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Sustainable development in São Paulo's Green Belt Biosphere Reserve: between the void of municipal environmental policies and the ecosystem management of the territory

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Abstract

Introduction: The Green Belt Biosphere Reserve, with 2.33 million hectares and its internal urban area with 220 thousand hectares, is configured as a water security territory and expresses a direct relationship between urban development and areas that ensure well-being and ecosystem services for 12% of Brazil's population. With seventy-eight municipalities that fully or partially integrate the GBBR, the socioeconomic differences and the different contexts of urbanization and governance reflect on territorial management at the local level and impact the environmental and regional sustainable development agendas.
Objective: Based on a survey of environmental policies and correlations between economic and socio-environmental indicators on a municipal scale for the entire study area, this article assesses the level of development of the main environmental public policies and identifies the relationship between these policies and socio-environmental indicators.
Originality: Although the Green Belt Biosphere Reserve is an area recognized by the United Nations (UN), the management of its territory depends on municipal actions that comprise it. Little attention has been paid to environmental management, especially in terms of public environmental policies and a broad and ongoing understanding of the conservation of this area.
Results: The analysis shows that the different municipalities in the GBBR have different levels of implementation regarding Environmental Agenda. When considering the Municipal Plans for Urban Afforestation, Adaptation to Climate Change, Atlantic Forest and Solid Waste, only

Guarujá, Mogi das Cruzes, Santos and São Paulo have these four policies in preparation or completed, while for 33.3% (n=25) of the municipalities, none of these agendas was developed, and a positive correlation was identified between the HDI and the largest number of implemented policies.
Contribution: Large and medium-sized cities in the state of Sao Paulo, Brazil, present studies addressing ecological patterns and processes, however, they do not address specific questions on the environmental sector itself, which this paper aimed at providing.
Conclusion: As the Green Belt accounts for 72% of the volume of drinking water in all of São Paulo, the disparities between the municipal indicators analyzed reinforce the need to adopt the GBBR as a platform for adequate governance to integrate policies at different scales for sustainable regional development. Systemic efforts are needed, especially at the municipal scale, in order to carry out adequate environmental management of the GBBR territory.
Keywords: Sustainable Development Goals. Public policy. Environmental agenda. Climate change.

Desenvolvimento sustentável na Reserva da Biosfera do Cinturão Verde da Cidade de São Paulo: entre o vazio das políticas ambientais municipais e a gestão ecossistêmica do territorio

Resumo

Introdução: A Reserva da Biosfera do Cinturão Verde da Cidade de São Paulo (RBCV), com 2,33 milhões de hectares e sua área urbana interna com 220 mil hectares, configura-se como um território de segurança hídrica e expressa uma relação direta entre desenvolvimento urbano e áreas que garantem bem-estar e serviços ecossistêmicos para 12% da população brasileira. Com setenta e oito municípios que integram total ou parcialmente a RBCV, as diferenças socioeconômicas e os diferentes contextos de urbanização e governança refletem na gestão territorial em nível local e impactam as agendas ambientais e de desenvolvimento sustentável regionais.
Objetivo: A partir do levantamento das políticas ambientais e das correlações entre indicadores econômicos e socioambientais em escala municipal para toda a área de estudo, este artigo avalia o nível de desenvolvimento das principais políticas públicas ambientais e identifica a relação entre essas políticas e os indicadores ambientais.
Originalidade: Embora a Reserva da Biosfera do Cinturão Verde da Cidade de São Paulo seja uma área reconhecida pela Organização das Nações Unidas (ONU), a gestão de seu território depende de ações municipais que a compõe. Pouca atenção tem sido dada à gestão ambiental, principalmente no que diz respeito às políticas públicas ambientais e a uma compreensão mais ampla e permanente da conservação dessa área.
Resultados: A análise mostrou que os diferentes municípios da RBCV têm diferentes níveis de implementação em relação à Agenda Ambiental. Considerando os Planos Municipais de Arborização Urbana, Adaptação às Mudanças Climáticas, Mata Atlântica e Resíduos Sólidos, apenas Guarujá, Mogi das Cruzes, Santos e São Paulo possuem essas quatro políticas em elaboração ou concluídas, enquanto para 33,3% (n=25) dos municípios, nenhuma dessas agendas foi desenvolvida, e foi identificada uma correlação positiva entre o IDH e o maior número de políticas públicas implementadas.
Contribuições: Cidades de grande e médio porte do estado de São Paulo, Brasil, apresentam estudos que abordam padrões e processos ecológicos, porém não abordam questões específicas sobre o setor ambiental propriamente dito, que este trabalho se propôs a fornecer.
Conclusão: Como o Cinturão Verde responde por 72% do volume de água potável de todo o município de São Paulo, as disparidades entre os indicadores municipais analisados reforçam a necessidade de se adotar a RBCV como plataforma para integrar políticas em diferentes escalas para o desenvolvimento sustentável regional. Esforços sistêmicos são necessários, especialmente na escala municipal, para realizar uma gestão ambiental adequada do território na RBCV.

Palavras-chave: Objetivos de Desenvolvimento Sustentável. Políticas públicas. Agenda Ambiental. Mudanças Climáticas.

Desarrollo sostenible en la Reserva de la Biosfera del Cinturón Verde de São Paulo: entre el vacío de las políticas ambientales municipales y la gestión ecosistémica del território

Introducción: La Reserva de la Biosfera Anillo Verde (GBBR), con 2,33 millones de hectáreas y su casco urbano interno con 220 mil hectáreas, se configura como un territorio de seguridad hídrica y expresa una relación directa entre el desarrollo urbano y las áreas que aseguran el bienestar y los servicios ecosistémicos para 12% de la población de Brasil. Con setenta y ocho municipios que integran total o parcialmente la GBBR, las diferencias socioeconómicas y los diferentes contextos de urbanización y gobernanza se reflejan en la gestión territorial a nivel local e impactan en las agendas ambientales y de desarrollo sostenible regional.
Objetivo: A partir de un relevamiento de políticas ambientales y correlaciones entre indicadores económicos y socioambientales a escala municipal para toda la área de estudio, este artículo evalúa el nivel de desarrollo de las principales políticas públicas ambientales e identifica la relación entre estas políticas y los indicadores ambientales.
Originalidad: Si bien la Reserva de la Biosfera del Anillo Verde es un área reconocida por la Organización de las Naciones Unidas (ONU), la gestión de su territorio depende de las actuaciones municipales que la conforman. Se ha prestado poca atención a la gestión ambiental, especialmente en términos de políticas públicas ambientales y una comprensión amplia y permanente de la conservación de esta área.
Resultados: El análisis muestra que los diferentes municipios de la GBBR tienen diferentes niveles de implementación en cuanto a la Agenda Ambiental. Al considerar los Planes Municipales de Forestación Urbana, Adaptación al Cambio Climático, Mata Atlántica y Residuos Sólidos, solo Guarujá, Mogi das Cruzes, Santos y São Paulo tienen estas cuatro políticas en preparación o concluidas, mientras que para 33,3% (n=25) de los municipios, ninguna de estas agendas fue desarrollada, y se identificó una correlación positiva entre el IDH y el mayor número de políticas implementadas.
Contribución: Las ciudades grandes y medianas del estado de Sao Paulo, Brasil, presentan estudios que abordan patrones y procesos ecológicos, sin embargo, no abordan cuestiones específicas sobre el sector ambiental en sí, que este artículo pretendía brindar.
Conclusión: Como el Anillo Verde responde por 72% del volumen de agua potable en todo São Paulo, las disparidades entre los indicadores municipales analizados refuerzan la necesidad de adoptar el GBBR como una plataforma de gobernanza adecuada para integrar políticas en diferentes escalas para sostenible desarrollo regional. Se requieren esfuerzos sistémicos, especialmente a escala municipal, para realizar una adecuada gestión ambiental del territorio GBBR.

Palabras clave: Objetivos de Desarrollo Sostenible. Política pública. Agenda ambiental. Cambio climático.

INTRODUCTION

Biosphere Reserves are “learning places for sustainable development” nominated by national governments and designated under the Man and Biosphere (MAB) Program of the United Nation agency - UNESCO. They are sites for testing interdisciplinary approaches to understand and manage changes between social and ecological systems (UNESCO, 2022).

The World Network of Biosphere Reserves from the MAB Program consists of an interactive and dynamic network of sites that promotes North-South collaboration. The

ecosystem and theme-specific networks include research, capacity building and educational collaborations on drylands, mangroves, marine, costal and island areas; mountains; savannahs; tropical forests, and wetlands. Currently, there are 738 Biosphere Reserves in 134 countries (UNESCO, 2022), areas with defined limits under to sovereign jurisdiction of the states where they are located. These territories are involved in interdisciplinary research to generate knowledge about the interactions between biotic and anthropic environments (Rodrigues et al., 2020).

