URBAN SPRAWL. TRANSFORMATIONS IN THE URBAN FABRIC OF BRAZILIAN CITIES AND THEIR RELATIONSHIP WITH CLIMATE CHANGE

LA EXPANSIÓN URBANA. TRANSFORMACIONES EN EL TEJIDO URBANO DE LAS CIUDADES BRASILEÑAS Y SU RELACIÓN CON EL CAMBIO CLIMÁTICO

JEFERSON TAVARES
Doctor, Instituto de Arquitetura e Urbanismo, Universidade de São Paulo, Brasil
https://orcid.org/ 0000-0003-2482-0380

Recibido: 15 de febrero del 2024
Aprobado: 7 de mayo del 2024
doi: https://doi.org/10.26439/limaq2025.n015.6961

This article argues that the contemporary transformations of the urban fabric in Brazilian cities are characterized by urban sprawl, a process distinguished from earlier ones due to its association with new cultural values and new challenges for urban planning. Accordingly, the aim is to research the extent to which urban sprawl impacts the planning of Brazilian cities, with a focus on understanding the relationship between urban sprawl and climate change. Initially, the article questions key foreign concepts related to urban sprawl, demonstrating the contemporaneity of this process. Through an exploratory methodology, it characterizes urban sprawl through Brazilian interpretations and territorial evidence. The discussion centers on five conditioning factors stemming from sprawl and their relationship to climate events. In conclusion, the article advocates for multifunctional and multiscale premises that address local development by recognizing the systemic nature of this process.

urban sprawl, climate change, urban system, urban fabric, vulnerabilities

Este artículo sostiene que las transformaciones contemporáneas del tejido urbano en las ciudades brasileñas se caracterizan por la expansión urbana, un proceso que se distingue de los anteriores por su asociación con nuevos valores culturales y nuevos desafíos para la planificación urbana. En consecuencia, el objetivo es investigar hasta qué punto la expansión urbana impacta en la planificación de las ciudades brasileñas. La cuestión central es comprender la relación entre la expansión urbana y el cambio climático. Inicialmente, el artículo problematiza conceptos clave extranjeros relacionados con la expansión urbana, demostrando la contemporaneidad de este proceso. A través de una metodología exploratoria, se caracteriza la expansión urbana mediante interpretaciones brasileñas y evidencias territoriales. La discusión gira en torno a cinco factores condicionantes derivados de la expansión y su relación con eventos climáticos. Como conclusión, se aboga por premisas multifuncionales y multiescalares que respondan al desarrollo local reconociendo el aspecto sistémico de este proceso.

Expansión urbana; cambio climático; sistema urbano; tejido urbano; vulnerabilidades

INTRODUCTION

The recent changes in the growth patterns of Brazilian cities, especially within those that have benefited from public and private investments over the past thirty years, reflect a new aspect of urbanization. These changes can be characterized as a departure from the traditional model of cohesive, monocentric cities, characterized by predominantly continuous urban fabric expansion. Such characteristics are related to the global productive system, new standards of livability, and new urban cultures. They reflect a shift from the urban models promoted by modernity —marked by many uncertainties— and represent a contemporary and distinct issue in the Brazilian urbanization process.

These changes are influenced by the implementation of global productive complexes responsible for transnational activities, the provision of urban infrastructure at the national level, and land use regulation, as well as its mediation through the real estate and construction markets at the local level. While these developments are part of the historical process of Brazilian cities' formation and development, they are currently occurring through new growth fronts and are related to new challenges. In the context of climate change, extreme events are intensifying (e.g., rising average temperature, increased precipitation, sea level rise), risk situations are multiplying (e.g., heat islands, increased pollution, cyclones and windstorms, landslides, floods, coastal erosion), and socio-environmental vulnerabilities are becoming more pronounced. These factors raise a central concern regarding the relationship between urban sprawl and its effects on society, justifying an approach to the topic as a contribution to the field of urbanism.

In light of the current context, this article is structured as follows: after this introduction, the second section will examine the state of the art on urban sprawl, understanding its contemporary aspects within the international debate; the third section will characterize urban sprawl in Brazilian cities through national perspectives and an analysis of its territorial evidence, using regionalized case studies; the fourth section will present the results by systematizing five determinants of Brazilian urban sprawl related to the intensification of climatic effects. These results will lead to the conclusion, in the fifth section, that a revision of national urban planning parameters is necessary, motivated by local considerations but integrated within the regional scope, given the systemic nature of urban sprawl's effects.

The conceptual framework refers to the polysemy of the expression *urban sprawl*, encompassing related concepts such as dispersed urbanization (Reis, 2006), diffuse urbanization (Indovina, 2019), suburbanization (Monclús, 1996), extensive urbanization (Domingues, 2008), periurbanization (Dematteis, 2015), among others. The analysis is supported by evidence of the transformation of the urban fabric from academic research projects (FAPESP Regular Project Research 2018/13637-0 and CNPq Process 308936/2020-5) that studied the impact of infrastructures on the urban fabric between 1990 and 2019 across 777 municipalities, with a sample of 55. Methodologically, the research is exploratory, leading to the hypothesis that urban sprawl can be understood as the functional rescaling of the urban fabric through the transformation of its form and its influence on people's daily life, urban structure, and the intensification of vulnerabilities.

INTERNATIONAL DIALOGUES: URBAN SPRAWL AS A CONTEMPORARY URBANIZATION PROCESS

Analyses of urban sprawl in North America and Europe have largely emerged from the contrast between the industrial city and the contemporary city. Fishman (1990, pp. 43-49), for example, demonstrated the anachronism of the center–periphery model in relation to the reality of contemporary American metropolises. In decentralized cities, suburban areas have gained prominence as areas that concentrate middle-class populations and new activities distinct from those traditionally found in the city center, thus granting them a degree of autonomy from other urban sectors. According to Fishman, in these cities, the scale shifts from streets or blocks to growth corridors, which play a fundamental role in forming *urban regions*. These regions are composed of *edge cities* and clusters of services, offices, and low-density entertainment complexes without a single center, strongly oriented by highways, and combining urban, rural, and suburban characteristics.

