by state and private capital interests (Gould and Lewis, 2018a: 12). This is related to what Pais and Elliot (2008: 1,423) describe as elite "upgrades" following hurricanes that result in "elite retrenchment" of coastal areas. Interestingly, Greenberg (2014b) describes similar elite upgrades following the non-natural disaster of the terrorist attacks on 9/11 in New York City. The wealthy rebuilt with "superior infrastructure" that then protected them during Hurricane Sandy. When this takes place in the context of a class stratified society, wealthier people live in more resilient structures and less wealthy live in less resilient structures and/or further from disaster prone areas like coasts[3].

[3]Even without a storm or flooding, the threat of climate change can affect coastal real estate by increasing the prices of neighborhoods on higher ground. The value of property that is less susceptible to climate change-enhanced storms and sea-level rise is inflated as market demand increases. There is some evidence that this is happening in Miami, resulting in what observers have termed "climate gentrification" (Keenan et al., 2018).

COMPARATIVE ANALYSIS

We compare and analyze two cases: one from a global city where the economic elite live, and one from a tropical island where the economic elite play, both places where the environmental concerns with rebuilding are high, to illustrate the similarity in climate injustice outcomes from the structural mitigation synthesis of the coastal resilience dialectic. While the local contexts vary dramatically, the social forces and the social actors driving resilience gentrification came together in both cases to create similar outcomes: greater coastal capital investment, greater coastal population density and less economic/social equity. These very different cases are used as examples to illustrate the process.

We did not intend to do post-disaster research in either Gowanus or Barbuda. In both instances, we were already engaged in work in the sites when disaster struck. In Gowanus, we had begun research in 2010 to understand the causes and consequences of the canal being designated a Superfund site and how the designation intersected with green gentrification. Hurricane Sandy hit in 2012, which introduced an unexpected variable into the research, and, surprisingly, did little to alter the gentrification course. This analysis is based on the case history of the site we constructed using data from published research, media accounts, census data, and field work pre- and post-disaster focused on the relationships among the economic uses of the canal, the city's growth machine, sustainability-related issues, real estate development, and demographic changes in the neighborhood (Gould and Lewis, 2017). Our field experience and photo-documentation in Gowanus has spanned many years.

In Barbuda, prior to Hurricane Irma, we were working with the elected Barbuda Council on the creation of a sustainable development program for the island linked to plans for foreign investment in ecotourism. We designed an island-wide participatory action research (PAR) to identify the types of development projects Barbudans themselves wanted to pursue.

Our initial work on-island took place in August 2017. Aided by the Council's introductions, we had informal conversations with over 40 residents. We explained our role and sought initial understandings of their points of view. We toured the main touristic sites of Barbuda and proposed development sites. Weeks after that work began (September 5–6), the eye of Hurricane Irma passed directly over Barbuda, killing one and leaving widespread devastation. As had been originally scheduled as part of the PAR project, we returned to Antigua and Barbuda later that same month. Given the drastic changes in the context, rather than meeting with the full Barbuda Council in Barbuda, we were guided by an official of the Barbudan government in Antigua who took us to meet with government officials and some of the islands' residents who had been evacuated to Antigua. While the context had changed, the overarching goals remained understanding Barbudans' points of view regarding the development of the island. Our approach also changed, focusing on listening rather than asking, to acknowledge the trauma the people had experienced. Barbudans were sheltered with families and in two shelters. We visited both shelters where we met with the directors of the shelters who provided us with information

about the evacuees. The directors introduced us to evacuees who we met with informally in the facilities' general areas. We spoke with 14 evacuees about their hurricane experiences, their thoughts on their immediate needs for rebuilding, and their hopes for how future development would be the same/different from how the island had been prior to the hurricane. As noted in Peek and Tobin, 2020 "Tips for empathy," survivors wanted to tell us their story. We let them speak and did not ask intrusive questions. We did not conduct formal interviews nor did we take people's names[4].

We also spent a morning at the ferry dock in St. John's (Antigua) observing and interacting with Barbudan residents who gathered to try to return on the first residents' ferry to Barbuda. We went to Barbuda on the second day of the commercial ferry's return and spent the day surveying and photographing the damage on the island and observing the few residents who were working on gathering possessions and securing their homes, along with workers clearing debris with backhoes and dump trucks, attending to powerlines, removing and treating standing water, dealing with stray animals, and doing work at the airport. We supplemented our field experience with published research and media accounts.

STRUCTURAL MITIGATION IN BROOKLYN'S GOWANUS CANAL

The Gowanus Canal is a 2.9 km waterway completed in 1869 as the centerpiece of one of the United States first planned industrial development districts. As such it became the repository of a wide range of industrial effluent, as well as a recipient of raw sewage when it was integrated as the outfall for one of the country's first municipal sewage systems (Alexiou, 2015). Although it was once the busiest industrial waterway in the U.S., by the end of World War II it began to be abandoned for deeper harbors. It is only in the twenty-first century that it was reconceptualized as waterfront property in the midst of Brooklyn's gentrification boom.

In October of 2012, climate demolition occurred in Gowanus. Hurricane Sandy, which killed 44 people and flooded 17% of New York City's land, pushed a thirteen-foot storm surge up the Gowanus Canal sending sewage-laden waters over the banks, and into the residential, industrial, and commercial spaces of the neighborhood. Floodwater spread out for more than a block on either side of the canal, submerging proposed sites for luxury condo and retail developments. Flooding and power outages took the Gowanus Canal pumping station off line, causing 13 million gallons of untreated sewage to discharge into the floodwaters that covered the neighborhood. Test results indicated that the Gowanus floodwaters contained high levels of bacteria such as enterococcus due to raw sewage discharges. Levels of semi-volatile organic compounds of the type (such as PAHs) known to be a major component of Gowanus Canal sludge were found in on-land samples. However, neither enterococcus, storm surge flooding, or damaged homes and businesses proved much of a deterrent to the coastal development process. Little more than a year after Sandy, a sustainability-themed Whole Foods celebrated its grand opening on the banks of the Gowanus, and The Lightstone Group broke ground on a 700-unit apartment complex on the previously flooded development site (Alexiou, 2015). "Resilient" planning and gentrification ensued.

Following Sandy, New York City adopted a number of changes to its building codes based on the recommendations of the Building Resiliency Task Force report of June 2013. The report was produced by a non-profit comprised of and funded by engineering firms, real estate interests, architectural firms, construction interests and others poised to benefit economically from a structural mitigation response. The changes recommended included Local Law 29/13: Raising and Moving of Buildings, and Local Law 99/13: Raising Building Systems (Ackroyd, J., Eschenasy, D., and Sirakis, G.). Both of those building code changes required structural mitigation to raise living spaces and critical systems above projected flood levels. Flood prone locations were thus slated for continued occupation at higher building costs, rather than for non-residential use.

Arguing that its initial plans took full account of federal flood prevention standards, the development corporation building the 700-unit condo development on the Gowanus canal stated that, "The project was designed to exceed federal 100-year storm standards by significantly elevating the development above the 100-year flood plain" (WNYC News 2010). That is the primary response of developers bent on capitalizing on waterfront real estate by increasing coastal population density—build but elevate, to have flood waters wash under and around increasingly expensive residential development. While the logic of adaptation to ecological conditions argues for a staged retreat from coastal flood zones, the logic of capital argues for increased investment in real estate with water views. Private real estate developers have incorporated the price of the mitigated infrastructure into the price of the waterfront real estate. Some of the broader infrastructure costs are also borne by the local government, which is pressed to provide services to areas with high real estate values. The result is a public subsidy to private coastal development. Working class residents living in older homes in the flood zone had less financial capacity to structurally mitigate and less assistance to do so.

Demographic analysis of the Gowanus neighborhood reveals that structural mitigation, building "resilience," is linked to gentrification. In Gowanus, housing prices for new construction exceeds the rate of Brooklyn housing cost increases, while the neighborhood shifts from a working-class community of color to a wealthy white enclave (Gould and Lewis, 2017; Parks, 2019). A

[4]The ethical work involved in generating a PAR project align closely with what the CONVERGE project at the University of Colorado-Boulder summarizes as best practices for "ethical post-disaster community outreach and engagement" (Villarreal, 2020). They note that the work should be community situated, collaborative, and action oriented. Our pre-engagement and consultation with leaders prior to the PAR project, and our prior background research into "the historical, social and political context of the community" situated us well to engage in post-disaster Barbuda. Our data collection was "community-situated" in that it was framed around the Barbuda Council's interest in generating a Sustainability Plan. We collaborated with our partners by sharing our work with them And finally, the work was "action-orientated" — "meant to lead to positive social outcomes and to promote social equity for community members" by giving Barbudan residents voice, especially with their elected council (Villarreal, 2020).

structurally mitigated, climate resilient Gowanus is increasingly available only to the sustainability class.

Similar processes occurred in other neighborhoods of New York City. For instance, within weeks of Sandy, the developers of Hudson Yards, a former tidal wetland on Manhattan's west side, noted that "The inherent design of the Yards is resilient toward flooding due to the fact that our platform puts our first floor well above the flood plain." "All of our electrical and support systems are above grade." "Since Sandy, we've made some minor adjustments to the design to make it even more floodproof." (Dwyer, 2012). An architect on the project indicated to us that more substantial redesign was initiated later, and that these structural mitigation elements raised building costs substantially. Hudson Yards opened with a climate resilient luxury mall including Cartier, Dior, Piaget, Rolex and other shops geared to the global elite.

Hurricane Sandy should have been a wake-up call for Gowanus, and for New York City as a whole to begin the process of managed retreat. However, despite years of talk and largely superficial nods to climate resilience under the leadership of Mayor Michael Bloomberg (PlaNYC 2030, 2007), the dominance of real estate interests in New York City's growth machine militated against meaningful redirection of its development paradigm. The administration of Bill DeBlasio, elected in 2013, required a higher percentage of "affordable" housing in new developments, but did not reverse larger trends in coastal housing markets. The premium placed on waterfront property simply overwhelmed concern for the increased precarity of coastal development in the Anthropocene. Likewise, major new New York City waterfront developments including Manhattan's Hudson Yards, and the Domino Sugar site in Brooklyn proceeded as planned after Sandy, with added structural mitigation redesign due to increased coastal precarity (Rose, 2017). New York City took an approach to climate resilience that exacerbates already unsustainable levels of housing inequality.

STRUCTURAL MITIGATION ON THE ISLAND OF BARBUDA

Barbuda is a small island: 176 square kilometers and 1600 inhabitants. It is part of the nation of Antigua and Barbuda. On September 6, 2017, it suffered climate demolition. Irma hit Barbuda as a category five hurricane, with the eye of the storm passing directly over the island. The result was total devastation of the island's infrastructure; climate demolition. Nearly every structure was damaged, and homes that were not completely destroyed were left temporarily uninhabitable. Power, water service, and communications were knocked out, as was the only ferry dock linking the island to Antigua. The entire population of Barbuda was evacuated. With the hospital and schools badly damaged, and food supplies disrupted, return to the island for roughly 1600 Barbudan climate refugees was far off. While Barbudans were sheltered in facilities on Antigua, the government struggled to initiate recovery with minimal resources and organization. Barbudans' access to their island was tightly restricted, and most were unable to return to patch roofs, apply tarps, or collect belongings for weeks.

Restoration of basic services was slow, and in the meantime the necessity of enrolling Barbudan children in Antiguan schools, finding jobs, and leaving shelters to stay with family and friends dispersed the Barbudan population, making it difficult to organize as a socio-political force in rebuilding plans. While Barbudans struggled to establish temporary normalcy, the Government of Antigua and Barbuda grappled with a $250 million rebuild project on a $1 billion national economy, primarily dependent on tourism for foreign exchange. In seeking to make Barbudan recovery pay for itself, the state moved to privatize communally held land to make home and business owners eligible for private sector loans, and to make Barbuda more attractive and available to global coastal tourism capital. Prior to this, land was leased from the community, not privately owned, part of the historical legacy of emancipation. In abolishing communal land tenure, Barbudans were told by Prime Minister Brown that they had been "squatters" on their own island (Gould and Gould and Lewis, 2018b). With land now part of the cash economy, capacity to invest is open to global competition in which Barbudans must outbid global capital to access land. The change in land tenure displaces Barbudans and facilitates the colonization of Barbuda by the global elite.

Hurricane Irma made it possible to recast development geared toward serving non-Barbudans as a humanitarian effort to rebuild and improve resiliency. Global developers teamed up with the national government to lead a "green" recovery. However, these actors are renewing the island to attract wealthy outsiders, not the displaced (Boger and Perdikaris, 2019). Land privatization and tourism development includes resilient second home developments, renewable energy projects, new parks, and "eco-friendly" luxury resorts. Prior to Irma, when residents were on the island, Barbudans approved a number of new development requests. They were able to control their island's development trajectory by controlling communal land use decisions. They limited the footprint of Robert DeNiro's Paradise Found vacation home and eco-resort project, and rejected the siting of another such development. With many Barbudans still displaced in Antigua, communal land ownership eliminated by the state, and the government lacking any public plan for recovery, the global elite with their access to transportation and resources, now wield the power. Billionaire John Paul DeJoria plans to build an eco-resort on the island named Peace, Love and Happiness (PLH). The target audience for PLH is high carbon footprint jet setters. Another 700-acre proposed development includes 500 vacation home residences and an 18-hole golf course (Boyle, 2020). A different billionaire investor has proposed a marina for super yachts. Clearly, plans to "build back better" have little to do with building back the community that existed prior to Irma which was based on a mixed subsistence and commercial economy and communal land stewardship.

The Caribbean version of green gentrification markets island paradise locations for vacation homes and resort retreats for global elites, some of the same people who own property in the greenest, trendiest global city neighborhoods like Gowanus. In the Anthropocene, climate change enhanced storms do

the demolition and population removal work, and set the stage for global capital to "help" desperate communities by buying up property and providing returning local residents jobs as service workers for the global sustainability class. Because resilient development is framed as hurricane relief, much of the green infrastructure construction to support private investors is subsidized by international donors. The first major redevelopment project on Barbuda is the construction of new larger airport, begun without environmental review. And that is the nature of green gentrification; using the visible markers of ecological concern to mask increased inequality and the servicing of higher consumption populations from outside the community. Barbuda's experience with a post-climate disaster green gentrification scheme is not unique, and resilience construction priced beyond the reach of the local population is a key feature.

We asked evacuees what changes they recommended for the island's recovery. Many suggested a better school and hospital. None suggested an 18-hole golf course and luxury second homes. Almost all of them did suggest that new residences have concrete roofs. A few advocated changes to building codes that would require a percentage of each structure be covered with concrete. As in New York City post-Sandy, governments often adopt regulatory changes involving structural mitigation following climate-related storm events. While the logic of this is unassailable from a real estate market perspective, from a sustainability perspective, it is problematic. One consequence is that it raises the cost of rebuilding, causing resilience gentrification: global investors can bear the new infrastructural costs while locals find the burden of resilience measures unaffordable. Structural mitigation to resist climate change increases the costs of living on Barbuda, makes formal sector employment necessary, and thus further limits access to coastal spaces on the island. Formal sector employment will likely mean serving as waiters and maids for vacation home and eco-resort residents, constructing structural dependency on their island's use as a playground for the rich. Resilience is equated with wealth, and the sustainability class emerges as the new gentry.

TABLE 1 | Case comparison: Gowanus and Barbuda.

	Gowanus (urban neighborhood)	**Barbuda (rural island)**
Cause of real estate damage	Hurricane Sandy (2012)	Hurricane Irma (2017)
Type of change	Resilience gentrification: increasing the prices of building that incorporate resilient features	Climate demolition: clearing existing coastal property and residents, making physical and social space for new capital investment
Type of damage	Basements flooded and contaminated; prospective development sites flooded	Majority of structures (public and private) damaged
Population directly affected by damage (most vulnerable)	Homeowners	Island residents
Real estate interests affected by damage (least vulnerable)	Homeowners and national/regional real estate developers	Island residents and foreign resort developers
Policy responses	New building codes	Land privatization
Policy effects	For homeowners, recovery costs; for developers, continuation of multi-unit developments with higher costs of structural mitigation features	For residents, higher costs to rebuild; for resort developers, legal access to land for development
Long-term effects	Most vulnerable homeowners sell and relocate; least vulnerable homeowners structurally mitigate; wealthier newcomers rent and buy new development; neighborhood wealthier	Most vulnerable island residents remain "evacuated" in Antigua; least vulnerable that can afford to rebuild return; resorts built for wealthy newcomers; island wealthier

COMPARISON

Here are two very different locations whose real estate was transformed by climate change enhanced hurricanes—climate demolition. Policy responses favoring structural mitigation exacerbated local losses, but created opportunities for outside developers promising greater "resilience." But these strategies have the long-term effect of deepening inequality as the most vulnerable homeowners find it costly to rebuild or remain and wealthier outsiders can afford the demands of resilient construction. The social structural forces incentivizing structural mitigation as a response to climate change threats are global, and they imply that the Anthropocene will be an era of increasing inequality.

Whereas the island of Barbuda experienced dramatic climate demolition as a result of Hurricane Irma in 2017, the Gowanus neighborhood of Brooklyn experienced far less structural damage from Hurricane Sandy in 2012 (**Table 1**). Nonetheless, in both cases, the cost of redevelopment was greatly increased as climate resilience was built into future construction plans. In the case of Barbuda, the state intervened to clear the island of residents in the name of safety. In Gowanus, real estate market inflation, enhanced by the increased costs of new climate resilient construction, is taking a somewhat slower path toward the same outcome, the removal of the pre-existing lower income population. The ways that markets and states interact to make it difficult for long-term residents to remain in both cases is somewhat similar in that changes to building requirements imposed by states on private developers raise the costs of return (or remaining in place), and those costs are passed on to residents. The process is slower in Gowanus, as there was not state sanctioned forced removal, and the damage to homes in Gowanus was less extensive. Additionally, home lots in Gowanus

were already private and deeded, and land was already exchanged through market mechanisms. In Barbuda, the state intervened to impose those conditions on a population that had not been subject to private real estate markets prior to the climate disaster. In both cases, however, the most vulnerable residents will be unable to return, housing costs will increase due to the imposition of structural mitigation as a means of resolving the climate resilience dialectic, and both communities will be largely replaced by wealthier in-migrants. Also, in both cases, external capital is a primary agent of post-climate disaster decision-making.

Both cases demonstrate how recovery and rebuilding based in structural mitigation as a strategy for planning and actual redevelopment leads to resilience gentrification. In short, the use of structural mitigation both increases coastal development and makes structures more resilient, but increases housing inequality. In effect, it institutionalizes environmental privilege for the sustainability class by equating resilience with wealth. It also plays into the problems of neoliberalism, allowing the wealthy to quarantine themselves from the ecological conditions they play a significant role in creating, leaving the poor vulnerable to conditions that they have little opportunity to shift (Szasz, 2007). It is a private solution to a public problem that increases inequality and makes our communities less sustainable.

CONCLUSION

The Anthropocene has brought increasing climate change-caused disasters. This creates opportunities to reshape human patterns of distribution to protect society from future disasters. The dominant recovery response has been to build "resilient" buildings and infrastructure through structural mitigation. This response fits within the general category of resolving the ecosystem—social system dynamic that Schnaiberg (1980) calls the *managed scarcity synthesis*.

Consistent with the Treadmill of Production model of socioenvironmental relations, structural mitigation as a strategy for resolving the conflict between increasing coastal precarity and increasing coastal development is socially regressive. Structural mitigation requires more and more resources be dedicated to the construction of homes, roads, hotels, and other social amenities in order to provide the same social goods. Treadmill theory also argues that, as ecological withdrawals and additions expand, social inequality increases. As the cost of structural mitigation increases, in large part due to the increased requirement of resources for stronger buildings and elevated infrastructure, coastal amenities become less and less accessible to those lower in the social stratification system. By raising the cost of coastal development, structural mitigation institutionalizes environmental privilege (Park and Pellow, 2011) for the sustainability class (Gould and Lewis, 2017).

Coastal real estate, which in most areas is already priced so as to restrict access to elites, increases in cost under this managed scarcity scenario. In an ecological synthesis of staged retreat, coastal real estate values would decrease. In coastal areas where markets have not already priced the poor away from their environmental amenities, structural mitigation decreases the capacity of the less wealthy to resist displacement. In this way structural mitigation equates climate resilience with wealth. By employing a private solution (stronger residences) to a public problem (climate change) within the context of a highly unequal stratified social order, what structural mitigation makes resilient is privilege. This process is reinforced by the system of insurance which allows the wealthy to protect themselves from catastrophic climate-related financial loss (Flavelle, 2018).

