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ABSTRACT

Extreme climate events have intensely affected the urban territory, becoming a systemic threat to cities in general. Faced with the growing concentration of people and economic activities in cities, Metropolitan Regions are becoming victims of environmental disasters. This article seeks to understand whether Master Plans at different scales have incorporated concepts that represent new approaches to urban and regional planning. Therefore, the presence of the terms Climate Change, Nature-Based Solutions, Ecosystem Services, and Green Infrastructure were investigated in the Master Plans and the Development Guide of the Integrated Urban Development Plan of the Metropolitan Region of Vale do Paraíba and the Northern Coast. This study points out that there is a lack of alignment and coordination between the Master Plans with regard to the new planning guidelines for addressing climate change and emphasizes that the Integrated Urban Development Plan can serve as a benchmark in the development of the next municipal Master Plans if it overcomes the challenges of articulation and interfederative cooperation.

Keywords: Climate Change. Nature-Based Solutions. Ecosystem Services. Green Infrastructure. Urban Planning.

RESUMO

Os eventos climáticos extremos têm afetado de maneira intensa o território urbano, tornando-se uma ameaça sistêmica às cidades de maneira geral. Diante da crescente concentração de pessoas e atividades econômicas nas cidades, as Regiões Metropolitanas passaram a ser vítimas dos desastres de cunho ambiental. Esta pesquisa busca compreender se os Planos Diretores em diferentes escalas têm incorporado os conceitos que representam as novas abordagens de Planejamento Urbano e Regional. Para tanto, investigou-se a presença dos termos Mudança Climática, Soluções Baseadas na Natureza, Serviços Ecossistêmicos e Infraestrutura Verde nos Planos Diretores e nos Cadernos de elaboração do Plano de Desenvolvimento Urbano Integrado da Região Metropolitana do Vale do Paraíba e Litoral Norte. Este estudo aponta que há falta de alinhamento e de coordenação entre os Planos Diretores no que se refere às novas diretrizes de planejamento para o enfrentamento das mudanças climáticas e ressalta que o Plano de Desenvolvimento Urbano Integrado pode servir como balizador na elaboração dos próximos Planos Diretores municipais se superar os desafios de articulação e de cooperação interfederativa.

Palavras-chave: Mudança Climática. Soluções Baseadas na Natureza. Serviços Ecossistêmicos. Infraestrutura Verde. Planejamento Urbano.

INTRODUCTION

Climate change has caused substantial losses to cities, affecting the lives of billions of people around the world and becoming one of the biggest threats to humanity in this century. We understand that the vulnerability of cities, in view of climate change, emerges from several dramatic transformations that occurred in the urban territory itself, and its expansion into risk areas that exposes the population and infrastructure to disasters (IPCC, 2014). Furthermore, according to Habitar (2020), there is a trend of growing urbanization expected for the next decade: the world population will increase from 56.2% to 60.4% by the year 2030, which may raise the number of people who live in cities to over 6 billion by the year 2045.

This process of concentration and urban growth increasingly exposes the population to environmental disasters, leading to increased public and private costs, especially given the more frequent occurrence of extreme climate events in cities (Habitat, 2020). In large urban areas of the Global South, urban growth and concentration of population have been characterized by significant socioeconomic inequalities, increased poverty, and intensified risk scenarios.

The progressive soil sealing, especially due to the large amount of concrete and asphalt (gray infrastructure) still represents a large portion of urban infrastructure, as well as the traditional drainage systems, traffic routes, and rectification of rivers and urban streams. Additionally, urban expansion continues to negatively impact the proportion of green areas in cities. The loss of green areas also results in the loss of social and environmental benefits they provide, such as positive effects on rainwater infiltration (Bolund; Hunhammar, 1999), people's mental and physical health (Maas *et al*., 2006), and the capacity for resilience in terms of climate change (Villanova, 2022).

Modern cities have ended up being planned in a disconnected way from the natural systems (Marques *et al.,* 2021), using and drastically changing the natural environments. Thus, they lose their capacity to provide Ecosystem Services (ES), which consist of the benefits directly to the population arising from flows and processes inherent to nature, such as the prevention of landslides, flash floods, and urban floods (TEEB, 2011).