These observations align with Dematteis's (1996, pp. 9-16; 2015, pp. 14-34) analyses regarding the occurrence of this process in Europe, particularly in Italy. Dematteis describes how urban sprawl has been shaped by demographic shifts followed by functional changes between city centers and their expanding peripheries, which are quite different from the compact periphery of the Fordist period. This has resulted in two scales: the regional or functional systems scale, characterized

by daily commuting movements, and the urban and territorial systems scale, defined by the growth of peripheral cities, decentralization, and recentralization of work. These dynamics can be observed through three morphological types: periurbanization, which essentially depends on regional services; reticular diffusion, involving mixed residential and productive fabrics, metropolitan expansion, or industrial districts; and the overlap of both along communication axes, leading to a detachment from the traditional and symbolic spaces of the city.

In this context, Monclús (1996, pp. 2-8) identifies the decentralized city as a new type of city, characterized by the process of suburbanization or the "dissolution" of the traditional compact city, leading to increased dispersion and fragmentation. Its origin is linked to the proliferation of low-density residential areas and the extensive decentralization of new industrial areas, parks, universities, sports facilities, airports, shopping centers, among others, which occur not only in metropolitan areas but also in smaller cities.

The recognition of the transformation of the urban space as the dominant way of societal territorialization across vast areas caused by increased traffic (the intense movement of people, vehicles, and information) was termed "extensive urbanization" by Domingues (2008, pp. 1-10). In this context, attention is drawn to the large-scale urbanization that emerges from multiple dimensions structuring dynamics and processes at the microscale of sites. The large scale allows us to understand how economic, infrastructural, and biophysical systems connect and impact everyday places. Regional infrastructures (such as highways) overlay urban ones (such as the grid), while mega-structures (e.g., large regional hospitals, multi-purpose condominiums, logistics centers) are designed in isolation, disconnected from their surroundings.

In this regard, the understanding is that dispersion and concentration should not be viewed as opposed forces. As the city dissolves, some concepts —including function, homogeneous zones, hierarchy, density, and proximity— also dissolve, while new ones emerge, such as compatibility, incompatibility, porosity, and just distance (Secchi, 2007, pp. 122, 132-136). At the core of this entire process lies the urban fabric. Within its multiple interpretations (Sieverts, 2007, p. 304), it has been generally understood as a combination of elements related to infrastructural mobility, housing, services, and production spaces, ultimately forming *dispersed regions* rather than just dispersed cities.

From a historical perspective, Bruegmann (2011, p. 24) sees urban sprawl as a polysemic concept, though it has traditionally been defined by low-density development that is spread out, lacking systematic public territorial planning and occurring on a large or regional scale. Indovina (2019) interpreted urban sprawl within the context of broader territorial transformations, leading to the understanding of cities according to the analogy with archipelagos to characterize the fragmented nature of peripheral occupations that extend beyond the monocentric city model.

Since the late 20th century, the recognition of urban sprawl has sparked debates about compact versus dispersed cities (Álamo, 2014, pp. 175-177). However, urban sprawl is not a recent phenomenon, nor does it represent a polarization between models (Pescatori & Faria, 2019, pp. 1-20). In this regard, some interpretations have observed the social dynamics involved in urban sprawl, like gentrification, territorial segregation, congestion, stratification of real estate values, and the need for regional-urban management (Guevara, 2015, pp. 5-24). There is even discussion of the death of the city or, more complexly and appropriately, the questioning of the existence of urbanity in these new scales of urbanization (Choay, 1999).

Within this framework, city peripheries are no longer interpreted as residual, marginal, and excluded areas. Instead, they are recognized as spaces for hosting new functions, new scales of social relations, and new aspects of urban lifestyle. Due to their extent, they move away from the image of a peripheral ring surrounding a traditional center and, in some cases, do not even maintain direct ties to it. These areas often concentrate more opportunities and diversity, including varied social classes, thereby gaining autonomy and reshaping their relationship with the main center. However, the most recurrent aspect across these interpretations is the recognition of a change in territorial organization, reflecting contemporary lifestyles.

READINGS AND TERRITORIAL EVIDENCE OF URBAN SPRAWL IN BRAZIL

In Brazil, pioneering studies have directly engaged with this international debate and contributed to interpretations regarding changes in the urbanization process. Two works (Reis, 2006; Chatel & Sposito, 2015) are particularly significant in this context for systematizing diverse perspectives, terminologies, meanings, and foreign concepts most commonly used by Brazilian researchers.

From this perspective, Reis (2006, pp. 12-14) characterized urban sprawl as comprising dispersed urbanized areas that form a single system regionalized by mobility, involving new private space management, new real estate products, and new architectural and urban projects aimed at meeting these emerging demands. Urban sprawl operates on two scales: the expansion of occupations in metropolitan regions and the dispersion of the urban fabric. Reis (2007, p. 39) highlighted the predominance of the condominium model for all income levels, changes in rural exodus patterns and demographic growth in cities, regions with entirely urban populations, dispersion of productive units, and universalization of markets and mass consumption patterns. These factors lead to understand urban sprawl through the decrease in urban density, the expansion of peripheral areas, and the formation of new urban concentrations at the microregional scale (Reis, 2015, pp. 92-107).

Since then, the perception of urban sprawl has been shaped by the idea of the decentralization of urban agglomerations as a structural element of the current urbanization process (Sposito, 2009, pp. 40-43). From this perspective, the spatial unity of the city dissolves through the sprawl of the urban fabric and the relative decrease in demographic density. This condition leads to the intensification of flows of people and goods, driven by the acceleration of ways to commute and communicate. These transformations characterize diffuse urbanization by larger and discontinuous urban fabrics, reinforcing the interpretation of society as a network. In this process, along with diffuse urbanization, the dispersed city —characterized by new socio-spatial practices marked by fragmentation, socio-spatial selectivity, and justified by the aspect of urban (in)security (Sposito, 2009, p. 50)— becomes the new hallmark of urban life.