"Resilience" has become a dominant paradigm in post-disaster recovery and rebuilding. The way that resilience recovery played out in both Gowanus and Barbuda demonstrates that the concept of resilience obscures the processes of recovery/rebuilding that favors wealth at the cost of social equity. The current process that emphasizes resilience leads to gentrification, and more precisely *resilience gentrification*. "Resilient" recovery reinforces climate injustice. On the coasts, climate change paves the way for resilience gentrification as less wealthy coastal residents find themselves unable to remain in place, and public policy fails to adopt equity-based climate adaptation strategies.

This is just one example of climate injustice. Other consequences of climate change, such as heat waves, also disproportionately affect rich and poor, highlighting issues of unequal social vulnerability to disaster (Klinenberg, 2003). In a capitalist political economy, resilience—the ability to "bounce back" —is equated with wealth, and anthropogenic climate change aids capital by clearing out the less wealthy and precluding their return via climate demolition. Through their energy intensive lifestyles and fossil fuel investments, the wealthy support the climate change-generated bulldozers that clear the path for the construction of coastal enclaves of environmental privilege. In this way the rich reap benefits from climate change while the poor pay the price for conditions they did not create.

States favor adaptation strategies that meet the needs of private capital, opting for structural mitigation that is affordable to the sustainability class. The sustainability class coastal gentrifiers claim the mantle of ecological consciousness by building and occupying "resilient" structures on the coasts. This is the essence of resilience gentrification. Wealthy citizens that desire water views as an environmental amenity, and who often take pride in their willingness to "live with nature" in climate adapted homes, become the new coastal residents in the Anthropocene. In both Gowanus and Barbuda, they are able to imagine themselves as environmentally conscious citizens adapting to new ecological realities, while remaining unconscious of both their regressive social impacts, and the ways in which their high consumption lifestyles and investment strategies help to generate those new ecological realities that disadvantage the population they replace. This is but one example of the ways in which the rich create ecological conditions under which only the rich can survive.

Resilience gentrification is not an inevitable outcome of coastal adaptation in the Anthropocene. There are alternatives to a managed scarcity/structural mitigation/ "resilient" recovery. In Schnaiberg's, 1980 lexicon, these would be *ecological syntheses*, which incorporate ecological principles and social equity.

A more ecological synthesis of the climate resilience dialectic would suggest managed retreat from the most vulnerable coastal

areas (O'Neill and Van Abs, 2015; Koslov, 2016; Hino et al., 2017). Where full retreat is not socially desirable, natural systems—"nature-based solutions" might be productively employed to blunt the impacts of sea level rise and storms, while supporting richer, more resilient ecosystems (Frantzeskaki et al., 2019). Retention and expansion of mangrove forests (instead of replacement with artificial beaches) in tropical zones, and the restoration or creation of sponge parks in lieu of hardened coastal infrastructure in more temperate climates could offer low-cost solutions, though the impacts on housing costs is unclear.

Managed retreat and degrowth can be encouraged through public policies that decouple resilience from wealth. These include policies to eliminate public subsidies for building on the coasts and in flood zones, buyouts and relocation (Cheong, 2011). Laws prohibiting private ownership of land in proximity to coastlines would also have equitable impacts. However, these, too, need to consider equity (Marino, 2018; Siders, 2019). For instance, in her analysis of post-Katrina New Orleans, Tierney (2015) has shown the clear ties that link neoliberal policies and disaster resilient strategies and their inequitable results: "The neoliberal turn in disaster risk management was never clearer than in Hurricane Katrina…The vaunted public-private partnerships that are viewed as central to community disaster resilience were on full display following Katrina, and with utterly shocking results…" (1337–1338). She describes corporate profiting around temporary housing, the firing of public employees including school teachers, the demolition of public housing, and the undercutting of wages. In general, lower levels of economic inequality mean a more equitable distribution of the capacity to withstand climate impacts, and a reduction of the incentives for structural mitigation by shrinking the potential market for resilience-inflated housing.

Buyout programs are another policy mechanism that could provide paths for residents to move to more ecologically sound and habitable areas, but again, equity needs to be a component of these programs. Elliot et al. (2020) investigated over 40,000 FEMA buyouts of flood-prone homes in the U.S. over 25 years. They found, "the federal buyout program disproportionately targets whiter counties and neighborhoods, especially in more urbanized areas where the program now concentrates. Yet it is neighborhoods of color that have been more likely to accept buyouts in urban areas…" (2). Raising the cost of flood insurance is another approach that would disincentivize living in flood prone areas. The same researchers point out that FEMA has acknowledged that the National Flood Insurance Program, "subsidiz[es] residential development in hazardous, flood-prone areas in ways that are not only dangerous to residents but fiscally unsustainable for taxpayers" (1). Despite this, there is political pressure not to raise rates. For instance, under Democratic President Biden, who is foregrounding policies to address climate change, the Senate Democratic leader, Representative Chuck Schumer from New York is resisting an increase in insurance rates because it would hurt his constituents (and campaign donors) in Long Island. When public subsidies sink costs into hazardous areas, the cycle continues. Sun (2011) explains this treadmill: "Once redevelopment occurs, however, huge public investments in redeveloped areas (financed by borrowing against anticipated future tax revenues from the redevelopment), increased property prices, and reinvigorated communities will intensify calls for structural protections and make retreat far more difficult, even if sea level rise or other conditions ultimately make retreat the most viable option" (2157). These policy processes are common in the U.S. context. However, there are examples from Europe, for instance Garcia-Lamarca's (2021) work in Nantes, France, which illustrates how public policy reduced green gentrification.

An even broader social structural approach to climate adaption would be social policies favoring degrowth (D'Alisa et al., 2015; Stuart et al., 2021). Degrowth strategies would not only incorporate staged retreat from the most climate vulnerable locales, but would also reduce (and ultimately reverse) the engines of climate change so that planetary conditions become increasingly, rather than decreasingly, favorable to human and other life. Less carbon emissions, less extraction, less consumption, less waste generation, less deforestation would all lessen the pressure on adaptation to an increasingly hostile environment of our own making. This requires a major reorientation of thought—part of the ongoing intellectual project to "decolonize." Reflecting on analysis of the Caribbean experience, which seeks a "decolonial resilience" —not to "bounce back" but to "bounce forward," Popke and Rhiney (2019) (5–6) suggest "to draw from local knowledge and experience to build an alternative model of disaster planning and response…through practices built around collective action, self-reliance, indigenous knowledge production, and principles of inclusion and equity." Degrowth and decolonizing could go hand in hand to imagine recovery from the Anthropocene.

Addressing ecological crises requires an active and responsive feedback loop between social systems and ecosystems so that changes in the ecosystem result in the necessary adjustments in social organization to sustain ecological integrity and basic life support functions. A social system that responds to both increasing coastal storm frequency and intensity and sea level rise by densification of coastal development and shifting population to precarious zones is clearly dysfunctional. The feedback loop between the social system and the ecosystem has been disrupted by high levels of inequality, allowing the privileged to escape or even benefit from the negative ecological consequences of their economic decisions. Resilience gentrification is an indicator of this feedback loop disruption. Ecological syntheses rooted in decolonizing and degrowth, by necessitating redistribution, offer a path to repair the social system-ecosystem feedback loop that would open a path toward a more just sustainability (Agyeman, 2013).

At each level at which a more ecological synthesis to the climate resilience dialectic is sought, the approach is one that promotes public policy solutions to a public problem. In the long run, private solutions to the public problem of global warming are not viable. It will not be possible, even for the wealthy, to establish an inverted quarantine (Szasz, 2007) from the entire planet.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

Both authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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POLICY BRIEF
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Green Gentrification and Environmental Injustice: A Discussion Based on the New Pinheiros River Program, São Paulo, Brazil

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Through the analysis of the New Pinheiros River Program, São Paulo, Brazil, the differences in the solutions presented are considered to implement environmental projects in different territories over the same sub-basin. Vulnerable neighborhoods upstream will receive only basic infrastructure; while Marginal Pinheiros, a rich place, will be contemplated with aditional leisure, sports and cultural equipments. The general aim is to analyze the process of capitalist production of the Pinheiros River depolluting program area, proposed by the São Paulo State government in 2019, as well as green gentrification and creation of environmental injustice. Methodology consists of bibliographic research and analysis of the program's documents and speeches of people in charge. Global South cities have been experimenting environmental injustice as a result of financial capital investments.

Keywords: green gentrification, New Pinheiros River Program, Global South, environmental justice, sanitation

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INTRODUCTION

Paragraph: In the last decades, the search for urban environmental sustainability has been followed by environment improvement and development projects. However, when lacking rogatory policies considering urban functions and the social characteristics of neighboring populations, they may lead to social exclusion, characterizing a process of green gentrification (Gould and Lewis, 2017; Anguelovski I. et al., 2018; Immergluck and Balan, 2018; Blok, 2020; Yazar et al., 2020) and social injustice for depriving populations of these improvements (Gould and Lewis, 2017).

This paper discusses the expansion of the phenomenon of gentrification in the region known as Marginal do Rio Pinheiros, in São Paulo, that has been occurring since the 1970s. The region used to be an industrial and middle-class neighborhood that has been transformed into a predominant business center of high technology buildings, constructed after public investments in urban requalification and transport systems (Nobre, 2000). In the 1990s, new public investments turned the region into a showcase of globalization, based on public–private partnership and real estate production through financial capital (Fix, 2007).

This study case is the *New Pinheiros River Program* (NPRP) started by São Paulo State Government, in 2019, as a stage of the 4th phase of the *Tietê River Depollution Program* (TRDP),

the largest environmental sanitation program in Brazil, that has been in progress, since the 1990 (SABESP, 2018, 2019a,b).

The article aims to analyze the capitalist production of urban space and its relation to the intensification of gentrification at Pinheiros River side through green projects in contrast to the permanence of environmental injustice in poor neighborhoods, inside the territory of Rio Pinheiros sub-basin.

Through the observation of this on-going case, we ask whether it is possible to create cities with better environmental quality for all or the program will enhance socio-environmental inequality, since there are populations in poverty and environmental risk situations in the area, that will be disproportionately benefited. There will be intensification of the valorization of urban space at Marginal do Rio Pinheiros, through public–private partnership, while the program limits its actions to implement drainage and basic sewage systems in the poorest neighborhoods of the same river basin territory (SABESP, 2019a).

Discussions contextualize the studied case with experiences of the Global South, which can be understood as a view over development emphasizing geopolitical power relation patterns and the prevalence of poverty all throughout Latin American, Asian, African, and Oceanian countries (Dados and Connell, 2012; Watson, 2019; Gosens, 2020), characterizing places and populations negatively affected by contemporary globalization (Mahler, 2017). The Metropolitan Region of São Paulo (MRSP) is composed of irregular urban territories, including illegal ones, in both urbanistic and environmental terms and lacking infrastructure, which shelter socio-environmentally vulnerable populations. However, it is known that the necessary investments to correct environment risks and frailty issues bring forth property valorization and may contribute to cast out the same population in need for benefits.

STUDIED AREA

The Pinheiros River Basin territory is in the MRSP, State of São Paulo, Brazil. It is the country's most populated area, with ∼21 million inhabitants (EMPLASA., 2016). This river basin is composed of 25 other sub-basins (SABESP, 2019a). The hydrographic region is located among 12 of the 39 MRSP municipalities (**Figure 1**) (SABESP, 2019b).

The specific NPRP covers 271 km^2 and includes neighborhoods in São Paulo, Embu das Artes, and Taboão da Serra [São Paulo (State), 2019a]. The other municipalities will be indirectly benefited, according to a document provided by the São Paulo Basic Sanitation Company (SABESP).

Part of the territory impacted by the NPRP has already undergone several urban interventions, specially at the Marginal Pinheiros region. In 1927, the Billings Reservoir, by the *Light* Electric Power Company, was built to generate hydroelectric energy at the Henry Borden Plant, with severe changes in the Pinheiros River body (Luz and Rodrigues, 2020). As a mechanism for generating additional electricity at the plant and to control floods, it was made a system of pumping of the waters of the Pinheiros River, and its flow was reversed. The mechanism brought additional pollutants from the Tietê River, contaminated by industrial effluents and domestic sewage (Luz and Rodrigues, 2020).

Therefore, there are different socioeconomic territories inside the sub-basin of Rio Pinheiros, target of the NPRP, and different public actions were planned for each territory [São Paulo (State), 2021b]. Marginal Pinheiros, already high valued and with a big offer of urban equipment, will receive sewage and drainage systems, and investments in innovative equipment of leisure, sports, and culture, close to the *Cidade Jardim* bridge [São Paulo (State), 2021b], one of the richest regions of São Paulo city.

Territories of low-income communities, slums, and middle-class neighborhoods will just receive the basic, namely, sewage and drainage systems and proper solid waste management, although they are socially vulnerable territories with deficit of public equipment of leisure, sports, and culture.

SOCIO-ENVIRONMENTAL VULNERABILITY IN THE CAPITALIST PRODUCTION OF URBAN SPACE

According to neo-Marxist urban sociology theories, the formation of cities in capitalism is interpreted under the perspective of decisions on land investments, escalating unequal relations between the working and capitalist classes, which include the access to collective consumption goods, as the green infrastructure (Alves and Fracalanza, 2019).

The formation of cities was important to the development of capitalism, in which lands were transformed into commodities and became financial assets, and infrastructure was essential for capital and workforce circulation (Harvey, 1992). Durable high cost of production goods enabled by urban infrastructure do not generate profit, despite adding high value to places they are implemented in (Marques, 2003). Man-made landscapes in capitalist cities follow the logic of accumulation and class conflict, creating unequal territories, with differences in investment quality and quantity (Alves and Fracalanza, 2019).

Contemporary urban planning is characterized by zoning laws and master plans that meet real estate and other private groups' interests, overlooking the collective needs. Urban space production is no longer based on mechanisms for territory planning but the result of market influence (Harvey, 2002).

Urban land is used within economic planning as a commodity over a part of city planning, as a social space for sociability and for the satisfaction of inhabitant needs, including the need for environmental quality (Alves and Fracalanza, 2019). Brazilian cities remain socially unequal and unfair, answering to real estate capital and political interests through investments on great construction works. Basic infrastructure and the improvement of inhabiting conditions for most of the population are disregarded (Maricato, 2013).

The city of São Paulo suffers with contrast between investments in noble areas and the lack of infrastructure in peripheral ones, especially due to slavery heritage, maintained through a patrimonial legal order consolidated by conservative modernization projects (Ferreira, 2011).

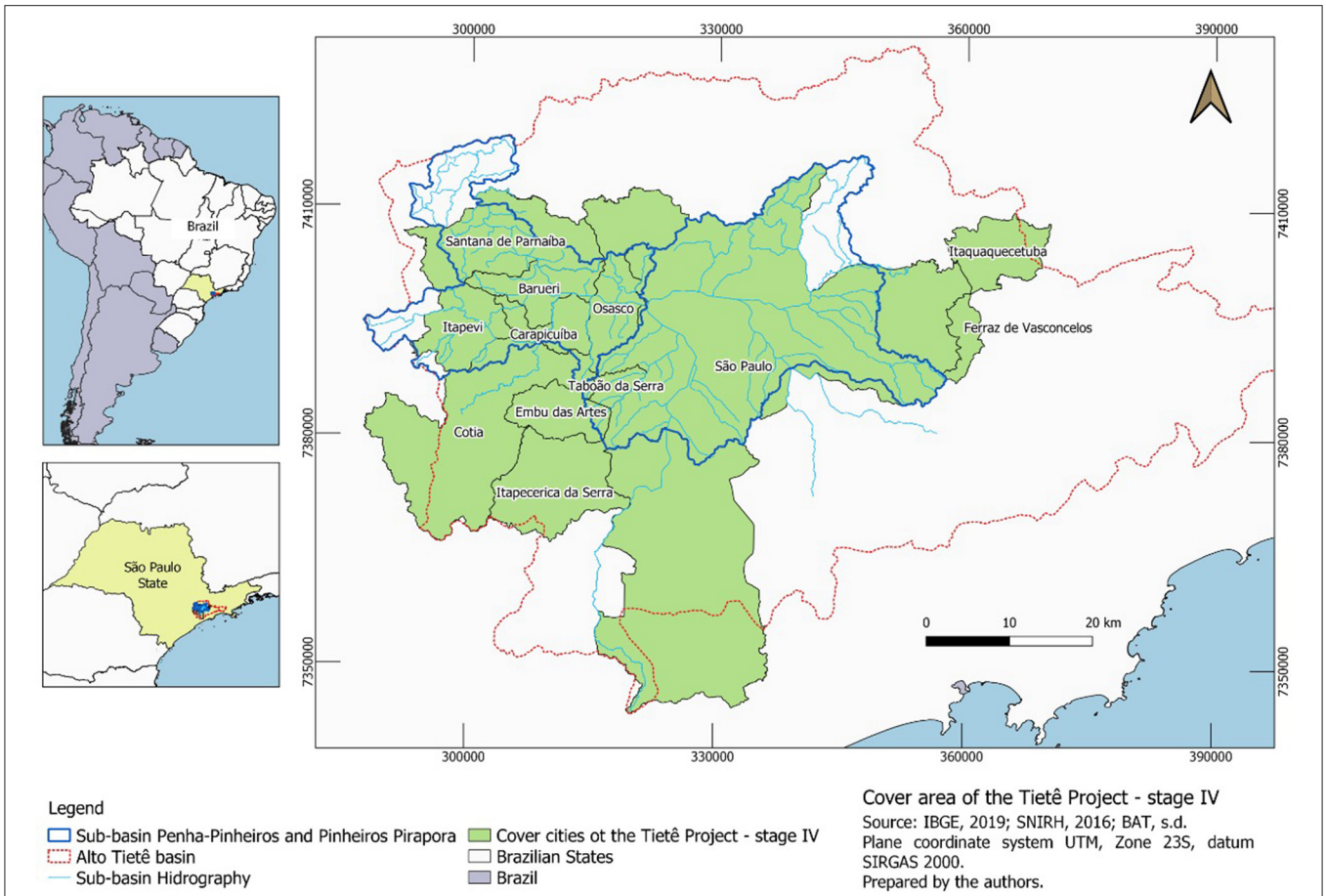

FIGURE 1 | Localization of the Pinheiros River sub-basin and municipalities covered by the 4th phase of the *Tietê River Depollution Program*. Source: Designed based on SABESP, 2018; São Paulo (State), 2019a.

GREEN GENTRIFICATION—CAN GREEN INTERVENTIONS BE SUBVERSIVE?

Studies on green gentrification have been identifying and questioning the processes of environmental improvements in a capitalist scenario, which result in real state valuation around the interventions, and produce the expulsion of the poorest social classes of the area (Curran and Hamilton, 2012; Gould and Lewis, 2012; Pearsall, 2012); in this case, vulnerable populations will remain far from part of the environmental improvements by public actions applied in urban equipment at Marginal Pinheiros. When implemented, green gentrification processes also characterize environmental injustice (Curran and Hamilton, 2012).

Recent publications on green gentrification commonly identify relations between populations excluded from these improvements and social class, race, and other social factors that characterize exclusion (Gould and Lewis, 2017; Anguelovski O. et al., 2018; Immergluck and Balan, 2018; Blok, 2020; Goossens et al., 2020; Yazar et al., 2020). In this sense, we ask whether these projects could be called environmental improvements while excluding populations by social class and/or race. After all, what is "environment" or what do we refer to when using the term "environmental"?

The understanding of environmental sustainability has been increasingly integrating the "total environment concept" (Smith et al., 1999). Environmental complexity demands integration of many study fields to fully consider it, and a view "that considers the natural, built, and social environments together with a persons inherent or intrinsic biological determinants, activities/behaviors, and policies/programs over different life stages and generations" (EPA).

The Global Environmental Agenda itself has evolved since the Agenda 21 in 1992 to the Sustainable Development Goals (SDG) in 2018, which included social matters, such as gender, race, and poverty, among other necessary paths for countries to follow in search of sustainability (United Nations, 2021). Therefore, we ask: was there actual environmental improvement, even with losses for the society affected by the intervention?