As a result, planning solutions considered as new sustainable urban archetypes gain recognition in the academy, with the Non-Governmental Organizations (NGOs), funding agencies, and public managers. The new paradigms of urban development, based on the integration between cities and the natural environment, are directly involved in tackling the effects of climate change. According to Pozoukidou (2020), alternative strategies to the traditional "gray infrastructure" have exponentially increased over the past years, such as the adoption of Nature-Based Solutions (NBS) and Green Infrastructure (GI), which are alternatives and valuable complements when compared to more costly and complex measures (Macedo, 2019) and to the interest in adding NBS and GI in the land management and planning.

Urban areas benefit when there is a planning oriented to GI and NBS, not only due to better adaptation to climate change but also because of several ecosystem services provided, such as the regulation of processes that improve urban environmental conditions by mitigating air pollution; the reduction of urban heat islands; protection of natural *habitats* in view of growing urban expansion; and fragmentation of open areas (Santiago-Ramos; Hurtado-Rodríguez, 2022). Therefore, the State and the municipalities are expected to incorporate, in their land management plans, such strategies to address climate change. The metropolitan plans will increasingly have to coordinate policies, not

only for regional development but especially for addressing the obstacles to the development, the so-called social inequalities (*Observatório das Metrópoles*, 2022) and climate change (Lombardo, 2009) that are elements of a vicious cycle, in which the poorest social groups are disproportionately affected by the effects of climate change. This causes an increase in poverty and further inequalities (Islam; Winkel, 2017).

Therefore, the general objective of this article is to analyze the Master Plans (MP) of the municipalities belonging to the Metropolitan Region of Vale do Paraíba and the Northern Coast (MRVPNC)[1] and the Integrated Urban Development Plan (IUDP) of the region, seeking to identify whether they deal with these new concepts that are becoming more prevalent in the academy, NGOs, and funding agencies. This article aims to explore whether there is a coordination of guidelines and goals between the municipal and metropolitan Master Plans with regard to mitigation and adaptation actions to climate change.

In terms of methodological procedures, this research uses methodological procedures based on the technique of indirect documentation. To that end, it uses sources from official authorities that provide legislation to be consulted in the documents of the municipal and IUDP Master Plans of the studied region. The data collected from these laws has been carefully structured into a table, making it possible to analyze whether the studied terms are present or absent. A literature review has also been conducted on the topic, focusing on studies published in the past 10 years, which considered papers and technical and scientific articles included in the following research platforms: Google Scholar, Redalyc, and ScienceDirect. The selected terms (in English and Portuguese) were Climate Change, Nature-Based Solutions, Ecosystem Services, Green Infrastructure, Public Policies, Master Plan, and Integrated Urban Development Plan.

In total, this study has analyzed the plans of 39 municipalities of the MRVP and the Northern Coast. Initially, as exploratory research aiming at broadening the understanding of the interfederative context of the MRVPNC in addressing climate challenges, the concepts of Ecosystem Services, Nature-Based Solutions, and Green Infrastructure are presented, then moving on to the presentation of the MRVP and the Northern Coast, as well as the Integrated Urban Development Plan of the region.

1 The MRVPNC IUDP is currently under development. For this reason, this study uses the Evaluation Guides and the proposals created so far.

Following that, the Master Plans and the New Paradigms of Urban Planning were discussed, subsequently presenting the evaluation results of the 39 municipalities' plans and ending with a reflection on the presence and use of the terms. The scope of this research does not cover an analysis of the effectiveness of the plans or implementation of these new paradigms. It is expected that this analysis may contribute to the regional planning segment and, more specifically, the construction of metropolitan plans since the Metropolitan Regions are facing challenges of articulation and interfederative cooperation in developing the IUDP (Pinto; Siqueira, 2019).

ECOSYSTEM SERVICES, NATURE-BASED SOLUTIONS, AND GREEN INFRASTRUCTURE

The 2020s is the Decade of Action, when the governments at different levels, civil society, and the private sector have intensified efforts in order to achieve the Sustainable Development Goals (SDG), urging solutions for several world dilemmas, among them, the actions to tackle climate change. Cities have become the main focus of actions due to their growing urbanization and socio-spatial vulnerability (Habitat, 2020). Nature, processes, and flows have started to be valued due to social and economic losses incurred following extreme climate events (Fraga; Sayago, 2020).

The increased extreme events in urban areas, associated with the growing incapacity of local governments to expand gray structures in a safe and fair manner, gave new meaning to the natural environment and a range of natural benefits, commonly known as Ecosystem Services (ES), as healthy ecosystems are the foundation for sustainable cities, influencing and affecting human well-being and the most local economic activities (TEEB, 2011).