Urban sprawl in Brazil takes into account not only the idea of both sprawl and fragmentation but also the concentration and formation of subcenters and centralities, as they become part of the same urbanization framework. This includes the importance of the center as a reference, particularly in metropolitan areas, as well as centrifugal movements, the expansion of central activities to the periphery, and the fragmentation driven by social factors rather than just physical ones (Chatel & Sposito, 2015, pp. 121-122).

By observing urban sprawl as part of a broader process involving changes in people's lifestyle, city organization, and the relationship between cities, Botelho (2009, p. 275) identifies four characteristics

that synthesize this phenomenon: the distancing of the urban fabric from the center; the formation of urban nuclei of different sizes forming constellations or nebulae integrated into a metropolitan area, a cluster, or a system of them; the incorporation of highway and railway systems into daily intrametropolitan transportation of people; and the diffusion of metropolitan lifestyles.

With regard to demographic and territorial shifts, urban sprawl can be characterized by several factors (Catalão, 2015, pp. 250-277): the territorial expansion outpacing population growth, the rebalancing of density and compactness in the center–periphery relationship, the disruption of urban territorial continuity marked by voids, and the intensification of socio-spatial differentiation. This process comprises four elements: pronounced territorial expansion, progressive decrease in densities, loss of urban territorial continuity, and extensive social segmentation. These phenomena clearly imply two factors in urban growth (Ojima, 2007, pp. 277-300): one related to population, which directly affects infrastructure demand, and another one related to the physical expansion of cities, which entails social costs and environmental impacts.

In the five macroregions of the country, these characteristics reoccur with varying degrees of intensity, demonstrating a transformative process across different areas of the Brazilian territory. However, each case has important specificities that need to be understood. Even so, some cases are paradigmatic of these general relationships and their particular nuances.

In the Southeast region, the implementation of Complexo Petroquímico do Rio de Janeiro (COMPERJ - Rio de Janeiro Petrochemical Complex), located in the municipality of Itaboraí-RJ, has significantly transformed the real estate dynamics of the neighboring municipality of Maricá-RJ by attracting new condominium developments (Holzer, 2016, pp. 71-89). These developments are driven by the demand for jobs generated by large federal public investments in COMPERJ and further drawn by the low cost of land and the availability of infrastructure provided by local, state, and federal governments. Such developments occur at the edge of the urban fabric, justified by a pursuit of quality of life outside the metropolis.

Near the same area, the establishment of the Porto do Açu (Açu industrial port complex) also attracted other developments across a group of cities within its sphere of influence: São João da Barra,

Campos, Macaé, Rio das Ostras, Cabo Frio, Araruana, Niterói, Maricá, and Itaboraí, all in the state of Rio de Janeiro. This project consolidated an interdependence between these cities and the state capital, Rio de Janeiro, reorienting the regional role of the cluster (Araujo, 2016, pp. 91-111) and altering the hierarchy of the urban network.

In both cases —COMPERJ and Porto do Açu— a regionalized land market emerged, expanding under the influence of large federal projects of national and international scope. The most significant transformations occurred at the local scale, driven by federal and private capital investments that are often detached from the existing urban characteristics. This predominance led to changes in the urban fabric, whether through densification of previously unoccupied areas, the expansion of the urban fabric, or the formation of secondary urban fabrics.

In the Northeast region, especially in metropolitan areas such as the Região Metropolitana de Natal-RN (Metropolitan Region of Natal-RN), the observed sprawl is characterized by discontinuous urbanized patches with frequent and intense demographic shifts. This sprawl is marked by low population density, horizontal occupation, and a reliance on individual transportation. Commuter movement is intensified due to the emergence of new urban hierarchies and developments of different scales (Ojima et al., 2015, pp. 9-20). The metropolitan region's main city is no longer the primary origin or destination of these flows, as it was until the 2000s. Additionally, the growth of nearby towns does not exclusively derive from the migratory overflow from the capital. These factors demonstrate the establishment of new hierarchies and a redirection of commuter movements.

In the South region, particularly in the state of Paraná, the urban agglomeration of Maringá (Cordovil & Barbosa, 2019, pp. 21-30) has experienced growth in commuter movements oriented towards the pole municipality of Maringá. This has been accompanied by the establishment of large attraction centers in peripheral areas, an increase in individual passenger transport, and regional flows that have created new centralities and occupations along key regional axes such as railways and highways. The proliferation of residential condominiums, universities, an airport, shopping centers, and industries in rural areas, all connected by regional roads, shapes the growth of the urban fabric and promotes the sprawl of cities around Maringá.

In the North region, within the Amazon, urbanization at the jungle's edge and far from traditional settlements has consolidated a type of sprawl conceptualized as extensive urbanization (Monte-Mór & Linhares, 2009, p. 148). This concept helped pioneer an understanding of the relationship between means of production and urban production in this region. Also referred to as diffuse urbanization, the expansion of this process has been more closely linked to the rising importance of medium-sized cities within the regional framework of the Amazon (Trindade Júnior, 2015, pp. 305-334).

There is also an imminent sprawl of villages and isolated communities from urbanized districts. Present in the Northeastern backlands, the interior of the North region, and the low-industrialization cities in the Midwest, Southeast, and South, these small villages and communities are considered rural areas by planning instruments but function as important commercial, political, and religious centers within the areas under their influence (Tavares et al., 2020). This places strain on the urban fabric and, for political and/or productive reasons, leads to the development of secondary urban fabrics.

Finally, the role of planning in this process of urban sprawl in Brazil is worth highlighting. As recent studies indicate (Leonelli et al., 2019, pp. 299-312), local governments have contributed to urban sprawl. In cases like Araraquara-SP, Chapecó-SC, Ribeirão Preto-SP, and Uberlândia-MG (in the Southeast and South regions), master plans expand land reserves classified as urban —sometimes exceeding the city's actual urbanized area—. This practice encourages urban sprawl by enabling more flexible regulations for the approval of subdivisions, land divisions, and the establishment of new productive activities.