In 1994, UNESCO recognized the São Paulo Green Belt Biosphere Reserve (GBBR). It is a biosphere reserve that, together with the capital of the state of São Paulo, involves another 77 municipalities, where more than 12.1% of the entire Brazilian population is concentrated in a region responsible for nearly 19% of the Brazilian gross domestic product (GDP) (Victor et al., 2018). This region hosts one of the largest populations on Earth and involves the Metropolitan Region of São Paulo (MRSP) – the fourth largest metropolis in the world (UN-Habitat, 2016). This area faces a severe challenge of anthropic pressure and puts at risk the largest preserved corridor of the Atlantic Forest biome, precisely where GBBR is fully inserted (Rodrigues et al, 2020; UNESCO, 2022).

With approximately 2,33 million hectares, GBBR with its inner urban area (220 thousand hectares) host an expressive terrestrial and marine biodiversity, typical to the Atlantic Forest and Cerrado biomes. The territory of the GBBR provides important ecosystem services essential to human well-being, health, and quality of life of more than 25 million inhabitants. Its benefits include the maintenance of biodiversity; water supply; energy resources; forest products; regularization of air quality; disease and pest control; geological support, such as soil erosion control; and cultural services such as ecological tourism, as well as services aimed at the aesthetics of the environment (Rodrigues, Victor & Barradas, 2020; Casado-Arzuaga Madariaga & Onaindia, 2022).

The conservation and preservation of its natural ecosystems becomes fundamental in the strategic environmental planning of cities of the Green Belt, which had urban development focused on economic and non-environmental aspects (United Nations, 2019; Ferreira et al., 2021). These cities present multiple and complex challenges related to the Sustainable Development Agenda. With growing population and *per capita* consumption, besides intensification of urbanization processes, environmental changes are amplified and generate negative impacts on local, regional and global scales (UNDSDG, 2022). In addition, cities must include adaptation and mitigation actions for climate change in their strategic planning, since this discussion permeates economic, social, and environmental aspects.

As the planet's urban areas concentrate more than half of the global population in only two percent of its territory (UN-Habitat 2020), climate change risks to cities, settlements, and key infrastructure will increase rapidly in the medium to the long term (IPCC 2022

Additional challenges will be imposed to urban planning considering the consequences of global climate change in synergy with the impacts of local change (IPCC, 2021). Cities face drastic problems in land use and other environmental issues, which entails and impacts, e.g., atmospheric and water pollution interfering in public health and biodiversity (Saldiva et al., 2020; Bicudo et al. 2020; Bulbovas et al., 2020; Nakazato et al., 2021; Santanna et al., 2022).

Serious problems that will increase in future climate change scenarios, especially in cities with high social inequality, are water availability and basic sanitation. The network of sewage and the supply of drinking water are priority challenges, that appear in the 2030 Agenda as one of the 17 Sustainable Development Goals – especially regarding “SDG 6, Drinking water and sanitation” (Adell, 2017; Ahmadi et al., 2020; UNSDGS, 2022).

However, it is noteworthy that climate change threatens existing systems that currently affect 2.3 billion people who are not even assisted by basic sanitation service (Dickin et al., 2020). In addition to bringing environmental implications, i.e., emissions associated with the decomposition of organic matter, the lack of sanitation is a potential vector of public health problems (Smith & Woodward, 2015; Bicudo et al., 2020).

This situation mainly affects countries in the global South, which have weak economies and suffer from poor governance and corruption. These attributes currently represent one of the main obstacles to climate finance in low-income countries (Araos et al., 2016; Beard et al., 2022).

A way of strengthening local governance systems and creating efforts to fight corruption is through the development of public programs and policies that consider popular participation from conception to enactment of laws. This is still a challenge for many cities in São Paulo, Brazil’s richest state. Although at the local level, municipalities currently face problems with climate change and the loss of biodiversity. One example is the Atlantic Forest Municipal Plan, the main instrument of the Atlantic Forest Law (Brasil, 2006) that requires that municipalities inserted in this biome develop such policy. The main benefits of this legal instrument are the cartographic base of the entire territory and the selection of priority areas for conservation.

In addition, plans for afforestation and adaptation to climate change help regulating the environmental sector of the municipalities, including the search for incentives to carry out transformative adaptation actions (Amorim-Maia et al., 2022). This becomes more relevant in regions with a special interest in climate change mitigation and biodiversity conservation, as is the case of the GBBR.

Thus, contributions focused on policies can assist transformation actions in different territories. Large and medium-sized cities in the state of São Paulo, Brazil, present studies addressing ecological patterns and processes (Ferreira et al., 2014; Ferreira and Uchiyama, 2015, Ferreira et al., 2018; Ferreira et al., 2019; Arratia et al., 2020), in addition to works that seek indexes to assess environmental quality (Gaudereto et al., 2019) and the promotion of

ecosystem services in urban areas (Sanches et al., 2020; Rodrigues, Victor & Barradas, 2020), however, they do not address specific questions on the environmental sector itself.

On the other hand, UNESCO designated sites, including World Heritage Sites, Global Geoaprques and Biosphere Reserves, constitute focal points of significant value for sustainable development, contributing to the formulation of policies related to the 17 Sustainable Development Goals of the 2030 Agenda (LUO et al., 2022). Therefore, within the scope of systemically understanding the state of the art of environmental policies that can legally protect the GBBR, this study aimed to assess the existence of the main environmental public policies of the GBBR municipalities and to identify the relationship between these policies and socio-environmental indicators.

These issues may reveal regions that deserve priority attention to implement the 2030 Agenda at local level, in addition to strengthening the governance system in the metropolitan regions of Santos and São Paulo. These regions concentrate, respectively, coastal cities and one of the largest urban settlements in the world, vulnerable to the adverse impacts of global climate changes and anthropogenic interferences.

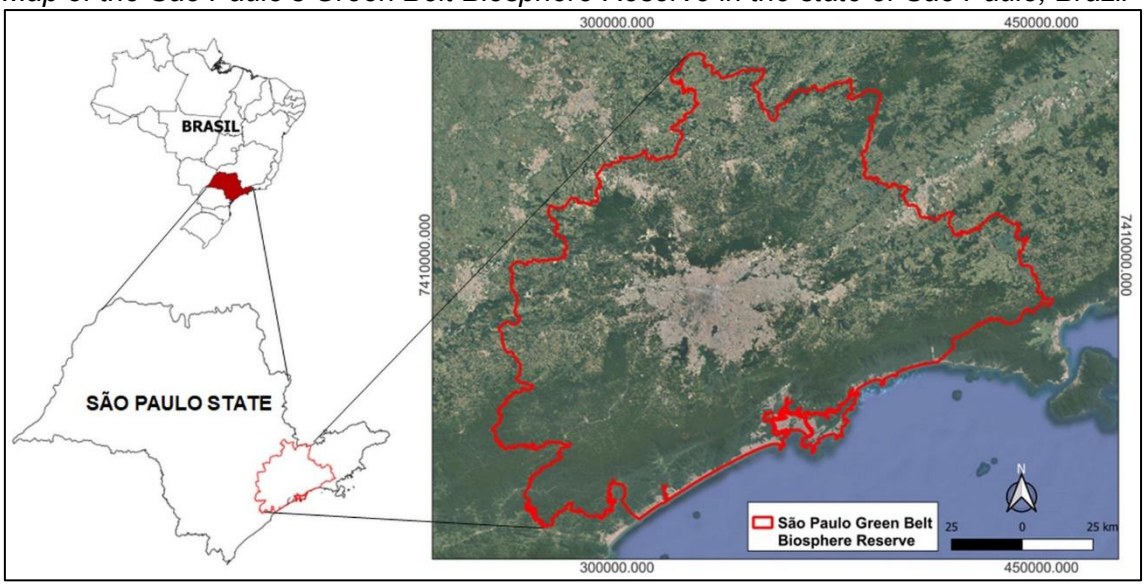
Material and Methods

Study area

The City of São Paulo Green Belt Biosphere Reserve is located in the southeastern part of the State of São Paulo (Figure 1). This area includes the whole metropolitan region of São Paulo, almost the entire metropolitan region of Santos, and partially the metropolitan region of Sorocaba, Campinas, Vale do Paraíba (including the North coast of São Paulo state), São José dos Campos and Registro administrative region, totaling 78 municipalities. They comprise public, private, urban, rural, coastal, and marine areas, including environmental protected territories. The GBBR is home to an expressive biodiversity of terrestrial and marine species, typical of the Atlantic Forest and Cerrado biomes.