According to *IPBES* (2019) and Omare (2022), Ecosystem Services are the benefits that nature offers to people and are classified into three categories: regulation, which covers ecosystem services involving the regulation of ecosystem processes (climate regulation or water purification); non-material, which corresponds to the non-material benefits provided by ecosystems (spiritual and cultural services); and material, which covers the material products obtained from ecosystems (food and water). The purpose of this structure is to enable an understanding of the practical use of ecosystem services in public policies (*IPBES*, 2019).

Consequently, new approaches to urban planning have received attention from the academy, government, and organized civil society, and have found space in municipal and metropolitan master plans, creating paths towards a more resilient urban system in view of climate change (TEEB, 2011; Santiago-Ramos; Hurtado-Rodríguez, 2022).

Among the new approaches, Nature-Based Solutions (NBS) are inspired by natural processes, and their objective is to produce social, economic, and environmental benefits. This term has emerged from debates about climate change and quickly turned into an "umbrella" concept that seeks to represent solutions based on natural processes, aiming at the provision and maintenance of ecosystem services (Fraga; Sayago, 2020). In this category, there are the following ecosystem restoration approaches: forest landscape restoration; ecosystem-based management, such as integrated coastal and river basin management; ecosystem protection, such as the creation of protected areas; and natural or green infrastructure (Fraga; Sayago, 2020).

The term Green Infrastructure was first used by Charles Little (1990) in order to describe a networked assemblage of natural landforms and green open spaces that create alternatives to municipal or regional infrastructure and, since then, GI has been recognized as a network of multifunctional natural ecosystems at different spatial scales (Adegun, 2017). Hence, GI offers significant benefits to the urban environment, with its primary roles focused on the improvement of the ecosystem services provision and biodiversity conservation, expanding the permeability of cities and implementing the change from a gray infrastructure to a green-gray infrastructure (Benedict; Mcmahon, 2002; Kopperoinen; Itkonen; Niemelä, 2014).

It is argued that, in an environment filled with climate uncertainties, NBS contribute to the resilience of cities, with a greater capacity of socioecological systems to absorb impacts, preserving their functions and reducing human exposure to risks. Faced with cities increasingly impacted by negative effects arising from climate change, making this space more resilient ensures their long-term sustainability, increasing social learning and adaptive capacity (Kabisch *et al.,* 2017).

MASTER PLANS

The rapid growth of the urban population from the 1960s onwards, combined with the growth of the metropolises, which housed everything from industries to slums, resulted in a change in the perspective on urbanism that had been advocated until then. Brazilian metropolises and cities have become the target of new problems, making it necessary to have the tools for urban reform and democratization of urban management (Monte-Mór, 2008).

During the 1988 constituent process, a movement fought to include, in the constitutional text, tools that would define the social function of the city in its conception phase. A platform, built in the 1960s in the country, was brought up to date by this movement. Hence, the initiatives for building a regulatory milestone at the federal level for urban policy refer to bills related to urban development created by the Brazilian Council of Urban Development in the 1970s. For the first time, the Constitution covered a specific chapter dedicated to urban policy that provided tools to assure, in the context of each municipality, the rights to the city, the social function of the city, property, and the democratization of urban management (*Instituto Polis*, 2020).

Given that the Constitution acknowledges the Master Plans as the key tools to implement development and urban expansion policies, in the 1990s, when planning and management were democratically structured, environmental issues found a place on the public agenda. Brazil started to include environmental issues in urban management, and concerns about social development started to share space with the environmental agenda, creating conflicts, such as land management for economic growth and conservational interests (Ultramari; Firkowski, 2012).

An important step for urban development is the Statute of the City,[2] established in 2001, with the purpose of offering tools for the democratization of planning and management, as well as land use regulation, to tackle property speculation and assure social, environmental, and economic sustainability in cities.

In that respect, the discussion about the Master Plans arises since its creation is mandatory for cities with the following characteristics: with over 20,000 inhabitants or that are part of metropolitan regions and urban agglomerations; that are part of tourist interest areas; inserted in areas affected by

2 Law no. 10,257 dated July 10, 2001.

activities or developments with considerable environmental impact at national or regional level; that are part of the national municipal registry with areas that are susceptible to significant landslides, floods, or other relevant hydrological and geological processes (*Instituto Pópolis*, 2001). Therefore, the Master Plan is also a vital tool for regional and metropolitan planning and needs to be integrated into the metropolitan land management strategy.