Thus, successful initiatives emerge from the real estate and construction sectors, as in the emblematic case of the company Alphaville (Silva, C. P. C., 2016), which has developed projects in major Brazilian cities beyond just metropolitan regions. This land urbanization industry promotes urban sprawl through standardized subdivisions responsible for occupying rural areas or voids on urban fringes, benefiting from low land costs and the adoption of new lifestyles.

In summary, the evidence confirms the expansion of urban fabric and urban sprawl driven by new real estate developments, as occurred in Maricá-RJ; the interconnection of neighboring cities, disrupting classical

hierarchies related to commuting patterns, as observed in the Região Metropolitana de Natal-RN; the growing reliance on transportation infrastructures, as evidenced in the urban cluster of Maringá-PR; and the replication of a metropolitan lifestyle through extensive urbanization in the Amazon. The effects of these elements are amplified by the widespread diffusion of infrastructure provisions that provide economic, legal, and material security, facilitating urban fabric growth.

This process in Brazil is characterized by intensified regional relations through interurban and metropolitan flows; the functional diversity of new developments; the formation of a few new centralities; and the valorization of existing urban and rural nuclei that previously lacked regional expression. These changes affect the relationships between centers, subcenters, and peripheries within municipalities, thus contributing to the metropolization of spaces and altering the relationship between the user and the city, as they imply a set of conditions for the citizen's daily life. In other words, the definitions of center, centrality, and periphery within each municipality evolve over time with the transformations in the urban fabric.

Therefore, it is important to rely on more enduring frameworks and parameters for these concepts. The term *center* here refers to the area that, given the high degree of social division of labor (Sposito, 1991) and a concentration of diverse, specific, and exclusive functions (Villaça, 2001), defines the hierarchy of the city by promoting accessibility to a mix of commerce and services, and carries significant symbolic value for the municipality. Centrality, therefore, refers to the attributes and qualities that define a center. This concept applies not only to the main center but also to any subcenters that may exist in the city and perform similar functions on a smaller scale. Centrality can take various forms such as axes or clusters of diversified activities.

Although the term *periphery* is specifically used to elucidate the interpretations of sprawl, it is defined here as a geographical location on the margins of the center. In recent contexts, *periphery* has not been linked to low-income areas but rather has been characterized by the concentration of middle- and high-income classes that reside near areas with poor urban and housing conditions. This definition is complemented by the plurality of the term (Bonduki & Rolnik, 1979), which can designate low-income areas in both central and peripheral locations, reflecting different stages of development.

CONSTRAINTS AND CHALLENGES OF NEW URBANIZATION PATTERNS IN BRAZILIAN CITIES

Can urban sprawl be linked to climate change? Urban sprawl in Brazilian cities manifests in three ways: increase of building density within the urban fabric, consuming natural land (as seen in Rio Branco-AC in Figure 1); expansion at the urban fringe or through extensions that enlarge the perimeter, blurring the boundaries between urban and rural areas (as seen in the municipality of Palmas-TO in Figure 2); and isolated growth through the establishment of new secondary urban fabrics, thus extending distances (as seen in the municipality of Lauro de Freitas-BA in Figure 3). These forms can be tentacular, composed of lots along the roads; fractal, continuously expanding urban fringes into natural environments; or clustered, comprising subdivisions and/or facilities targeting new fronts of occupation.

Figure 1

Municipality of Rio Branco–AC in 2010 and 2020. Housing developments intensifying the constructive densification, attracted by highways.

Note. *Google Earth images*[1].

Figure 2

Municipality of Palmas–TO in 2014 and 2020. Housing complexes and subdivisions at the edge of the urban fabric and reducing differences between urban and rural areas

Note. Google Earth images[2].

[1] De Google Earth Pro v.10.65.1.2 (2024, 17 de junio). Residencial Rui Lino III. 9°56'49.55.46" sur, 67°51'21.08" oeste. Altura de la vista 2500 metros. Exploración. Airbus, 2024. (Consultado el 20 de octubre del 2024).

[2] De Google Earth Pro v.10.65.1.2 (2024, 17 de febrero). Conjunto Belo Vale. 10°21'28.46" sur, 48°17'12.60" oeste. Altura de la vista 3.500 metros. Exploración. Airbus, 2024. (Consultado el 20 de octubre del 2024).

Figure 3

Municipality of Lauro de Freitas–BA in 2009 and 2020. Urbanization of slums and housing provisions in isolated districts, distinct from the the main urban area and providing new fronts of occupation

Note Google Earth images[3].

These methods and forms entail functional changes in both central and peripheral areas, the establishment of growth corridors, and the formation of urban regions. Many of them are linked to the proliferation of regional infrastructures that overlay the urban fabric and the repositioning of technical and urban systems. As a result, there is an increase in social costs and environmental impacts.

Although some of these patterns are typical in urban growth in Brazilian cities, they may be considered a novelty in contemporary urbanization, as they have become closely linked to national infrastructure provisions, as well as regional and global capital-related conditions. This emerging growth pattern has led to —at least— five main conditions that simultaneously reshape the daily lives of citizens and can contribute to climate change and the intensification of its effects through increased socio-environmental vulnerabilities (Painel Brasileiro de Mudanças Climáticas [PBMC], 2016). The following analysis seeks to briefly characterize these five conditions amidst the national and international debate in order to identify and delineate the challenges posed by this stage of urbanization.