Figure 1

Map of the São Paulo's Green Belt Biosphere Reserve in the state of São Paulo, Brazil



Source: Prepared by the authors

Public policy mapping

Firstly, all municipalities belonging to the GBBR were selected. Then, the existence of four environmental public policies of all these municipalities was investigated, namely: Municipal Urban Afforestation Plan (MUAP); Municipal Plan for Adaptation to Climate Change (MPACC); Atlantic Forest Municipal Plan (AFMP); and Municipal Plan for Solid Waste (MPSW).

The policies were represented in our dataset in three stages: i) Non-existent (score 0), ii) In preparation (score 1) and, iii) Finalized and implemented (score 2). For the maps elaboration, a vector (in .shapefile format) containing the municipal limits of the State of São Paulo was used, in a scale of 1:250,000, taken from the website of the official Brazilian Institute of Geography and Statistics (IBGE, 2022a).

Using Quantum GIS software - version 3.22 (QGIS, 2021), a query was carried out in the vector attributes table within the municipal limits to highlight only the 78 municipalities that belonged to the study area.

From this query, a new vector (.shapefile) was elaborated, with only the municipal limits of this study area. In this new table of attributes, the following four new columns were inserted: MUAP, MPACC, AFMP, MPSW.

The database used to fill in these four columns consisted of the double-checked information from the Green and Blue city Program from the Infrastructure and Environment Secretariat of the State of São Paulo (São Paulo, 2022a), as well as from the Brazilian Institute of Geography and Statistics and the municipalities website (IBGE, 2022b), accessed in August

2022.

Socioenvironmental data and statistical analysis

The socioeconomic indicators raised in this study were obtained from the official databases of the Brazilian federal government, through the website of the Brazilian Institute of Geography and Statistics (IBGE, 2022b). This information was the most recent available in this public database. It is important to highlight that, different indicators had been published in different periods by the IBGE, e.g. human development index (2010); Public afforestation (2010); Percentage of sanitary sewage (2010); GDP per capita (2019); and hospitalization for diarrhea (2016).

To understand the multivariate correlations between economic and socio-environmental indicators across all GBBR cities, a principal component analysis (PCA) was carried out. In addition, we sought to understand the grouping of municipalities in terms of the existence of environmental public policies. For this, a presence-absence matrix was set up. Municipalities that had the policy or were preparing it were attributed score 1 (presence), however, the municipality that did not have such policy scored 0 (absence). Data were then categorized by human development index value (HDI) and analyzed by cluster test. The analyzes were performed using the PAST software (Hammer et al., 2001).

Results and Discussion

Environmental public policies in GBBR

The São Paulo Green Belt Biosphere Reserve houses a total of 78 municipalities[1] with different territorial areas, socioeconomic conditions, environmental characteristics, and demography. All these cities are part of the Atlantic Forest biome, covering several phytophysiognomies (Dense Ombrophilous and Semideciduous Forest; Savanna/Dense Ombrophilous Forest; Cerrado; Natural Grasslands; Altitude Forests; Sandbanks and Mangroves) and are under high pressure due to the urbanization process and agrosilvopastoral systems (Weller et al., 2017; 2019; Rodrigues, Victor & Barradas, 2020). The current scenario of land use change threatens biodiversity conservation and underutilizes climate change mitigation potential due to the high capacity of sequestering and storing carbon in its tropical forest compartments.

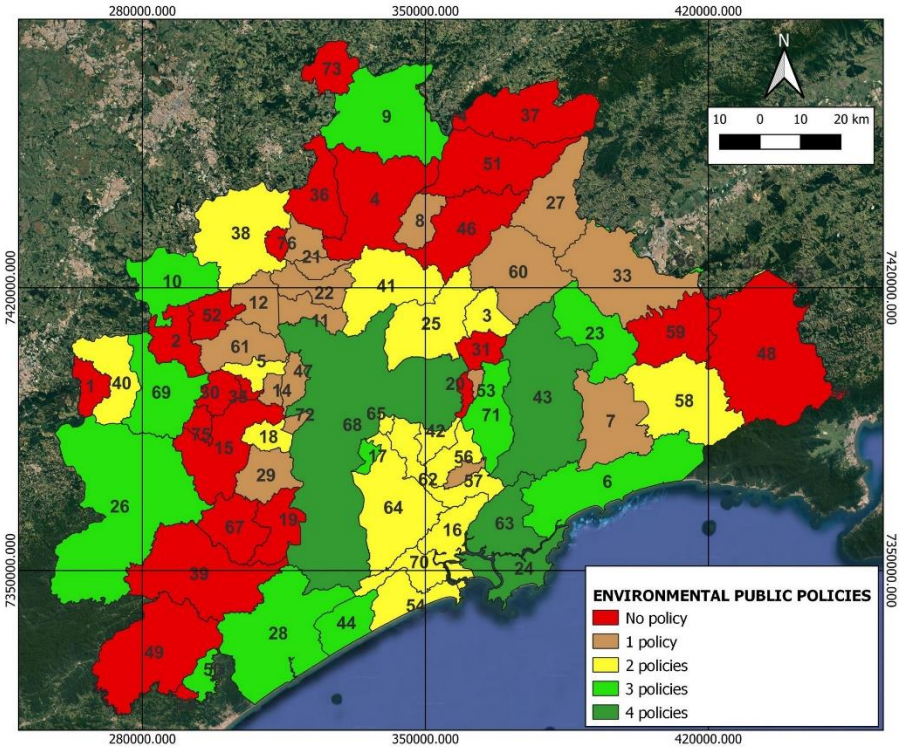
Such threats require greater political strength and governance to address emerging socio-environmental problems and fight climate change and biodiversity loss. Thus, it is expected that municipalities have their respective public policies aligned with the aspirations

[1] The municipalities of Itariri, Natividade da Serra, Pedro de Toledo, Peruíbe, Redenção da Serra and São José dos Campos are partially included within the RBCV boundary

of the population and various social actors. However, among the public policies analyzed, only four municipalities have (or are preparing) the four of them (5.1%); thirteen cities have (or are preparing) three of the four policies (16.6%); eighteen cities have (or are preparing) two policies (23.1%); eighteen cities have (or are preparing) one environmental plan (23.1%) and twenty-five cities (32.1%) do not have any public policy related to the environment (Figure 2 and Table 1).

Figure 2

Cities of the Biosphere Reserve in the green belt of São Paulo and their respective numbers of environmental public policies. Numbers are referred in Table 1



Source: Prepared by the authors

Such results are concerning, as more than 55% of the cities do not have any or have only one of the studied environmental public policies. It is worth noting that as it is a municipal public policy, it should be displayed as an easy access information to citizens and for all interested parties. For this reason, we did not check personally the existence of such policies with each municipal secretariat located in the territory of the GBBR, which could be further investigated in detail. However, in a random exploratory search on the websites of the Municipalities that make up the RBCV, no information was identified about the public policies studied.

It is evident that, if any city hall has a policy that is not made available on its website it does not play its public role and can be characterized as an instrument of regulation for obscure purposes from the perspective of public management transparency.

Table 1

Municipalities of the Sao Paulo Green Belt Biosphere Reserve and their socio-environmental indicators and public policies. HDI - human development Index; PA - Public afforestation (%); SS - Percentage of sanitary sewage (%); GDP – Gross Domestic Product per capita; DIA - Diarrhea - hospitalizations for diarrhea (per thousand inhabitants); MUAP - Municipal urban afforestation plan; MPACC - Municipal plan for adaptation to climate change; AFMP - Atlantic Forest Municipal Plan; MSWP - Municipal Solid Waste Plan

