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Assessing Multi-Level Climate Governance and Adaptation in a Coastal Metropolitan Context in Brazil

Evaluación de la Gobernanza y la Adaptación Climática Multinivel en un Contexto Metropolitano Costero en Brasil

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Keywords: climate change, institution, coastal management, interplay, organizations.

Abstract

The article examines the complexity of climate change adaptation, particularly in coastal regions, with a specific focus on the Baixada Santista Metropolitan Region in southeast Brazil. As an area directly exposed to climate risks, this dynamic region provides a valuable case study for understanding the challenges and developing governance solutions. The study explores the multi-level governance framework involving national, state, and local policies, examining how organizations within this structure interact to address climate change adaptation. The paper conducted semi-structured interviews with institutional representatives to unravel the dynamics of climate adaptation efforts. Results reveal the absence of a unified climate agenda, with interactions primarily manifesting through the implementation of public policies, educational projects, and NGO initiatives in local and regional forums.

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The research identifies barriers, challenges, and recommendations, stressing the imperative for a realignment between climate change adaptation and integrated coastal zone management within the metropolitan context. The findings not only contribute to comprehending climate adaptation in other coastal urban cities at the metropolitan governance level but also provide insights into addressing a diverse range of socio-environmental changes across different levels of engagement in climate policies or adaptation initiatives.

1. Introduction

Climate change in the coastal zone is one of the most complex contemporary problems with effects transcending natural boundaries and jurisdictional levels (Álvarez-Romero et al. 2011; Rosen & Olsson 2013, Percival *et al.,* 2017). Coastal management requires a complex policy and institutional framework because of its socio-ecological dynamics, interactions of stakeholders, and relevant economic activities, such as tourism, shipping, and fisheries (Dos Santos *et al.,* 2019). Coastal municipalities and settlements, particularly those located in low-lying areas, are more vulnerable to severe climate-related conditions such as sea-level rise, storm surges, and erosional processes (Oppenheimer *et al.,* 2019). Planning for climate change is another layer in the complex relationship between organizations, its different levels of governance in the coastal zone.

In this context, addressing the far-reaching consequences of climate change, formulating effective mitigation strategies, and adapting to the dynamic socio-environmental shifts demand a concerted effort across different levels of governance (Bauer and Steurer, 2014; Corfee-Morlot, 2009; Ostrom *et al.,* 2010). A novel strategy for climate governance is emerging, which emphasizes the involvement of both state and local governments in public policy-making activities related to climate change (Jordan *et al.,* 2015). This approach underscores the importance of comprehending the performance of climate change-related laws and policies (Massey *et al.,* 2014; Jordan *et al.,* 2015). At the core of this strategy lies the concept of Multi-Level Climate Governance (MLCG), which has gained traction as a means to explore the intricate web of connections and potential gaps in interactions across various governance levels. Such interactions necessitate a coherent coordination among governmental levels, considering the multi-dimensional nature of climate change challenges (Corfee-Morlot *et al.,* 2009; Di Gregorio *et al.,* 2019; Fidelman *et al.,* 2013; Zen *et al.,* 2019).

MLCG is best defined as a comprehensive system of actions aimed at ensuring the effective execution of climate change strategies within legal and institutional frameworks at both national and subnational levels, and across regional and local scales (Corfee-Morlot *et al.,* 2009). This framework serves as a critical tool to bridge gaps and strengthen linkages between disparate governance levels, thereby fostering a collaborative approach that is essential to address the challenge of climate change and coastal management in a cohesive and impactful manner.

The MLCG framework stands as a globally recognized tool employed to dissect the intricate interactions among stakeholders operating across diverse strata of governance. Effectively implementing this framework necessitates comprehensive government reforms, structural realignments, and paradigm shifts (Betsill and Rabe, 2009; Di Gregorio *et al.,* 2019; Jörgensen *et al.,* 2015). This framework serves as an invaluable lens, facilitating a profound comprehension of the interplay between various governance levels and the manifold actors, encompassing both state and non-state entities, engaged in both mitigation and adaptation endeavors. This involves a fusion of

bottom-up and top-down processes, culminating in a comprehensive understanding (Cerna, 2013).

The versatility of the MLCG framework is evident across a spectrum of domains. It transcends the boundaries of environmental policy at large (Zen *et al.,* 2019), permeating socioecological systems (Glaser and Glaeser, 2014), renewable energy sectors (Jörgensen *et al.,* 2015), pollution control domains (Zhang *et al.,* 2020), and even in addressing challenges like wetland loss (Bataille *et al.,* 2021). Its manifold applications stand as a testament to its efficacy in navigating the multi-dimensional scenario of climate change adaptation (Capelari *et al.,* 2020; Fidelman *et al.,* 2013; Rocle *et al.,* 2021).

Considering its extensive applicability, the MLCG framework holds immense potential within the realm of Integrated Coastal Zone Management (ICZM). By leveraging its insights, this framework can play a pivotal role in stimulating sustainability and adaptive measures to address the ever-evolving challenges posed by climate change. Moreover, the study inherently underscores the paramount importance of ICZM. This management paradigm acts as a guiding compass, ensuring that climate change adaptation initiatives are coordinated with sustainable coastal development. This approach recognizes that coastal regions are uniquely vulnerable to the impacts of climate change, necessitating an integrative strategy that bridges environmental, social, and economic aspects. Therefore, this study not only elucidates the complexities of MLCG but also underscores its synergy with the ICZM approach, thereby steering the region towards enhanced resilience and sustainability.

Although research drawing on MLCG has growing lately (Di Gregorio *et al.,* 2019), most studies have looked at MLGC in the northern hemisphere context or at global-national linkages (Betsill and Rabe, 2009; Piattoni, 2009; Jordan *et al.,* 2015; Sapiains *et al.,* 2019). Nevertheless, the Global South jurisdictions tend to face different challenges such as uneven development, high levels of poverty, income inequality, and power imbalance (Pereira and Viola, 2021), remaining an underexplored area (Di Gregorio *et al.,* 2019; Sapiains *et al.,* 2019).

This paper serves as a synthesis of research committed to the exploration of multi-level governance and climate change adaptation. Its primary objective is to unravel the complex dynamics and interplay among organizations as they navigate the climate change agenda and its associated initiatives, such as projects, policies, and events, all within the context of a coastal metropolitan region. Furthermore, this study is driven by another critical goal: the identification of barriers and opportunities that can act as compasses, directing the course of multi-level governance within coastal regions.

Here, we investigate the mechanisms that enable interactions and level of influence of institutions towards adaptation actions in the Baixada Santista Metropolitan region (BSMR), located at the southeast coast of São Paulo state, Brazil. The BSMR serves as a crucial case study due to its unique characteristics. Home to the largest port of Latin America, the Port of Santos, the region presents a complex interplay of factors, including distinct levels of public administration, conflicts in protected areas, diverse socio-economic interests, and urban expansion. In addition, the region faces climate change impacts like sea level rise and extreme weather events. The inquiry extends further to encompass perceptions of stakeholders concerning essential aspects such as resource mobilization capacity, distribution of responsibilities, and their attitudes toward the endeavors in climate change adaptation within a coastal zone context.