ENVIRONMENTAL JUSTICE

Green gentrification can increase inequality and environmental injustice, depending on how it deals with different inhabitants

and populations. Environmental injustice is the process in which socio-economically unequal societies allocate most environmental damages to low-income populations, discriminated racial groups, socio-economically vulnerable populations, and discriminated minorities (Acselrad et al., 2009).

Environmental injustice is related to the term "Environmental Racism," a form of institutionalized discrimination (Bullard, 2004, p. 43). Bullard's research in 1987 showed that the localization of hazardous waste warehouses in the USA was strongly connected to racial and class factors, while race was, in that case, a stronger indicator of the correspondence between the place people live and toxic waste warehouses (Bullard, 2004, p. 20), with prevalence for Afro-American, Latinos, and Native Americans (Martinez Alier, 2009).

Unequal exposure to environmental risks due to development processes for socio-environmentally vulnerable populations and minorities is environmental injustice, as well as unequal access to environmental resources (Acselrad et al., 2009). In this work, unequal access to land or expulsion from privileged urban areas are considered cases of environmental injustice.

NEW PINHEIROS RIVER PROGRAM

This study case is the NPRP started by the São Paulo State Government, in 2019, as a stage of the 4th phase of the TRDP. The NPRP aims to return a clean Pinheiros River for the population until 2022 [SABESP, 2019a; São Paulo (State), 2021b]. It involves several state bodies responsible for sanitation services.

Besides infrastructure implementation, the NPRP establishes the recovery of the margins of Rio Pinheiros, around the area known as Marginal Pinheiros, with the construction of leisure equipment and a linear park, that were granted to private initiative for exploitation [São Paulo (State), 2021b]. One of them will be implemented at a former water lifting plant (UE Traição), based on the model of the Argentinian neighborhood *Puerto Madero*, in Buenos Aires [São Paulo (State), 2019a].

The program counts with financial resources from funding contracts with the Inter-American Development Bank (IDB) and the World Bank Group (WBG) of US$ 405.2 million (R$ 2.197 billion), besides US$ 105.8 million (R$ 1.198 billion) as SABESP's compensation [São Paulo (State), 2019b]. All amounts in *reais* in this article were updated to *reais* in February 2021 and converted into dollars in February 2021.

Regarding the participation of the population, SABESP indicates that popular engagement is important for the project's success, in the form of effective connection to sewage systems and the proper disposal of waste, so that it does not end in the rivers. The company also mentions that populations in informal areas will receive improvements, and that big companies and other segments will also be benefited [SABESP, 2019c; São Paulo (State), 2021b]. Engagement mechanisms for civil society were Community Consultation, Community Communication (SABESP, 2018), and Public Hearings (SABESP, 2019c).

SABESP carried out three public hearings with IDB for the communities covered by the 4th phase of the TRDP. The hearings happened in all three regions, at accessible days and times for workers (weekends and at night on weekdays) (SABESP, 2019b). The forms of social participation declared in the project's communication and advertising means were characterized by consultive and informative processes, with passive features and little or no possible action and/or decision-making by the population (Paz and Fracalanza, 2020).

The schedule fits the duration of the current governor office (2018–2022), focused on works on regions of high real estate value in the municipality of São Paulo. These aspects indicate economic objectives in the state plan, focused on widening businesses and development for the MRSP.

The NPRP is clearly a project of sustainability used to value territories already important for real estate market and financial investors. Technically, depollution of the Pinheiros River requires actions for cleaning the contribution drainage area upstream, where are localized the residential area benefited with systems of sewage, drainage, and garbage collection. There are ∼400,000 families that already received this basic infrastructure, since 2019 [São Paulo (State), 2021b].

The important factor to be considered for the poorest territories covered by the NPRP is that part of the households is judicially irregular, so they cannot receive infrastructure of any kind, mainly because they affront the law for the protection of water sources (*Lei Estadual* no. 9.866/1997). In those cases, the houses in social and environmental vulnerable situation will not be benefited by the NPRP: there will just be constructed small treatment plants, the Water Quality Recovery Unities, and the water will be treated directly on water streams, before it flows into the Pinheiros River [São Paulo (State), 2021b].

This is a palliative solution, which links the two territories covered by NPRP, highlighting the situation of environmental injustice, where the most vulnerable population will continue living with pollution from sewage, while the richest territories comprised in NPRP will have access to treated downstream water, leisure, sports, culture, and consumptions equipment, at the *Marginal Pinheiros* neighborhood.

The discussion proposed here over this project is whether this investment around a water stream, a common good, that will serve to further appreciate noble neighborhoods in the city is really a government program aiming to promote environmental quality fairly and democratically.

Public information made available by SABESP affirms that 16 contracts to expand and improve sewage collection and transportation to an existing treatment facility are in execution (SABESP, 2019a). Still, investments in parks and sports, leisure, and service structure are focused only on the noble part of the city and not on the areas to receive sewage connection.

Regarding the program's business potential, after the Pinheiros River depollution, government representatives inform that there will be economic exploitation of the river in activities as: navigation, sports, bike path, and "creative economy," gastronomy, and other services [São Paulo (State), 2019a]. The depollution program actions involve the private sector and the sanitation company SABESP, each in one project phase to reach the program's aim: to clean the river; provide urbanism and

touristic exploration; grant train lines in the region to private companies; build new accesses through pedestrian walkways; and actions for nighttime use in the region. The final aim is to appreciate the surrounding areas using the least public resources possible [São Paulo (State), 2019a].

More investments were recently proposed for the program through a partnership between the São Paulo State government and private initiative for the linear park at the Pinheiros River margins. The park is located in a region of high real estate value and restricted access to most of the population, especially due to the neighborhood gentrification, which refrains the access of people from other areas, characterizing an improvement focused on a part of the population, corroborating Gould and Lewis (2017) studies on green gentrification in Brooklyn, New York.

Regarding the creation of the São Paulo *Puerto Madero*, in November 2020, the state government signed a contract to revitalize the former Traição Plant with the Metropolitan Water and Energy Company S.A. (EMAE) and the São Paulo Plant Venture SPE S.A. [São Paulo (State), 2020a]. The concession price was US$ 56.6 million (R$ 307 million) in February 2021 and was signed after financial and environmental debate, in February and April of that year, by a state government body responsible to establish free competition [São Paulo (State), 2020a,b].

The environmental debate considered that there are Permanent Conservation Areas (APPs) among the granted areas, with restriction for the construction of new buildings, as well as the lack of technical reports on structural conditions of the Traição Plant building, constructed more than 80 years ago with no projection of "use intensification" [São Paulo (State), 2020b].

Concerning the linear park, its contract was signed in January 2021 between the Metropolitan Water and Energy Company S.A. (EMAE) and the New Pinheiros River Park Venture. The contract establishes a US$ 5.8 million (R$ 31.5 million) investment in the next 5 years for the implantation and maintenance of park infrastructure [São Paulo (State), 2021c]. Although park equipment is free, there are compensations for private investment allowing advertising and event organization in the granted area, which can lead to environmental injustice [São Paulo (State), 2019a]. Therefore, the population that contributes the least to environmental problems could be excluded from private events foreseen in the park grant, clearly leading to the requalification of public areas for private initiative and to a case of environmental injustice (Acselrad et al., 2009).

FINAL REMARKS: REQUALIFICATION AND GREEN GENTRIFICATION

This article aimed to discuss the NPRP proposed by the São Paulo state government that connects river depollution to two works considered as the main results of the program: a leisure area and the construction of a linear park.

According to the analysis, the leisure area, called *São Paulo Puerto Madero*, is a construction model based on excluding capitalist consumption, despite the area reconstruction depending on basic sanitation works performed by the São Paulo State government.

As for green gentrification, it is considered that there is a possibility that the process will be observed in the next years after the implementation of the sustainable green structures as the linear park, leisure, and sports equipment at Marginal Pinheiros. According to the São Paulo government, the depollution of the River Pinheiros will result in real state valuation of neighborhoods in the immediate surroundings of Marginal Pinheiros [São Paulo (State), 2021a]. Associated with the implantation of the *Puerto Madero Paulistano*, the raise of value of the neighborhoods could lead to the expulsion of lower- and middle-income populations from these places, which would result in continuous green gentrification processes.

This mode of production of qualified and valued urban spaces included in the ranking of global cities is supported by public resources invested in infrastructure, with the purpose of leveraging private business (Fix, 2007). As controversial results, these public investments generate more socio-spatial segregation, deepen processes of environmental injustice, and may in the future result in green gentrification depending on capital investments.

Lastly, it is important to observe that cities in the Global South have been the focus of exploration by the international financial capital, which expands to occupy new markets, such as water and sanitation. The NPRP thus fits this expansion logic of the financial capital that invests on Global South cities aiming to widen markets and profits, but not to improve environmental quality or proposing solutions for the promotion of environmental justice. In this case, green gentrification is one path for such international investment.

As alternatives for processes of green gentrification, as this case, the construction of linear parks in public areas located in low-income neighborhoods should be considered, contributing to environmental justice. And more ambitious could be the partnership with the cities involved in the project to improve informal communities and favelas, with urbanization investments or production of social housing, this way looking toward a real environmental sustainability, instead of the constructions of exclusionary leisure structures. Urban sustainability connected to social housing is a strategy that has been proposed by UN Habitat, to achieve sustainable development (Ministério do Meio Ambiente et al., 2015), The criticism presented here is about the precarious housing situation of part of the families covered by the NPRP and the communities living without access to urban equipment, basic sanitation, and proper garbage collection; however, the investments in sustainability and urban requalification were primarily designed downstream, at the *Marginal Pinheiros* neighborhood, where high technological commercial buildings impose characteristics of global city. The project covers only one sub-basin territory but proposes two unequal solutions. So, we observe that the *NPRP* is a continuity of the perverse logic of

capitalist urban space production that widens inequalities in the territory.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Socio-Ecological Conflicts in a Global South Metropolis: Opportunities and Threats of a Potential Greenway in the São Paulo Metropolitan Region

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Greenways are a measure of environmental remediation within a broad framework aimed at promoting urban greening and adaptation to climate change. The typical characteristics of large urban agglomerations, including land use (such as commercial, industrial, and residential areas) with few public spaces and fragmented landscapes, make it difficult to apply these solutions to the urban fabric, forcing decision-makers and planners to act in informal settlements, highways, and industrial parks. One proposed area is an enclave with unused or underutilized lots, where fragments of the Atlantic Forest, parks, landfills, and rapidly expanding informal settlements can be found. This manuscript examines the socioeconomic and environmental processes that shaped this potential urban greenway between Santo André, Mauá, and Ribeirão Pires, which are part of the São Paulo Metropolitan Region (SPRM), the largest in South America. A survey was conducted based on municipal and regional plans, the environmental and urban laws of Brazil, and the socioeconomic history of this part of the SPRM. In addition, satellite images were used to analyze land use evolution through geotechnologies. Finally, we prepared land use recommendations, considering opportunities and threats, highlighting the possibilities of protection and expansion of the Atlantic Forest. To this end, we examined the literature on environmental urban planning and design, green infrastructure, and other concepts. This study intends to stimulate researchers, planners, and decision-makers regarding the urban greening process in the Global South. According to the recommendations, this stimulus would develop these concepts according to the real situation of the region, which would combine the protection of wild habitats and urban environmental amenities. However, this effort makes no sense if one of the defining Global South characteristics not addressed is social inequality. Therefore, we recommend that an effort be made to develop and incorporate processes from urban greening in slum upgrading.

Keywords: Urban Greenways, Global South, Atlantic Rainforest, Green infrastructures, Informal settlements, Dump sites, Landfills

INTRODUCTION

Greenways have gained prominence among researchers, planners, and activists as an important element in urban greening that integrates design and ecology and makes a significant contribution to more livable cities (Frischenbruder and Pellegrino, 2006). In other words, they are an essential resource for addressing contemporary urban socio-environmental problems, many of which result from the twentieth-century concept of the city in a scenario of uncertainty in the face of climate change (Bonzi, 2017, p. 8; Chen et al., 2017; Moura, 2017). A greenway can be defined as a cluster of elements (green spaces) that enhance the fundamental connectivity between green urban areas and the remaining fragments of forest throughout a landscape (Frischenbruder and Pellegrino, 2006). This definition, which is adopted in this article, is broader than the similar term conceived by Little (1995), which only links green spaces or accessible areas that are established along natural corridors such as streams or empty lots in parallel to roads and railways. We understand the greenway as an element that is part of a framework for multiscale green infrastructure interventions (Chen et al., 2017). Tzoulas et al. (2007, p. 169) define it as:

> (...) all-natural, semi-natural and artificial networks of multifunctional ecological systems within, around and between urban areas, at all spatial scales (…) [it] emphasizes the quality as well as quantity of urban and peri-urban green spaces.

Thus, multifunctional, and multiscale green infrastructure is based on spatial patterns of connectivity in a natural network (Ahern, 2007; Escobedo et al., 2019). Green urban spaces considerably enhance urban water management and air quality, reduce urban noise levels and human stress levels, create habitats available for urban wildlife, and enhance the performance and resilience of gray infrastructure (McPherson and Muchnick, 2005; Heynen et al., 2006; Tzoulas et al., 2007; Berland et al., 2017; Dong et al., 2017). These benefits can be applied to food production in urban areas (Jerome, 2017). However, the literature on urban greening processes, especially green infrastructure, rarely considers urban agriculture (Russo et al., 2017). This use of urban areas for food production could also meet a growing demand for vacant urban lots to be returned to citizens through a variety of urban agricultural practices (Thomaier et al., 2015; Liu et al., 2017).

In the region studied, the development of green infrastructure plans is still slow (Serra-Llobet and Hermida, 2017; Vásquez et al., 2019). In contrast, the Global South has the world's richest and most diverse ecosystem, including several biodiversity hotspots (Pauchard and Barbosa, 2013; Dobbs et al., 2019; Vásquez et al., 2019). Nagendra et al. (2018) argue that urbanization impacts in the Global South have adverse effects on rich ecosystems, mainly on water sources and soils. In some cases, the consequences can reach hundreds of thousands of kilometers (Nagendra et al., 2018).

To understand the relationship between rapid and precarious urbanization in the Global South, especially in Latin America, it is fundamental to consider that capitalist development has not occurred in this region in the same way as in major capitalist economies (Marini, 2015). The process that led 80% of the Latin American and the Caribbean population to live in urban areas resulted from the incorporation of their societies into the international system of the division of labor, helping to consolidate the industrialization that was taking place in the Global North (Pírez, 2013). The combination of a weak state, a reduced internal market, and rapid urbanization has resulted in large unplanned informal settlements in different places, giving us a small sample of how the reproduction of capital in the Global South is linked to the definition of territories for urban expansion, including the occupation of sites for the disposal of municipal solid waste (MSW), such as dump sites or landfills (Ogata, 1983; Rafael, 2006; Rodrigues and Zanirato, 2021).

The consolidation of an urban greening agenda has evolved since the 1970s. It requires and promotes reconciliation between the anthropic and the natural processes. Therefore, it is worth asking how we could induce the beginning of a human-nature relationship reconciliation process in a context where so many contemporary and historical socio-economic and political issues damage this relationship, such as the formal and informal pressures on the green areas still available in the largest metropolitan region of Brazil.

In an attempt to answer this question, this article analyzes a possible area for the establishment of an urban greenway located between three Brazilian municipalities, Santo André, Mauá, and Ribeirão Pires, in the southeastern part of the São Paulo Metropolitan Region (SPMR). This is one of the world's largest urban agglomerations, consisting of 39 municipalities (**Figure 1**), and the most urbanized and industrialized in Brazil. However, 2.1 million people of the SPMR live in precarious housing conditions, many in at-risk areas (Travassos et al., 2021). The three municipalities belong to the southeastern sub-region of the SPMR, known as the "Greater ABC." This region consolidated itself as an industrial region in the twentieth century, along the old railroad—the São Paulo Railway Company—from the seaport at Santos via São Paulo to Jundiaí, a coffee-growing region inaugurated in the 1860s.

According to the São Paulo State Data Analysis Foundation (SEADE), in 2021, Santo André's population totaled 693,897 inhabitants, Maua's 463,338, and Ribeirão Pires's 119,339. Together, they include 6% of the SPMR population, with 21,252,384 residents (SEADE, 2021). It is worth noting that the population of these municipalities is not evenly distributed throughout the territory. More than half of the territory of Santo André has been declared an environmental protection area—a water-producing area–inhabited by <5% of its population. In the urban area making up just over 40% of its territory, and on which 96% of its people are concentrated, the population density reaches 9,000 inhabitants per square kilometer. In this sub-region, where there are fragments of the Atlantic Forest and the old mining areas (some of them transformed into landfills), several precarious settlements have drastically increased in recent years due to the severe socio-political crisis taking place in Brazil.

Swyngedouw et al. (2002) argue that environments are specific historical results of socio-environmental processes. In their

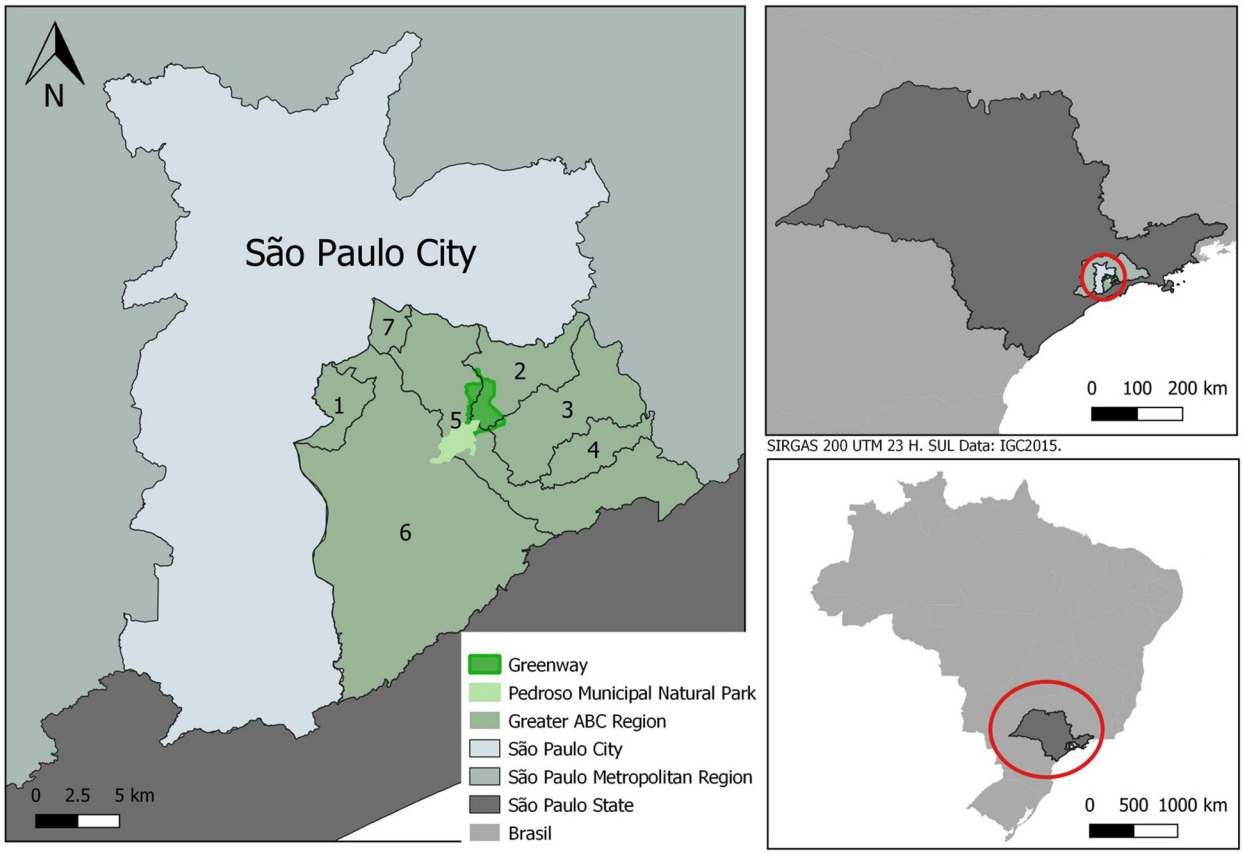

FIGURE 1 | Location of the State of São Paulo, Metropolitan Region of São Paulo, Greater ABC, and the Greenway. This map was made by Beatriz Dunder (IEE-USP).

words, "the character of the physical and environmental changes and the resulting environmental conditions are not independent of the specific historical, social, political, or economic conditions" (Swyngedouw et al., 2002, p. 126). This statement explains what drove the area that we study, which we refer to as the Greenway, to take on its current characteristics. Based on the master plans of the three cities and the Greater ABC regional plans, we delimited an area starting from its northern end, which is a narrow strip of riparian forest on the banks of the Itrapoã Stream that forms the municipal boundary between Santo André and Mauá. We incorporated the Barão de Mauá residential complex, close to the limits of this riverine green space, because it was built on an old industrial dump site. We consider that the recovery of the soil quality of this residential complex is also part the integration process of the Greenway, for reasons that will be addressed in the later sections. The Pedroso Municipal Natural Park (PMNP) is located almost 6 km south of the northern part of the Greenway. To the east of the PMNP, we find the Lara Company Landfill in Mauá and some forest fragments. This strip comprises ∼1,207.79 hectares (not including the PMNP area). This large greenway area has a history of different land uses, including mining, dump sites, landfills, housing, and industrial activities. We developed this review paper based on laws and municipal plans, especially the Pedroso Natural Municipal Park Management Plan, an obligation under the National System of Conservation Units (NSCU). For this manuscript, we consulted the Climate Change Action Plan guidelines proposed by the Consortium of Greater ABC Municipalities. We selected green areas, among other types of areas, that had some level of connectivity for the delimitation of the Greenway situated no more than 20 m away from each other.