	City	HDI	PA	SS	GDB	DIA	MUAP	MPACC	AFMP	MSWP
1	Alumínio	0,766	71,2	85,2	153904,22	#	0	0	0	2
2	Araçariguama	0,704	80,8	66,5	115258,2	0	0	0	0	2
3	Arujá	0,784	83,4	85,9	72172,65	0,1	0	0	0	2
4	Atibaia	0,765	67	80,8	48596	0,1	1	0	2	2
5	Barueri	0,786	72,7	95,4	192647,61	0,9	2	0	2	2
6	Bertioga	0,73	56,5	77,1	28923,67	0,4	2	0	0	2
7	Biritiba Mirim	0,712	56,9	81,1	23273,98	0,1	0	0	0	2
8	Bom Jesus dos Perdoes	0,713	96,5	96,3	35640,89	0,2	2	0	1	2
9	Bragança Paulista	0,776	71,2	87,1	38406,56	0,1	2	0	1	2
10	Cabreúva	0,738	80,4	89,7	107046,16	0,1	2	0	1	2
11	Caieiras	0,781	83,6	92,1	38554,9	0,1	0	0	0	2
12	Cajamar	0,728	51,1	76,3	252959,85	0,1	0	0	0	2
13	Campo Limpo Paulista	0,769	80,8	76,4	25363,13	0,1	0	0	0	2
14	Carapicuíba	0,749	82,9	87	15356,09	0,6	2	0	0	2
15	Cotia	0,78	68,4	81	53632,41	0,2	0	0	0	2
16	Cubatão	0,737	87,3	62,7	115116,84	0,1	0	0	0	2
17	Diadema	0,757	76,3	97,4	36097,9	0,6	0	2	0	2
18	Embu	0,735	75	78,8	53798,98	0,3	0	0	0	2
19	Embu-Guaçu	0,749	82,7	56	17452,19	0,2	0	0	0	2
20	Ferraz de Vasconcelos	0,738	44,3	85,1	16714,9	0,2	0	0	0	2
21	Francisco Morato	0,703	48,3	58,2	9034,56	0,7	0	0	0	0
22	Franco da Rocha	0,731	73,7	74	21442,87	0,1	0	0	0	2
23	Guararema	0,731	49,7	71,1	48313,05	0,6	0	0	2	2
24	Guaruja	0,751	68,2	82,4	28417,36	0,1	2	0	2	2
25	Guarulhos	0,763	71,2	88,4	47249,21	0,2	1	2	0	2
26	Ibiúna	0,71	75,1	48,2	23392,98	0,1	2	0	2	2
27	Igaratá	0,711	93	85,3	21953,32	0,1	0	0	0	2

Continua

	City	HDI	PA	SS	GDB	DIA	MUAP	MPACC	AFMP	MSWP
28	Itanhaém	0,745	47,4	80,2	20011,41	0,1	2	0	2	2
29	Itapecerica da Serra	0,742	67,8	52	22084,42	0,5	0	0	1	2
30	Itapevi	0,735	37,3	83	50673,18	0,4	0	0	0	2
31	Itaquaquecetuba	0,714	62,5	80,4	20653,57	0,2	0	0	0	2
32	Itariri	0,677	47,2	56	18748,36	#	0	0	0	2
33	Jacareí	0,777	81,3	95,1	57183,66	0,2	0	0	0	2
34	Jambeiro	0,756	64	64,6	38568,38	0,2	0	0	0	2
35	Jandira	0,76	69,3	90,2	33294,36	0,3	0	0	0	2
36	Jarinu	0,733	49,8	51,5	84061,56	0,2	2	0	1	2
37	Joanópolis	0,699	66,8	81,5	16137,27	#	0	0	0	2
38	Jundiai	0,822	81,6	96,6	112068,21	0,2	2	0	2	2
39	Juquitiba	0,709	24,1	46,8	17311,76	0,2	0	0	0	2
40	Mairinque	0,743	74,3	81,1	36310,82	0,1	0	0	0	2
41	Mairiporã	0,788	67,2	67,4	18456,83	0,3	0	0	0	2
42	Mauá	0,766	72,8	90,7	34430,52	0,2	0	2	0	2
43	Mogi das Cruzes	0,783	62,2	85,5	36381,52	0,3	2	0	2	2
44	Mongaguá	0,754	56,3	85,4	19676,56	0,1	2	0	0	2
45	Natividade da Serra	0,655	78,5	67,9	11048,15	#	0	0	0	2
46	Nazaré Paulista	0,678	60,2	62,6	19790,93	0,8	0	0	0	2
47	Osasco	0,776	80,4	89,3	117298,82	0,3	0	0	0	2
48	Paraibuna	0,719	63,9	63	16255,07	0,2	0	0	0	2
49	Pedro de Toledo	0,696	42,2	81,1	13474,72	#	2	0	0	2
50	Peruíbe	0,749	65,3	80,8	24403,9	0	2	0	0	2
51	Piracaia	0,739	27,9	77,4	17797,36	#	0	0	0	2
52	Pirapora do Bom Jesus	0,727	62,6	72,4	25816,09	0,2	0	0	0	2
53	Poa	0,771	73	95,9	38131,3	0,1	1	0	1	2
54	Praia Grande	0,754	74,1	92,9	23432,68	0	2	0	0	2
55	Redenção da Serra	0,657	100	42,1	14369,47	#	0	0	0	2
56	Ribeirão Pires	0,784	70,6	86	25497,11	0,1	0	2	0	2
57	Rio Grande da Serra	0,749	57,4	77,2	14179,63	0,2	0	2	0	2
58	Salinópolis	0,732	45,7	82,9	12324,76	0,1	0	0	1	2
59	Santa Branca	0,735	45,3	77,5	17748,67	0,1	0	0	0	2
60	Santa Isabel	0,738	83,4	78	26367,17	0,7	0	0	0	2
61	Santana do Parnaíba	0,814	58,4	71,8	67531,85	0,1	2	0	0	2

Continua

	City	HDI	PA	SS	GDB	DIA	MUAP	MPACC	AFMP	MSWP
62	Santo André	0,815	82,2	95,9	42209,54	0,2	2	2	0	2
63	Santos	0,84	87,3	95,1	52509,91	0,1	2	2	2	2
64	São Bernardo do Campo	0,805	84,1	91,9	60871,06	0,1	0	2	0	2
65	São Caetano do Sul	0,862	95,4	100	85062,97	0,2	1	2	0	2
66	São Jose dos Campos	0,807	94,7	94,3	60194,93	0,2	1	2	2	2
67	São Lourenco da Serra	0,728	17,4	75,7	16158,58	0,1	0	0	0	2
68	São Paulo	0,805	74,8	92,6	62341,21	0,3	2	2	2	2
69	São Roque	0,768	73,9	81,1	34699,1	0,1	0	0	0	2
70	São Vicente	0,768	82,8	90,8	15164,69	0,2	0	0	0	2
71	Suzano	0,765	75,2	89,7	40453,09	0,1	1	0	2	2
72	Taboão da Serra	0,769	84,1	93,6	30423,33	0,3	0	0	0	2
73	Tuiuti	0,728	36,8	38	20674,24	#	0	0	0	2
74	Vargem	0,699	67,7	43,4	12552,31	0,1	0	0	0	2
75	Vargem Grande do Sul	0,737	83,6	94,8	23134,13	1,5	1	0	0	2
76	Várzea Paulista	0,759	79,3	92,4	23860,4	0	0	0	0	2
77	Votorantim	0,767	83,4	96,1	27816,38	0,1	2	0	2	2