The IUDP/MRVPNC

Growing urbanization has been considered a megatrend, both worldwide and in the MRVPNC, considering its coverage and extent, since it covers issues ranging from the economic aspect to environmental sustainability (Elmqvist *et al.,* 2013). Factors, such as population growth, the transition from rural to urban lands, and rural-urban migration, are increasingly intensifying this process (IUDP/MRVPNC Final Proposal Guide, page 13, 2022).

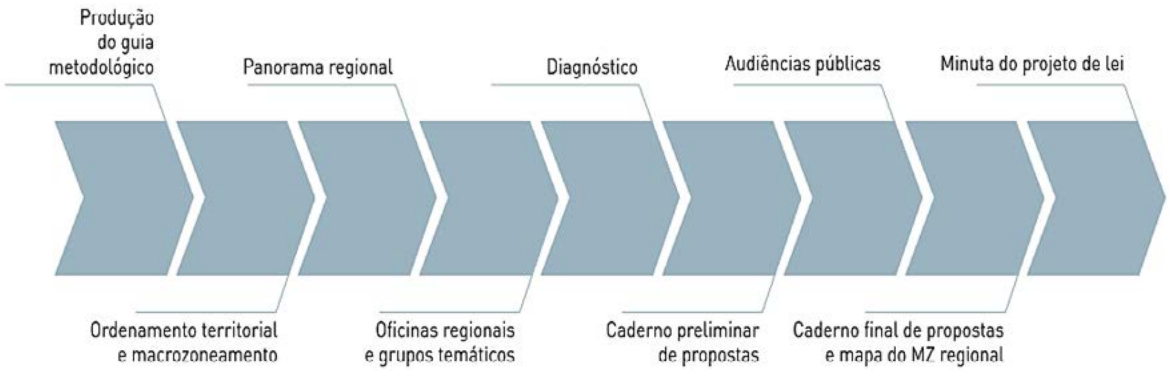
The region where the MRVPNC is located presents a huge potential for geographical interconnection due to its exact location between the inland of the state and the northern coast of São Paulo and surrounded by two national metropolises. These aspects are particularly important, especially regarding regional urbanization and management. Based on Law no. 1,166 dated January 9, 2012, the MRVPNC was created with 39 municipalities located between the two main capitals of the country: Rio de Janeiro and São Paulo. With a high level of wealth and 2.4 billion inhabitants, the MRVPNC has about 65.7% of its population centered in the six cities with over 100,000 inhabitants: Jacareí, Guaratinguetá, Taubaté, Pindamonhangaba, São José dos Campos, and Caraguatatuba (IPRS, 2014). In this region, there is a valuable environmental heritage with Atlantic Forest remnants, large regions of Integral Protection and Sustainable Use Conservation Areas, and plenty of water resources.

The land planning of the MRVPNC is challenging, both in terms of creation and approval of the IUDP (Travassos; Zioni, 2019). One challenge concerns Brazilian federalism, municipal autonomy, and lack of joint efforts that imply serious impediments to addressing urban problems, as regional development often ends up being at the mercy of the political will of the municipal governments (Pinto; Siqueira, 2019).

In view of the diversity of interests involved and considering that the IUDP should be revised every decade, the methodological process for building the current IUDP sought the alignment of topics, the relationship between the state and municipal governments and their respective roles, as well as the inclusion of contributions and results from the participatory social process, to create guidelines and proposals applied to the study of the five Regional Units, including the MRVPNC.

Categories of study have been defined to uphold the bill on the IUDP, with macrozoning and proposals structured regarding the public roles of common interest, based on the Evaluation Guide, Method and Participatory Process Guide, Final Proposal Guide (P13), which are the technical foundation of the IUDP law (IUDP/MRVPNC P15, 2022). Figure 1 illustrates the technical production of the IUDPs.

Figure 1 | Technical production of the IUDP



Source: IUDP/MRVPNC P15 (2022, page 7).

Key: Production of the methodological guide – Land management and macrozoning – Regional overview – Regional workshops and thematic groups – Evaluation – Preliminary Proposal Guide – Public hearings – Final proposal guide and regional MZ map – Draft bill

As stated in the P15 guide regarding the participatory process, regional workshops, group meetings on specific topics, and public hearings were conducted, and contributions to the development of the IUDPs were selected. Also, several actors were involved in multiple phases using a range of tools and communication channels, such as working groups, digital platforms, public hearings, and regional workshops. Therefore, many documents[3] have been produced during the whole process.