The MLCG was used as a theoretical framework to examine cross-level dynamics and resources in taking account of climate adaptation policies and on-ground actions. First, it addresses which adaptation measures, resources, and pathways, organizations

are gathering to cope with coastal climate change in the BSMR. Second, it investigates the levels of interaction and influence that contribute to the development of MLCG and its potential for articulation. Third, it adds new knowledge on multi-level governance challenges and opportunities from evidence-based attitudes and policy networks needed to strengthen the response to climate events at the local and metropolitan levels. We conclude by drawing some implications for future climate adaptation policy of coastal municipalities operating across jurisdictions and governance levels in a metropolitan context and elsewhere.

2. The theoretical framework: Multi-level Climate Governance (MLCG)

MLCG is regarded as a crucial policy approach to assure the alignment and readiness of climate actions across jurisdictional levels and the multidimensional nature of climate change adaptation (Betsill and Rabe, 2009; Fidelman *et al.,* 2013; Pietrapertosa *et al.,* 2021). Nevertheless, it is important to remind that the policy context in which multilevel framework is implemented is often complex, fragmented and framed by the interaction of climate and non-climate strategies (Fidelman *et al.,* 2013). In Australia, for instance, major threats to effective climate adaptation in the Great Barrier Reef includes presence of short-term measures, a top-down process, and the lack of a purposefulness arrangement for managing interactions posed as major threats to effective climate adaptation in the Great Barrier Reef region (Fidelman *et al.,* 2013). Coordinating and integrating climate and non-climate strategies is a formidable challenge for multilevel governance across jurisdictions and policy sectors.

Examining into city-level dynamics, Zen *et al.* (2019) showcased the utility of the MLCG framework in discerning the disparity between national and local levels in the context of Malaysia. Shifting focus to regional dimensions, Bauer and Steurer (2014) harnessed a multi-level governance lens to scrutinize the role of regional climate adaptation partnerships, contrasting the government-centric approach in Canada with the pluralistic stakeholder-centered approach in England. Despite the contextual variances, an underlying convergence emerged: both frameworks facilitated mediation between governmental levels, nurtured synergies between the public and private sectors, and provided essential support for capacity-building and the formulation of adaptation policies (Bauer and Steurer, 2014).

Furthermore, on a regional scale, Pietrapertosa *et al.* (2021) conducted an insightful exploration into the multi-level climate planning endeavors across thirty-two Italian regions, provinces, and cities. Their investigation encompassed a comprehensive analysis of both mitigation and adaptation commitments with the aim of decrease carbon emissions. The significant revelations of the study emphasize the proactive involvement of cities in shaping mitigation policies, while the focal point of adaptation strategies predominantly rests at the regional level (Pietrapertosa *et al.,* 2021).

In a broader context, MLCG emerges as an auspicious and continually evolving paradigm. Its mission is to echo the rising influence of pertinent interest groups, extending beyond the jurisdictions of government or state entities. This paradigm gains prominence in tackling complex issues, like the management of climate impacts that transcend national boundaries (Sapiains *et al.,* 2019). An approach rooted in the perspective of the Global South, one that integrates local experiences and scales up to regional

governance, enhances the comprehension of adaptive capacities. This approach is particularly instrumental in advancing the pursuit of effective climate policy initiatives.

3. Previous attempts at climate governance

The pioneering endeavors of Brazil to confront climate change are exemplified by the enactment of Law No. 12.187/2009, which lays the foundation for the National Policy on Climate Change (PNMC; Brazil, 2009). A defining moment arrived in 2015 when Brazil ratified the Paris Agreement and solidified its commitment through the intended Nationally Determined Contribution (iNDC). This commitment entailed an ambitious target: a reduction of greenhouse gas emissions by 37% by 2025 and a more substantial 43% reduction by 2030, with reference to the 2005 levels (BRASIL, 2015).

Elevating these commitments to actionable strategies, the federal government of Brazil orchestrated a collaborative effort, enlisting the active participation of civil society, the private sector, and state governments. In 2016, the outcome materialized as the National Plan for Adaptation to Climate Change (PNA), a strategic initiative created to not only to improve the vulnerability of the nation to the effects of climate change but also to foster a culture of risk management (BRASIL, 2016).

This dynamic sequence of legislative, international, and collaborative efforts underscores the commitment of Brazil to addressing climate change comprehensively. It signifies not only the recognition of the country of its responsibilities on the global stage but also its commitment to safeguarding its own environmental and socio-economic scenario through an integrated and multi-faceted approach.

In the state of São Paulo, a crucial step was taken with the establishment of Law No. 13.798 in 2019, ushering in the São Paulo State Policy on Climate Change (PEMC). This landmark legislation was conceived with a dual purpose: to underscore the commitment of the state to cope with climate change and to give a robust framework for both adapting to its impacts and contributing to the mitigation of greenhouse gas emissions (SÃO PAULO, 2009). Notably, the PEMC highlights the imperative of creating comprehensive and integrated plans to effectively coastal management and metropolitan regions, equipping them to navigate the challenges imposed by climate change.

In response to these imperatives, a series of climate change initiatives have been set in motion to strengthen strategic adaptation endeavors. Back in 2014, the Baixada Santista Metropolitan Agency (AGEM) headed an initiative known as the Metropolitan Strategic Development Plan for Baixada Santista (PMDE). The primary objective of the outline was to foster a unified vision among the municipalities of the region, pooling data, projects, and programs under a singular strategic outlook. The plan englobes a diverse array of themes spanning housing, mobility, sanitation, and economic development, all of which harbor proposals extending into the horizon of 2030 (AGEM, 2014). However, it is noteworthy that while the PMDE was laudable in its scope, it conspicuously lacked climate policies or specific adaptation strategies.

On the other hand, the municipality of Santos, the center of the BSMR, expressed forward with decisive action. Through Decree No. 7.295/2015, the Santos council established the Municipal Commission for Adaptation to Climate Change (CMMC). This proactive body, composed of various public sectors encompassing environment, civil defense, urban de-

velopment, port and maritime affairs, public services, health, infrastructure, and buildings, with the support of an advisory academic commission, created a pioneering endeavor known as the Municipal Plan for Adaptation to Climate Change. An emblem of innovation, this plan stands as the first of its kind in the Brazilian Coastal Zone, showcasing the commitment of the municipality of Santos to proactively tackling climate change (De Freitas *et al.,* 2018).

The momentum in Santos continued to gather steam in 2018 with the advent of Complementary Law No. 1.005, which meticulously addressed climate change adaptation and mitigation within the framework of the Santos Master Plan. This integrated approach coordinated with the pre-existing Municipal Plan for Adaptation to Climate Change. Remarkably, no other municipality within the BSMR had at that juncture presented policies or plans designed to cope with the impacts of climate change. The proactive stance of Santos made it national acclaim and established it as an example for other municipalities across Brazil.