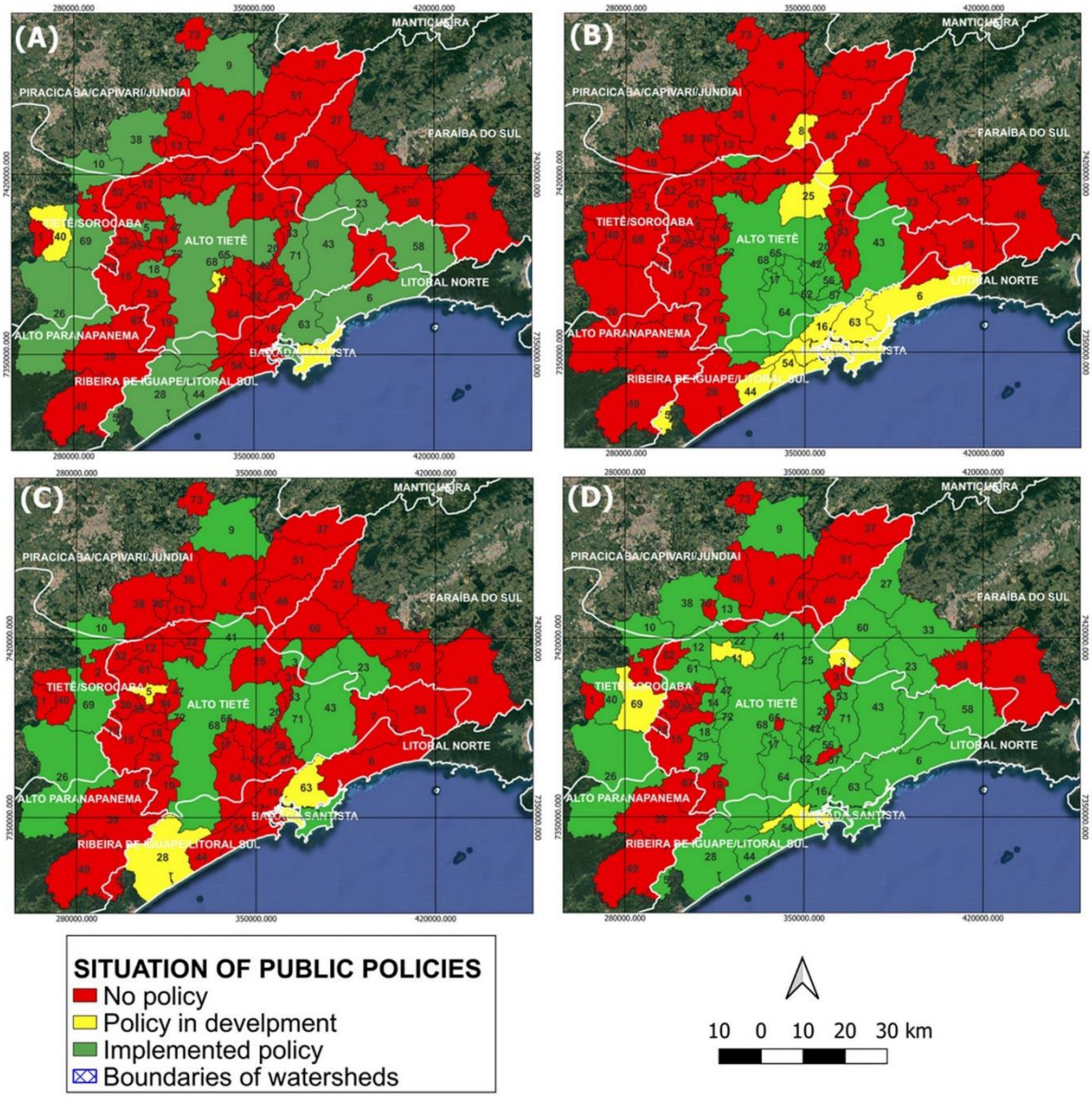
Fonte: [1]IBGE (2022); [2]São Paulo (2022a)

Among all municipalities of the São Paulo's Green Belt Biosphere Reserve area, 53 did not have Municipal urban afforestation plan (67.9%) and only three of them were preparing this public policy (Figure 3A). Due to the insertion of the GBBR in the Atlantic Forest Biome, we would expect that many municipalities have their Municipal Plans for the Atlantic Forest, mainly integrated into their Master Plans. Unfortunately, only 13 municipalities showed completed plans (16.6%). As for the municipal solid waste plan only ten (12.8%) municipalities had this public policy already implemented. Regarding the climate change policy, ten municipalities have implemented the policy (12.8%), eleven are preparing this plan (14.1%) and vast majority of the cities (n=57; 73.1%) have not even started to develop this important policy.

The municipal plan regarding adaptation to climate change was identified in only 10 cities (12.9%) (Figure 3).

Figure 3

Map of the Green Belt Biosphere Reserve municipalities with public policies. (A) Municipal Urban Afforestation Plan; (B) Municipal Climate Change Adaptation Plan; (C) Atlantic Forest Municipal Plan; (D) Municipal Solid Waste Plan.



Source: Prepared by the authors

Thirty-four municipalities of the GBBR are part of the Alto Tietê hydrographic basin (ATB). They differ from other basins due to the intensity of urban pressure, and their territory is almost coincident with that of the MRSP. Among the metropolitan municipalities, only Guararema, Juquitiba, Santa Isabel and Vargem Grande Paulista do not integrate the ATB. With 20.7 million inhabitants, ATB is home to 99.5% of the population of the MRSP and centralizes important industrial, commercial, and financial complexes, which represent the greatest pole of national wealth. On the other hand, the ATB presents one of the most critical situations in Brazil with regard to guaranteeing water in quantity and quality to supply the

majority of the GBBR population (Bicudo et al., 2020).

This demands strong attention from afforestation and ecological restoration programs prioritizing the quality and quantity of water in the basin. In addition to the existence of plans, efforts aimed at the integration of these policies should be a priority agenda, considering the importance of these ecosystems for water and food security.

These measures demand the understanding and adoption of the GBBR as a territory of metropolitan water security and territorial planning, since future disturbances in water supply have the potential to affect human well-being (Victor et al., 2018; 2022).

The Integrated Water Resources Management System (IWRMS) of the state of São Paulo is based on participation, decentralization, and integration of water management throughout the state, as recommended by Águas Paulistas Law (São Paulo, 1991). IWRMS is composed by members of the State, Municipalities and civil society and has actions based on the State Plan for Water Resources. Considering the extreme importance of keeping the hydrographic basin conserved (ecological unit), municipal afforestation policies could foster strategies and strengthened action plans for greater regional water security.

Furthermore, it should be considered that one of the central proposals of the AFMP is, through cartographic bases, selecting priority areas for conservation. This could be allied to the State Plan for Water Resources and to other territorial planning actions, especially those linked to the local Master Plan.

With projections of ecological droughts and excess rainfall in the coming decades for the southeastern region of South America (IPCC, 2021), climatic anomalies and social impacts are expected in a near future. This requires strategic planning for possible climate scenarios, which highlights the need to have specific plans or programs to face anticipated climate changes.

In the GBBR, as in the entire Southeast region of Brazil, the worst water scarcity was recorded between 2013 and 2016, with a negative record in the rainfall regime and worryingly low reservoirs that supply the MRSP (Victor et al., 2018). The water crisis experienced brought a series of challenges and lessons learned, emphasizing the need to think differently about water governance in the context of climate change (Jacobi, Cibim & Leão, 2015). It is an intellectual, technical, and political articulation that strengthens the engagement of multiple actors in a participatory governance concept, especially for civil society.

It is worth mentioning that there is an urban dynamic that involves demographic parameters, land use and basic service conditions for the population. Thus, it is worth emphasizing the need to continuously evaluate the main actions that are related to the quantity and quality of natural environments.

The 2003 water crisis brought up a series of challenges related to land use in urban and peri-urban areas. Among the various examples, the loss of vegetation cover in strategic

preservation areas, an intense occupation of protected areas called "permanent preservation area", in addition to disorderly occupation for mining purposes and inadequate disposal of urban solid waste and sewage are highlighted (Whately, 2007; Soriano et al., 2016).

As more recurring scenarios of climate extremes are expected in the future (Bicudo et al., 2020; IPCC, 2022), it would be interesting for cities to make available their respective plans for adaptation to climate change in line with other municipal and/or regional policies. This is the case of Baixada Santista, in the south coast of São Paulo state, which started the elaboration of a Regional Plan for Resilience and Climate Adaptation. This action takes place within the scope of the project “Resilient Municipalities of São Paulo” (*“Municípios Paulistas Resilientes”, in portuguese*) of the state of São Paulo government. Other 3 cities from GBBR take part in this program (Embu das Artes, Francisco Morato and Guarulhos) (São Paulo, 2022b).

Due to the lack of solid waste treatment in Brazil throughout its history, in addition to the severe environmental and public health problems associated with people living in damp areas, regulatory instruments suggest that to claim financial resources for the federal government, cities must have municipal solid waste plans (Brasil, 2010).

Thus, although MSWP is the analyzed environmental policy with the greatest adherence by the municipalities, this policy should be highly recurrent among cities, as it facilitates obtaining funding from the federal government. However, our results did not show a strong support from municipalities of GBBR for the Municipal Solid Waste Plan.

It should be noted that a strong intervention by the public prosecution, through the Special Action Group for the Defense of the Environment (*GAEMA, in portuguese*) and by the São Paulo State Court of Auditors, decreed the end of dumps, as well as the non-licensing of sanitary landfills in detriment to new technologies for the treatment of solid waste. Thus, there is an effort by different public bodies pressuring municipalities to have their own municipal policies and to promote effective means of treating solid waste and basic sanitation.

It is also worth mentioning the important role of the Basic Sanitation Company of the State of São Paulo (*SABESP, in portuguese*), which requires municipalities to carry out basic sanitation and solid waste plans in the contract in order to receive financial resources.

All these pressures resulted in a high number of cities with a solid waste policy, but it still lacks greater adherence on the part of the municipal administrations of several cities. Special attention must be given to the fact of solid waste management itself, since having the public policy implemented does not mean that it has a good action plan in place.