Land-use maps were constructed using the free software QGIS 3.16. The land-use classification was based on sattelite imagery from 2005 to 2020 obtained through the Orbview-3 satellite (provided by the U.S. Geological Survey Earth Resources Observation and Science [EROS] Center). From these images, a semi-automatic classification was performed with the assistance of the SCP program for QGIS based on a previous collection of samples carried out by photo interpretation, corrections, and on-site verification.

The first part of this paper presents a brief description of the macro institutional framework and of the Climate Change Action Plans of the Greater ABC Consortium, which proposes guidelines and actions that we developed in this work, specifically in the proposal for the buffer zone in the PMNP Management Plan.

The next section discusses the Greenway area and its biotic, physiographic, and socio-economic characteristics. In the second

half of this section, we make a brief diagnosis of the natural and man-made elements of the cities and the region that compose the Greenway.

ASSESSMENT OF OPTIONS AND IMPLICATIONS OF GUIDELINES

Institutional Framework

Analyzing the SPMR environmental plans and zoning, it is noted that the Greenway area in southwestern of the "São Paulo Green Belt Biosphere Reserve". UNESCO recognized the Green Belt of São Paulo as a Biosphere in 1994, by UNESCO's "Man and Biosphere Program". UNESCO established the Biosphere Reserves sites to host a network of areas on the globe with relevant environmental value to humanity (UNESCO, 2021). The São Paulo City Green Belt Biosphere Reserve is over 600,000 hectares of forests and other Atlantic Forest ecosystems (Ribeiro, 2015).

The first element of analysis is the PMNP, the largest conservation unit in the Greater ABC, and its management plan (SEMASA, 2016). The National System of Conservation Units determines the mandatory elaboration of management plans for all Conservation Units, and buffer zones are among the many actions to be defined in these documents. They correspond to "the surroundings of a conservation unit, where human activities are subject to specific rules and restrictions, to minimize the negative impacts on the unit" (Brasil, 2000, p. 2). Therefore, their function is to protect the conservation units from the possible impacts of human activities, or at the very least to mitigate them, preventing their fragmentation and edge effects. This strategic function is indicated by Dramstad et al. (1996), who emphasized the importance of buffer zones to minimize impacts on protected areas according to landscape ecology. Thus, the PMNP management plan establishes two categories of buffer zones: class 1, delimited around PMNP, but restricted to the municipality of Santo André; and class 2, which goes through and beyond the city, being defined in collaboration with neighboring municipalities while taking into consideration the specific state law focused on the protection of water sources: the watershed protection law of the Billings Reservoir Hydrographic Basin (São Paulo, 2009), the largest in the São Paulo Metropolitan Region.

The second element that supports our study is the Greater ABC Consortium's Action Plan to Combat Climate Change (CIGABC and ICLEI, 2016). From this plan, we highlight, from among the 52 potentialities, two items for environmental and territorial planning: (1) the "Mosaic," which allows for a mosaic of regional conservation areas in the watershed of the Billings Reservoir, and (2) ecological corridors interconnecting the borders of parks, buffer zones, and green spaces. However, our focus is on the buffer zones, especially those suggested by the PMNP management plan. This management plan delimits the transition sites to the north as buffer zones, creating a corridor that circumvents areas of high population density. The mosaics need to be investigated, especially concerning the impacts of the Rodoanel Highway (Ferreira, 2012; Brito, 2014). This highway bypasses the SPMR and reaches areas of interest for environmental preservation, which could serve as possible connections with other conservation units and protected areas. However, discussion of this issue lies outside the scope of this study.

The following is a brief description of the region's native vegetation and its natural and man-made characteristics.

Atlantic Rainforest and Dense Montane Rainforest

The urban areas presented in this study are located in a forest formation classified as dense montane rainforest. This formation has three main characteristics: (1) the high density of vegetal organisms per square meter; (2) the fact that it can be found at elevations between 500 and 1,500 m; and (3) a high number of rainy days, from 305 to 365 days with some level of rain, and high mean temperatures (25°C) throughout the year. Other characteristics include its phanerophyte vegetation cover with a mean canopy size of 20 m, and the soil, which plays an important role in determining the size of the vegetation (IBGE, 2012). This particular forest formation is inserted in the Atlantic Forest phytogeographic region. Being the second largest forest in South America (Muylaert et al., 2018), the Atlantic Forest is crucial for the conservation of biodiversity and for the preservation of human wellness both locally and globally, as shown by Marques et al. (2021).

Anthropic expansion and attendant habitat fragmentation have driven the Atlantic Forest and its native biodiversity to a critical level of danger. The weak environmental governance and dismantling of environmental policies by the Brazilian government reinforce the land-cover change, which is the main source of damage to the biome (Abessa et al., 2019). The Atlantic Forest has been degraded since the discovery of Brazil in the sixteenth century. Historically, the Brazilian economy has been based on the deforestation of this biome: the extraction of brazilwood (*Paubrasilia echinata*) from the coast of the country or precious metals from the mountains, sugarcane, and later coffee farming cycles under the plantation system, and, since the second half of the last century, rapid urban sprawl and increases in population (Lira et al., 2021). This biome houses many of the most densely populated state capitals and cities and two of Brazil's main megalopoli, São Paulo and Rio de Janeiro. Together, they are inhabited by more than 50 million people, who directly depend on the ecosystem services of the forests (Carlucci et al., 2021; Pires et al., 2021).

Parks, Streams, and Geomorphology in the Proposed Greenway Through Santo André, Mauá, and Ribeirão Pires

The Atlantic Forest covers almost half of the Santo André and Ribeirão Pires land area, a high percentage of their territories than in other cities in the state of São Paulo. Data from the Forest Information System of the São Paulo State (São Paulo, 2020) show that, in the case of Mauá, the area we defined as part of the Greenway area holds around 65% of its forest

FIGURE 2 | View of the Pedroso Municipal Natural Park (PMNP), (SEMASA, 2016).

cover. The city of Santo André, whose territory is almost three times as large as that of Mauá (18,100 vs. 6,700 hectares), has a higher percentage of Atlantic Forest still standing (35.78%), but the largest concentration of forests is to the south, away from the Greenway.

Ribeirão Pires, with a minor fraction of its territory in the Greenway (only 63.1 hectares), has an area of 10,700 hectares. Mauá contributes to the Greenway with 824.6 hectares, almost the totality of this forested land located in the industrial district (Mauá, 2007, 2016). Santo André has 318.2 hectares in the Greenway. Although forested areas are under considerable pressure from urban sprawl, they still maintain considerable biodiversity. For example, a survey of birds shows more than 300 species close to the Santo André landfill, some of which are at risk of extinction (SEMASA, 2021). It is worth mentioning that the three municipalities have a significant part of their territories in the watershed protection area—Ribeirão Pires has 100% of its territory in that area, with Santo André and Mauá having 55 and 19%, respectively (**Figure 1**). The overlap of the Greenway territory with watershed protected areas (the Billings Reservoir Basin) makes up only a small part of its southern area. To the west, the PMNP borders Santo André and Ribeirão Pires, where there are some fragments of the native forest and some exotic species reforestation (silviculture), according to the Forest Inventory of the State of São Paulo (São Paulo, 2020).

The main element to be connected to the Greenway, Pedroso Municipal Natural Park (PMNP), is an 812-hectare park created in 1944 to safeguard a fragment of the native forest and protect the watershed for the water provision for the city of Santo André (**Figure 2**; Freitas, 2011; SEMASA, 2016). As the PMNP is close to the neighboring municipalities, its buffer zone goes beyond Santo André's municipal limits. This conservation unit serves a variety of human uses, including a leisure area, for the population of neighboring regions, many of which are precarious settlements. There is also a sanctuary of Umbanda, an Afro-Brazilian religion, which was officially established in the PMNP with a concession by the Santo André municipal government in 1985. It occupies an area equivalent to 7.42% of the total area of the park (SEMASA, 2016). Within the PMNP perimeter, there are still other structures with different uses: a Catholic chapel, "Santa Cruz dos Carvoeiros"; a Japanese garden; a water pumping station for provision purposes; and the municipal vivarium.

This conservation unit is under significant anthropic pressure because it is close to densely populated areas, especially on its northern limits (Freitas, 2011), and suffers from the impacts of the Rodoanel Highway, built in the early 2000s (Ferreira, 2012).

There are two parks within the Greenway's limits. The first is Guaraciaba Park, also in Santo André, which is smaller than PMNP, with 52 hectares. Guaraciaba Park is a micro drainage watershed with remnants of the Atlantic Forest inside (SEMASA, 2004). The lake is the result of a sand extraction operation that took place between the end of the 1950s and the beginning of the 1980s (**Figure 3**). This lake has only 7.7 hectares with satisfactory ecological and sanitary quality (Mucci et al., 2004; SEMASA, 2004). Momm-Schult et al. (2014) identified a potential green corridor that could connect this park to PMNP to its south, as well as the already known environmental benefits that its creation could secure. Finally, in the proposed Greenway area, there is a small park to be considered, Marek Park, north of the Santo André landfill, with an area of 2.93 hectares.

Regarding the geomorphological domain of the region, the environmental impact study evaluated the possibility of expanding the Santo André landfill (SEMASA, 2008) into an area of low-lying hills with closed valleys (Poletto, 2006; SEMASA, 2008). The water springs in this region form the tributary streams of the Tamanduateí River, the main river in the southeastern region of the Greater ABC (Santo André, 2004; SEMASA, 2004).

Uses, Impacts, and Threats

It is essential to highlight that the three cities (Santo André, Mauá, and Ribeirão Pires) are part of the axis that promoted urban growth in the cities of the SPMR—the Santos-Jundiai Railway; in 1946, the São Paulo Railway Company was nationalized and became the Estrada de Ferro Santos-Jundiaí. The railroad was responsible for the first stage of industrialization in the Greater ABC between the early twentieth century and the 1950s (Ribeiro, 2008). The second stage was promoted by the automobile industry, with the construction of the Anchieta Highway in 1947 between São Paulo and the Port of Santos. This whole region had a high growth rate as a result of the expansion of the industrial sector (albeit based on low wages), especially in the 1950s. According to IBGE, between the 1960s and the 1980s, the region had a growth rate of 227.70%, which was higher than those of the SPMR (162.70%), São Paulo (95.5%), and Brazil as a whole (69.8%). Due to the debt crisis of 1973, the Greater ABC region underwent a localized process of deindustrialization, which substantially decreased the previously presented growth rates, reaching 42.50% between the 1980s and the 2000s (IBGE, 2021), closer to the growth rate of the SPMR and that of Brazil as a whole. The departure of industries from the region and the change in the capital accumulation matrix after the mid-1970s generated a "tax war," impacting economic activities, the production and distribution of wealth, and the availability of jobs, altering the levels of income, building infrastructure, and implementation of public policies (Ribeiro, 2008).

Although the Greater ABC region has undergone economic restructuring (through the generation of wealth driven by industrial production for the service sector), it accounts for more than 10% of the gross domestic product of the SPMR and almost 6% of that of the state of São Paulo (EMPLASA, 2017). This urbanization process generated a considerable contrast: On the one hand, we have urban areas concentrated to the north, in the municipality of Santo André, where most of the population lives and where most of the services and industries are still located; on the other hand, in the south of this region, we find a loosely populated area where the Billings Dam Watershed lies (CIGABC and UFABC, 2016). The Billings Dam Watershed is also responsible for part of the drinking water supply of the cities in the region. As a result, it now has its own hydrographic basin, which occupies 56% of this sub-region, protected by a state law promulgated in the 1970s, in the same region where we find the Sertãozinho Industrial District (belonging to the municipality of Mauá), created in 1975, 1,160 hectares in area (Mauá, 2007) and access to the "Rodoanel." This highway, which has been under construction since the 1990s, bypassed the SPMR (Ferreira, 2012).

To understand the current status of the studied area, it is important to examine the history of its land use. Specific mining sites were used to configure places for other services. Observing the aerial photos of 1990, the Guaraciaba Park Plan (SEMASA, 2004), and the Santo André landfill study (SEMASA, 2008), we found two sand extraction sites that were active between the 1950s and the 1990s. The first and smallest resulted in Lake Guaraciaba. The second site became the current Lara Company Landfill in Mauá. It is worth mentioning that there is a lack of information about mining activities in the SPMR until the end of the 1970s (Poletto, 2006). From the surveys carried out, we estimated that in the same period in which mining activities were taking place, the final disposal of MSW was already underway in the dump site on Espírito Santo Street (Rafael, 2006; SEMASA, 2008).

Dump Sites and Landfills

The history of the final disposal of MSW in the Greater ABC can be divided into two parts. The first period was between the 1950s and the 1980s, with the registration of dump sites in Santo André and Mauá (Rafael, 2006; CETESB, 2013; Okamura et al., 2015). The second period, with the disposal of MSW in landfills in Santo André and Mauá, began in the 1980s. An emblematic case is the industrial dump site located on a vacant lot in Mauá on the banks of the Itrapoã Stream, which establishes the limits between the municipalities of Mauá and Santo André. The COFAP factory (Companhia Fabricadora de Peças) used approximately 16 hectares of this area to deposit industrial solid waste, predominantly foundry sand (CETESB, 2013; Okamura et al., 2015). The lack of information about its history is a striking feature of this dump site. There are no exact data on the operation dates or on the characterization and volume of the solid waste disposed of. Reports and interviews with company employees stated that the operation took place ∼40 years ago (Okamura et al., 2015). The only thing that is known for certain is that COFAP bought this lot in 1974 and sold it to the housing cooperative "Cooperativa Habitacional Nosso Teto" in 1995 (Matsuura, 2006). The Barão de Mauá residential condominium was built in this area where industrial residues were disposed: a group of eight-story buildings, four apartments

FIGURE 3 | View of the Guaraciaba Park Lagoon and its southern slope, limited by the informal settlement Vista Alegre/Sítio Cassaquera and eucalyptus reforestation areas. The work carried out by the Santo André Green Space Department to reopen this park is shown. Source: Author's photo, taken on May 2nd, 2021.

per floor, totaling 59 buildings distributed over nine blocks, where about 7,500 people live. The project prescribed 72 blocks in total. Part of the area is contaminated by 44 toxic substances, including benzene, chlorobenzene, trimethyl benzene, decane, and other organic and inorganic volatile compounds. This contamination was discovered through an accident in April 2000: Workers who maintained a lower reservoir of drinking water in one of the buildings were hit by an explosion that resulted in one death and two injuries (Matsuura, 2006). The legal actions against the liable company required the adoption of remediation actions, such as the identification and characterization of contaminants and the remediation of the soil and groundwater in the condominium area (**Figure 4**; CETESB, 2013). In 2015, the environmental recovery required by the São Paulo State environmental agency (CETESB) began, according to the Justice decision.

In his master's dissertation at the Polytechnic School of the University of São Paulo (USP), Luis Fernando Armidoro Rafael identified several sites of irregular waste disposal in the city of Santo André. The dump site on Espírito Santo Street operated from the late 1950s to 1981 and occupied 2.8 hectares. In this area, ∼108,000 m^3 of waste was deposited from households, general cleaning, industrial, and infectious refuse (Rafael, 2006).

For the dump site on Espírito Santo Street, there was a similar change in land use after the MSW disposal operation was terminated to housing. However, as is usual, this kind of precarious settlement occupies areas with environmental risks (Rodrigues and Zanirato, 2021). These factors compromise the geotechnical stability at the site, which has a slope above 15%. By the beginning of 2013, 820 houses had been demolished and their families moved to apartments built in Santo André (Marguti, 2013).

Technological development, associated with environmental control and engineering design standards, has made this landfill a safe option. However, this option for the disposal of solid waste generates externalities and, after its closure, control measures must be taken continuously for many years (Barros, 2017, p. 262). The Lara Company Landfill (Mauá) originated from an old sand extraction area in the early 1990s. It receives MSW generated by all the municipalities of the Greater ABC (except for Santo André), as well as MSW from three medium-and smallsized towns in the São Paulo state (CETESB, 2018). In the current phase, the Lara Landfill covers an area of 75 hectares, near to Billings Watershed Protected Area (CIGABC and FESPSP, 2016; CPEA, 2019). In 2019, CETESB approved an environmental license for construction of a waste-to-energy plant (CPEA, 2019) that will occupy 7.2 hectares within the Lara Treatment Center and will be built near the landfill. It was approved despite opposition from social movements (COMUGESAN, 2020) and particularly waste pickers' organizations (São Paulo, 2019). The Santo André Waste Treatment Plant began operations in the early 1980s with a composting plant between 1982 and 1997. The landfill began in 1986 and lies north of Guaraciaba Park (SEMASA, 2008). Currently, landfill management is preparing a new stage, which is under the licensing process with CETESB, with an additional 3.9 hectares of the area (from a total of 32.8 hectares) providing another 5 years of service life. Both landfills are approximately five kilometers apart and are well-evaluated by CETESB (Melo, 2020).

Concepts and Strategies for the Urban Greenway and Green Infrastructure

As a result of the heterogeneous character of the land use in the area studied in this article, we suggest the adoption of the four planning strategies proposed by Ahern (2007): protective and preventive preservation measures; offensive, corrective, or restorative actions; defensive measures, implementing actions to defend the elements of the landscape that are under pressure;

FIGURE 4 | (A) Above, left, part of the "Barão de Mauá" residential area built in Mauá that extended over the Itrapoã Stream and into part of the territory of Santo André (Moreno et al., 2012). **(B)** (Above, right) interior of the housing "Barão de Mauá" built on an industrial dump (CETESB, 2013). **(C)** Contaminant plumes generated by the disposal of industrial solid waste on the site where the "Barão de Mauá" condominium was built (CETESB, 2013).

and opportunistic, recognizing the potential of non-contributing aspects of the landscape. The main element that guides this study is the buffer zone established by the PMNP management plan. Thus, we assume that defensive strategies are evident. We apply a multi-scaled approach based on hierarchy theory, which addresses the structure and behavior of systems that function simultaneously at multiple scales (Ahern, 2007).

Escobedo et al. (2019) argue that interdisciplinary knowledge of urban ecosystems has evolved in recent decades, adopting a series of metaphors, such as green infrastructure and nature-based solutions, among others. We have adopted the concept of green infrastructure, as it is strongly linked to spatial standards (Ahern, 2007; Escobedo et al., 2019), since territorial planning is the premise of this article. It is also worth mentioning that "nature-based solution" has arisen as a new concept to cover the applications used to solve a series of urban and socio-political environmental problems (Dorst et al., 2019; Escobedo et al., 2019). Thus, it is worth noting that the concept of green infrastructure proposes planning and environmental design practices that incorporate components that articulate at different scales, ranging from urban lots to city-scale interventions (Tzoulas et al., 2007; Escobedo et al., 2019).