3 Integrated Urban Development Plan. Available at: https://rmvpln.pdui.sp.gov.br/. Accessed on: May 4, 2023.

NEW APPROACHES IN PLANNING THE MRVPNC

Considering the historical journey of Master Plans in Brazil, we wonder how such plans have incorporated new approaches in urban planning, which intend to overcome threats of intense, exclusive, and unequal urbanization in order to tackle losses arising from extreme climate events. To determine whether the Master Plans are incorporating these new approaches in urban development, this study conducted a survey of the MPs of the municipalities belonging to the MRVPNC to assess their understanding of these new approaches by identifying the presence of the following terms in their texts: Climate Change (CC),[4] Nature-Based Solutions (NBS), Ecosystem Services (ES), and Green Infrastructure (GI).

According to Benedict and Mcmahon (2002), and Escobedo (2018), the choice of these terms is reasonable, even though they are recent in literature and the academy, because such language has been frequently used by NGOs,[5] government, municipal master plans, international agreements (São José dos Campos, 2018; São Paulo, 2021a; 2021b; COP26),[6] and international funding agencies.[7]

Once the existence of these terms in the Master Plans was verified, the contexts in which these terms appeared were also identified. The same process was also applied to the reading of the preliminary guides consulted:[8] the Preliminary Proposal Guide – the Metropolitan Region of Vale do Paraíba and the Northern Coast (P10); the Final Proposal Guide – the Metropolitan Region of Vale do Paraíba and the Northern Coast (P13); and the Support Guide to the Bill: Method and Participatory Process (P15).

It is noteworthy that, until the end of the development process of this paper, the MRVPNC IUDP had not yet been created under the law. Given these circumstances and recognizing that it is an extensive and complex process that involves the conception of many documents, it is believed that analyzing these guides enabled us to identify whether the guidelines of the future plan address the new paradigms of urban development for the MRVPNC. Table 1 illustrates the presence (or not) of the terms in the guides of the IUDP.

4 Here, similar terms have also been considered, such as “climate event” and “climatic change”.
5 The Nature Conservancy *(TNC Brasil);* World Resources Institute *(WRI Brasil); Conservação Internacional (CI-Brasil).*
6 United Nations. Available at: https://unfccc.int/event/cop-26. Accessed on: Sep. 29, 2022.
7 We have, as an example, the Inter-American Development Bank (IADB), European Investment Bank (EIB), and International Bank (IBRD).
8 IUDP/MRVPNC. Available at: https://rmvpln.pdui.sp.gov.br/. Accessed on: Apr. 11 2023

Table 1 | Presence of the terms in the preliminary documents of the development process of the IUDP/MRVPNC

IUDP/ MRVPNC	TERMS			
	Climate Change	Nature-Based Solutions	Ecosystem Services	Green Infrastructure
	yes	yes	yes	no

Source: Prepared by the authors based on the IUDP/MRVPNC documents of the P10 and P13 guides.

The data was collected in October 2022, without considering any changes made during the development or revision process of Master Plans carried out after this period. During the data collection, it was revealed that the Master Plans from some municipalities were undergoing a revision process. Thus, it was considered the most recent documents (revisions) made available by the municipal authorities. For the municipalities that were conducting revisions not yet accessible to the public (Guaratinguetá and Jacareí), the survey of the terms was conducted in the older Master Plan that was still effective.

Moreover, it was also considered the municipalities that had just the Tourism Master Plans, as the Statute itself points out the importance of tourist cities, even when they have a population of less than 20,000 inhabitants. Table 2 illustrates the presence of the terms under analysis in the Master Plans of the MRVPNC. It is worth emphasizing that the number of inhabitants is based on the last census conducted by the Brazilian Institute of Geography and Statistics (IBGE, 2010).