Expansion of Urbanized Areas into Rural Areas or Regions Designated for Environmental and Food Production

Urban sprawl homogenizes peri-urban landscapes, minimizing traditional spatial dichotomies such as center–periphery, city–countryside, and urban–rural, ultimately leading to the loss of ecosystem services. Additionally, public spaces like squares and parks have increasingly disappeared from urban projects, being replaced

[3] De Google Earth Pro v.10.65.1.2 (2024, 15 de enero). Capiarara. 12°50'37.37" sur, 38°20'17.50" oeste. Altura de la vista 2.774 metros. Exploración. Airbus, 2024. (Consultado el 20 de octubre del 2024).

by conservation areas, reserves, and protected environmental zones, which emerge with a predominantly preservationist approach. Linear parks —which once fulfilled multiple functions such as aesthetic, green infrastructure, leisure, and river protection— have been reduced to a purely functional or even privatized role, often located within large private properties, gated communities, or condominiums.

This trend has resulted in an increase in built surfaces dominated by grey infrastructure and the suppression of green areas, disrupting the natural balances of energy and surface radiation. Therefore, cities become hotter with less capacity to ensure evapotranspiration and humidity control. Building concentration can generate heat islands and contribute to increased need for air conditioning, thereby raising energy consumption and heat release onto external surfaces (Stewart & Oke, 2012). Additionally, the morphology of the urban fabric can influence temperature variations and user comfort (Monteiro & Novaes, 2020). Just as urban and rural landscapes are merging in suburban areas, the effects of climate change, exacerbated by urban sprawl, also extend to non-central areas.

Change in Property Structures Through Segregation-Based Developments

These new forms of urban fabric emerge through the way private developments and state actions organize space without integrated connections. Condominiums, clusters, and public and private ventures are established on plots and tracts as enclaves, lacking interaction with the surroundings (Silva O. T., 2016). The traditional concept of neighborhood or community has shifted, often considered outdated due to concerns about security and social status (Caldeira, 2000). In this context, segregation is diffused throughout the territory by the way developments are planned, because they often promote them as enclaves.

It is not exclusively the result of an antagonistic process separating informal settlements and planned neighborhoods but rather a definition of urban planning and design. Class separation is part of the design of condominiums (whether high- or low-income groups), which are conceived without integration with the surroundings, although they may be located within the same sector and close to each other.

Segregation ceases to be solely a result of class struggle to become a societal project, planned and undertaken as a real estate product or

public policy. As in some Latin American countries, segregation has manifested in various typologies (Gómez Maturano, 2022), stemming from urban sprawl and new forms of urban fabric growth, whether through larger concentrations, isolation, or socially homogeneous zones. This issue is particularly significant in Brazil, where segregation influences both the form and function of urbanization by its arrangement within the urban fabric, becoming a predominant characteristic of intraurban typology (Instituto Brasileiro de Geografia e Estatística, 2017) and one of the main causes of vulnerabilities.

Changes in the Density of Central Areas and Urban Fabric Boundaries

These transformations are accompanied by shifts in relative density in both central areas and regions of urban dispersion —a process that interacts with metropolises, medium-sized cities, and small towns— and behave as a response to new urban lifestyles. Population displacement to the edges of urban sprawl or beyond leads not only to decreased population density in traditional central areas of cities but also to the (re)concentration in other urban sectors, with increased construction or demographic density.

Studies demonstrate that low densities (population, housing, construction) benefit the environment, social relations, and health; however, they also pose challenges to transportation, the economy, services, and technical infrastructure (Berghauser Pont et al., 2020). This often results in increased public service costs, making the city more expensive and less democratic. On the other hand, high densities also have a greater environmental impact due to the concentration of waste and effluent discharge. Therefore, the issue resulting from urban sprawl lies in the promotion of density changes without preventing or mitigating their impacts and without ensuring that these urban typologies (whether dense or sparse) support the inclusion of different social classes based on maintenance costs and services. Keil (2020) pointed out that density is relative and depends on its context, and Pérez (2020) emphasized that density is important enough to shape public policies that directly impact on quality of life.

Increase in Flows and Demand for Motorized Transportation

The expansion of urbanized areas, the changes in average densities, and the rise of condominium developments have contributed to an

increased demand for daily transportation. Public and private housing developments located in dispersed and distant areas from employment opportunities, services, shops, and leisure facilities often result in greater travel need. This spatial dependency may be related to the center or subcenters of the municipality where a condominium is located, necessitating motorized transportation and increasing daily traffic flows.

The growth of infrastructure —particularly roads and highways— provides access to services, employment, residences, and entertainment in other towns, creating a new diffuse system of daily activities. The relationship between cities, facilitated by work-related movements, breaks the traditional urban polarized model and contributes to the development of territorial nodes. These transformations bring to the discussion mobility issues, making intra- and inter-municipal connections critical through highways, railways, and state-managed terminals. Connector functions emerge, including shopping malls, metro stations, integrated bus terminals, commercial and service road/rail corridors, and clusters of commerce or services at important intersections within the city or between cities and districts (services, commerce, production, and leisure).

These changes lead to increased inter-regional dependencies (e.g., due to commuting) and intra-urban dependencies (e.g., due to greater distances between daily activities). This shift results in higher automobile use, increased ethanol consumption, more traffic jams, and elevated greenhouse gas emissions. This chain of events contributes to heightened air pollution not only in densely populated areas —such as metropolitan regions— but also in less dense rural areas where ethanol production as well as pollution from burnings and pesticide use occur (Rosário & Tavares, 2023). Furthermore, the increased circulation exacerbates climatic effects, which in turn can interrupt transportation systems or damage infrastructure caused by heavy rains, floods, and inundations (Brasil et al., 2017).

Consolidation of an Urban System

In this regard, while the administrative structure of the municipality remains crucial for political power and planning, it is surpassed as a landmark of territorial organization. Urban sprawl shapes centralities, nuclei, or clusters of settlements that are interconnected across different cities, forming networks with other places and requiring management approaches that differ from traditional municipal

bureaucratic practices. This articulation of the urban fabric transcends municipal administrative boundaries. The relationships arising from this urban fabric growth foster new inter-municipal connections within a broader urbanization process (Montejano Escamilla, 2013). Recent studies advocate for changes in local adaptability within the urban system (Artmann et al., 2019).