Therefore, for the guidelines summarized below, it is necessary to consider some aspects of the different scales that green infrastructure addresses. Yu and Padua (2006) developed a similar concept, the ecological infrastructure, according to which ecological services are delivered on three scales: large, medium, and small. Bonzi (2017) associates these scales in the following way: the macro scale deals with "green belts," types of land units that often shape urban areas and which, in this work, are

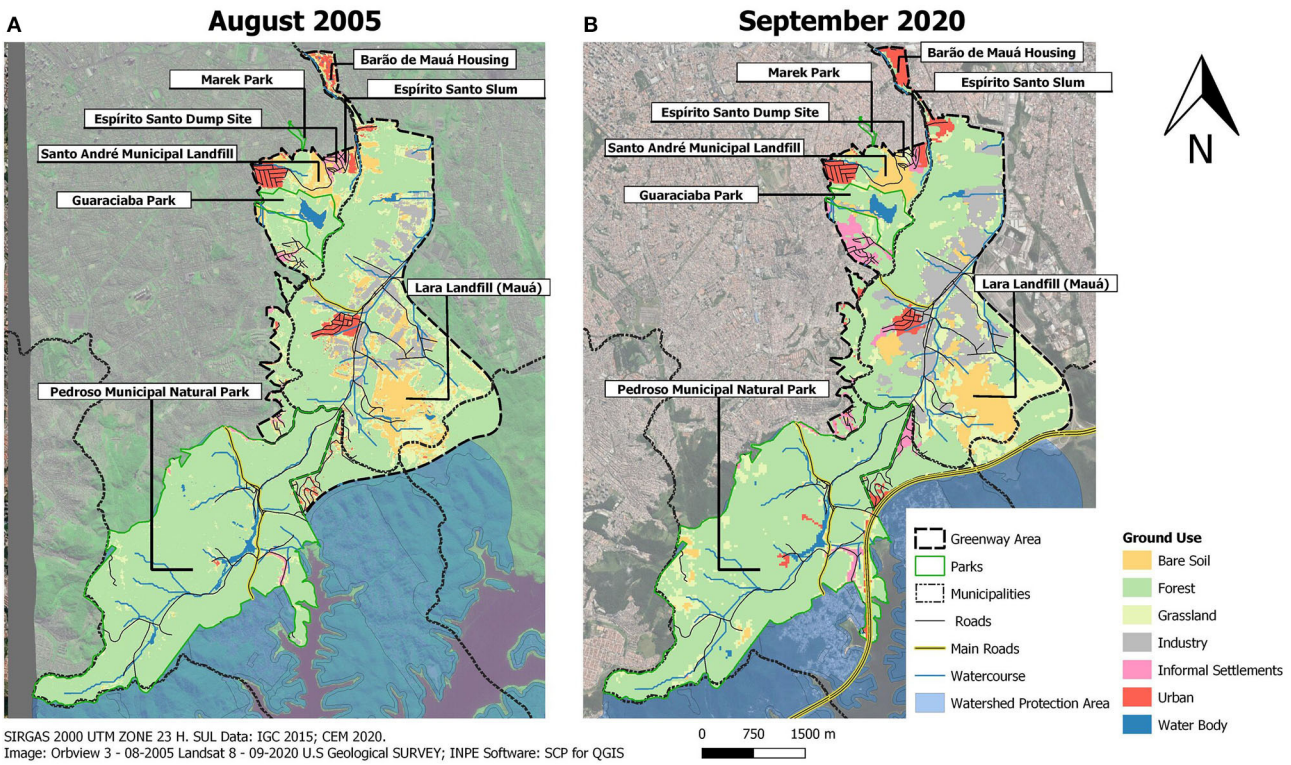

FIGURE 5 | (A) Greenway 2005 land use map (top left). **(B)** Greenway 2020 land use map (top right). The land use maps were made using free software from QGIS geotechnologies based on Landsat images from 2005 to 2020 from the Orbview-3 satellite (provided by the US Geological Survey Earth Resources Observation and Science -EROS- Canter). These maps were made by Beatriz Dunder (IEE-USP).

associated with watershed protected areas, large rural or peri-urban areas of agricultural production, and with conservation units (Brasil, 2000); the mesoscale, associated with types of green infrastructure such as street trees, riparian vegetation, constructed wetlands, stormwater ponds, and wildlife crossings; and the microscale, associated with bioswales, rain gardens, cisterns, and green roofs (Bonzi, 2017).

In this article, the Greenway is associated with the macroscale, which is, in the definition of Yu and Padua (2006), the level of the units that shape the limits of cities. For these authors, this pattern is linked to ecological networks, heritage corridors, and recreational corridors. These elements must be planned to take into consideration their own protection, but measures must be adopted to expand urban greening in the industrial district and residential neighborhoods in the Greenway. These structural elements are addressed in the following sections.

RECOMMENDATIONS

Keeping in mind the precepts mentioned above, we propose guidelines based on the land use map presented below.

Analyzing the land use map (**Figure 5**) and data obtained from previously mentioned reports (**Table 1**), we notice elements that reinforce the recommendation that this area becomes a greenway. The forest had the highest percentage of land use types (39%). If we add the park areas, forest, and grassland (5.8%), we have almost half (49.2%) of the greenway area covered by green spaces. The second-highest variety in land use is found in the industrial district (23.4%), and despite their impacts, landfills and dump sites make up just 12.9%. Residential districts served by urban infrastructure accounted for 7% and precarious (informal) settlements at 6%. The largest part of the forested land in the Greenway is in Mauá in the industrial district area.

Based on the different land uses identified in land use Map 1, we propose guidelines that follow the principles put forth by Yu and Padua (2006), Ahern (2007), and Bonzi (2017), as shown in **Table 1**.

For each type of urban element identified in **Table 1**, we provide detailed recommendations regarding its treatment.

- Dump sites and landfills

  Although landfills are the best option for MSW disposal, they also generate impacts on the land and need adequate treatment before, during, and after their operating life. Management is necessary after the closure. Thus, we put forward recommendations for both types of sites in these general guidelines; more specific approaches to each site will be detailed in future works. Regarding the COFAP dump site, it is necessary to investigate the adequacy of the use of this site as a housing area. In the absence of

TABLE 1 | Land use and possible guidelines to be adopted to consolidate the proposed urban greenway.

Urban elements	Size (hectares)	%	Guidelines
Residential neighborhoods	84.08	6.9	Small and medium-scale green infrastructure
Industrial districts	284.97	23.4	Small and medium-scale green infrastructure
Informal settlements	61.97	5.1	Small and medium-scale edible green infrastructure/ "green slum upgrading"
Landfills and dump sites	157.37	12.9	Medium and large-scale green infrastructure (phytoremediation)
Lakes	16.29	1.3	Medium-scale green infrastructure
Roads/highways	1.86	0.2	Medium-scale green infrastructure
Bare soils	10.34	0.9	Small and medium-scale green infrastructure
Atlantic forest (Native and exotic species)	474.40	39.0	Protection/reforestation
Grassland	70.62	5.8	Agroforestry/reforestation
Parks (not including PMNP)	54.10	4.4	Medium and large-scale green infrastructure
Total	1,207.79	100.00	

*Information about urban land use was obtained through a comparative land use survey between 2005 and 2020 carried out by Beatriz Dunder (**Figures 5A,B**) and data provided by the mentioned plans and reports (e.g., Santo André Landfill Environmental Impacts Study, Lara Waste-to-energy Environmental Impacts Study, PMNP Management Plan).*

data confirming the complete decontamination of this site, it is not possible to take a final position regarding its use. Phytoremediation is recommended for the Espírito Santo Dump. Although phytoremediation techniques are known as alternative or complementary methods to conventional methods, Nagendran et al. (2006) and Kirpichtchikova (2009) emphasize its versatility in application to different types of pollutants, combined with a low-cost treatment. Thus, it offers solutions to many related environmental problems, demonstrating its usefulness in waste management (Nagendran et al., 2006). For example, some studies of dumps and landfill treatment through phytoremediation have shown interesting results (Nagendran et al., 2006; Barros, 2017). The objective of these actions is to return this site to citizens as a public park, promoting the expansion of green coverage in Greenway. Therefore, it is necessary to consider the restoration of closed landfills. Santo André's landfill should cease operations within 5 years, and it is urgent to consider the project for its closure and measures to deal with it afterwards. In this case study, some research results demonstrate the potential for transforming closed landfills in parks (Do et al., 2014; Barros, 2017; Klenosky et al., 2017). The Lara Landfill will have a longer service life. Its area is larger than that of the Santo André landfill. It is also close to the limit of the Billings Basin. Part of its expansion area is in the environmental protection zone. Therefore, it is essential to prepare a macro zoning plan that follows the guidelines to be defined for dump sites and landfills to guarantee the connectivity of the PMNP area with other protection areas further south.

- Highways and roads

  The literature points to the possibility of implanting green corridors on their sides (Little, 1995; Ahern, 2007), which is a good way to utilize these open and unused spaces. However, it is necessary to develop studies for the implementation of wildlife crossing infrastructure (Ahern, 2007; Bonzi, 2017), especially in areas bordering the PMNP, the major conservation unit of this region. The Guaraciaba and Pedroso Parks' internal roads and Papa João XXIII Avenue should be studied as possible venues for the planting of street trees and the implementation of wildlife crossings, as well as other small-and intermediate-scale green infrastructure.
- Residential neighborhoods and industrial districts

  For these areas, it is necessary to develop guidelines for the implementation of small-and intermediate-scale green infrastructure components (Yu and Padua, 2006; Ahern, 2007; Bonzi, 2017). Examples include green roofs and walls, cisterns, bioswales (small scale), street trees, riparian vegetation, ponds, and constructed wetlands (intermediate scale).
- Informal settlements

  There are four slums in the Greenway: two within the city limits of Santo André, one within Mauá's limits, and the Vista Alegre/Sítio Cassaquera, the largest, which occupies areas between both cities. We do not address the slums to the south of the urban area of Santo André, to the north of the PMNP (Jardim Santo André), or to the south of the PMNP (watershed area), as these places lie outside the limits of the Greenway and thus will be evaluated later in our research. The resumption of slum urbanization must be a priority to afford the residents of risk areas, currently subject to floods and landslides, a safer and more dignified life. A survey performed in 2006 by the Housing Department of Santo André (Santo André, 2006) found that half of Vista Alegre slum residents lived in risk areas. Therefore, it is necessary to reallocate these families from hazardous places to new housing projects. However, it is necessary to update the information on precarious settlements collected through surveys from the housing departments of Mauá and Santo André. All available information is now outdated, at a time when the territorial expansion of informal settlements is notorious. The discussion of the expansion of the area of these settlements is based on satellite imagery obtained from Landsat 5 in 2020.
- Parks

  We recommend actions to promote forest restoration with native species and assess and control the quality of the edges of forest fragments, as well as the control of invasive exotic species. This means supplying green infrastructure to the buffer zones, especially in the green corridor and bordering areas. This is to be implemented in existing and future parks and in the buffer zones of the PMNP.

DISCUSSIONS

This manuscript sought to provide a review of urban greenway literature and outline general guidelines for the implementation of a heterogeneous greenway, which requires coordination between multiple neighboring municipalities. However, this proposal comes up against a decrease in public investments (performed to reduce the role of the State), a deep socio-economic crisis combined with a political crisis, and the erosion of fragile liberal democracies, especially in countries on the periphery of global capitalism such as Brazil (Dowbor, 2018). Because of this situation, this study indicates possible paths in the opposite direction of this trend, strengthening and improving public institutions to face the socio-environmental challenges posed. Momm-Schult et al. (2014), when analyzing Guaraciaba Park, denounced the disarticulation of the public sector, which has kept this park unusable by the population since its opening in 1992. This strengthening involves the resumption of medium-and long-term planning outlined by the Greater ABC Consortium, including an action plan to tackle climate change. It is necessary to implement the guidelines and actions established in the Greater ABC Action Plan in accordance with the strategies of Ahern (2007).

Another issue to be faced is the conservatism of institutions, both public and private, when dealing with emerging concepts in environmental planning and design, such as green infrastructure. We note that the structure of municipal administrations still depends upon twentieth-century engineering (Moura, 2017), which involves rules and procedures that must be revised. In addition, multidisciplinary teams of planners and engineers from different sectors of the local government are required to deal with green infrastructure plans and projects. However, given the complexity and extended timescale of green infrastructure, partnerships with researchers, NGOs, and social movements are essential. The participation of actors from different sectors of civil society is necessary because of the reduced predictability of results and the non-linear nature of green infrastructure projects (Ahern, 2013).

Paradigm changes are also necessary to manage the areas intended for preservation and restoration of the Atlantic Forest in this region. As most of it is found in the industrial district, it is necessary for this management to act on the borders of forested lots. In order for this to occur, it is important to promote urban greening in constructed areas such as industrial buildings and parking lots. The relevance and opportunities for improvement in the Greater ABC urban framework triggered by the preservation of the Atlantic Forest areas cannot be underestimated, as well as their threats, which we seek to summarize in **Table 2**.

This study focuses on Atlantic Forest coverage, but it does not ignore exotic species coverage, even though this represents a smaller fraction of the green areas we surveyed. The most widespread exotic species is eucalyptus (*Corymbia citriodora*). A praiseworthy example of forest management is an old farm, "Fazenda Tangará" (Tangará Farm), where a paint factory is located. There, we can find sites with coverage of native vegetation and areas covered with eucalyptus, that total 66.8 hectares. Forest management was carried out in this area in 2007, involving the replacement of exotic species with native ones in an area that totaled 38.42 hectares (FIESP, 2018). On the other hand, there is an undesirable example of forest treatment in private lots in Mauá involving the felling of 11.8 hectares of forest for the construction of a logistical warehouse at Maua's industrial hub (Martinez, 2018). Such findings are important because, in the preliminary survey carried out with land use maps (**Figure 5** and **Table 1**), we observed that the industrial districts of Mauá had the largest expansion in the period between 2005 and 2020 (a growth of 82.5%). On the other hand, there are few public spaces in the Greenway. Parks in areas along municipal boundaries are unexplored possibilities. Santo André had unfulfilled plans for a 4.85-hectares park on the banks of the Itrapoã (SEMASA, 2011). Our research found that if we used the Mauá side, with public and private lots, this area would increase to 15 hectares, including the old COFAP dump site.

We also observed a strong anthropic pressure on 318 hectares of the Santo André's portion of the Greenway. This is less than the observed expansion of the industrial district of Mauá. The areas with precarious settlements were concentrated mostly in Santo André, and they had a significant expansion (a growth of 282.6%); however, they only occupied 5.1% of the Greenway. Three of the slums listed in this research are located in Santo André and one in Mauá, and one, the largest, the Vista Alegre slum, has parts in both cities. Although they experienced the greatest expansion in this preliminary survey, they accounted for just over 20% of the industrial areas. For this study, satellite imagery from Landsat 2005 and 2020 was used. Although the cities of the Greater ABC have more than 30 years' experience of slum urbanization practices (Larangeira, 2003; Moretti et al., 2015), it is important that this institutional knowledge evolve toward "green slum urbanization," focusing on green infrastructure, food production, and mitigation of climate change effects. Therefore, research on new and better upgraded models must be conducted to address the different local situations found in the Global South. Adegun (2017) discusses the potential for improving the quality of life and the environment through urban green infrastructure from the perspective of informal settlements; there are some examples of urban greening for low-income settlements, including slum upgrades, in several cities in the Global South (Rocha, 2017, p. 248–254; Adegun, 2019; Caldas et al., 2021). These examples range from green roofs and community gardens and vivaria to the recovery of riparian corridors, slope reforestation, and other measures. Jerome (2017) argues that the development of green infrastructure at the community level presupposes the engagement of local groups that recognize its importance in addressing their pressing issues (e.g., ecological food systems).

Finally, the landfills and Espírito Santo dump site afford opportunities to expand the Greenway's vegetation and parks. The dump will be recovered and transformed into a small park of ∼1 hectares. On the other hand, the landfill in Santo André will be closed in 5 or 6 years. Therefore, according to studies by the Solid Waste Department of Santo André (SEMASA, 2003), it may offer a park with an area of up to 15 hectares. In relation

TABLE 2 | Summary table of opportunities and threats to the Greater ABC Greenway.

Urban Elements	Area (hectares)	Opportunities	Threats
Forest and Grassland	545.02	Forest cover that occupies half of the forests of Mauá, 11% of Ribeirão Pires and 6.5% of the Santo André forests. The bird survey shows more than 300 species close to the Santo André landfill, some at risk of extinction.	Between 2005 and 2020 this forest coverage (1207, 79 hectares and grassland, 70.62 hectares) decreased by 12.52%, mainly from the expansion of the industrial park, urbanized areas, highways (Rodoanel), and informal settlements.
Parks	54.1	The expansion of park areas and forest cover may be possible, with actions in areas along municipal boundaries. An example is the small strip of riparian vegetation on both sides of the Itrapoã Stream, which could become a park. This requires action by Santo André and Mauá making it possible to increase the parks' area to about 15 hectares.	There are only two parks in the Greenway, covering only 4.4% of the area.
Industrial District	284.97	Most of the forests are in the Mauá industrial district areas. One paint factory is carrying out forest management in an area equivalent to 12.25% of all Greenway Forest.	The second largest in extent, this land use showed a second major expansion between 2005 and 2020 (83.57%). There is clear industrial construction and equipment expansion with forest suppression, such as in Mauá in 2018 (11.2 hectares).
Informal Settlements	70.05	There are many experimental projects in several cities in the Global South that use green infrastructure, often edible green infrastructure. Despite many reference experiences, the Greater ABC region requires the development of this slum upgrading greening process.	Although informal settlements occupy a smaller area than landfills, industrial districts, and forests, they expanded the most between 2005 and 2020 (285.05%). This expansion occurred in areas susceptible to landslides and floods, such as springs, stream banks, and slopes.
Landfill and Dump site	157.37	After the closure of the Santo André landfill, scheduled in six years, a park of about 15 hectares can be created. The environmental licensing of the Santo André landfill expansions led to the reforestation of 3 hectares of Guaraciaba Park. There is also the Espírito Santo Dump, which will be recovered and can be transformed into a small park (1 hectares). With the Mauá waste-to-energy plant, the company will reforest 4.06 hectares. It would be important for this reforestation to take place in the Greenway area.	The landfill expansions and the construction of the Mauá waste-to-energy incineration plant in the PMNP buffer zone can generate serious impacts in environmentally sensitive areas. Although all dumps have been closed since the end of the twentieth century in Greater ABC, more studies are needed to locate smaller old dumps for proper recovery.

to Mauá, its landfill has a longer useful life; however, observing the environmental licensing of the incineration system, the company will reforest 4.06 hectares. From a planning perspective, it would be an advantage to use this reforestation process to improve the Greenway forest cover due to: (1) locally mitigate the effect of air pollution, (2) help to consolidate the area as a Greenway, and (3) it would improve the ecological benefits and ecosystem services provided by the Greenway for the local population.

Thus, we propose guidelines for protecting forests and developing and implementing urban greening. For that to happen, we must promote new research and develop and evaluate experimental projects (Ahern, 2013) to usher in the paradigm change that we suggest in this study. Another example is the need for the adoption of agroforestry processes and edible green infrastructure (Russo et al., 2017) in the Greenway.

It is important to keep in mind Ahern (2007) four planning strategies to develop new approaches to green infrastructure planning: (a) protective, aiming to act on the borders of PMNP and the large forest fragments in Mauá; (b) defensive, especially concerning the buffer zones; (c) offensive, with the restoration of the Espírito Santo Street dump site (the COFAP dump site remediation process is underway) and the recovery of degraded areas close to the parks; and (d) opportunistic, by means of the implementation of edible green infrastructure in informal settlements and the planting of trees alongside roads and avenues. Studies of forest fragments with the science of landscape ecology are examples of the application of these strategies. Thus, in this paper, we hope to encourage more discussions about the possible benefits of the application of the Climate Change Action Plan of the Greater ABC and the management plans for PMNP.

CONCLUSIONS

As discussed in this article, urban greenways have gained prominence among planning professionals and researchers as a way to promote urban greening and the ecological connectivity at a certain level of urban and non-urban forest fragments. When implemented in a context of heterogeneous urban land use, these greenways can provide multiple ecosystem services and functions. This heterogeneous land use runs from the PMNP to the northern region of the Itrapoã Stream in an old industrial dump site. It has many socio-environmental problems that can be mitigated by planning strategies for urban greenways. In this location, we indicate possible exits and environmental projects to restore the quality of water and soil, in addition to protecting the important areas covered by the Atlantic Forest in this region.