Table 2 | Presence of the terms in the Master Plans of the MRVPNC

Municipalities	Inhabitants	Master Plan	Law	Terms			
				CC	NBS	ES	GI
Aparecida	35,007	yes	Law no. 3,401/2006	no	no	no	no
Arapeí	2,493	yes	Comp. Law no. 278/2014	no	no	no	no
Areias	3,696	yes	Comp. Law no. 05/2014	no	no	no	no
Bananal	10,223	yes	Comp. Law no. 016/2014	no	no	no	no
Caçapava	84,752	yes	Comp. Law no. 15/2006	no	no	no	no
Cachoeira Paulista	30,091	yes	Law no. 1,558/2006	no	no	no	no
Campos do Jordão	47,789	yes	Law no. 2,737/2003	no	no	no	no
Canas	4,385	no	---	---	---	---	---
Caraguatatuba	100,840	yes	Comp. Law no. 73/2018 + Comp. Law no. 42/2011	yes	no	no	no
Cruzeiro	77,039	yes	Law no. 3,748/2006	no	no	no	no
Cunha	21,866	no	---	---	---	---	---
Guaratinguetá	112,072	yes	Comp. Law no. 23/2006	no	no	no	no
Igaratá	8,831	yes	Comp. Law no. 12/2011	no	no	no	no
Ilhabela	28,196	yes	Law no. 421/2006	no	no	no	no
Jacareí	211,214	yes	Comp. Law no. 49/2003	no	no	no	no
Jambeiro	5,349	yes	Comp. Law no. 83/2020	no	no	no	no
Lagoinha	4,841	no	---	---	---	---	---
Lavrinhas	6,590	no	---	---	---	---	---
Lorena	82,537	yes	Comp. Law no. 82/2010	no	no	no	no
Monteiro Lobato	4,120	yes ***	---	---	---	---	---
Natividade da Serra	6,678	yes	Law no. 706/2017	no	no	no	no
Paraibuna	17,388	no **	Comp. Law no. 72/2017	no	no	no	no
Pindamonhangaba	146,995	yes	Comp. Law no. 66/2022	no	no	no	no
Piquete	14,107	yes**	Comp. Law no. 715/1973 + Ordinary Law no. 2,062	no	no	no	no
Potim	19,397	yes	Comp. Law no. 108/2020	no	no	no	no
Queluz	11,309	yes	Law no. 715/2016	no	no	no	no
Redenção da Serra	3,873	no	---	---	---	---	---
Roseira	9,599	no	---	---	---	---	---
Santa Branca	13,763	no	---	---	---	---	---
Santo Antonio do Pinhal	6,486	yes	Comp. Law no. 03/1999	no	no	no	no
São Bento do Sapucaí	10,468	yes	Comp. Law no. 1,841/ 2016	yes	no	no	no
São José do Barreiro	4,077	no	---	---	---	---	---
São José dos Campos	629,921	yes	Comp. Law no. 612/2018	yes	no	yes	yes
São Luiz do Paraitinga	10,397	yes	Comp. Law no. 1,347/2010 + Law no. 1,458/2011	no	no	no	no
São Sebastião	73,942	yes	Comp. Law no. 263/2021	no	no	no	no
Silveiras	5,792	no	---	---	---	---	---
Taubaté	278,686	yes	Comp. Law no. 412/2017	no	no	no	no
Tremembé	40,984	yes	Comp. Law no. 283/2014	no	no	no	no
Ubatuba	78,801	yes	Law no. 2,892/2006	no	no	no	no

Source: Prepared by the authors based on the IUDP/MRVPNC documents.

The analysis of the P10, P13, and P15 guides of the IUDP/MRVPNC, which were still under development, identified that the terms Climate Change, NBS, and ES appeared in the scope of the guides. Climate Change is recognized by the guides as a megatrend (driver), suggesting mitigation and adaptation measures in cities. The presence of this term is shown especially in the P13 Guide, which promotes the creation of Climate Change Adaptation and Resilience Plans, within the scope of the São Paulo Resilient Municipalities Program, as well as its integration into master plans and regional planning, as outlined below:

> One of the most relevant climate changes is the increased extreme events, such as droughts, floods, and strong winds, among others, which may cause damage to economic activities, infrastructure, and human health. Developing countries, like Brazil, are generally more affected by extreme climate events. This is a consequence of less resilient infrastructure and the insufficient coordination of public prevention and evacuation policies. (IUDP/MRVPNC P13, page 57).

Nature-Based Solutions (NBS) are also shown in the scope of the plan, which promotes their implementation for regulating urban rainwater drainage, and as guidelines subject to be applied to risk areas. This term is found few times in the P13 and P15 Guides and not found in the P10 Guide, leading the reader to understand that further investigation is required to determine which solutions are suggested to be included in this list, given that NBS works as an "umbrella" concept for many approaches related to ecosystem services (Fraga; Sayago, 2020). Also, the P13 Guide explores the need for aligning the conservation of socio-environmental heritage, thus contributing to ecosystem balance, biodiversity protection, and maintenance of ecosystem services necessary for quality of life and sustainable development.