Taken together, these factors are closely linked to climate change because they contribute to increase resource and energy consumption and exploitation, and concentrate greenhouse gas emissions, pollution, waste, and effluents. They also favor hotter environments and water stress, play a role in changing rainfall patterns and average temperatures, inhibit ecosystem services, and disrupt the hydrological cycle.

Additionally, these factors exacerbate vulnerabilities by intensifying segregation and precariousness (through the development of gated communities and informal settlements), hindering access to opportunities by dispersing daily life (through the segmentation of the urban fabric), raising service costs (due to increased energy consumption and infrastructure deployment), and reinforcing inequalities by heightening the dependence of smaller cities on larger ones (with the expansion of developments detached from traditional centers), as larger cities concentrate a greater supply and diversity of services, commerce, and employment.

These elements shape cities that are less healthy, less resilient, and more vulnerable to the impacts of extreme events such as heat islands, floods, mass movements, coastal impacts, infrastructure collapse, wildfires, and water scarcity (PBMC, 2016). Their effects are felt across different urban areas, but the risks are higher in areas with greater concentrations of low-income populations, highlighting deeper vulnerability. Although these occurrences and their effects are not solely attributable to urban sprawl, it accentuates them. The five conditioning factors of urban sprawl occur with systemic and inter-regional impacts and reciprocal damages, requiring a new operational way for organizing urban growth that addresses these factors.

CONCLUSIONS

The new productive relations, the new cultural values of urbanity, and the suppression of comprehensive city planning are related to the changes brought about by urban sprawl. In summary, this new movement is

characterized by the fragmentation of urbanized areas, the continuous reproduction of the grid as a means to create urbanized land banks, the formation of urban enclaves, the alteration of the relationship with the existing center, the intensification of inter-municipal relations, the formation of new urban hierarchies, the change in lifestyles in peri-urban areas, and the development of more subtle (physical) urban boundaries.

Unlike conurbation, the scope of urban sprawl extends beyond metropolitan regions into areas influenced by a more intense division of labor —local, regional, national, and global— that integrates inter-municipal flows of different scales. Considering these factors, urban sprawl can be understood as a functional rescaling of the urban fabric, characterized by a transformation in its form, its impact on daily life, the city's structure, and the emergence of new vulnerabilities.

The characteristics of urban sprawl are sometimes confused with metropolization. However, they are distinct phenomena, although they complement each other in the current stage of Brazilian urbanization. In this context, urban sprawl manifests through changes not only in the periphery of the city but also in relation to its center. Therefore, it represents a shift in control and hierarchies in urban space production. This change is essentially driven by new social patterns, lifestyles, ways of working, cultural symbols, and references, as well as the relationship between capital, the state, and land.

These factors require a revision of urbanization parameters by urban planners. The criticism advocating for the end of the city in response to urban sprawl often overlooks the historical potential for transforming the surroundings of these settlements and the opportunities presented by interstitial voids. It also disregards the exhaustion of car traffic; the environmental, economic, and social drawbacks of gated communities; and the opportunities that could emerge from reviewing the conceptual references of urbanization models.

The capacity of public planning and urban instruments to adapt and innovate through understanding of contemporary urbanization processes should be guided by the goal of developing multiscale and multifunctional territories (Alves et al., 2024; Mello et al., 2020). It is essential to move beyond the polarized debate between dispersed city and compact city and instead focus on constructing a new model of urbanism that integrates local demands with the regional aspects of urbanization, as evidenced by urban sprawl.

This paper is part of the results of Grant No. 2022/01583-9 from Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP-São Paulo Research Foundation) and Grant No. 307498/2023-9 from Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq -National Council for Scientific and Technological Development).

The translation was supported by the Programa de Pós Graduação em Arquitetura e Urbanismo (PPGAU-Graduate Program in Architecture and Urbanism) at the Instituto de Arquitetura e Urbanismo (IAU-Institute of Architecture and Urbanism).

REFERENCES

Alves, A., van Opstal, C., Keijzer, N., Sutton, N., & Che, W. S. (2024). Planning the multifunctionality of nature-based solutions in urban spaces. *Cities, 146*, 1-16. https://doi.org/10.1016/j.cities.2023.104751

Amenós Álamo, J., & Fernández Scagliusi, M. A. (2014). Recensiones. *Revista de Estudios de la Administración Local y Autonómica*, *1*, 175-180. https://doi.org/10.24965/reala.v0i1.10147

Araujo, E. C. (2016). Processos recentes de urbanização em território fluminense: o fenômeno da dispersão sob a ótica da influência de grandes projetos urbanos. In R. Ojima, & E. Marandola Junior (Eds.), *Dispersão urbana e mobilidade populacional: implicações para o planejamento urbano e regional* (pp. 91-111). Blucher. https://www.researchgate.net/publication/315013772_Processos_Recentes_de_Urbanizacao_em_Territorio_Fluminense_O_Fenomeno_da_Dispersao_Sob_a_Otica_da_Influencia_de_Grandes_Projetos_Urbanos

Artmann, M., Inostroza, L., & Fan, P. (2019). Urban sprawl, compact urban development and green cities. How much do we know, how much do we agree? *Ecological Indicators*, *96*(2), 3-9. https://doi.org/10.1016/j.ecolind.2018.10.059

Berghauser Pont, M. Y., Perg, P. G., Haupt P A., & Heyman, A. (2020). A systematic review of the scientifically demonstrated effects of densification. In *IOP Conference Series: Earth and Environmental Science, 588*, 1.15-1.19. https://doi.org/10.1088/1755-1315/588/5/052031

Bonduki, N. G., & Rolnik, R. (1979). Periferias: ocupação do espaço e reprodução da força de trabalho. *Cadernos de Estudos e Pesquisa, 2,* 130. https://pesquisa.bvsalud.org/portal/resource/pt/ens-35368

Botelho, A. (2009). A cidade dispersa: uma nova escala da urbanização contemporânea. In N. G. Reis (Ed.), *Sobre dispersão urbana* (pp. 275-294). Via das Artes.