Functioning as the host of the largest port of Latin America, the municipality of Santos emerged as a central hub driving pioneering initiatives. Among these is the Local Climate Adaptation Plan (SANTOS, 2022), an innovative framework featuring strategic scenarios for the short (2025), medium (2030), and long term (2050). This approach positions Santos at the forefront of climate adaptation, setting a precedent for other municipalities to follow.

4. Methodology

The study method consisted of three steps: (1) characterization of sectors relevant to stakeholders, (2) description of organizational representativeness perceptions on emerging climate change adaptation efforts, and (3) identification of mainstream multi-level climate governance policies. The study region profile and description of data collection and analysis are given below. Furthermore, the study was underpinned by a meticulous and comprehensive bibliographical review of the subject matter.

Study region: The Baixada Santista Metropolitan Region (BSMR)

Located on the coastal portion of São Paulo, the BSMR has an area of 2.373 km², encompassing the municipalities of Bertioga, Cubatão, Santos, Guarujá, São Vicente, Praia Grande, Mongaguá, Itanhaém and Peruíbe (figue 1). The region is inserted within the Atlantic Forest with an expressive urban area covering 99.7 % of its territory (IBGE, 2013) and several protected areas, such as the Serra do Mar State Park and Xixová-Japuí State Park. Industries as diverse as gas and oil, civil construction, tourism, port logistics, and an Industrial Pole are among the most influential sectors in the region (AGEM, 2014).

The BSMR houses the largest port in Latin America, the Port of Santos, and it is projected that nearly 70 % of investments in the region will come from pre-salt oil exploration until 2030 (AGEM, 2014). Thus, we can observe complex and multi-layered relations in the region encompassing distinct levels of public administration, conflicts in protected areas, different socio-economic interests, and expansion of urban areas as well as climate change impacts. Sea level rise and intensification/increased frequency of extreme weather events are among the major threats to coastal zones, where usually there is a large population density (Baztan *et al.,* 2015; Wong *et al.,* 2014). The

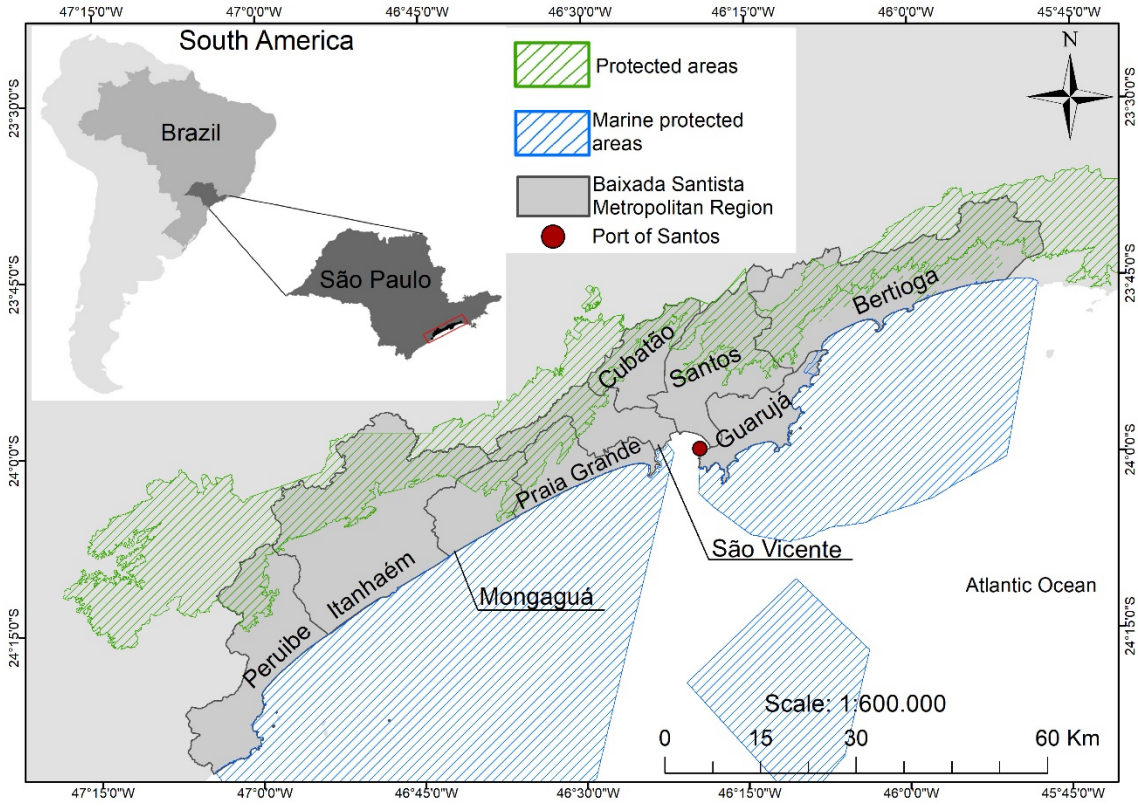

Figure 1. The Baixada Santista Metropolitan Region (BSMR), São Paulo, Brazil, and its municipalities (Bertioga, Cubatão, Santos, Guarujá, São Vicente, Praia Grande, Mongaguá, Itanhaém and Peruíbe). Source: IBGE (2010) and MMA (2019).

BSMR faces climate change-related impacts, such as coastal erosion, intense storm surges, floods and landslides (Nunes *et al.,* 2019).

Santos city is the most populated and crucial economic hub in the region, but at the same time it is highly vulnerable to climate change events (e.g., flooding and sea-level rise) since most of its continental area and critical infrastructure are located in low-lying areas (Zanetti *et al.,* 2016). Additionally, there is also complex social challenges regarding communities living in highly vulnerable areas, such as hills and estuaries, and indigenous reserves (Moschetto et al., 2020). Governance solutions to environmental changes in this region are important to reduce climate change vulnerability where multi-level governance and coastal management are needed to make various uses and stakeholders compatible (Adger, 2006; Fuhr *et al.,* 2018; Zen *et al.,* 2019).

Data collection and procedure

A semi-structured questionnaire was composed, incorporating both qualitative and quantitative inquiries. The designed questionnaire was subsequently administered to 321 representatives of key stakeholders drawn from pertinent organizations (regional, state and federal level), universities, industries, business, media, NGOs and civil society organizations

from all municipalities of the BSMR between July and December 2018.

Survey respondents were identified from official documents (commissions and board meeting minutes), websites and social media. Ethics protocols were followed as per approval from Human Research Ethics Committee of Brazil. The survey was sent five times to all organizations, every 30 days. In total, N=33 (10 %) responses were analyzed using *Microsoft Excel* for the qualitative analysis. The survey protocol was pilot-tested and revised prior to sending to respondents and it was structured as statements (table 1).