Environmental protected areas in GBBR

In the GBBR, there are 100 protected areas in different categories linked to the National System of Nature Conservation Units (*SNUC, in portuguese*), at the three administrative levels

- federal, state, and municipal (Brasil, 2001; Rodrigues, Victor & Barradas, 2020), which correspond to 54.1% of its territory (Supplemntary material).

Among these 100 units, 37 are "full protection" conservation units, corresponding to IUCN Category I and II, and cover 11.3% of the biosphere reserve's territorial area. In addition, conservation units belonging to the "sustainable use" category account for 63 protected areas in 42.8% of their territory (Rodrigues, Victor & Barradas, 2020). These data indicate the strong suitability of this territory to function as an ecological corridor. However, urban pressure must be controlled by efficient environmental policies and programs that promote environmental sustainability even in landscapes that are not covered by protected areas.

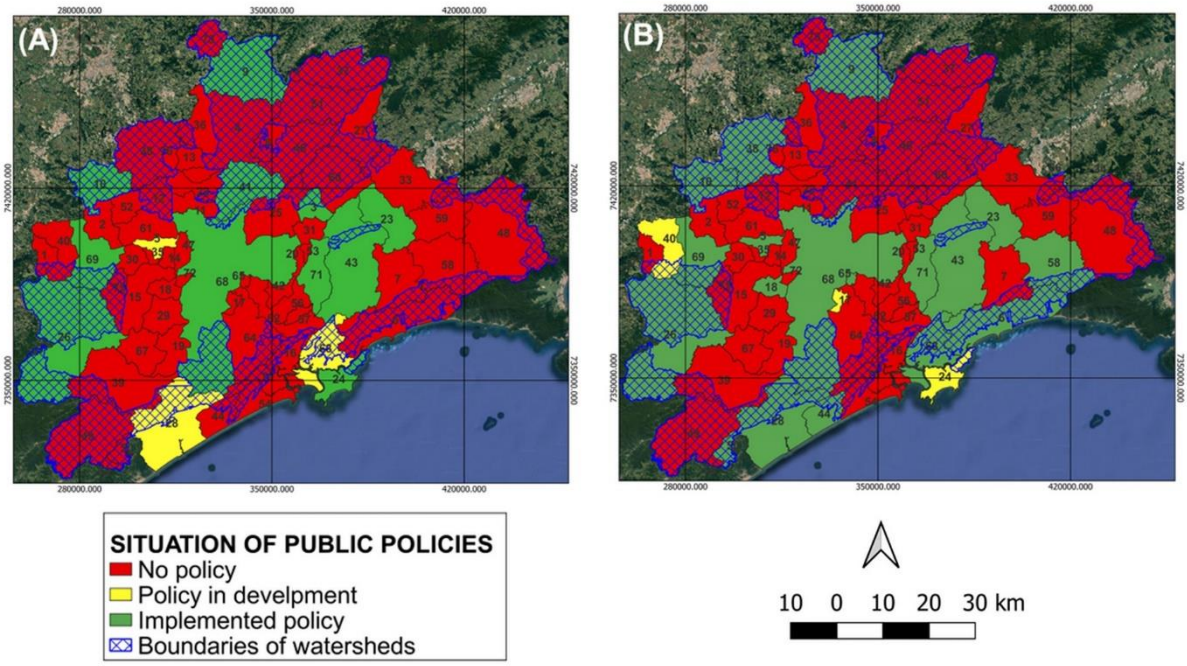
Although the number of conservation units established in the territory of the GBBR is relevant, it was found that most municipalities (n=62; 79.4%) did not have the Atlantic Forest Municipal Plan (Figure 4A). A similar situation occurred when analyzing the cities that did not have the MUAP in the territory (n=53; 67.9%) (Figure 4B).

This situation is particularly worrying because it is a territory with vocation for an ecological corridor for gene flow. As previously mentioned, the AFMP has in its basic precept the selection of priority areas for conservation. Efforts aimed at mapping and conserving biodiversity and actions to mitigate climate change through greater carbon capture and storage should guide municipal policies and be integrated into a common environmental plan.

However, the low adherence of cities to the implementation of the abovementioned policies puts the protection of biodiversity at risk and misses a great opportunity to optimize climate change mitigation strategies.

Figure 4

Overlap of Conservation Units to Municipal Plans for the Atlantic Forest (A) and Municipal Plans for Afforestation (B).



Source: Prepared by the authors

It is noteworthy that the natural areas of the GBBR promote urban and peri-urban ecosystem services with a profound influence on subsistence, human well-being, and quality of life in the region (Rodrigues et al., 2020).

This is highlighted in the context of the supply systems in the metropolitan region of São Paulo (Cantareira, Alto Tietê, Guarapiranga, Rio Grande, Rio Claro, São Lourenço, and Alto Cotia) and Baixada Santista (Pilões/Cubatão, Mambu, Melvi) which are fully inserted in the GBBR territory, highlighting the crucial role that the GBBR plays in the self-sufficiency of supply in these areas.

Although it corresponds to only 7.36% of the territory of São Paulo, GBBR supplies 72% of the volume of drinking water in the entire state of São Paulo, constituting, therefore, a critical territory for water security, crucial for more than 25 million of people. Because its limits are defined from an ecosystem approach, the GBBR is an appropriate instance for the integrated management of its cities and ecosystems (Victor et al., 2018; 2022; Rodrigues Rodrigues, Victor & Barradas, 2020). With a more comprehensive management framework, GBBR offers tools for more robust governance of land and water beyond their geopolitical boundaries.

Socio-environmental indicators of GBBR municipalities

As for the percentage of tree-lined streets, fourteen municipalities had less than 50% of public streets with trees. The five most critical cities for this item were São Lourenço da Serra (17%), Juquitiba (24.1%), Piracaia (27.9%), Tuiuti (36.8%) and Itapevi (37.3%). None of these cities have Municipal Urban Afforestation Plan (MUAP), Municipal Plan for Adaptation to Climate Change (MPACC) or Atlantic Forest Municipal Plan (AFMP). Only five municipalities had more than 90% of tree-lined streets, namely Redenção da Serra (100%), Bom Jesus dos Perdões (96.5%), São Caetano do Sul (95.4%), São José dos Campos (94.7%) and Igaratá (93%). Of these cities, São José dos Campos stood out for presenting three of the environmental policies selected in this study. On the other hand, Redenção da Serra does not have any selected policy, and Igaratá only implemented the MSWP.

Urban afforestation promotes multiple ecosystem services that goes from local to global importance. Cultural services include natural heritage, recreation, aesthetics, and the knowledge exchange. Provision services linked to city dwellers in developing countries include products such as food, firewood, drinking water, biochemicals products, natural medicines. Regulatory services include climate regulation, carbon storage, air pollution attenuation, geohydrological process control of erosion and flood control. In addition, urban afforestation also contributes to biodiversity in urban and peri-urban areas and helps to promote cultural diversity (Dobbs et al., 2018) including climate mitigation.

The GBBR has an expressive forest system and the ability to sequester and store carbon. The storage of carbon by its natural forest vegetation in the mature stage is equivalent to more than half a decade of the total emissions of the entire state of São Paulo from fossil fuels, while the absorption by vegetation in the growth stage contributes to the neutralization of 36 % of annual state emissions (Luca et al., 2020).

It should be noted that the part of GBBR occupied by exotic species (more than 107 thousand hectares of Pines and Eucalyptus) provides, among other ecosystem services, the storage of about 23 million tons of carbon in CO_2e, with an estimated annual rate of atmospheric carbon removal, due to the growth of these crops, of almost six million tons of C-CO_2 (Kronka et al., 2020).

Due to the relevance of the native forest cover and planted forests in the GBBR, that integrate the components of urban and peri-urban afforestation, it is urgent to encourage the development of plans or programs to adapt to climate change, since the number of cities with strong policies in this sector is still low (Table 1, Figure 3B).

Among the ecosystem services of the urban treescape, the attenuation of the thermal effects promoted by heat islands receives special attention. A study carried out with satellite images showed that areas of the city of São Paulo (the largest Brazilian city) and Curitiba

(considered the ecological capital of Brazil for its vast urban afforestation) showed a relationship between thermal attenuation and the presence of urban green. The authors considered the evapotranspiration capacity of vegetation in the humidification of the atmosphere and curiously observed strong socioeconomic differences related to the amount of green spaces (Ribeiro et al., 2021).

This phenomenon of evapotranspiration in cities has the potential to reduce the average air temperature by up to 2.9º C when vegetation cover is increased by 16% (Marando et al., 2022). Moreover, high tree density combinations in large forest fragments amid water bodies can increase water evaporation capacity, thus attenuating more severe heat island effects (Wu et al., 2022), although this capacity might vary spatially in urban environments (Pereira et al., 2022). This fact suggests that GBBR cities with a low percentage of afforestation on public streets should strategically plan their urban greening actions.