Our review showed some possible opportunities and benefits of consolidating an area that still has a large forest cover. The practical importance of urban greening processes in the southeastern metropolitan region of São Paulo is highlighted. The recommendations and discussion presented were based on previously institutional instruments (or municipal and regional plans) that indicate elements that are in tune with opportunities to expand green areas in three municipalities of the Greater ABC. In this manuscript we demonstrate the importance of structuring the urban and socio-ecological systems to contain anthropic expansion in the patterns of twentieth-century Latin American cities. Furthermore, this socio-ecological system structured in the proposed greenway could produce large amounts of ecosystem services essential for SPMR. In this sense, it is necessary that urban-environmental governance be strengthened regionally and that it act on several simultaneous socio-environmental fronts and across borders. The implementation of green infrastructure in informal settlements may support the evolution, through local parameters, of "slum upgrading" that will promote ecological and economic benefits for the region, in addition to expanding the total green coverage of the municipalities.

As demonstrated in the discussions, the political processes involved in promoting environmental justice (in the pursuit of equitable distribution of environmental goods) and mitigating the effects of climate change pose a challenge to environmental governance, especially in the Global South. The implementation of green infrastructure based on local needs has proven to be opportune, especially in metropolitan regions with high population density. It is a powerful tool for improving the quality of life, including the impoverished population. At the same time, it produces ecosystem services that benefit the general population of the municipality and, to a greater extent, the region.

We believe that this manuscript scientifically contributes to the study agenda on urban greenways, green infrastructure, and ecosystem-based adaptation, among other emerging concepts, in the Global South cities. In addition, it may sensitize and demonstrate to planners and decision makers involved in the Great ABC Consortium of the value of implementing green infrastructure solutions.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Urban River Interventions in São Paulo Municipality (Brazil): The Challenge of Ensuring Justice in Sociotechnical Transitions

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The paper aims to discuss the sociotechnical transitions regarding urban rivers policy in São Paulo Municipality by focusing on programs and projects conducted since 2000. Accordingly, we use a theoretical reflection on sociotechnical transitions and just transitions in interventions related to water and cities. Our work is based on a documental analysis of programs and projects for urban rivers in the municipality conducted *via* theoretical discussion. The primary focus is on the current sociotechnical regime, the channeling of streams and construction of road systems on its banks, and disputes and pressures brought by the technological landscape and niches, which lead to the construction of linear parks and leisure areas along with the bodies of water. It also shows how the issue of justice has been losing ground in this transition, which although is "in the making," already presents many factors of injustice. This is due to the low presence of the theme of precarious settlements, in innovative speeches and practices, and the different treatment given by the programs and projects for rivers in the consolidated middle- and upper-class regions and for those located on the peripheries.

Keywords: sociotechnical transitions, just transitions, urban rivers, São Paulo, inequalities

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INTRODUCTION

The paper aims to discuss the sociotechnical transitions in urban river policy in the Municipality of São Paulo by focusing on programs and projects carried out since 2000. The proposals for urban rivers from 2000 to the present have been representing an inflection over the standard practices of the 20th century; however, it has been done without continuity and with disruptions along with incomplete projects and interventions. Thus, the article analyzes the advances and barriers of this transition—as well as its characteristics—by considering the context of Brazil's largest city. Furthermore, it contributes to the theoretical debate on sociotechnical transitions to water management-related infrastructures and the debate on transitions in the cities of peripheral countries.

São Paulo is located in the headwaters of the Tietê River Basin. The site has a complex hydrological network, with more than ∼1,500 km of small streams arranged in a dense dendritic form. In urban areas, it is possible to find closed as well as open-channeled rivers, but notably, rivers running almost naturally through precarious settlements are the prevalent ones. Less common, but also present, are some river parks, which are called linear parks.

Historically, the urban rivers' margins in São Paulo City have been used to provide space for avenues and transportation infrastructure. The debates on the urbanization of river valleys at the beginning of the 20th century have resulted in a paradigm that associates the construction of avenues with the channeling of streams. First, this binomial was part of a structural avenue's plans, but later, especially after 1970, it became part of urban improvement programs. Yet, flooding and water degradation problems were not solved by these interventions.

Since the 1980s, this paradigm has been questioned by a wide range of researchers, environmentalists, and technicians from the city hall. This resulted in the beginning of a sociotechnical transition, with the widening of institutions and actors who think and propose these policies, programs, and interventions in the floodplains and rivers. This effort has considered new perspectives on technologies, especially ones aiming to build a different relationship between the rivers and the city through the proposal of projects and elements that can be configured as green infrastructure. But, by the middle of the last decade, it had lost its force in public policies and things quickly went back to the old paradigm.

As a theoretical basis for the case being studied, the use of the transition literature is relevant to shed light on how certain paradigms, ideas, and proposals associated with sustainability are (or are not) implemented (Markard et al., 2020). In a political technical naïve view, sustainability is not achieved by a lack of understanding of the long-term economic and collective benefits. Hence, the efforts to the present, at each new regulatory framework or international platform (e.g., climate change), there are new conceptual approaches, instruments, and techniques suggested with the hope of changing the path dependence. However, the non-implementation is due to—among other factors—a web of interests and resistance associated with a political context (interests of groups and actors) and also to a sociotechnical panorama making it difficult to deviate from mainstream practice (Geels and Schot, 2007). Considering climate change as a driver, the transition literature has been mainly incorporated to the theme of energy, but not so much with regard to water (García Soler et al., 2018).

Moreover, the use of this literature also has limits, one of which comes from its European origin and the great difference between the context in which it was developed and the reality of countries like Brazil. Another limitation, still associated with the first, involves environmental justice, or how these changes in the patterns of infrastructure and planning mainly occur in valued areas and drive inequality and gentrification. In this sense, it is important to put together sociotechnical transition and just transition literature and to confront both with case studies in peripheral countries.

The methodology is organized on the two following main bases: first, the literature review was conducted on sociotechnical transition and the sociotechnical transition associated with drainage infrastructures. Then, another specific review was conducted on just transition, which also covered texts that relate sociotechnical transition to a broader concept of justice. The reviews are based on the Scopus platform searching; also, the selection of the bibliography used was made by content and narrative adherence. At this moment, it is appropriate to point out that this last review was not intended to cover the whole debate on environmental justice, but rather how the idea of justice has been understood within the analyses concerning transition. The theme of Just Transition is still little covered in the literature; thus, this paper also seeks to contribute to this dimension of transitions.

The discussion on the sociotechnical transition in the policies for urban rivers in the city of São Paulo was mainly based on documental analysis, and it is detailed in section Material and Methods of this paper.

Structurally, the paper is organized into four parts besides this introduction. First, the theoretical basis is organized into two parts: terms and concepts from the founding literature of transitions and urban waters and the theme of just transitions. Then, in section Material and Methods, we detail the documents used and how they were searched and analyzed. Finally, we present and discuss the results. First the spatial configurations of urban rivers in the city are briefly presented, finally leading to the detailing of the policies, programs, and projects for urban rivers throughout the 21st century. The article shows that there is a sociotechnical transition "in the making" with some results in changes in the way of thinking and intervening in urban rivers, but these practices do not expressively consider a fair distribution in the city. The maintenance of this new trajectory should contribute to maintaining and even increasing the deep spatial inequality that exists.

TRANSITIONS, CITIES, AND WATER

The term "transition" has been gaining ground in plans and policies related to sustainability. In the academic field, the term "sociotechnical transitions" emerged in the early 2000s in innovation studies (Newell and Mulvaney, 2013; Geels, 2019). Specifically, Geels and Schot (2007) define transitions as changes from one sociotechnical regime to another. "The sociotechnical regime concept accommodates this broader community of social groups and their alignment of activities" (Geels and Schot, 2007, p. 399). This refers to deep structural changes in systems such as energy "that involve long-term and complex reconfigurations of landscapes with technology, policy, infrastructure, scientific knowledge, and social and cultural practices toward sustainable ends" (Newell and Mulvaney, 2013, p. 133).

The Multi-Level Perspective (MLP) is a framework (Geels and Schot, 2007; Geels, 2019) used to understand the process of innovation and sociotechnical transition on an interrelated three-level framework of landscape (macro), regime (meso), and niche (micro) (Hodson and Marvin, 2010). Landscape level refers to pressure and driving forces in a broader context that do or do not create conditions to innovations and affect; accordingly, it is affected by the forces from the regimes and niches. For Geels and Schot (2007, p. 400) "changes at the landscape level usually take place slowly (decades)." Regarding niches, these authors point out that "Technological niches from the micro-level where radical novelties emerge. These novelties are initially unstable sociotechnical configurations with low performance.

Niche-innovations are carried and developed by small networks of dedicated actors, often outsiders or fringe actors." (Geels and Schot, 2007, p. 400). Although the three levels are closely related, there is a debate as to whether innovations necessarily emerge from niches or whether they are a response to landscape and regime pressures from an adaptive perspective (Hodson and Marvin, 2010).

Another important point is the role of places for transitions, especially that of cities in urban sociotechnical transitions (Hodson and Marvin, 2010; García Soler et al., 2018). "A series of economic, ecological, population and institutional constraints have produced new challenges and pressures on urban growth and to the management of cities' critical infrastructures." (Hodson and Marvin, 2010, p. 477). These authors point out that evaluating urban transition also involves considering that it is intertwined with a web of networks, and therefore, we must consider various scales of governance or multilevel governance.

The work of Hodson and Marvin (2010) addresses the role of cities and socio-technical transitions. Between 2006 and 2009, they analyzed London, New York, Tokyo, San Francisco, and Melbourne and concluded that there is evidence, in these large cities, of deliberate attempts to reconfigure the sociotechnical systems in the proposals and implementation of infrastructure. For these authors "in a period of resource constraint and climate change, the world's largest cities are beginning to translate their strategic concern about their ability to guarantee resources into strategies designed to reshape the city and its relations with resources and other spaces" (p. 478). However, they highlight the context of disputes over urban territorial priorities in which political elites seek to gain degrees of control over the organization and management of energy, water, waste, and transportation infrastructures. This aspect develops in what will be discussed below about just transitions. In addition to intranational inequalities, Hodson and Marvin (2010) point to the necessary research efforts that "engage with transitions in cities outside of premium world cities and examine what transitions look like in ordinary cities and cities of the global south." This is an aspect that will be, in an exploratory way, developed in the case of São Paulo (Brazil).

The work of García Soler et al. (2018) involves a long-term analysis of the policies and projects implemented to promote rainwater harvesting in Berlin. Subsequently, it is a contribution to the theme of transitions and urban waters. They reason about the need for exploring the topic of how the city is molded by the transitions. The authors "used the Berlin experience to challenge conventional models of linear transition pathways and sensitize scholars to the messiness of urban water management trajectories, which can involve reversals, diversions and sudden leaps" (García Soler et al., 2018, p. 105).

In Brazil, much of the literature on macro and micro drainage has an approach that disregards these elements and focuses on *stricto sensu* aspects of the components of hydrology and their scientific expressions. Even from an integrated water and sanitation management perspective, and the regulatory frameworks of the last decade of the last century and the first of this century, there is still a focus on sectoral and technical approaches as responses to problems in this field. It is common to find terms like "lack of [urban or metropolitan] planning" to justify countless factors that hinder and even prevent more advanced solutions from being implemented. In contrast, the growing literature on green infrastructure, solutions based on nature, and those linked to social actions such as civic ecology and insurgents have brought new possibilities to the theme—but still without the proper scale and scope (Momm et al., 2020), as we will see in the case studied.

JUST TRANSITION

The analysis of the sociotechnical transition must be accompanied by the following key issue in peripheral and extremely unequal countries: justice. Routledge et al. (2018) understand that the possibilities of guaranteeing sustainable and fair futures fail because the essential resources and the production of knowledge are managed by elites in sociotechnical regimes committed to maintaining the status quo.

If it is climate change that pressures the transition, these same authors deeply criticize the guidelines developed at the Paris Conference, as they understand that they are based on neoliberal foundations of governance, since it does not address inequalities and does not confront issues of interest to the private sector, like free markets, and are also quite restricted to the possibilities of each nation-state. Thus, they understand that such goals do not address policies to reduce inequality which between nations and even within them results in an unequal distribution of vulnerabilities and possibilities to deal with climate change, including in terms of political participation. In extremely unequal countries, these dimensions of inequality occur within the same city (Canil et al., 2020; Torres et al., 2020). Although inequality can lead to social participation in the construction of public policies, analyzing the relationship between participation and inequality complex (Gaventa and Martorano, 2016), through the outcomes it is possible to highlight the maintenance of inequalities. In other words, inequality of participation contributes to the construction of unequal policies.

Newell and Mulvaney (2013) agree with the hole of the elites in shaping the policies to their interest, especially because the political economy of global environmental justice is characterized by uneven power relations, conflict, and often violence. Also, the interests of global elites are more often than not misaligned with the needs and environmental vulnerabilities of the world's poorest people. In this context, they intend to "emphasize the ways in which uneven exposure to environmental benefits and harm is often not accidental and unintentional, but rather a product of a particular way of organizing production and its constitutive social relations" (Newell and Mulvaney, 2013, p. 133).

Then, there is the term "transition," which has been increasingly used in public plans and policies related to a low-carbon economy. It needs to be extended to a broader sustainability perspective and accomplished by the term, justice. To Newell and Mulvaney (2013), there is an increasing recognition that the politics of transition have to ensure that

the proposed policies are socially just and that they address environmental inequalities in terms of exposure to localized degradation. Furthermore, the actions taken to alleviate global or regional environmental threats cannot reproduce the inequalities at local levels.

Heffron and McCauley (2018) debate the concept of a just transition, to put together these three existing justice approaches in the literature: energy justice, climate justice, and environmental justice. They consider that there is a distortion, especially in the traditional economic literature, on the attempts of achieving a just transition within societies in time and space. They argue that justice needs a global and human rights perspective, rather than a local and civil rights one, and the just transition concept has the advantage to engage all three justice stakeholders—especially in overcoming inequalities. Also, the authors build the "Just Framework" to be applied to just transition. In this framework, they proposed the four dimensions of Justice, Universal, Space, and Time. The first recovers the three types of justice: distributional, procedural, and restorative; Universal deals with recognition and cosmopolitanism; Space focuses on the places where the events are happening; last but not least, Time brings the horizons to transition, short, medium, or long-term. Specifically, the idea is to combat the status quo in research and practice (Heffron and McCauley, 2018).

Similarly, Fitzgibbons and Mitchell (2019) argue that recognition, redistribution, and participation are three essential dimensions of justice in planning processes and outcomes. Through them, they propose an analysis of the Rockefeller Foundation's 100 Resilient Cities initiative using two broad dimensions: Open Process and Recognitional and Distributive Justice. They discovered that "resilience thinking, in practice, supports the status quo." The reason is that, in the first place, the overcoming of the structural inequalities is not considered in the program or the majority of the proposals received. So, these three main issues are linked to the dimension mentioned: the concentration of experiences in cities in central countries; the insufficient space for communities to participate in decisions linked to projects; and the existence of acts of omission and commission, established from another important work that analyzes adaptation plans, by Anguelovski et al. (2016).

The categories of acts of omission and acts of commission are important references to assess the relationship between resilience and environmental justice and can be mobilized to sociotechnical transition issues. Based on reading that many of the adaptation plans increased social inequalities, Anguelovski et al. (2016) sought to establish categories that report the dimensions of the plans and their resulting inequality. They are classified as acts of omission when inequality is caused indirectly, for example, when there is a choice to prioritize richer communities for the implementation of infrastructure or when the poorest part of a given community is not engaged in the construction of proposals. The acts of commission result from a direct action of the plan, which produces or reproduces inequalities. An example of one of these equalities is removal actions, the relocation to places in worse urban conditions, or even the gentrification processes generated by the development of infrastructure.

It is possible to summarize these dimensions by the 5 W's proposed by Meerow and Newell (2016) to put in the center of the agenda the recognition of politicized decisions, scalar dimensions, and trade-offs of resilience plans which leads to the analysis of justice within them. Between other questions, they inquired about the following: who defines and who is excluded by the plans; what sectors and networks are included and what disturbances are focused; regarding the "when" questions, if the plans have short- or long-term horizons; where is the resilience prioritized and if this focus undermined the resilience elsewhere; and why were some goals defined to resilience plans.

Finally, we highlight that regarding the lack of investments in infrastructure in the cities of peripheral countries, the State has a fundamental role to play in the transition, but also it has a fundamental role to play in just transition. Routledge et al. (2018, p. 79) claim that the state is "a continued terrain of possibility for positive social, economic, and environmental change, noting the imperative of historically attentive state-enabled redistribution along persistent axes of difference." This emphasizes the large cities where strategic transition projects can be held by supportive state actors and civil society groups (Routledge et al., 2018).

MATERIALS AND METHODS

The methodology that was utilized for the empirical analysis was documental research. Certain documents were gathered which covered over 25 years of research—including master and doctoral researches—and are detailed in the academic presentation (Travassos, 2004, 2010). It consisted of a historical retrieval of speeches, plans, programs, and projects related to urban rivers in the Municipality of São Paulo. The speeches were collected in specialized magazines and newspapers (e.g., *Revista de Engenharia or Construção São Paulo*) or of wider circulation, from the collection of the newspaper *O Estado de São Paulo*. From articles and reports, it was possible to analyze how the experts and the public opinion considered what should be done with São Paulo's rivers. The second set of documents were the plans, programs, and projects existing in the collections of the main public agencies that planned and intervened in urban rivers. At the municipal level, the documents were consulted in the secretariats that are now called the Municipal Secretariat of Urban Infrastructure and the Municipal Secretariat of Urban Planning and Licensing. At the state level, and with special emphasis on the post-1970s period, at the now-extinct São Paulo Metropolitan Planning Company, Emplasa, there was a wealth of documentation on the urban drainage problems of the Upper Tietê River Basin and debates on possible solutions. The analysis emphasized the Master Plan concerning drainage and linear parks projects; moreover, it also relied on texts that analyze specific aspects of these policies. Extensive documentation was also gathered from the Central Library of the Polytechnic School and the School of Architecture and Urbanism of the University of São Paulo, which keep archives of many urban and sanitation plans. The first one is concentrated on information, especially up to the 1930s and 1940s; the second one is focused on posterior documents.

All documents were read thoroughly, and we extracted information from them concerning the actors, institutions,

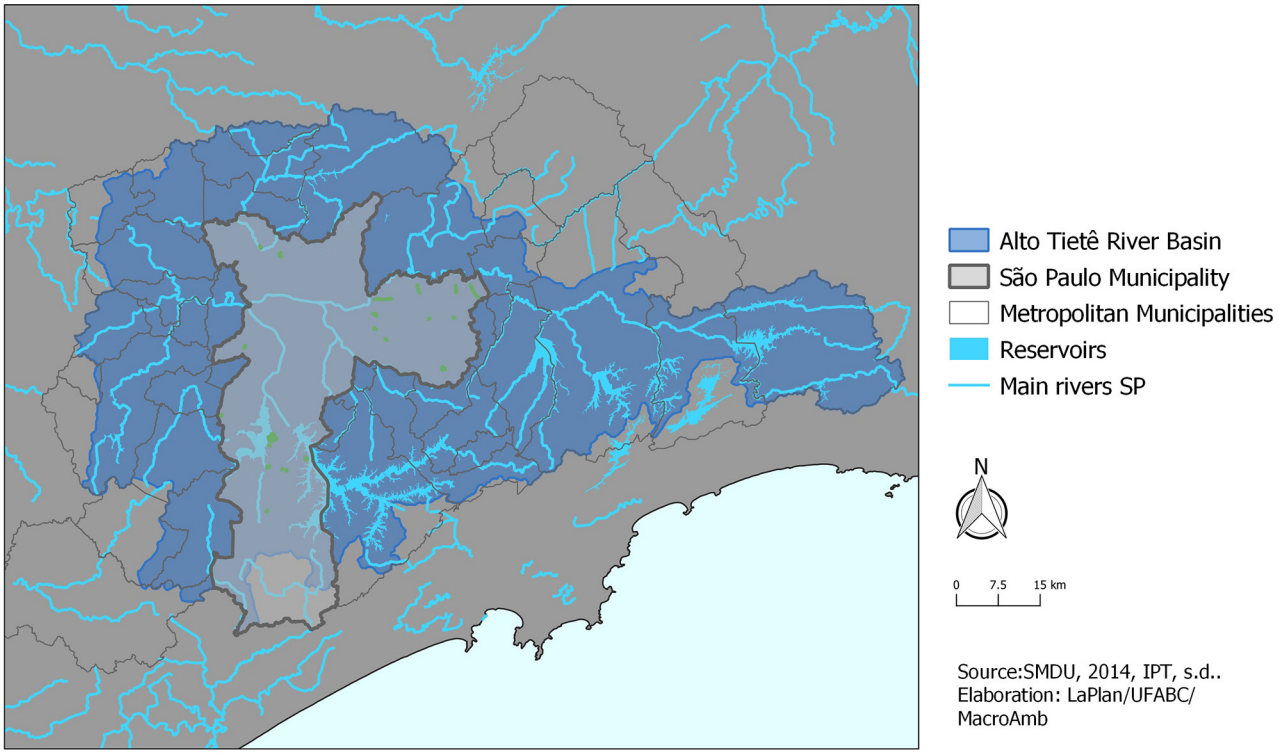

FIGURE 1 | São Paulo municipality at Alto Tietê River basin.

discourses, and proposals for urban rivers, as well as prioritized rivers and watersheds. From there, it was possible to understand the consolidation, permanence, and rupture of intervention practices in urban rivers and to establish three important moments of the constitution of sociotechnical regimes. The first, established around the 1930s, was configured by the canalization of streams and the construction of valley bottom avenues. This was done *via* projects that comprised road plans for the city. The second, starting in the mid-1970s, still repeats the pattern of valley bottom avenues and open or gallery canalization—now disconnected from road plans—composing improvement programs; thus, where there was a stream, it would be canalized and would give way to a road. The third period, on which this article is focused, is configured by the questioning of this binomial: stream canalization and construction of valley bottom avenues, which gives rise to other forms of intervention and the growth of the debate on linear parks and the renaturalization or recovery of waterways.