The collected data underwent meticulous compilation and organization, structured around distinct categories of analysis: i. Profiling of Stakeholders, ii. Engagement of Organizations, iii. Financial Aspects, iv. Interactions among Organizations, and v. Level of Influence. Participants were solicited to express their level of agreement with statements, employing a structured 5-point Likert-type scale encompassing options from "1. Strongly Disagree" to "5. Strongly Agree" (Moreira *et al.,* 2017). The network analysis was carried out using *NodeXL Basic*, which is a toolkit for network overview. While this tool has been used to analyze social media networks, the method can be broadly applied (Smith *et al.,* 2009).

Table 1. Survey statements by category.

Categories	Statements mentioned in the survey
Organization engagement	Your organization develops activities aimed at climate change adaptation in the coastal zone.
	Your organization promotes or encourages actions/events related to climate change adaptation.
Finance	It has its own source of financing for climate change adaptation.
	It is responsible for allocating resources.
Organization interaction	The various forums and committees in the BSMR can contribute to the development of actions to adapt to climate change.
	Efforts by government, community and private sector on climate change adaptation on the coastal zone are well articulated.
Level of influence	Your organization has power to influence government scales (municipal, state and/or national).
	It has authority to take actions on climate change adaptation.
	In your opinion, which institution(s) in the BSMR is (are) capable of influencing attitudes and activities aimed at climate change adaptation? (open-ended question)
	Your organization has a close relationship with other sectors (public, private, civil society).

5. Results

Profiling of stakeholders, engagement of organizations and financial aspects

Most respondents are male (73 %) and from the public sector (61 %), whose sphere of influence is at regional level (46 %; Table 2). The majority are located in the municipality of Santos (38 %), followed by Bertioga (13 %), Guarujá (9 %), São Vicente (6 %), Peruíbe (6 %), and Praia Grande (3 %). There were no representatives from municipalities of Mongaguá, Itanhaém, and Cubatão.

In order to give a first account about the perceptive and representational context, the statement "*Your organization develops activities aimed at climate change adaptation in the coastal zone*" was proposed to identify which actions the institutions are performing in BSMR. It yielded 24 % "Agree" and 40 % "Strongly agree" answers (figure 2). A significant number of individuals (49 %; "Agree" and "Strongly agree") indicated that *has institutional initiative to take actions on climate change adaptation* in various educational initiatives, projects, collaborative efforts, forums, or discussions. Collaborations described were between: universities - municipalities, local media - municipal education network, state agencies - universities, state agencies - municipalities, and international agencies - federal government - local governments (*e.g.,* the Santos City Hall established a partnership with Deutsche Gesellschaft für Internationale Zusammenarbeit - GIZ and the Ministry of Environment - MMA via the ProAdapta Project – "Supporting Brazil in the implementation of the National Agenda for Climate Change Adaptation").

To understand financial support for climate change initiatives, the statement "*It [your organization] has its own source of financing for climate change adaptation*" was made. Only 12 % of the respondents answered,

Table 2. Organizations surveyed and their level of action.

Level	Organization
Local	Public sector: Civil Defense of Santos, Municipal Secretariat of the Environment - Santos (SEMAM), Municipal Secretariat of the Government - Santos (SEGOV), Santos Technological Park Foundation (FPTS), Municipal Secretariat of the Environment - Guarujá (SEMAM), Municipal Environmental Planning Coordinator of Bertioga, Civil Defense of Guarujá, Municipal Science and Innovation Directorate of Guarujá, Sub prefecture of São Vicente - Continental Area, Peruíbe Civil Defense Commission. Private sector: Orla newspaper, Monte Serrat University Center (UNIMONTE), Santa Cecília University (UNISANTA), Social Service of Commerce - Santos unit (SESC), Pilotage of Santos Port (Santos Pilots), BoqNews newspaper. NGOs: Volunteer Group Greenpeace Bertioga, Full & Forest Ocean, Cultive Resistência, Biopesca Institute. Popular movement: Save the Itapanhaú River.
Regional (BSMR)	Public sector: Fire Department (CB), Metropolitan Agency of the Baixada Santista (AGEM), Federal University of São Paulo - Baixada Santista Campus (UNIFESP), São Paulo State University - Coastal Campus (UNESP). Non-profit entities: Association of the Civil Construction Entrepreneurs of the Baixada Santista (ASSECOB).
State	Public sector: São Paulo State Secretariat for Environment (SMA/SP), Environmental Agency of the State of São Paulo (CETESB), Forestry Foundation (FF), Fisheries Institute (IP). Non-profit entities: Architects Union of the State of São Paulo (SASP).
National	Public: Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA).

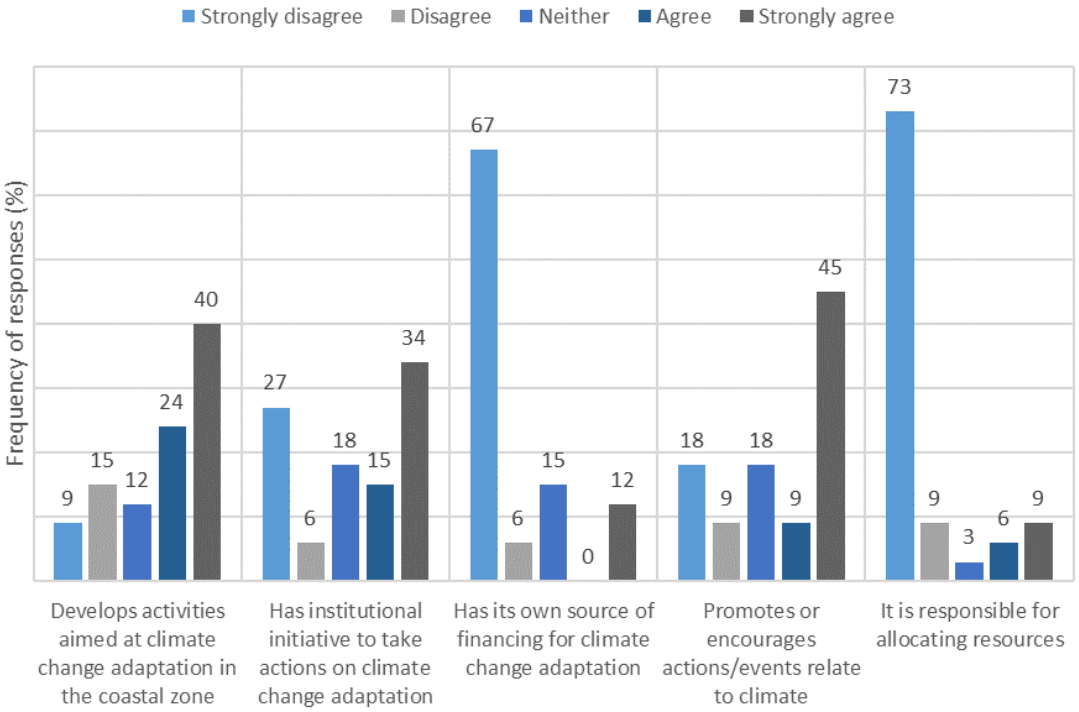

Figure 2. Frequency of responses (%) based on a 5-Likert scale regarding perception on resource mobilization capacity to climate change adaptation.