In GBBR, the loss of climate-regulation ecosystem service affects the entire population. Children and elderly people living in degraded areas on the outskirts of the GBBR are the most exposed to ecosystem changes and extreme weather events (Pereira Filho et al., 2020).

There are sustainable strategies that combine the use of urban solid waste decomposition products in the management of urban afforestation, thus contributing to two emerging problems in cities with a lack of environmental planning (Conceição et al., 2021). This greening promotion in cities can change the population's environmental perception and promote greater harmony between citizens and public environmental management (França et al., 2016).

In general, trees have a high potential to mitigate the effects of atmospheric pollution (Martins et al., 2021; Ramon et al., 2023). Biomonitoring studies of air quality with plants have identified contamination hotspots in places with high environmental impact, thus denoting key points in the urban area that can be afforested (Ferreira et al., 2012; Ferreira et al., 2017a; Ferreira et al., 2017b; Zabotto et al., 2020; Theophilo et al., 2021).

Studies in different parts of the world have shown that trees and parks in urban areas can reduce air pollution in a region around 1 to 80%, directly influencing people's quality of life, reducing mortality and public health spending. In research conducted in five parks in the city of São Paulo, Brazil, it was shown that the central areas of the parks have a lower concentration of pollutants than at their edges, with evidence that GBBR is a potential reducer of atmospheric pollution generated by urban áreas (Saldiva et al., 2020, Martins et al., 2021).

Our results showed that five municipalities have less than 50% of sanitary sewage (Tuiuti, Redenção da Serra, Vargem, Juquitiba and Ibiuna). No municipality has MPACC and only Ibiúna has MUAP, AFMP and MSWP. Ten municipalities had values above 95% of sanitary sewage in the study area, but only seven exhibited MSWP. Of this total, only Santos, Votorantim and Barueri had the AFMP. Considering the need for specific regulation for sanitary

sewage in future scenarios of climate change, the situation of the municipalities becomes worrying, since only 26.9% of the cities had MPACC.

This picture becomes even more worrying when considering that 37 cities have more than 0.2 cases per thousand inhabitants who had been hospitalized by diarrhea (Table 1). Numerous diseases associated with climate change, e.g. arboviruses, may threaten public health, especially diarrhea, a disease of high concern on a planetary scale (Santanna et al., 2022). Twelve cities in this study scored 0 or did not even figure in the IBGE database regarding diarrhea. On the other hand, Vargem Grande Paulista registered 1.5 cases of diarrhea for every thousand inhabitants and did not show any environmental public policy in this study.

A recent study showed a strong positive association between water and sanitation index with global neurological disorders (Sarmadi et al., 2021). This relationship between basic sanitation and public health becomes more relevant in countries of the global South, where climate change currently represents one of the greatest challenges facing humanity. More vulnerable populations need strengthened governance systems for climate action proposals to be effective (Peirson and Ziervogel, 2021). Beard et al., (2022) analyzed 30 informal cities and settlements in sub-Saharan Africa, South Asia, and Latin America and showed that more than 60% of human waste is not well managed. The authors highlighted serious problems with the disposal of municipal solid waste, promoting mixtures of fecal sludge with waste, creating a situation of high risk to the public health of the population.

Currently, there are several climate finances programs that prioritize the end of social inequality and the mitigation of climate change, however, a strengthened system of environmental governance and policies that support this transfer of resources to be applied are necessary (Vicent & Cundill, 2022; Simpson et al., 2022).

Socio-economic characteristics in GBBR and environmental public policies

Assuming that economic inequality may be associated with socio-environmental indicators, this study sought to carry out a multivariate principal components analysis (PCA). The statistical test was explained in axis 1 (47.42%), axis 2 (25.43%) and axis 3 (17.82%), totaling 90.67% of total variability. The ordering of the sample units related to the high-income cities of this study, ie. cities with more than R# 50,000.00 of Gross Domestic Product per capita (GDP) were associated with the highest values of public wooded areas and coverage of sanitary sewage. Only HN234 5CSWET66few sample units of cities with lower GDP per capita are also associated with these vectors. Many cities with economic challenges are located in areas of low urban interest or low agricultural aptitude, due to the geomorphological characteristics of the terrain, which promotes a high vocation for forest protection, especially

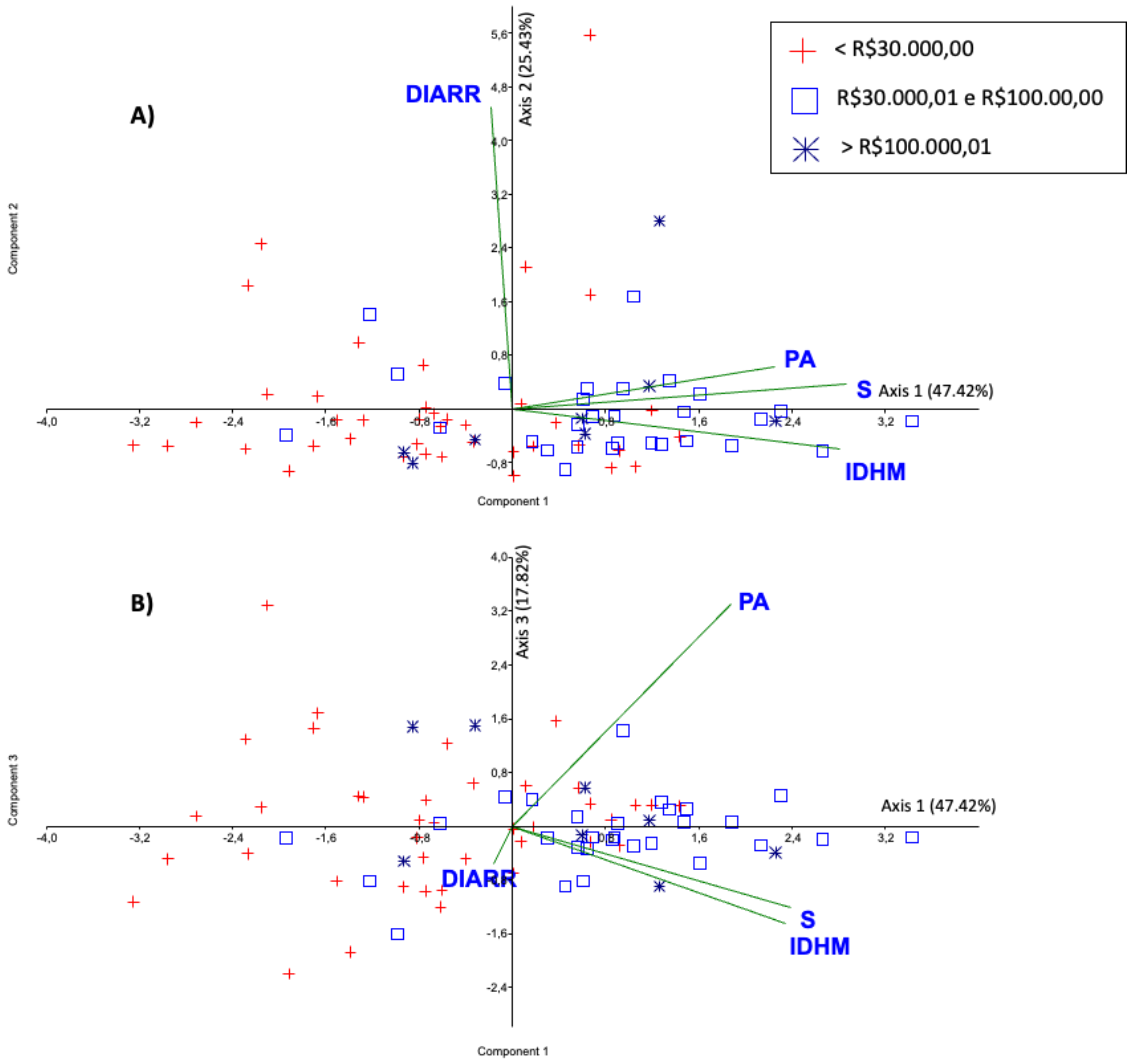
in cities located on the outskirts of the metropolitan region of São Paulo.

The PCA showed that the eigenvalues associated with diarrhea were usually associated with cities with lower GDP per capita, reinforcing that income is an important variable in public health aspects (Scheelbeek et al., 2021). The scientific literature points to greater severity of climate change in the world's poorest populations, however, it should be considered that the amount of information available in these countries is scarce, which makes effective action on environmental problems difficult.