Brasil, Ministério das Cidades, Instituto de Políticas de Transporte e Desenvolvimento Brasil, & Instituto Nacional de Pesquisas Espaciais. (2017). *Estudo*

Técnico. Adaptação às mudanças climáticas na mobilidade urbana. ITDP. https://antigo.mdr.gov.br/images/stories/ArquivosSEMOB/ArquivosPDF/Estudo_T%C3%A9cnico_-_Adapta%C3%A7%C3%A3o_%C3%A0s_mudan%C3%A7as_clim%C3%A1ticas_na_Mobilidade_Urbana.pdf

Bruegmann, R. (2011). *La dispersión urbana. Una historia condensada*. Comunidad de Madrid, Consejería de Medio Ambiente y Ordenación del Territorio.

Caldeira, T. P. R. (2000). *Cidade de muros: crime, segregação e cidadania em São Paulo*. Editora 34. https://csociais.wordpress.com/wp-content/uploads/2014/05/caldeira-teresa-a-cidade-de-muros-completo.pdf

Catalão, I. (2015). Dispersão urbana: apontamentos para um debate. *Revista Cidades, 12*(21), 250-277. https://doi.org/10.36661/2448-1092.2015v12n21.11943

Chatel, C., & Sposito, M. E. B. (2015). Forma e dispersão urbanas no Brasil: fatos e hipóteses. *Revista Cidades*, *12*(21), 108-152. https://doi.org/10.36661/2448-1092.2015v12n21.11938

Choay, F. (1999). O reino do urbano e a morte da cidade. *Projeto História. Revista do Programa de Estudos Pós-Graduados de História*, *18*, 67-89. https://revistas.pucsp.br/index.php/revph/article/view/10977/8097

Cordovil, F. C. S., & Barbosa, L. C. (2019). Dispersão e mobilidade urbana no Brasil: estudo de um aglomerado urbano. *Bitácora Urbano Territorial*, *29*(3), 21-30.

Dematteis, G. (1996). Suburbanización y periurbanización. Ciudades anglosajonas y ciudades latinas. In F. J. Monclús (Ed.), *La ciudad dispersa. Suburbanización y nuevas periferias.* Centre de Cultura Contemporània de Barcelona. https://planificacionyterritorio.wordpress.com/wp-content/uploads/2015/05/c_anglosaj_y_c_latinas_giuseppe_dematteis.pdf

Dematteis, G. (2015). Contraurbanização, periurbanização, cidade dispersa e rede de cidades na Itália. *Revista Cidades*, *12*(21), 14-34. https://doi.org/10.36661/2448-1092.2015v12n21.11933

Domingues, A. (2008). Urbanização extensiva. Uma nova escala para o planeamento. In *CITTA 1st Annual Conference on Planning Research.* Faculdade de Engenharia da Universidade do Porto.

Fishman, R. (1990). Metropolis unbound: the new city of the twentieth century. *Flux*, 1, 43-55. https://www.persee.fr/doc/flux_1154-2721_1990_num_6_1_1172

Gomez Maturano, R. (2022). Análisis multiescalar y multidimensional en la transformación de la segregación residencial en la Ciudad de México. *Espacialidades*, *12*(1), 32-52. http://espacialidades.cua.uam.mx/lts/index.php/espacialidades/article/view/226

Guevara, T. (2015). Abordajes teóricos sobre las transformaciones sociales, económicas y territoriales en las ciudades latinoamericanas contemporáneas. *EURE*, *41*(124), 5-24. http://dx.doi.org/10.4067/S0250-71612015000400001

Holzer, W. (2016). A urbanização dispersa e seu incremento pelo Programa "Minha Casa, Minha Vida": O caso de Maricá-RJ. In R. Ojima, & E. Marandola

Junior (Eds.), *Dispersão urbana e mobilidade populacional: implicações para o planejamento urbano e regional* (pp. 71-89). Blucher.

Instituto Brasileiro de Geografia e Estatística. (2017). *Tipologia intraurbana: espaços de diferenciação socioeconômica nas concentrações urbanas do Brasil*. IBGE. https://geoftp.ibge.gov.br/organizacao_do_territorio/tipologias_do_territorio/tipologia_intraurbana/Tipologia_Intraurbana.pdf

Indovina, F. (2009). *Dalla città diffusa all'arcipelago metropolitano* (1st ed). FrancoAngeli. https://www.francoangeli.it/Libro/Dalla-citt%C3%A0-diffusa-all%27arcipelago-metropolitano?Id=17509

Keil, R. (2020). The density dilemma: there is always too much and too little of it. *Urban Geography*, *41*(10), 1284-1293. https://doi.org/10.1080/02723638.2020.1850025

Leonelli, G. C. V. , Mocci, M. A., & Maia, A. C. (2019). Área urbanizada e urbanizável: o incentivo à morfologia dispersa em cidades médias brasileiras. In *8ª Conferência PNUM (Portuguese-language Network of Urban Morphology),* Maringá-PR, 299-312.

Maturano, R. G. (2022). Análisis multiescalar y multidimensional en la transformación de la segregación residencial en la Ciudad de México. *Espacialidade*, 12(01), 35-52. https://doi.org/10.24275/uam/cua/dcsh/esp/2022v12n1/Gomez

Mello, K. de, Taniwaki, R. H., Paula, F. R., Valente, R. A., Randhir, T. O., Macedo, D. R., Leal, C. G., Rodrigues, C. B., & Hughes, R. M. (2020). Multiscale land use impacts on water quality: Assessment, planning, and future perspectives in Brazil. *Journal of Environmental Management*, 270, 1-16. https://doi.org/10.1016/j.jenvman.2020.110879.

Monclús, F. J. (1996). Suburbanización y nuevas periferias. Perspectivas geográfico-urbanísticas. In F. J. Monclús (Ed.), *La ciudad dispersa. Suburbanización y nuevas periferias*. Centre de Cultura Contemporània de Barcelona.