"Strongly agree" (figure 2) and it was represented by two state-level organizations (CETESB and SMA/SP), a private sector organization (Pilotage of Santos Port – Santos Pilots) and an NGO (Full Forest & Ocean). Only 15 % of the respondents acknowledged "*being responsible for allocating resources*". Respondents were asked how resources are allocated and what motivates decisions. As an example, the following is a quote from a public sector respondent at the state level:

> "(Resources are allocated) *through technicians that make environmental inspections in areas considered essential for environmental preservation and conservation; areas subject to flooding and geological risk".*

According to respondents, allocations are decided based on research projects conducted by institution researchers, board priorities, board decisions, and fundraising through projects. Thus, there are different profiles for decision making regarding allocation of resources that reflect different forms of internal arrangements in the organization.

Interactions among organizations and level of influence

The statement "*The various forums and committees in the BSMR can contribute to the development of actions to adapt to climate change*" was constructed to identify the existing forums and committees in terms of their potential for collaborative and impactful engagement within the climate change adaptation sphere.

The collective response to this statement was noteworthy, with a substantial 85 % expressing agreement (Agree; Strongly agree). A minor proportion,

comprising 6 %, expressed disagreement (Disagree; Strongly disagree). These responses underscore the recognition of the potential efficacy of these forums and committees in driving proactive climate change adaptation efforts within the BSMR.

Upon thorough analysis of the quotes of the respondents, a recurrent perception of barriers becomes evident within the domain of democratic participation within the forums and/or committees, for example:

> "It is necessary to legitimize the occupation of such forums, facilitate new composition and, above all, diversify representativeness".
> (Popular movement representative)

> *"The BS* (Baixada Santista) *has an historical process of organizing society in forums and many other spaces; however, it does not have the effective practice of democracy proposed by these spaces, in addition to the lack of effective regional integration".*
> (Local government secretariat representative)

To understand interactions between the surveyed institutions, the following statements were made, as shown in Figure 3. Notably, the statement "*Your organization has a close relationship with other sectors (public, private, civil society)*" had a substantial concurrence, with 85 % of respondents indicating agreement ("agree"; "strongly agree"). In contrast, the statement "*Efforts in government, community and private sector initiatives on climate change adaptation on the coastal zone are well articulated*" registered a markedly lower agreement rate of 13 % (figure 3). Remarkably, the category of "disagree" emerged as the most prevalent response, constituting a significant 42 % and culminating in an overarching rate

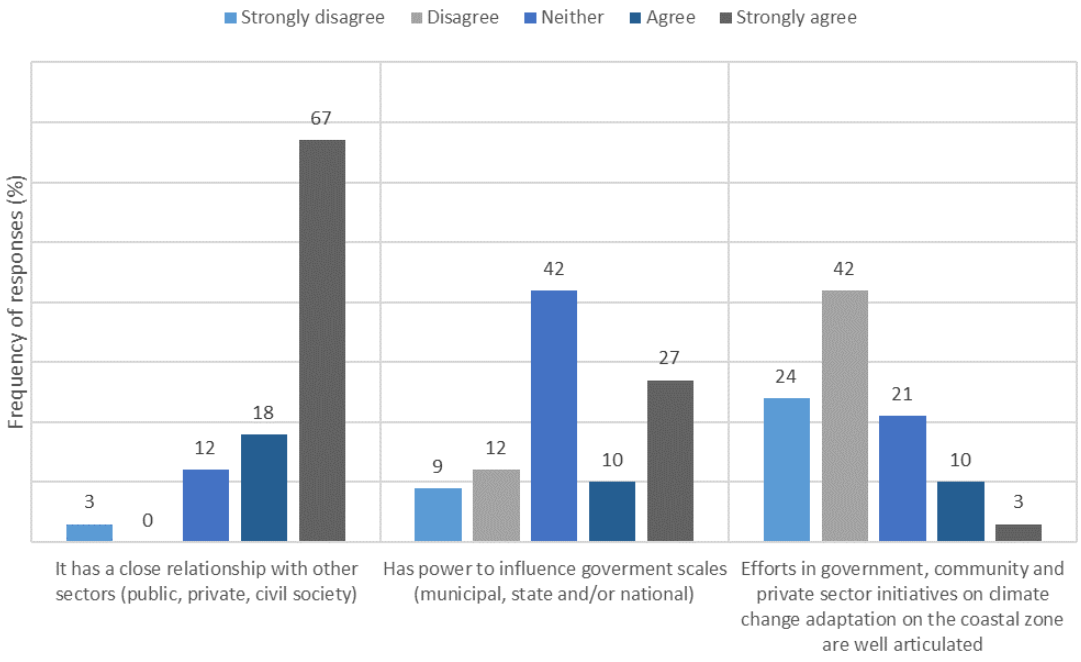

Figure 3. Frequency of responses (%) based on a 5-Likert scale regarding perceived multi-level influence in the BSMR.

of disagreement ("disagree"; "strongly disagree") amounting to 66 %. This distinct pattern underscores the consensus among interviewees that fortifying interactions among governmental, civil society, and private sector entities remains a pressing need.

The influence of organizations in the BSMR was measured with the following question "*In your opinion, which organization(s) in the BSMR is (are) capable of influencing attitudes and activities relating to climate change adaptation?*". From the responses, a multi-level scheme was generated linking organizations that can influence climate change adaptation in the region. The most cited institutions were: at local level: City Halls (13 mentions), universities (8), Civil Defense (5), NGOs (3), Press and media (3), and Schools (3); at regional level: AGEM (5) and CBH-BS - Baixada Santista River Basin Committee (3); at State level: CETESB - Environmental Agency of the State of São Paulo (4), SMA/SP - Environmental Secretariat of the State of São Paulo (4), and São Paulo State Government (4); and at National level: CODESP - Santos Port Authority (3), and IBAMA - Brazilian Institute of Environment and Renewable Natural Resources (3). The network of organizations is represented in figure 4, which shows respondent institutions (where arrows come from) and organizations cited as influential in the region (where arrows are pointing).

Certain organizations assert their influence within the domain of climate change adaptation actions. Notably, state-level bodies such as SMA/SP, CETESB, and the Fisheries Institute, as well as federal-level entities like IBAMA, and the non-governmental organization Full Forest & Ocean, stand out as notable instances of self-identified influential players in this sphere.

6. Discussion

The study served to better understand the role of the institutional arrangements and to examine the perceptiveness and multi-level dynamics about emerging climate change adaptation effort. The mechanisms employed by local and regional organizations to interact and adapt to climate change challenges and coastal management were assessed. In the following sections, the salient findings and insights from the analysis are expounded upon, exploring their implications and significance.

Interactions between organizations

Through the exploration, organizations employing potential influence within a dynamic coastal metropolitan region were successfully unearthed. This influence is manifest in their engagement through projects, activities, and forums, all channeled towards the strategic planning of climate change adaptation measures. However, an intriguing revelation emerges: these interactions are often disassociated from a unified metropolitan agenda.