The term Green Infrastructure (GI) is not mentioned in the Guides. However, the P13 Guide discusses the implementation of green corridors, structuring, and expansion of green areas system. Considering that GI can be represented by tree planting, engineering solutions for sustainability, which are environmentally effective in achieving the green-grey integration, as well as by the connection of green areas using green corridors, it can be stated that the essence of this topic is included in the Plan (Franco, 2010; Benedict; Mcmahon, 2002; Villanova, 2022).

In regard to the terms CC, NBS, ES, and GI in the Master Plans of the municipalities belonging to the MRVPNC, we have verified that they are rarely mentioned, including those that were developed

in the past 10 years. Some Master Plans, like that of Campos do Jordão, only mention the need for "protecting climate, natural resources, and landscape", not using any of the terms and not providing details on their implementation, whether through the construction of additional plans or the implementation of programs or projects (Campos do Jordão, 2003, page 2 – art. 8).

Other Master Plans solely discuss the need for developing other plans to address climate change, as shown in the example of Caraguatatuba (2011, art. 41), or implement green areas (2018, art. 43). In the case of São Bento do Sapucaí (2016, page 4 - art. 12), the term CC is mentioned only as a reference to the State Climate Change Policy (Law no. 13,798 dated November 9, 2009, and Decree no. 55,497 dated February 26, 2010).

São José dos Campos was the sole municipality to use most of the terms, offering a more detailed context compared to other municipalities. Its Master Plan highlights the need for increasing resilience in face of severe climate events arising from climate change; investing in new planning aimed at addressing climate change by creating a Municipal Mitigation and Adaptation Plan and structuring integrated actions to manage relevant risks; giving a new meaning to the rivers and urban streams in order to reestablish ES; fostering recognition of ecosystem services provided by implementing urban parks; and adopting the implementation of green infrastructure as a strategy for sustainable development, among others. As stated by Villanova (2022), even though the municipality does not describe what it considers as GI, there is a degree of concern about adopting these new paradigms of urban development.

Therefore, the alignment of guidelines and goals between the municipal and metropolitan Master Plans, regarding the mitigation and adaptation actions to climate changes, represents a challenge to the future MRVPNC IUDP. Although the Statute of the Metropolis (Federal Law no. 13,089/2015) is a legal instrument that sets out the general planning guidelines of the IUDP and the interfederative governance guidelines, the articulation of several municipalities in pursuing coordinated solutions for common problems is not trivial.

The Statute of the Metropolis outlines the need for integration of municipal plans with the Metropolitan Region plan under laws and agreements, also showing the need for joint efforts to address urban problems; however, the experiences of state leadership are still in their early stages, as

a mediator of conflicting interests and unequal capacities, and, at the same time, without imposing the metropolitan interest over the interest of each municipality (Pinto; Siqueira, 2019). On the other hand, municipalities need to understand the metropolitan scale, the impacts of their urban policies on their neighbors, and the structures of Public Function of Common Interest (PFCIs) (IPEA, 2021).

Indeed, the Statute of the Metropolis points out possibilities for metropolitan regional management, interfederative governance, the integrated urban development plan, and the public function of common interest. Notwithstanding, regional development, especially for the MRVPNC, is subject to the political wills of municipal governments, particularly when it comes to the articulation of public functions of common interest. This combination of agendas creates a separation between the regional governance practices and the real needs of the MRVPNC, showing practices and models other than those outlined in the Statute of the Metropolis (Pinto; Siqueira, 2019).

Furthermore, it should be noted that, if the Municipal Plans for the Conservation and Recovery of the Atlantic Forest (MPAF)[9] usually have, in their scope, the terms analyzed, the municipalities are responsible for incorporating these concepts into their Master Plans.

CONCLUSION

In the documents produced in the development process of the MRVPNC IUDP, guidelines are specified for a development plan that fosters new approaches as alternatives to the traditional gray infrastructure. A planning oriented towards Green Infrastructure works in such a way that integrates the ecological dimension and offers a wide range of ecosystem services (Lennon; Scott, 2014). Environmental protection areas, floodplains, and springs, such as Serra da Mantiqueira and Serra do Mar, are important metropolitan green infrastructures for the protection of water resources, emphasizing the need for biodiversity preservation and conservation, by implementing techniques of equalized land use and management (Amorim *et al.,* 2022). In the P10, P13, and P15 Guides of the IUDP, we have noted that the terms CC, NBS, ES, and GI were present; however, most Master Plans still refrain from using them.