This documental analysis was combined with a reflexive practice from the authors, mainly in the urban drainage plans of the São Paulo Municipality, during the years 2013 through 2014 and at the Alto Tiete River Basin Committee since 2017.

For the last years, documents from the websites of the municipal government (for the amount and typology of ongoing and recently completed works) and state government, especially the page of the Novo Rio Pinheiros project and the Sanitation Company of the State of São Paulo, Sabesp, were used. We also conducted a brief survey on news portals using Google's advanced search machine, to verify the presence of urban rivers and the most commonly cited problems, in order to understand if and how the topic has grown in recent years, with a special focus on discourses about channeled gallery rivers. A similar search on Google Scholar was used to confront the criticism that has been made about São Paulo's urban rivers, focusing on the observation of the discourse about the gallery-channeled rivers in relation to the peripheries. For the present paper, some important documents that represent the changes and continuities of the regime were selected.

URBAN RIVERS IN SÃO PAULO

The São Paulo Municipality is the capital of the State and the Metropolitan Region of São Paulo. It has an area of 1.5 km^2, an urban area that occupies two-thirds of it, and a population of 12.3 million people. Despite having the highest GDP per capita in Brazil, about 31% of its inhabitants live on an income below half a minimum monthly wage, an amount equivalent to <$100 per capita, according to data from March 2021. Among urban households, only 50.3% have adequate urbanization infrastructure, such as drainage and paving (Instituto Brasileiro de Geografia e Estatística., 2021).

São Paulo is located in the vicinity of the spring of its main water body, the Tietê River, a destination of the vast majority of water bodies in its territory. There is an exception

FIGURE 2 | Bibi stream channeled into closed galleries at July 9th Avenue (by the authors).

FIGURE 3 | Inhumas stream at Arraias do Araguaia Avenue (by the authors).

FIGURE 4 | Linear park at Itaim stream (by the authors).

regarding a small stretch of the basin, at the southern end, which flows into the ocean (**Figure 1**). During its passage through the city, this river and also its main tributary, the Rio Pinheiros, present a very low slope, which means that, in its natural structure, forms a series of meanders and occupies an enormous floodplain, which was gradually occupied while the rivers were being rectified. However, their tributary rivers have greater energy. They are configured in small watersheds, with greater slopes and a great amplitude between the base and flood flows, thus forming a dense dendritic network of small streams. These differences are fundamental to understanding the drainage node in the city, as floods configured as flash floods have always characterized the processes of rising water and drainage plans and projects over time. So, instead of mitigating this situation, they have intensified it.

In the São Paulo Municipality, there are currently four spatial configurations of urban rivers. These configurations are closely related to the time frame of public policies throughout the 20th and early 21st centuries, as shown by Travassos (2004, 2010). Notably, rivers channeled into closed galleries are the oldest of them, the result of a practice that was established in the 1930s and lasted for about 50 years (**Figure 2**). During those decades, the covering of rivers was required by the population and supported by the logic present in sanitation and road engineering. Thus, it was a practice that, in the view of that particular time, made it possible to clean up the city and represented an opportunity to support the construction of the structural system of avenues. Newspaper reports (Porchat, 1920; Prado, 1936; Estado de São Paulo, 1962, 1984; A Construção São Paulo, 1972), urban plans and drainage programs (Maia, 1929; São Paulo (Municipality), 1958, 1969), and articles in scientific engineering journals (Maia and Cintra, 1924), not only in São Paulo, contributed to the construction of a sociotechnical regime supported by this binomial, reflecting a sociotechnical landscape around the world.

In the 1980s, with the growth of drainage problems and the incorporation of environmental debates into the production of urban space, the model underwent its first change, with the guideline of no longer building closed galleries, but making open channels (**Figure 3**). Here, although the sociotechnical regime has adjusted to the speeches and even incorporated new actors, it has not changed. The presence of large resources and the creation of specific lines of financing for drainage (Jorge, 1987) accelerate the implementation of interventions, but, at that moment, alongside the permanence of the avenues in the floodplains, there was no longer a relationship between them and the structural road plans. Therefore, wherever there was a stream, it was considered an opportunity to build an avenue (Travassos, 2004). In the 1970s and 1980s, much of the streams in the oldest urbanization area were channeled (São Paulo (Municipality), Geprocav, (n.d.); São Paulo (Municipality), EMURB, COGEP, COPLASA, 1974; São Paulo (Municipality), Sempla, 1982), in both forms, open and closed. In this sense,

FIGURE 5 | Precarious settlement at Corumbé stream (by the authors).

although the sociotechnical landscape was changing, especially at the international level, it was still not enough to cause changes in the sociotechnical regime. However, it started to create conditions for the emergence of some sociotechnical niches, as will be further presented in this paper in more detail.

Thus, the open channeling with the construction of valley-bottom avenues remained as a hegemonic discourse and practice until the beginning of this century. Then, the Executive Group of the Program of Canalization of Streams, Implementation of Roads, and Environmental and Social Recovery of Valley-bottoms (GEPROCAV) was quietly dismantled. This particular sector of the Secretariat of Urban Infrastructure was responsible for maintaining the sociotechnical regime in the Municipality since the 1980s.

At that moment, because of the changes brought about by the Strategic Master Plan of 2002 (Municipal Law No. 13,430), which instituted the Environmental Recovery Program for Water Courses and Valley-bottoms, the debate on the construction of linear parks began to gain traction. In conjunction with the Regional Master Plan of 2004, 146 linear parks bordering the water network were proposed (Silva-Sánchez and Jacobi, 2012; São Paulo (Municipality), 2020). The strengthening of the Secretariat of the Environment (SVMA) in the mid-2000s was also fundamental for the discourse on the recovery of rivers and streams to gain political space. In 2006, a working group was created under its management to operationalize the implementation of linear parks (Ordinance SVMA 75/2006). Around 25 linear parks were implemented, with most of them occurring between the end of the 2000s and the beginning of the 2010s. Notably, the number of parks is slightly higher as there are parks that are not managed by the SVMA (**Figure 4**) (Travassos, 2010; Silva-Sánchez and Jacobi, 2012).

Despite the promising data, it is necessary to point out two issues. The first one is that most of the urban rivers that have received public interventions since the beginning of the 20th century are in the first two spatial configurations. That is, where there was a public policy, the main result was the one recommended by the sociotechnical regime in force. After it arrived in mid-2010, the implementation of new linear parks, which can be characterized as a sociotechnical niche, dropped dramatically.

Furthermore, it should be noted that the fourth spatial configuration—rivers that cross precarious settlements (slums or favelas)—is the most serious in the São Paulo Municipality. This configuration is abundantly present in the peripheries, in spaces that have never been the subject of public urbanization policies. Thus, there are hundreds of kilometers of urban rivers that have not received any type of treatment of their beds or banks which then has created serious risks for the population that lives there (**Figure 5**).

The presence of rivers in precarious settlements on the peripheries already indicates that these historical regimes of intervention have specific spatialities. Specific spatialities, in the context of inequality in Brazilian cities, also mean that different social classes have, in their neighborhoods, different configurations and degrees of infrastructure—which includes the treatment of rivers and streams. In the São Paulo Municipality, the gallery system under the roads is mostly in the middle- and upper-class neighborhoods (**Figure 6**).

The transition in discourses should also not lead to the false idea that open and closed channeling associated with new or existing road systems are not being carried out in the Municipality. The data collected for this article show that the amount of these interventions is much higher than the implementation of linear parks and continues to be the model for urbanization. On the other hand, in the most central areas, there is a growing clamor for the ecological restoration of rivers and streams. There is also a construction of a false discourse that establishes that the totality of the city's watercourses is buried or that these are the main issues presently related to the urban rivers, thus giving rise to the prioritization of plans and projects of "renaturalization" (Brocaneli and Stuermer, 2008; Viana, 2014; Algodoal, 2019; Conselho Municipal do Meio Ambiente e Desenvolvimento Sustentável – CADES, 2019; Ribeiro, 2020), which happen to be concentrated in the central areas of the city.

"In the Making" Transition

To show two points, we can discuss some quantitative aspects and the three levels of the MLP that are a consequence of the programs and projects of each river spatial configuration in São Paulo. The first one is that the sociotechnical transition is "in the making" and currently the sociotechnical regime of the last century seems to have resumed the hegemony in the definition of actions. At the same time, external forces and pressures—especially from the environmental global platforms—have been increasing the conditions for establishing new policies and initiatives, such as the 1992 Rio Declaration and Agenda 21. Despite the neoliberal policies of the period with budget restrictions and privatizations, the Federal Constitution of 1988 and the regulatory frameworks that would come next regarding planning and the environment have established an outline of principles and instruments. These items have created suitable conditions so that agents from niches (micro-level), organizations, the academy, and the government could propose innovations to processes and projects. Then, at the end of

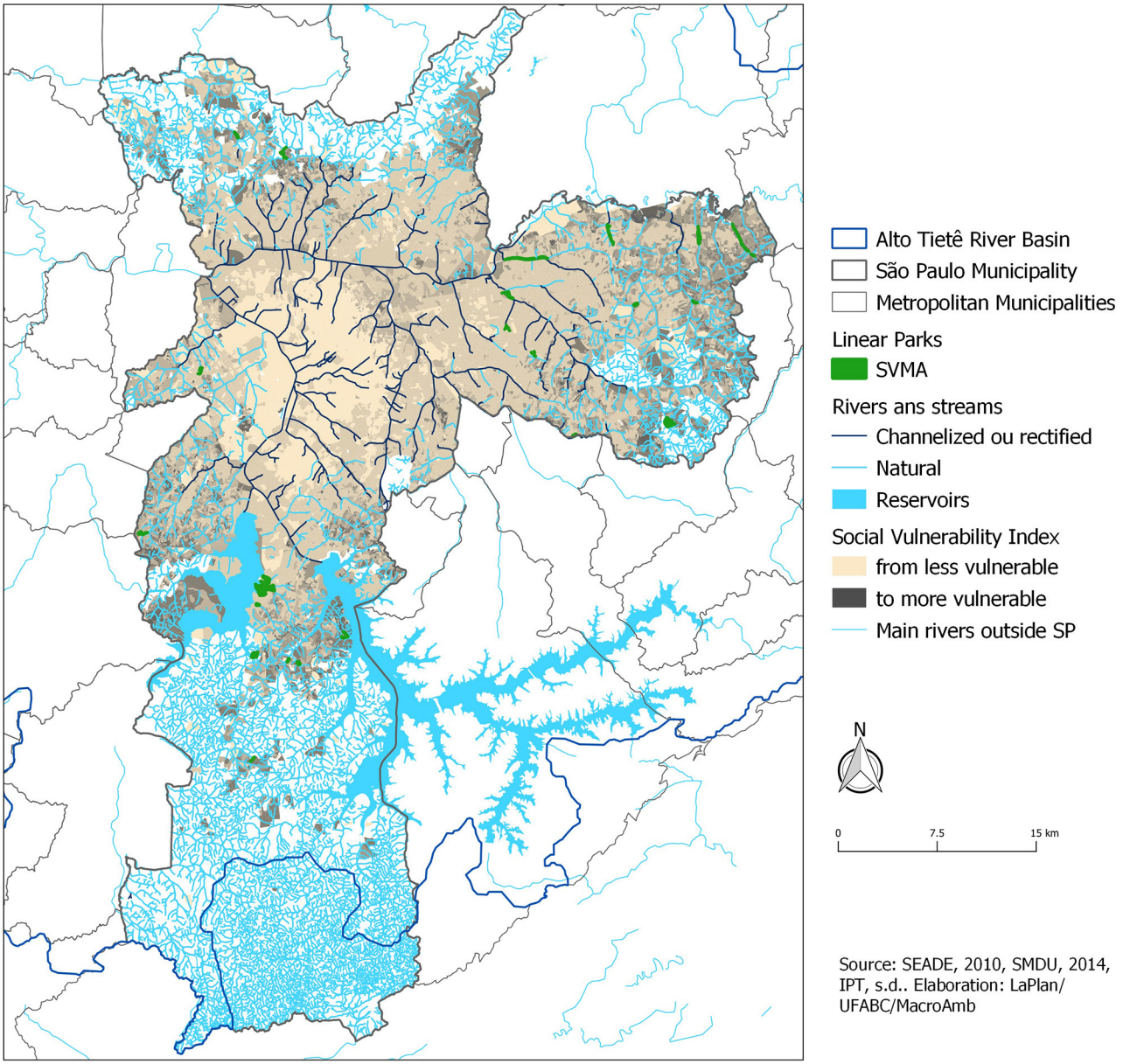

FIGURE 6 | Urban rivers and vulnerability at São Paulo municipality.

the 2000s, there were conditions for a just transition, but its trajectory had not been linear, as one can see in the upcoming table (**Table 1**). It summarizes plans, programs, and projects and characterizes a transition process that is not completed yet. The non-completeness is configured in summary by the notable presence of new proposals that have been poorly implemented or even not implemented at all. There is a relation between the typology of interventions (in bold, third column), for example, canalization vs. comprehensive and the level of implementation.

Also, the contours of the current transition discourse fail to recognize the main challenge of environmental and spatial conditions and justice, which is the prioritization of innovations in the peripheries. So, while the agenda for a new relationship between rivers and the city has won, it has failed to challenge the *status quo* of urban inequality, water degradation, and the jeopardizing of ecosystem services.

At the beginning of the 21st century, under the implementation of the second stage of the Program for Canalization of Streams and Environmental and Social Recovery of Valley-bottoms (Procav II), which had begun in 1993, the standard intervention had been the majority. Its previous stage, Procav I, 1987, echoed the paradigm established throughout that century, the channeling of streams, and the construction of avenues on its banks, and was managed by the then Secretariat

TABLE 1 | Main intervention proposals to urban rivers and associated sociotechnological regime or niche experience.

Period	Plan, program, or project that addressed river intervention	Regime or niche	River intervention goals	River intervention situation
1987–1992	PROCAV I	Valley bottom avenues (regime)	Closed **canalization** of streams and construction of valley bottom avenues	Implemented
1988	Tiquatira intervention	Linear park (Niche)	Open **canalization** and construction of a linear park and valley bottom avenue	Implemented
1989–1992	Debates conducted to a new phase of PROCAV	Valley bottom avenues (regime)	**Comprehensive projects** to streams and valley bottom	Not implemented
1993–2004	PROCAV II	Valley bottom avenues (regime)	Open **canalization** and construction of valley bottom avenues Precarious settlements **reallocation** Environmental **protection** and education	Implemented
2002–2013	Strategic Master Plan for the São Paulo Municipality (Municipal Law No. 13,430)	Green infrastructure (regime transition)	**Linear parks** and green corridors	Partially implemented
2007–2010	Córrego Limpo Program (1st and 2nd phases)	Green infrastructure (regime transition)	Stream **cleanup**	Partially implemented
2008–2012	100 Parks Program for São Paulo	Green infrastructure (regime transition)	**Linear parks** and green corridors (following the Strategic Master Plan)	Partially implemented
2014 to present	Strategic Master Plan for the São Paulo Municipality (Municipal Law No. 16,050)	Green infrastructure (regime transition)	**Linear parks**	Not implemented
2016 to present	São Paulo Municipal Stormwater Management Plan - PMAPSP	Green infrastructure (regime transition)	Reduction of flood risks in six watersheds, with the implementation of some **linear parks**	Not implemented
2017 to present	Córrego Limpo Program (3rd phase)	Green infrastructure (regime transition)	Stream **cleanup**	Being implemented
2019 to present	Novo Rio Pinheiros Program	Green infrastructure (regime transition)	**Revitalization** of the river with reduced sewage discharge, improved conditions for aquatic life, and environmental and landscape recovery of its surroundings.	Being implemented

Bold terms represent the main intervention proposed to the rivers.

of Public Roads through its executive group, GEPROCAV. At that time, the program was financed by the Inter-American Development Bank, IDB, which replaced the federal drainage financing lines that existed during the dictatorial period (Travassos, 2004). Nevertheless, between the projects in Procav I, there was the formation of a sociotechnical niche, and a unique and isolated experience undertaken until that moment, which was the construction of a linear park along the Tiquatira River in 1988. The project had been exclusively designed by technicians from municipal and state bodies, without centrality in the sociotechnical regime, who can be considered as fringe actors (São Paulo (State), SOMA, Cetesb, DAEE, 1984).

Between 1989 and 1992, with the implementation of Procav I in progress, a new phase for the program began to be discussed under the progressive management of Mayor Luiza Erundina from the Workers Party. Subsequently, the name of the program was changed to "Program for the Environmental and Social Recovery of Valley Bottoms in the São Paulo Municipality." There was the idea of elaborating comprehensive projects in which the treatment of valley bottoms did not initially presuppose the construction of roads on the stream banks. Accordingly, this would allow the treatment of a larger number of watersheds with the same investment of resources (São Paulo (Municipality), Câmara Municipal, Comissão Especial de Estudos Sobre Enchentes, 1995). In addition, it could lead to the diversification of spatial results. However, in 1993, the engineer, Paulo Maluf, a right-wing politician with strong relationships with urban infrastructure entrepreneurs, was elected as mayor, and the road system was once again prioritized.

Yet, the dominant sociotechnical regime of valley-bottom avenues has not changed. At that time, Procav II presented two important inflections regarding the first stage of the program, which can be characterized as a predevelopment phase of a sociotechnical transition. The first of these inflections was institutional, with the insertion of the Secretariats of Housing (SEHAB) and of the Environment (SVMA) in GEPROCAV, which led to an expansion of the actors beyond the engineers in the design of the program. Thus, two other programs were created parallel to the channeling and construction of roads: social housing and environmental protection and education. This reflected a change in the technological landscape both globally and locally. The growth presented in the discourse about urban sustainability and the recognition of the exponential increase in the population living in precarious settlements motivated the broadening in the scope of the program. The regulatory frameworks and national systems on water, sanitation, environment, and urbanization, based on the Federal Constitution of 1988, kept deepening the possibilities for macro-level innovations.

Regarding precarious settlements, despite the difficulty of specifying their data, studies at the time observed that in 1973 about 1% of the population were living in these conditions (Saraiva and Marques, 2007). In 1987, the number jumped to 7.7% of the population, 813,000 people, with almost 50% living on the banks of streams (Rolnik et al., 1990; Taschner and Pequeno, 1992). New calculations showed that, in 1991, the number doubled again and about 15% of the population of the municipality was living in favelas (Marques et al., 2003). The population resettlement program designed in Procav II, however, had brought back old and questionable solutions. The population that lived in the intervention areas, i.e., where the avenues would be built, would be removed to three social housing facilities in the limits of the urban area, as the 14 streams to be channeled could be found halfway between the central areas and the extreme periphery.