As emphasized by Kern and Alber (2009), an inherent spatial mismatch prevails within the confines of municipal boundaries within metropolitan regions. This spatial disparity necessitates a pivot towards horizontal collaboration. Adaptation strategies encompassing water management, urban drainage, and mobility, among others, intricately demand decisions and implementations executed at a regional scale. This underscores the imperative for a cohesive approach that transcends municipal boundaries, fostering a unified and coordinated response to the multilevel challenges posed by climate change within a metropolitan coastal context.

Remarkably, even in the absence of a unified climate agenda, this study reveals a noteworthy discov-

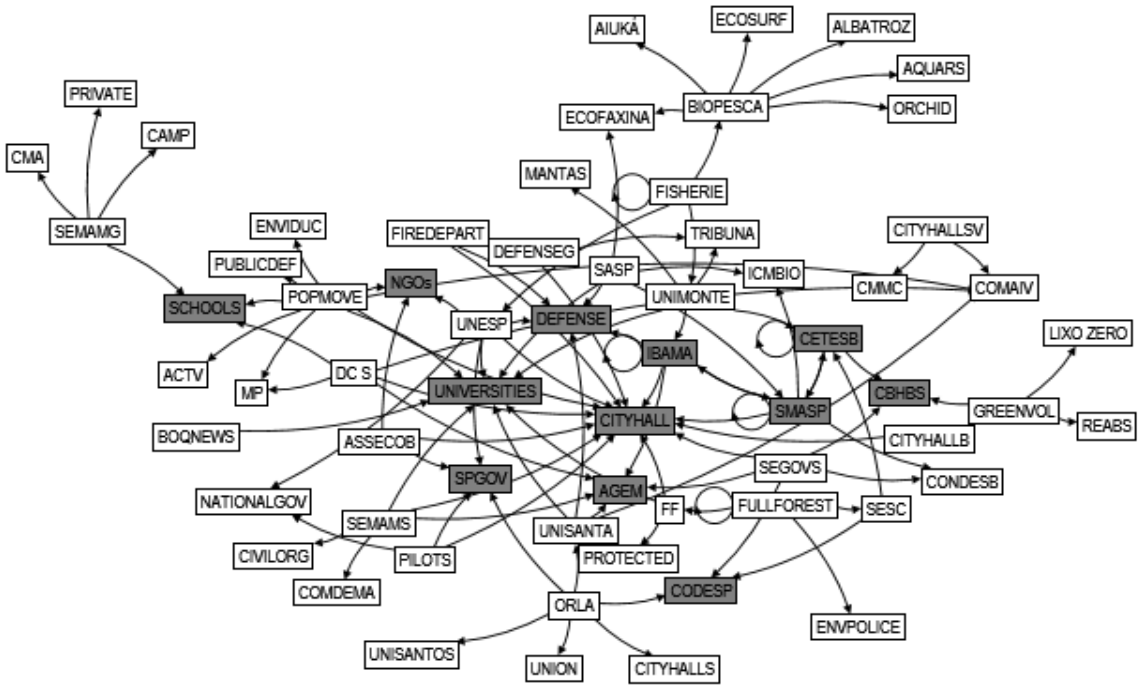

Figure 4. Network of organizations cited by respondents as influential in climate change adaptation actions in the BSMR. In dark gray are the organizations with three or more citations. Arrows start from the respondent organization and point to the one that was cited, and those that self-cited are indicated with a circular arrow. Created with NodeXL Basic.
Labels: DCS - Civil Defense of Santos; AGEM - Metropolitan Agency of the Baixada Santista; PRESS - Press and media; MP - Public Ministry; CITYHALL - Includes all BSMR municipalities; SCHOOLS - Includes all BSMR schools; SEMAMS - Secretariat of the Environment of Santos; COMDEMA - Municipal Council for the Defense of the Environment; UNIVERSITIES - Includes all BSMR universities; CIVILORG - Civil organizations; SEGOVS - Municipal Secretariat of the Government of Santos; CONDESB - Baixada Santista Development Council; CBHBS - Baixada Santista River Basin Committee; CODESP - Santos Port Authority; SEMAMG - Secretariat of the Environment of Guarujá; PRIVATE - Private sector; CAMP - Training and Social Integration Center; CMA - Guarujá Environment Commission; CITYHALLSV - São Vicente City Hall; COMAIV - Municipal Neighborhood Impact Analysis Commission of Santos; CMMC - Municipal Commission for Adaptation to Climate Change of Santos; DEFENSEG - Civil Defense of Guarujá; TRIBUNA - A Tribuna newspaper; CITYHALLB - Bertioga City Hall; SMASP - São Paulo State Secretariat for Infrastructure and Environment; IBAMA - Brazilian Institute of the Environment and Renewable Natural Resources; ICMBIO - Chico Mendes Institute for Biodiversity Conservation; CETESB - Environmental Agency of the State of São Paulo; DEFENSE - Civil Defense; FIREDEPART - Fire Department; FF - Forestry Foundation; PROTECTED - Protected areas; FISHERIE - Fisheries Institute; BIOPESCA - Biopesca Institute; UNIMONTE - Monte Serrat University Center; UNESP - São Paulo State University; MANTAS - Mantas do Brasil Project; NGOs; SPGOV - São Paulo State Government; NATIONALGOV - National Government; UNISANTA - Santa Cecília University; ORLA - Orla newspaper; CITYHALLS - Santos City Hall; UNION - Union of Port Workers; UNISANTOS - Catholic University of Santos; BOQNEWS - BoqNews newspaper; GREENVOL - Greenpeace volunteers; REABS - Environmental Education Network of the Baixada Santista; LIXOZERO - Zero Waste Santos; ASSECOB - Association of the Civil Construction Entrepreneurs of the Baixada Santista; ALBATROZ - Albatroz Project; AQUARS - Santos Municipal Aquarium; ORCHID - Orchidarium of Santos; AIUKÁ - Aiuká Consulting in Environmental Solutions; ECOSURF - Ecosurf Institute; ECOFAXINA - Ecofaxina Institute; SESC - Social Service of Commerce; ENVPOLICE - Environmental Police; POPMOVE - Popular movement; PUBLICDEF - Public Defense; ENVIDUC - Environmental educators; ACTV - Activists; SASP - Architects Union of the State of São Paulo; and PILOTS - Pilotage of Santos Port.

ery: an interaction of both horizontal and vertical interplays characterizes the scenario of climate change adaptation initiatives within the study region. Horizontally, these interactions manifest in connections between disparate entities such as local media and schools, universities and local government. Vertically, the interplay transcends levels, spanning relationships like those between universities and state governments, municipalities and state governments, and even municipalities and federal governments with international support. These relations are connected for the development of initiatives aimed at coping with the impacts of climate change.

The exploration has yielded another observation: committees and forums play a pivotal role in fostering interaction and collaboration among organizations operating across various levels. However, it is worth emphasizing that interviewees have highlighted a prevalent challenge: a distinct lack of robust social trust in public participation within government representative spaces. This aligns with the perspective presented by Marques (2013), underlining the influence of specific sectors comprising interest groups on the implementation of regulations within the Brazilian context.