Our results show that cities in the GBBR with the lowest income are the ones with the worst socio-environmental indicators, increasing the challenge of state management to achieve the SDGs.

Figure 5

Principal Component Analysis showing the main associations of socio-environmental variables organized by GPD per capita. In A - Axes 1 and 2 with 72.8% of the joint explanation of the data. In B - Axes 1 and 3 complement the explanation up to 90.67% of the variability of the analysis.



Source: Prepared by the authors

Economically, the results revealed that twenty cities in the GBBR had GDP per capita below R$20,000.00 (25.6%), twenty-one municipalities had a GDP between R$20,000.01 and R$30,000.00 (26.9%) and only eight cities had a GDP above R$100,000, 01 (10.2%). These results show that more than half of the studied cities presented low values of GPD per capita. The city with the highest GDP per capita (Cajamar) is 96.4% higher than the city with the lowest indicator (Francisco Morato) showing high amplitudes in inequality of this socioeconomic indicator.

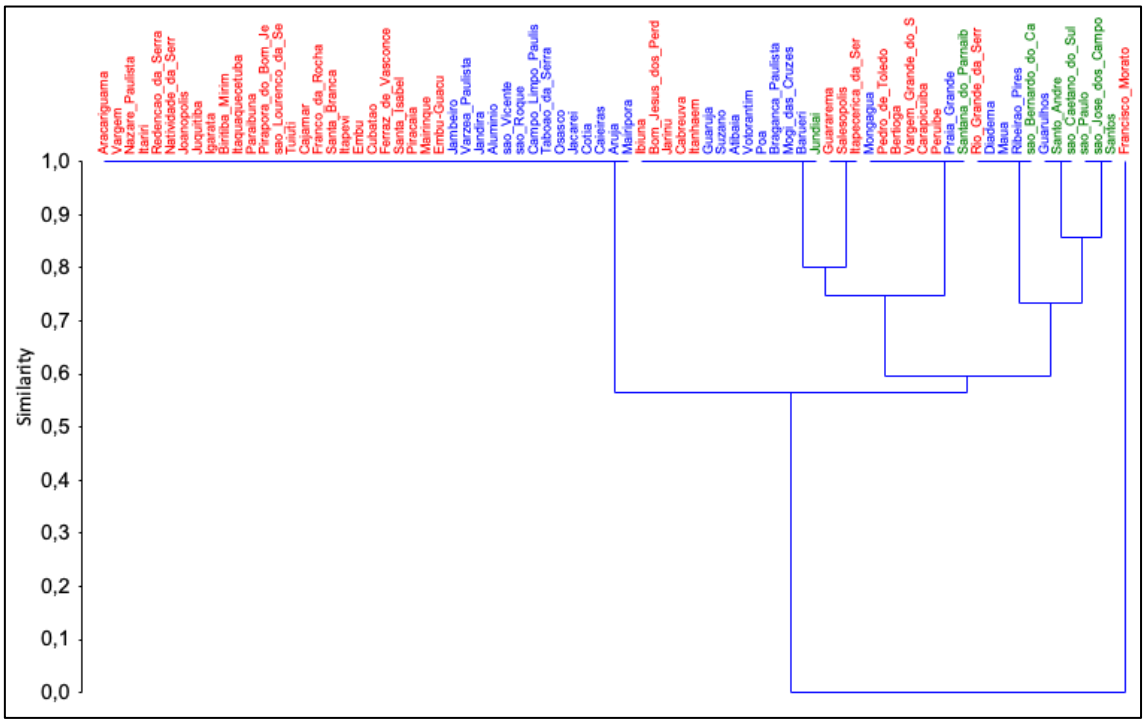
Among the cities with the lowest GDP per capita (<R$ 20,000.00) 70% do not have any public environmental policy implemented or under development, while among the cities with the highest GDP per capita only 12.5% (n=1) have this situation. On the other hand, 50% of the richest cities have two or more policies in place while among the poorest cities this figure is only 20%.

Socioeconomic instruments are strongly related to environmental degradation in terms of ecological footprint, which reinforces the difficulty of achieving the sustainable development goals of the 2030 Agenda (Khan, Yahong & Zeeshan, 2022). In this way, our socio-environmental results showed that, in order to achieve efficiency in actions towards an environmental and climate agenda, efforts are needed to develop and implement public environmental policies, in addition to having a strengthened governance system.

Interested in knowing whether cities with different GPD per capita were similar in the numbers of environmental policies, we conducted a cluster analyses. We used the Euclidean distance to measure the test (coeph. corr.=0.9325) and found a cluster of cities with lower GDP per capita and with no public policy in the development phase (red and pink colors). At the right and left sides of Figure 6, a mix of cities with different amounts of environmental policies under development or implemented can be found (typically with medium and high GPD per capita).

Figure 6

Cladogram assembled from the presence matrix absence of environmental public policies. Colors represent differences in MHDI. Cities in red color have GPD per capita up to R$20,000.00; cities in pink have GPD per capita between R$ 20,000.01 and R$ 30,000.00; cities in light blue have GPD per capita between R$ 30,000.01 and R$ 50,000.00; cities in dark blue have GPD per capita between R$ 50,000.01 and R$ 100,000.00 and, cities in green are those with GPD per capita greater than R$ 100,000.01.



Source: Prepared by the authors

The GPD per capita is one of the instruments to assess human development of a given population. Just a few cities located in the GBBR had GPD per capita greater than R$100,000.00. Many authors have reported that, to solve the environmental and climate crisis, it is necessary to reduce social inequality (Campiglio et al., 2018; Mostafa et al., 2016; Weiler et al., 2018). However, rich economies complain that financing low-income countries has problems such as corruption and lack of governance. In this sense, combining a system of environmental public policies strengthened by the respective municipal councils (and various stakeholders) is an alternative to find out critical solutions in the environmental scenario of GBBR cities.

CONCLUSION

Our results showed that the cities belonging to the Green Belt Biosphere Reserve of São Paulo presented low implementation of environmental public policies, although there is a current effort in the elaboration of these plans.

This fact puts the conservation of biodiversity and the provision of ecosystem services

at risk, under strong pressure from urban areas and land use changes. The growing urbanization towards critical water supply systems and the trend of adverse impacts of climate change, require the establishment of robust policies and integrated planning among the municipalities of the Green Belt, based on the understanding of GBBR as a continuous territory of water security, since the establishment of isolated municipal policies are not enough to guarantee the provision of ecosystem services to support sustainable metropolitan development.

About the relationships between the low adherence in the implementation of environmental public policies and socioeconomic indicators, it became clear that there is a factor that associates economic development and the execution of environmental policies at the municipal scale in the GBBR. Further efforts should be given to low-income municipalities to increment new mechanisms of governance once monetary incentives could change the actual scenarios.

In addition, the high adherence of cities in the implementation of solid waste policies shows that linking public funding, as well as the participation of multiple public actors in the requirement of specific law for protecting the environment can be an effective alternative. This structure can be reinforced with the GBBR management system, which involves several public institutions, municipalities, civil society, the scientific community, and other stakeholders, as well as an action plan with management strategies to reconcile socioeconomic development with conservation and the sustainable use of their ecosystems.

These socioeconomic relationships associated with environmental concerns amplifies the debate on achieving the 17 SDGs of 2030 Agenda.

The mere existence of a law does not guarantee the necessary management of natural resources, but it is an indicator of governance in relation to the environmental and climate agendas at the local scale. As sustainable development and human well-being in the urban area of the metropolises of São Paulo and Santos are directly linked to the ecosystem services provided by their peri-urban areas and surrounding municipalities, this local agenda needs to be complemented by the adoption of the GBBR as an adequate management structure for the integration of policies at different scales and for the promotion of ecosystem-based solutions.

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Supplementary Material. Conservation Units located in the study area by administrative level, category, and typology according to SNUC (IP - Integral Protection; SU - Sustainable Use); and IUCN category (Ia – Strict Nature Reserve; Ib – Wilderness Area; II – National Park; III – Natural Monument or feature; IV – Habitat or Species Management Area; V – Protected Landscape or Seascape; VI – Protected Area with Sustainable Use of Natural Resources). SNUC Category: AGEI – Area of Great Ecological Interest; BR – Biological Reserve; EPA – Environmental Protection Area; ES – Ecologic Station; MNP – Nature Municipal Park; NM – Natural Monument; PRNP – Private Reserve of Nature Patrimony; SF – State Forest; SP – State Park; WLR – Wild Life Refuge.