The environmental programs, in turn, had been demanded as a counterpart to the IDB in the new round of loans for the program (São Paulo (Municipality), Secretaria De Vias Públicas, 1994). Hence, two sub-projects were created: "Environmental Protection of Watersheds" and "Environmental education." The first one specifically referred to the creation and maintenance of green areas in the watersheds that were the objects of the interventions. The second created an environmental education program for the residents of the watersheds and the housing complexes to be built (São Paulo (Municipality), Secretaria Do Verde E Do Meio Ambiente (SVMA), PROCAM (PROCAV II AMBIENTAL), 1995).

The second inflection of Procav II was technical. After a century of interventions aimed at increasing the speed of flow of the river channels, without ever being able to resolve the issue of floods always being transferred downstream, the State Government, through the Department of Water and Electricity (DAEE), approved the Macro Drainage Plan of the Alto Tietê Basin[1] in 1999 (São Paulo (State), DAEE, ENGER-PROMON-CKC Consortium, 1999). This plan introduced the following important change in the logic of urban drainage: the restriction flow. Specifically, restriction flow is the highest flow supported by the main rivers in the basin and serves as the maximum flow parameter for intervention in the tributaries.

This measure leads to the need for reserving water in the watersheds of these tributaries. However, among various possibilities for reserving, a new practice that soon became hegemonic started to be implemented: the construction of large containment reservoirs, known in Brazil as big pools (*piscinões*). This innovation places the works in progress by Procav II in a paradox formed by channels designed to quickly expel the waters and the construction of reservoirs to stop them (Travassos, 2004).

In 2003, after several interruptions and reprogramming, there were still seven Procav II streams under construction, three reservoirs were being built, and some of the residents were still in precarious settlements in the watersheds. The Environmental Education Program, although well-evaluated by residents who would not be removed (Sacardo, 2001), had stopped 6 years earlier.

At the beginning of the century, in 2002, the Strategic Master Plan for the São Paulo Municipality, PDE (Municipal Law No. 13,430), was approved. Furthermore, it was complemented by the Regional Strategic Plans (PREs) (Municipal Law No. 16,050), which were elaborated for each municipal subprefecture in 2004.[2] The plans were based on the Statute of the City, a federal law that oriented the review of the Master Plan in Brazil at the macro-level. The approval of these municipal plans, under new progressive management, also of the Workers' Party (PT), now with Marta Suplicy as mayor, brought light again to the several critical issues about the established way of urbanization of the valley bottoms and a possibility of change in the relationship between the rivers and the city. The water network was considered as one of the four municipality structural elements. So, the main planning guideline for this network and its floodplain treatment was the creation of a series of linear parks and green corridors. Thus, the plan represented a significant change in the discourse on the treatment to be given to rivers and streams in São Paulo, pointing to new forms of design and intervention in these areas.

In the context of the sociotechnical landscape, both in the debates of the early 1990s and in those carried out for the preparation of the PDE 2002, we assume that the main role of pressure for the transition mainly came from a group of municipal technicians—at this moment mainly the SVMA technicians—and various elements from academia. During this period, there were no environmental movements organized around the agenda of public policies for the urbanization of rivers and their banks yet. Despite this, there was social pressure in favor of the depollution of the Tietê River, with some significant victories in the 1990s (SOS Mata Atlântica, 2016). Conversely, the macro-level went on creating suitable conditions for innovations in local policies and processes.

Only 4 years after the approval of the PDE 2002, under the neoliberal government of Gilberto Kassab—who had been Secretary of Planning in the administration that replaced Maluf, being very close to his group, but who gave political importance to the SVMA—the municipality began to organize itself to set in motion its new guidelines for urban rivers. The already mentioned workgroup was created but was formed exclusively by SVMA technicians. Without the participation of other public bodies, therefore, it was quite limited. Travassos (2010) and Silva-Sánchez and Jacobi (2012) showed how the implementation of linear parks needed to face a complex territorial and institutional situation, which required the articulation of several actors, be sufficient to think in an integrated program, the different intervention's dimensions, and the specificities of each stream and hydrographic basin. It would be necessary to integrate housing, sanitation, green areas, urban drainage, and mobility so that the urbanization projects of the rivers and their banks should result not only from a sociotechnical, but also from a just

[1]The Alto Tietê Basin covers 35 of the 39 municipalities in the São Paulo Metropolitan Region.

[2]The municipality of São Paulo is divided into 31 Subprefectures (Municipal Decree n° 13,399/2002).

transition. Thus, having its installation in the bulge of a single organ, weakened its potential for change.

In 2008, the linear parks became part of the 100 Parks Program for São Paulo, which aimed to create a bank of public lands that were suitable for the provision of environmental services. The program also intended to create a plan to adapt to global climate changes (Devecchi, 2008), thereby echoing the global agenda. Then, it did happen, as most of the implemented linear parks avoided the most precarious and conflicting areas. This was because there was no integrated planning strategy or funding which allowed the recovery of abandoned or occupied public lands with functions that could be easily relocated. Also, the project and implementation were made expeditiously and without any social or popular participation. Contrastingly, the parks were mainly implemented in peripheral areas and represented a gain—even if partial—in infrastructure in these regions (Travassos, 2010).

However, in just over 5 years, the pace of proposals and projects dropped considerably, and the next government, again from the Workers' Party with Fernando Haddad, did not emphasize the program. In 2015, the last linear park in São Paulo was inaugurated, still reminiscent of the moment before it, as may be seen in the portal of the Secretary of the Environment, SVMA. The Strategic Master Plan approved in 2014 (Municipal Law No. 16,050), which is still in force, followed the guidelines brought by its predecessor, but the proposed linear parks have not been implemented yet.

Currently, the data collected on digital media[3] indicate that there are only two linear parks in more advanced stages of debate within the municipal government; specifically, both are in the northern zone. This same data reveals that there is a strong resumption of channeling streams and construction of road systems on the river banks with varying degrees of importance in the constitution of the municipal road system. In the news database of the Secretariat of Urban Infrastructure, there are 29 projects or works completed or in progress, with rare exceptions, were found in streams located on the outskirts of the city. In addition, although the 2014 Strategic Master Plan had included a specific section on the recovery of valley bottoms, with the objective of articulating sanitation, drainage, implementation of linear parks, and urbanization of slums, there was no more municipal effort to prioritize planning and design in these areas.

Relegated Justice

At the beginning of 2021, the Secretariat for Infrastructure and Works (the renamed SIURB) made available the "Drainage Notebooks" prepared for six hydrographic watersheds in the municipality, in 2016 (São Paulo (Municipality), Secretaria Municipal De Infraestrutura Urbana E Obras (SIURB), Fundação Centro Tecnológico De Hidráulica (FCTH), 2016a,b,c,d,e,f). In the second semester, they published six other notebooks, elaborated in 2019 (São Paulo (Municipality), Secretaria Municipal De Infraestrutura Urbana E Obras (SIURB), Fundação Centro Tecnológico De Hidráulica (FCTH), 2019a,b,c,d,e,f). These proposals are presumably associated with the São Paulo Municipal Stormwater Management Plan (PMAPSP), a plan that is not a plan, but the sum of these watersheds programs, without any consideration about why these and not other choices. From 2016 to 2019, it is possible to notice a large increase in proposals linked to green infrastructure and also river daylighting. This increase shows how, from the infrastructure point of view, there is a transition under consolidation. On the other hand, the interventions are still thought of in a sectorial way. Although sanitation and roads are mentioned, the precarious settlements practically disappear, especially in the 2019 proposals, even in the peripheral basins, where their presence is significant.

Half of the 12 watersheds are in consolidated areas, occupied by middle- and upper-middle class population; two of them are more diverse in terms of income, and four of them are occupied predominantly by low- and middle-income population. In the last six basins, the closer to the headwaters, the greater the prevalence of low-income population and the presence of precarious settlements. The proposed interventions, however, do not prioritize areas with less infrastructure, nor do they allocate more resources to where there is more precariousness, which can be seen in two comparisons. In 2016 notebooks, although the linear parks proposals were quite conservative, it was already possible to notice its unequal distribution, while for the peripheral Morro do S basin, with its 22 km² area, a single park with 4 thousand m² was proposed; for the Águas Espraiadas Creek basin, with its 11 km², in an area of intense land valuation, a linear park with 111 thousand m² was proposed. In 2019, the difference in resources provided for the consolidated watersheds compared to the peripheral ones is striking. Considering the proposals that advocate more elements of green infrastructure, the resources foreseen for the Uberaba watershed, which runs through upper and upper middle class neighborhoods, are 98 million reais per km², while for the Aricanduva River watershed, which is on the periphery and shelters a relevant part of the precarious settlements and risk areas, the foreseen values are 8 thousand reais per km².

Simultaneously, the number of precarious settlements located on the banks of streams remains very high and growing. Although it is not possible to update the number of residents since the last Brazilian Demographic Census dates from 2010, the mapping carried out on data from the Municipal Housing Secretariat in 2015 indicates that there were about 247,000 households in precarious settlements on the banks of bodies of water (Travassos et al., 2017). In other words, there is still an intrinsic relationship between urban rivers and favelas in the city.

Conversely, it is also in the last decade that the perception about "unseen rivers," "invisible rivers," or "hidden rivers" in the urban areas has gained strength; correspondingly, this is accompanied by the exponential growth of academic works and media articles on the subject. A search on the Scholar Google portal for these terms in Portuguese resulted in significant

[3]The data was collected in the "News Page" of the Secretariat of Urban Infrastructure, SIURB, between 2010 to the present. Available online at: https://www.prefeitura.sp.gov.br/cidade/secretarias/obras/noticias/ (accessed March 2021).

differences between the decades of 2000 and 2010. Accordingly, for "unseen rivers," the total ranged from 11 to 18; for "invisible rivers," from 6 to 118; and for "hidden rivers," from 11 to 25. Considering the most prevalent term, together with the term "periphery" in the complete period, there are only 33 results, with the term "favelas" accounting for only 20. In a media search for the same term utilizing Google Search Advanced Engine, there is no report before 2010. Then, from that point, there are 140 reports, with only 40 of them noting the term "periphery," which is mostly related to a play with that name staged in a neighborhood in the far eastern section of the city. The term "favela" appears in only 20 news stories. Through this research, it was possible to note the strength that the discourse about urban rivers in São Paulo has gained. Urban rivers were the subject of theater groups, environmental movements, collaborative mapping initiatives, workshops to recognize watercourses, and pages on social networks. However, an important part of these speeches is incomplete once it is predominantly based on the criticism of the first spatial configuration that we dealt with, whose spatial location is in the neighborhoods of the middle and upper classes.

FIGURE 7 | Pinheiros River landscape.

An example of the form that this discourse takes can be seen in a short documentary entitled "Between concrete walls,"[4] which was produced by *FAPESP*, the magazine of the main research foundation in the country. The images and speeches selected for the documentary make it clear that rivers under the consolidated city are spoken of when the intention is to integrate rivers into the urban landscape. Furthermore, there is not a single image of precarious settlements. So, reintegration, renaturalization, and coexistence with water bodies are terms mobilized in a kind of metonymy, which takes a specific spatial configuration as universal, without complexifying the look at the various spatial configurations of urban rivers in the city. Moreover, although there are small initiatives that are echoed from periphery to periphery in some neighborhoods, as shown by Moreno and Momm (2019), the discourses linked to the central areas have a much greater power to transform themselves into public policy.

In particular, two recent programs illustrate how new public policy proposals, currently underway in the municipality, deepen infrastructure inequality and the unequal approach to urban rivers and streams. They are the third phase of the Córrego Limpo Program and the Novo Rio Pinheiros Project.

The Córrego Limpo Program was created in 2007 by the São Paulo State Sanitation Company, Sabesp, in conjunction with city hall (São Paulo (State), SABESP, São Paulo (Municipality), 2007). The objective was to clean up 300 rivers and streams through integrated sanitation, slum upgrading, and the creation of linear parks. The first phase of the program had two criteria for prioritization, which were: open channeled streams and basins in which the works could be completed in up to 2 years. Given the current situation, it is not difficult to imagine that such criteria would be very difficult to be achieved, except in watersheds whose infrastructure was almost complete. Thus, it was precisely in the areas of better infrastructure that the program concentrated its efforts, centering on complementing the structures of sanitary sewage. Since 2017, its third phase has been underway, presenting, according to its managers, two "innovations," the first of which is the establishment, until 2039, of long-term goals. The second one involves the focus on streams channeled in closed galleries, "*located in densely urbanized and important tributaries of the two most important hydrographic basins in the capital.*" (São Paulo (Municipality), Secretaria Do Verde E Do Meio Ambiente (SVMA), 2017). These "closed streams," after being cleaned up, "*can be returned to the urban landscape through renaturalization projects*" (São Paulo (Municipality), 2020). The report also highlights the positive impact of the measures in upper-class regions, such as Moema and Ibirapuera. There were interventions proposed for 11 streams in the period between 2019 and 2020, only two of which were peripheral (São Paulo (Municipality), Comitê Gestor Dos Serviços De Água E Esgoto Da Capital Paulista, 2019).

The Novo Rio Pinheiros Project, at the main tributary of Tietê River (**Figure 7**), is even clearer in reproducing inequalities, since it assumes the rupture between sanitation and housing works and treats consolidated and precarious areas differently. Launched in 2019, the program aims to reduce the sewage released in the tributaries of the river and to improve water quality, and fully integrate it into the city (Silva and Porto, 2020; São Paulo (State), SABES, 2021). This will be accomplished through the five following pillars: water treatment of tributaries, control of silting, solid waste collection and disposal, revitalization of banks, and environmental communication and education. In addition, these three business groups were planned: energy, water resources, and real estate (Momm et al., 2020).

Attempts to clean up the Pinheiros River are not new, nor were the few financial resources invested in the project. It is the river flanked by the wealthiest neighborhoods and the most thriving business centers; it has experienced an intense wave of real estate appreciation in recent years, strongly related to

[4]Original title: "Entre paredes de concreto". Available online at: https://www.youtube.com/watch?v=l9GF0qpOhOY&list=UUYhTgGdeaBbbZ-h_LVJ_6bw (accessed March, 2021).

the reconfiguration of the infrastructure, both real and planned (Tone, 2010; Ferrara, 2018). However, there are also watersheds of its tributaries that are occupied by precarious settlements, whose urban and sanitation solutions are complex. Thus, to achieve the goal of a clean river and the construction of the desired waterfront in the wealthy neighborhoods, the state government treats the urban areas of the basin in two ways. First, there is the complete infrastructure for the tributary watersheds in the regular neighborhoods. Second, there is the treatment of the river mouth of the tributary rivers whose watersheds are occupied by precarious settlements. In other words, the State assumes the maintenance of very serious social and environmental liabilities as long as the sanitary effluents from these spaces do not contaminate the areas that matter for business investors and upper-classes. In several aspects, the set of these plans represents the reproduction and intensification of inequalities—that is, it shows that there is no just transition, or that justice is not an objective to pursue.

FINAL CONSIDERATIONS

The trajectory described above shows that the policies and projects concerning the relationship between rivers and urban spaces—specifically through linear parks and other leisure open spaces—have not been able, up to the moment, to be configured as a new sociotechnical regime. This incompleteness is due to both the point of view of the relationship between the actors and institutions, and from the point of view of the spatial and environmental results of these policies and projects. The resumption of interventions in channeling streams accompanied by a road system shows that there is resistance and inertia of the regime in force throughout the 20th century. We highlight, however, the changes that have occurred since 1980, with the growth of the urban environmental agenda. It was responsible, at first, for some modification in infrastructure proposals, from closed to open channeling, and after the expansion of the aspects that should be addressed by urbanization programs, especially issues related to precarious settlements and environmental education. At the end of the 2000s, the construction of new intervention proposals seemed to advance through all these themes, although in a sectorial and incomplete way, with many integration problems that needed to be solved to enable a real environmental and social recovery of the urbanized valley bottoms. However, from the middle of the last decade, with the growing demand for green infrastructure and the recovery of waterways, the programs that until then were designed for rivers that had never been subject to intervention, began to focus on restructuring the relationship between rivers and cities in consolidated and higher income areas. It is noteworthy that these processes of advances and setbacks are part of the sociotechnical transition. In this sense, it is possible to affirm that there is a sociotechnical transition "in the making," especially because sociotechnical niche experiences remain, and so do external pressures and resistances in the macro-level boosting these initiatives.

Regarding the interventions carried out by the public authorities, it is possible to state that, in the São Paulo Municipality, the sociotechnical niches are formed by fringe actors, with little political strength, however institutionalized. At the center of this group is the SVMA, with a portion of its technicians, and some presence of technicians from other government agencies. That was the case of the intervention of the Rio Tiquatira and even in the institutional changes verified in GEPROCAV between the first two phases of Procav. It is necessary to recognize that these actors pressured, at various times, the current sociotechnical regime, having been able for a little less than a decade to change the role of public authorities in interventions in urban rivers.

The hegemonic regime's alteration is supported by the continuous perception that previous works did not result in the reduction of the impacts of pollution and floods associated with the city's rivers. These three aspects put pressure in this alteration: (1) climate change and extreme events, which pressure local governments to respond to the increase of deaths and more intense and frequent material losses; (2) the various initiatives for urban rivers around the world, which yielded political fruits to the managers in charge of them and created spaces for real estate valuation; and (3) policies and global platforms, such as the one on climate change, that include not only specific groups related to climate and the environment but the national coalition and financial groups which were oriented by these agendas. In contrast, neoliberalism as a global trend has been increasing inequalities as it reduces the role of the government. This force results in the dismantling of social policies that make up for the low-income population of poorer countries and their ability to provide resources and basic infrastructure. Still, on the topic of neoliberalism and infrastructure, the privatization of urban infrastructure and essential services tend to make equitable and universal solutions more scarce. In this sense, if the presence of precarious settlements on the river banks was in the speeches and political agendas associated with urban rivers until a decade ago, it has now disappeared in the current policies. The Novo Rio Pinheiros Project is the most explicit in this sense, for deliberately treating the watersheds of regular occupation and those of informal occupation in an unequal way and permanently separating sanitation works from urbanization ones where there is no real estate interest. This can be deeply configured as an act of omission.

Considering the debate of just transition, it is possible to identify issues related to participation, time, space, and the type of proposals that refer to the reproduction of inequalities. Considering this literature and the cases, participation was absent by the low-income population throughout all the programs and projects that were elaborated and implemented. There was also an inadequacy of the project and construction deadlines in relation to the complexity of the river and buildings situations. In the case of São Paulo, a great example can be seen in the Córrego Limpo Program, which, when selecting more complex watersheds for operation, limited the period to 2 years. This action made it unworkable and now it has a long-term schedule, also aiming at the possibility of "renaturalizing rivers" in the most consolidated and wealthy areas of the city.

In addition, the discourse of valuing the relationship between nature and city related to urban rivers also poorly includes the issues of the periphery and precarious settlements, as it is possible to learn from the academic works and media news presented.

While discussing the need to look at rivers in consolidated areas and advancing in studies and proposals of typologies and ways of treating these rivers, the city continues to channel rivers in the peripheries. This approach creates a context of two different cities, with two different sociotechnical landscapes regimes. The *status quo* of inequality remains in peripheral and precarious areas.

In this context, it is necessary to move forward in the development of the approach on the sociotechnical transition and its relation to justice. This approach is necessary for the understanding of the advances, setbacks, and inertia of new sociotechnical regime or the implementation of a new paradigm in the relationship between infrastructure and existing urban rivers. Furthermore, the sociotechnical transition literature has advanced in terms of its direction toward sustainability. However, for the context of large cities in peripheral countries, it is necessary to strengthen the link between this literature and that of justice, since an important part of the advances and setbacks are strongly related to the territorial inequalities of these cities. In other words, advances and setbacks are often concomitant in time and separated in space, which makes the analysis of the transition more complex. Above all, it is essential to build a coalition in favor of a just transition, which reverses the logic of the distribution of resources and innovation and prioritizes peripheral spaces through public housing, sanitation, drainage, park developments, and mobility policies.

DATA AVAILABILITY STATEMENT

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

AUTHOR CONTRIBUTIONS

LT contributed to the literature review and carried out the documentary and empirical research presented in the article. SM contributed to the literature review and documentary research. All authors contributed to the article and approved the submitted version.

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