Drawing from the insights shared by Di Giulio *et al.* (2019), it becomes evident that a complex interplay of factors can impede the whole consolidation of climate change adaptation initiatives. This interplay involves elements such as lobby influence from the private sector, inadequate oversight mechanisms, and a disconnection between urban planning and local government authority. There is cause for concern, as democratic processes, while facilitating the participation of the populace, are susceptible to influence from lobbying groups, underscoring the imperative to remain vigilant regarding the nuances of policy design and political processes (Pierre, 2011).

Therefore, a discerning perspective becomes imperative—one that strives for balance in representation. This balance must encompass not only an equal distribution between municipalities but also a comprehensive representation of various sectors within civil society. As shown in the results, the existence of forums and committees, with the deliberate pursuit of balanced and inclusive representation, emerges as a foundation. This endeavor is pivotal in shaping decision-making arenas that facilitate the performance of public policies in the realm of climate change.

Forums and committees, fortified by diverse representation, are important for the formulation of public policies dedicated to climate change and coastal management. Importantly, these platforms offer more than just a stage for interaction; they serve as conduits that bridge the gap between vertical and horizontal institutions. Notably, these platforms also serve as entries through which organizations can access essential funds—be it municipal, regional, or state—to effectively address environmental concerns. In sum, the pursuit of balanced representation and inclusive participation in forums and committees not only strengthens democratic values but also supports the foundation for robust climate change and coastal policies, all while enabling resource access for sustainable environmental action.

Financial resources

The majority of respondents underscored a significant aspect: their respective organizations lacked dedicated funding opportunities for climate change initiatives. Additionally, a significant portion conveyed that they were not vested with the responsibility of allocating the available funds. Interestingly, a noteworthy revelation emerged during the analysis: organizations that did possess independent funding sources for climate change initiatives belonged to the public sector at the state level, private sector, and non-governmental organizations (NGOs).

It is intriguing to note that the allocation of resources in these cases is contingent upon the distinct

vision and governance structures of each organization. This allocation process is channeled through diverse means, including project development research (in the case of research organizations), the submission of projects for public funding opportunities geared towards the environmental realm (for NGOs), or decision-making processes executed by the governing bodies (whether public or private). This confluence of approaches underscores the variety of resource allocation in the climate change context, often dictated by the underlying principles and priorities of the organizations involved.

Among the myriad of organizations mentioned by the respondents as promoters for climate change adaptation initiatives, the city hall stood out prominently. However, in the context of the Global South, local government resources are often dispersed among various secretariats, with environmental concerns often taking a back seat in comparison to areas yielding more conspicuous economic outcomes (De Freitas *et al.,* 2018; Di Giulio *et al.,* 2019).

Furthermore, a confluence of climate change-related demands converges within the environmental departments. This can be attributed to the marginalization of environmental issues within the levels of municipal authorities. This challenge is further compounded by the complexities inherent in expecting a solitary department to competently execute comprehensive and effective actions on its own (Bulkeley, 2010; Di Giulio *et al.,* 2019). The interplay of these dynamics highlights the complex scenario local authorities navigate while addressing climate change adaptation and the complexities they face in prioritizing environmental concerns within their broader agenda.

However, the findings have indicated that representatives from the private sector often possess dedicated funding mechanisms to boost climate change adaptation endeavors. It highlights a crucial dynamic: the appeal of adaptation-related opportunities is exerting a significant attraction on private entities, encompassing both small and medium enterprises and large corporations alike. Their interest lies in fortifying and expanding their production systems, supply chains, and market presence to ensure resilience in the face of climate change challenges.

Yet, despite the inherent advantages embedded within the expansion of adaptation activities within the private sector, the potency of these initiatives hinges on a confluence of factors. Notably, the orchestration of such endeavors necessitates concerted coordination and the provision of incentives. These key ingredients emanate from the levels of government, both at the national and state levels, and are further supported by the active engagement of local communities. Despite the benefits in expanding adaptation activities, these initiatives need coordination and incentives from the government (national and state) and communities (Noble *et al.,* 2014).

Within the study region, an example of support is the international agreement forged between Brazil and Germany. This partnership has paved the way for the formulation and enhancement of climate policies within the municipality of Santos. This resonates with the insights by Di Gregorio *et al.* (2019), underscoring the pivotal role international actors and external funding play as compelling incentives, especially within the context of the Global South.

The role of such international collaborations is undeniable into the complex of MLCG. Their contributions extend beyond mere financial support, often encompassing knowledge exchange, technical expertise, and cross-cultural collaboration. This synergy of efforts has the potential to amplify the effectiveness of climate policies, particularly within regions where resources and expertise might be otherwise constrained.

Multi-Level Climate Governance (MLCG) and Integrated Coastal Zone Management (ICZM): Barriers and opportunities

The Brazilian Coastal Zone experiences a range of uses, activities, institutions, and public policies that intersect with the territory. Managing this area is a complex endeavor that necessitates a strategy of coordinated and integrated action across various governmental, social, and economic sectors (Dos Santos *et al.,* 2019). Additionally, the evolving governance framework concerning the effects of climate change introduces another layer of complexity to the already complicated scenario of coastal management coordination.

In Brazil, there is a crucial imperative for state and local governments to develop their coastal management plans, in accordance with the mandates of the National Coastal Management Plan. These plans must include climatic and environmental considerations within the coastal zone. However, to date, the municipalities in BSMR have not yet developed their coastal municipal management plans. According to Santos *et al.* (2019), the National Coastal Management Plan is based on a rigid model centered around technical and normative instruments, which may be hindering an alternative approach to integrated management with active participation from coastal society.

The implementation of coastal management strategies centers heavily upon collaborative efforts involving various entities, prominently including municipal sectoral policies such as climate change adaptation plans (Gonçalves *et al.,* 2021). To bridge the current gap in coastal management preparedness, a multilevel approach is necessary. Encouraging partnerships between governmental bodies, non-governmental organizations, and academia can engender a robust knowledge-sharing framework that paves the way for informed decision-making.

In addition to these efforts, establishing an efficient system for continuous monitoring and evaluation is indispensable (Dos Santos *et al.,* 2019). Regular progress assessments can identify bottlenecks, facilitate adaptive management strategies, and underscore the importance of accountability and transparency in achieving the required coastal management goals.

In conclusion, the imperative for state and local governments in Brazil to proactively develop and implement integrated coastal management plans is undeniable. By merging climatic and environmental considerations and leveraging collaborative frameworks, a resilient coastal management strategy can be forged, ensuring the sustainable development of these vital regions for generations to come.

The organizations analyzed in this study do not consider themselves articulated enough in initiatives aimed at climate change adaptation. This circumstance could potentially stem from the lack of institutional structuring for coastal management across distinct levels of governance. Moreover, within metropolitan expanses, a complex interconnecting of governmental activities across different levels further complicates the integration of coastal management endeavors with adaptive strategies.