9 The Municipal Plan for the Conservation and Recovery of the Atlantic Forest was instituted by Art. 38 of Atlantic Forest Law (No. 11,428) dated December 2006. Available at: http://www.planalto.gov.br/ccivil_03/_ato2004-2006/2006/lei/l11428.htm. Accessed on: May 4, 2023.

After analyzing the Guides produced to support the development of Metropolitan IUDP, it became evident that there is a lack of alignment with the Master Plans regarding the municipalities' efforts to implement new paradigms of urban development in cities. The detailed information in the guides of the IUDP concerning the presence of these concepts and their socio-environmental implications may imply, in a favorable scenario, general guidance for the development of the next municipal Master Plans, seeking land management consistent with new climate challenges. Nonetheless, the municipalities – public authority and population – supported by the IUDP, are responsible for raising interest in these approaches for resilient and environmentally effective urbanization.

Master Plans are important tools for managing cities and are capable of establishing a foundation for the conception of new plans, programs, or projects. How may we expect a resolution of different interests given the varied resources and capacities of municipalities? It is the responsibility of the State to link different interests, in association with the existing conflicts, and overcome the competition provided by the municipal situation of Brazilian federalism (Pinto; Siqueira, 2019).

Additionally, it is understood that building resilience within cities is a process that, even if municipalities are interested in implementing it, there are also essential conditions for its achievement. Therefore, for implementing new paradigms of urban development discussed in this paper, in addition to the interest of municipalities, it is crucial to coordinate actions in the metropolitan scale. This is also because there are issues concerning financing, compensations, and alignment of sectoral policies, as well as the need for expert knowledge by technicians and its acceptance by the population.

São Luiz do Paraitinga has become an example of a municipality where the population's demands received considerable attention. In 2010, a severe flood led to a revision of the Master Plan by the Municipal Law no. 1,458/2011, whose branches of government (Executive, Legislative, and Judiciary) were supportive of the demanded purposes, achieving legal support leading to changes in attitude by corporations concerning the eucalyptus planting, a cause recognized as a practice that worsened the flood. This is a real example that pressure from society - associated with political articulation - is capable of meeting the population's demands, in which exclusively technical solutions would not always meet social interests (Farinaci, 2012). In this case, the Master Plan and its revision have not mentioned the terms searched, evidencing the lack of knowledge or the result of a correlation between local political

strength, existence, applicability, and benefits of implementing them.

It is expected that necessary compliance between the future IUDP and the Master Plans of the municipalities of the MRVPNC creates a dialogue and engagement aimed at seeking inclusion in their new Plans. However, this is a recent approach to metropolitan and regional planning, in which the State and municipalities share decisions in view of the common problems. The IUDP is also responsible for proposing projects and actions aimed at the population's well-being through the improvement of the urban environment (IUDP/MRVPNC, P10).

We understand that some of the Master Plans analyzed in this paper are over 10 years old, and this new language aimed at the resilience of cities was still unknown at the time of its development. Nonetheless, during the data collection, we noted municipalities working on the revision of their Master Plans. Hence, it is expected that this new language may be identified in these new plans.

The municipality of São José dos Campos uses the language that describes, in its land management plan, the new approaches of urban planning, thus justifying and implying further research with case studies and/or comparative studies among municipalities in order to broaden the knowledge about the building of public policies, with challenges and opportunities.

The Integrated Urban Development Plan's role is to inspire the new Master Plans to use these terms representing new paradigms of urban development towards climate resilience. It should be emphasized, however, that the terms included in these public policies should represent real actions in local territories, aiming to make these municipalities more adaptable to climate change and ensuring a safer and more sustainable future.

Finally, new studies and a future research agenda are presented as an opportunity to address climate change by participatory metropolitan and urban planning. In addition to the issues already known by the research agenda for metropolitan planning, such as the challenge of interfederative governance, socioeconomic differences among the municipalities (spatial segregation), and the fragility of the legal and institutional framework, there are specific issues related to Nature-Based Solutions.

As the nature-based approaches may bring solutions to the problems arising from climate change in cities, they are also subject to problems commonly seen in general planning, such as issues regarding social justice, society's effective engagement in planning, and the implementation of

solutions that are mostly built in the Global North. Therefore, the research carried out in this paper, which can be replicated in other metropolitan regions to understand how different locations have dealt with issues related to climate resilience in their public policies, as well as the challenges faced by public managers, is just the beginning of a promising and inspiring research agenda.

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