Monte-Mór, R. L., & Linhares, L. (2009). Urbanização extensiva: Expressões no Brasil. In N. G. Reis (Ed.), *Sobre dispersão urbana* (pp. 147-169). Via das Artes.

Monteiro, L. M., & Novaes, G. B. de A. (2020). Impactos da morfologia da cidade nas condições microclimáticas de áreas urbanas consolidadas em dias quentes. *PosFAUUSP*, *27*(51), 1-21. https://doi.org/10.11606/issn.2317-2762.posfau.2020.168232

Montejano Escamilla, J. A. (2013). Nuevos procesos de metropolización del territorio. *Espacialidades*, *3*(2), 34-66. http://espacialidades.cua.uam.mx/ojs/index.php/espacialidades/article/view/70

Ojima, R. (2007). Dimensões da urbanização dispersa e proposta metodológica para estudos comparativos: uma abordagem socioespacial em aglomerações urbanas brasileiras. *Revista Brasileira de Estudos de População*, *24*, 277–300. https://doi.org/10.1590/S0102-30982007000200007

Ojima, R., Monteiro, F. F., & do Nascimento, T. C. L. (2015). Urbanização dispersa e mobilidade no contexto metropolitano de Natal: a dinâmica da população e a ampliação do espaço de vida. *Urbe. Revista Brasileira de Gestão Urbana*, *7*(1), 9–20. https://doi.org/10.1590/2175-3369.007.001.AO01

Painel Brasileiro de Mudanças Climáticas. (2016). *Mudanças climáticas e cidades. Relatório especial do painel brasileiro de mudanças climáticas*. COPPE–UFRJ. http://www.pbmc.coppe.ufrj.br/pt/publicacoes/relatorios-pbmc/item/relatorio-especial-mudancas-climaticas-e-cidades?category_id=18

Pérez, F. (2020). 'The miracle of density': The socio-material epistemics of urban densification. *International Journal of Urban and Regional Research*, *44*(4), 617-635. https://doi.org/10.1111/1468-2427.12874

Pescatori, C., & Faria, R. de (2019). Por uma leitura historiográfica da dispersão urbana. *Revista Jatobá, 1*, 1-20. https://doi.org/10.54686/revjat.v1i.61697

Reis, N. G. (2006). *Notas sobre urbanização dispersa e novas formas de tecido urbano*. 1st ed. Via das Artes.

Reis, N. G. (2007). Sobre a dispersão em São Paulo. In N. G. Reis, N. Portas, & M. S. Tanaka (Eds.), *Dispersão urbana: Diálogos sobre pesquisas Brasil-Europa* (pp. 35-47). FAU-USP.

Reis, N. G. (2015). Dispersão urbana e modernização capitalista. *Revista Cidades, 12*(21), 92-107. https://doi.org/10.36661/2448-1092.2015v12n21.11936

Rosário, N. E., & Tavares, J. (2023). Processos de urbanização e o quadro de poluição atmosférica no Estado de São Paulo. In J. Tavares, & R. Anelli (Eds.). *Notas introdutórias sobre infraestruturas e mudança climática* (pp. 61-74). Instituto de Editorial Casa. https://www.livrosabertos.abcd.usp.br/portaldelivrosUSP/catalog/view/1219/1114/4222

Secchi, B. (2007). A cidade contemporânea e seu projeto. In N. G. Reis, N. Portas, & M. S. Tanaka (Eds.), *Dispersão urbana: Diálogos sobre pesquisas Brasil-Europa* (pp. 111–139). FAU-USP.

Sieverts, T. (2007). Do transbordamento entre cidades (zwischenstadt) às cidades regionais. In N. G. Reis, N. Portas, & M. S. Tanaka (Eds.), *Dispersão urbana: Diálogos sobre pesquisas Brasil–Europa* (pp. 297-311). FAU-USP.

Silva, C. P. C. (2016). *Alphaville e a (des)construção da cidade no Brasil* [Doctoral dissertation, Universidade de Brasília]. UnB. http://www.rlbea.unb.br/jspui/handle/10482/31571

Silva, O. T. (2016). *O ponto de ruptura: reestruturação espacial na região metropolitana do Rio de Janeiro.* [Doctoral dissertation, Universidade de São Paulo]. USP. http://www.teses.usp.br/teses/disponiveis/8/8136/tde-10042017-124411/

Sposito, M. E. B. (1991). Estruturação urbana e centralidade. In *Encuentro de geógrafos de América Latina.* Toluca, México. 44-55 http://www.observatoriogeograficoamericalatina.org.mx/egal3/Geografiasocioeconomica/Geografiaurbana/04.pdf

Sposito, M. E. B. (2009). Urbanização difusa e cidades dispersas: Perspectivas espaço-temporais contemporâneas. In N. G. Reis (Ed.), *Sobre dispersão urbana* (pp. 35-54). Via das Artes.

Stewart, I. D., & Oke, T. R. (2012). Local climate zones for urban temperature studies. *Bulletin of the American Meteorological Society*, *93*(12), 1879-1900. https://doi.org/10.1175/BAMS-D-11-00019.1

Tavares, J. C., Gonçalves, A. V. S., Rosas, J. C. S. V. C., & Lima, M. G. S. (2020). Urbanismo, planejamento e saúde. Nova centralidade urbana em cidades metropolizadas, no Brasil [Conference presentation]. In *Seminario Latinoamericano. Áreas Metropolitanas, Salud Territorial e* Incertidumbre [Virtual event].

Trindade Júnior, S. C. (2015). Cidades e centralidades urbanas na Amazônia: dos diferentes ordenamentos territoriais ao processo de urbanização difusa. *Revista Cidades*, *12*(21), 305-334. https://doi.org/10.36661/2448-1092.2015v12n21.11945

Villaça, F. (2001). Espaço intra-urbano no Brasil. 2nd ed. Studio Nobel, FAPESP, Lincoln Institute.