Evidently, the coordination of the institutional framework for climate change with coastal management policies and undertakings emerges as an essential prerequisite for achieving efficacy (Tobey *et al.,* 2010). The effectiveness of adaptation initiatives appears closely linked to the efficacy of coastal governance in metropolitan regions. Yet, it is apparent that this linkage deserves a more exhaustive examination in subsequent research endeavors.

To address these issues, a multilevel approach is imperative. Firstly, there is a pressing need for coherent and comprehensive institutional coordination. This necessitates forging stronger ties and enhancing communication channels between various organizations and stakeholders engaged in climate adaptation

and coastal management (Tobey *et al.,* 2010). An efficient approach can help overcome the existing disconnect and lead to a more holistic and synergistic implementation of strategies.

Secondly, the issue of overlapping actions among different levels of government, particularly in metropolitan areas, demands careful attention. Establishing clear delineations of responsibilities and mechanisms for collaboration can mitigate the complexity and competition that often arise in such situations. Furthermore, integrating climate change considerations into coastal management policies and projects is a strategic move. By embedding adaptation principles into the core of coastal governance frameworks, a more unified and effective response to climate-induced challenges can be achieved.

The complexity of metropolitan institutional arrangements transcends mere jurisdictional boundaries, encompassing federal and state levels, alongside municipal jurisdictions. Consequently, collaborative efforts among governmental organizations become imperative to effectively execute efficient climate strategies. This necessity is highlighted by the findings of the study underscoring a range of barriers and opportunities inherent in the implementation and enhanced synchronization of MLCG within coastal metropolitan regions.

Table 3 lists the barriers and opportunities showed by the study relating to the understanding of multi-level governance within coastal metropolitan regions. This comprehensive compilation is enriched further by the incorporation of recommendations collected from the consulted bibliography. This synthesis serves to support a holistic understanding of the challenges and potential pathways for advancing effective governance mechanisms in these complex geographical and administrative domains.

Locally implemented climate governance initiatives stand as exemplars for immediate municipalities and play a crucial role in bridging gaps among various stakeholders as they scale up their successful methodologies (Fuhr *et al.,* 2018; Kern 2019). Within the context of the case study, the initiative undertaken by the municipality of Santos holds the promise of transforming it into a pioneering city, a model that could be emulated across other municipalities within the BSMR region (De Freitas *et al.,* 2018). However, it is important to note that the efficacy of local climate policies frequently hinges upon the strategies delineated at the national and regional levels (Fuhr *et al.,* 2018).

In this complex scenario, national governments emerge as pivotal planners of advancing the adaptation agenda. Their influence is underscored by the formulation of funding priorities, negotiation of tradeoffs, establishment of regulations, cultivation of institutional frameworks, and provision of critical policy directives to district, state, and local governing organizations (Noble *et al.,* 2014).

Unfortunately, in the period between 2019 and 2022, the political scenario in Brazil has witnessed a conservative national administration taking office, precipitating the erosion of federal environmental safeguards. This has manifested through a series of measures and actions designed to undermine the environmental policies of nations, including the dissolution of the Secretariat of Climate Change and Forestry under the Ministry of the Environment (MMA), as well as substantial reductions in the budget of MMA (Capelari *et al.,* 2020; Menezes and Barbosa Jr., 2021; Pereira and Viola, 2021).

This context highlights the dynamic interplay between local, national, and global forces in shaping climate governance trajectories. As localities struggle to pioneer innovative strategies, they are concurrently influenced by overarching national policies that can either strengthen or impede their progress. Therefore, achieving comprehensive climate resilience demands an integrated approach that coordinates efforts across multiple levels of governance while addressing the

Table 3. Barriers, opportunities and recommendations for MLCG in metropolitan coastal regions.

Barriers
Limited integration of coastal management and climate change policies.
Financial limitation of institutions.
Low social trust in public participation in government representative spaces.
Lack of a common climate agenda in regional scale.
Need of financial and training support to tackle climate change at regional and local level.
Limited access to financial resources and low influence on regional planning in the short-, medium- and long term by local governments.
Lack of federal support for climate change initiatives.
Opportunities
Strengthening of environmental departments.
Capacity building and information transmission.
Co-production of knowledge with institutes and universities.
Strengthen relationships with schools to promote climate education.
Best-practice transfer of successful initiatives.
Coordination and incentives to the private sector support in climate initiatives.
Influence of international actors and external funding support.
Recommendations
Horizontal collaboration within metropolitan regions can avoid conflict and competition between municipalities to attract investors (Lundqvist and Biel, 2007).
Information sharing and capacity building can strengthen governance (Andonova *et al.,* 2009; Bäckstrand 2008; Bitzer *et al.,* 2008).
Support of the national government can advance the adaptation agenda and support initiatives at local level (Noble *et al.,* 2014; Pietrapertonosa *et al.,* 2021).
Integration of best available knowledge and involvement of local communities can integrate climate change and coastal processes (Tobey *et al.,* 2010).

intricacies of interrelated environmental, coastal and political dynamics.

Several limitations should be acknowledged in the context of this study. Firstly, the data collection methods were conducted in 2018, which may have implications for the current dynamics and developments within the studied region. Additionally, while efforts were made to ensure comprehensive representation of organizations, there exists the possibility that the organizational landscape has evolved since then, potentially influencing the findings of the study. Moreover, the dynamic nature of political representation, especially due to elections, can introduce fluctuations in governance structures and priorities that were not fully captured within the duration of the study. These limitations collectively underscore

the need for ongoing research and the importance of recognizing the temporal and contextual nuances that shape the scenario of multi-level climate governance in metropolitan coastal regions.

8. Conclusions and implications

The study makes a valuable contribution to the expanding body of knowledge concerning the role of MLCG in a coastal context. In a broader sense, the research serves to address some of the challenges and opportunities that emerge within a Global South case study scenario as it copes with climate change-induced regulations and policies within a metropolitan coastal region.

By exploring into the mechanisms that facilitate collaborative interactions among organizations for climate adaptation, both at the local and regional levels, it was established that, despite the absence of institutional metropolitan climate change policies, the organizations examined in this study are actively fostering integrated adaptation initiatives. The findings also underscore the significance of improving horizontal coordination, bridging national, state, and regional levels, to strengthen responses to climate-related events at both local and metropolitan scales.

Moreover, this study resonates with this pressing concern and, founded on the identification of barriers and opportunities within the BSMR, Brazil, it offers insights that could potentially be applicable to other coastal regions dealing with similar challenges. Given that a substantial portion of the global population resides in coastal areas, these regions bear the effect of climate change impacts, ranging from sea level rise to the intensification of extreme weather events.

In addressing the complexities of MLCG within coastal regions, a promising avenue for enhancing coordination and collaboration emerges through the framework of ICZM. The incorporation of ICZM principles can serve for improve efforts across various levels of governance, thereby restructuring the integration of climate adaptation strategies and organizational interactions into policies and practical implementations.

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11. Statements and declarations

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