

Social movements and collaborative climate adaption: the case of Campo do Bomba, in Duque de Caxias-RJ-Brazil

Ana Lucia Britto

Affiliation: Universidade Federal do Rio de Janeiro

Email: ana.britto@fau.ufrj.br

Thêmis Amorim Aragão

Affiliation: Universidade Federal do Rio de Janeiro

Email: themis.aragao@fau.ufrj.br

Jorge Nassar Fleury

Affiliation: Universidade Federal do Rio de Janeiro

Email: jorge.fleury@fau.ufrj.br

Abstract

The sources discuss climate adaptation challenges in Brazil, noting that most municipalities lack capacity and plans. Local adaptation and community participation are crucial, especially in vulnerable settlements. Duque de Caxias, a flood-prone municipality, exemplifies these issues, marked by unregulated development and political resistance to public debate. The FORAS movement emerged, advocating for urban rights. A conflict centres on Campo do Bomba, a key floodplain, which the municipality wants for economic development despite its ecological role. FORAS mobilized, arguing its "sponge" function is its social function. Collaborating with academics, the community proposed the Quilombo do Bomba Ecological Park, featuring nature-based flood control, green areas, improved mobility, and community facilities. This case illustrates the struggle between economic interests and environmental/community needs

Keywords: climate adaptation, local government, community participation, vulnerable settlements;

Introduction

Addressing climate adaptation at the local level in Brazil represents a significant challenge due to the lack of institutional capacity and challenges in integrating sectoral policies. In Brazil, there are 5,570 municipalities. Data from the National Confederation of Municipalities indicate that between January 2013 and December 2024, a total of 5,279 Brazilian municipalities (95%) were affected by different kinds of disasters. Drought and excessive rainfall were the disasters that most affected Brazilian municipalities between 2013 and 2024 (Confederação Nacional dos Municípios, 2025). On the other hand, data from the AdaptaBrasil Platform indicate that more than 65% of Brazilian municipalities have low or very low capacity to adapt to natural disasters, such as heat waves, droughts and heavy rains.

The Rio de Janeiro Metropolitan Area (RMRJ) has twenty-two municipalities and only two of them have a Climate Change Mitigation and Adaptation Plan. Despite the Metropolitan Region of Rio de Janeiro (RMRJ) having an Integrated Urban Development Plan (PDUI) and a collegiate metropolitan governance body that brings together both local and state-level representatives, the urban actions that have been implemented remain fragmented, lacking a mitigating or adaptive approach to climate change. These projects are fragmented not only in their territorial scope but also in terms of the cross-sectoral integration of public policies.

Literature on climate change highlights the importance of cities and the local level in building adaptation strategies. The United Nations Development Programme (UNDP) highlights that climate adaptation is local in nature and that local governments should focus on adaptation activities and develop local strategies and action plans; the European Union's (EU) Strategy on Adaptation to Climate Change stress the importance of climate adaptation at the local level; the Global Commission on Adaptation (GCA) places an important emphasis on locally-led adaptation, which aims to shift "power to local stakeholders (OCDE, 2023). For Wannewitz and Garschagen (2023) adaptation is at least partly a communal task given that communities are in many ways bound together through infrastructure, geography, or resource management. They shared a common perception of hazard risk.

The authors propose a definition of collective adaptation “as actions of a group of individuals or subcultures collaborating according to shared rules to reduce their climate risk, exploit climate change opportunities and/or achieve additional common development objectives adopting a long-term perspective” (Wannewitz and Garschagen, 2023, p.2).

Peeling argues that adaptation agenda has local and global components and indeed national level action too. High level legal frameworks and voluntary agreements can support local action, but local level action is also a potential driver for higher level policy. But when this agenda is absent at higher levels, local action has the potential to be decisive in determining capacity and action and influencing the construction of a higher-level policy (Pelling, 2011).

Even if adapting to climate change is an important issue for the local environmental agendas, it is also a growing challenge for local communities, especially in marginalized informal settlements. Many informal settlements face high risks of floods and landslides a result of poor-quality buildings and a lack of infrastructure to prevent flooding, withstand heavy storms, and cope with heat waves (Wannewitz and Garschagen, 2023; Satterthwaite et al. 2020). The literature highlights the importance of social participation in the construction of adaptation strategies. Communities, and especially people who are marginalized, excluded, or especially vulnerable, must have some control over how their community will adapt (Adger et al. 2011).

But participation in adaptation strategies or policies at informal and vulnerable settlements is a complex issue. The question is if a vulnerable population has the political power – or political capability – to influence adaptation decisions, or if people most vulnerable to harm are politically capable of having control over their environment reveals opportunities to address the root causes of their vulnerability, as well as barriers to transformational outcomes. Informal communities often face a lack of political power, as their voices are marginalized in decision-making processes and their needs are overlooked by formal governance structures.

The local arena of environmental and climate adaptation politics includes elected officials and bureaucrats, as well as non-governmental actors, such as business entities, non-profit organizations, independent academics, political advocacy groups, and ordinary citizens who have a stake in climate adaptation decisions. It is a space where different interests are expressed and is therefore marked by conflict. Scientific expertise holds a privileged position in this arena. The privileged role of expertise can then function to diminish the voice and disregard the experience of those exposed to environmental harms (Ottinger 2013). Holland stresses the importance of alliances built by vulnerable or marginalized communities to enhance their capacity to be politically capable of shaping adaptation decisions, such as alliances with media or academics.

This paper addresses this topic through a case study in Duque de Caxias, a municipality in the Metropolitan Region of Rio de Janeiro that is severely vulnerable to flooding. Data on flood susceptibility indicate that 45% of households are in high-risk situations (Casa Fluminense, 2024). Focusing on the issue of social participation in discussions about climate adaptation projects and based on the definition of collective adaptation mentioned before, the paper focuses on a case study related to the protection of an area, Campo do Bomba, that has an important function in preventing floods. It highlights a community-driven project of sponge park, built from an alliance between the Urbanism Post-graduate Program at the Federal University of Rio de Janeiro and FORAS, an articulation of local social movements. The paper is organized into three parts in addition to this introduction. The first introduces the municipality of Duque de Caxias, its social characteristics, and its challenges concerning climate change and the local social movement, FORAS, which articulates the second proposal. The second section discusses the clash between the two proposals. The third focuses on the FORAS proposal and its development.

The case study area: Duque de Caxias and its vulnerabilities

Duque de Caxias is a municipality situated in the Metropolitan Region of Rio de Janeiro. The city has a population of 808,161 inhabitants (IBGE, 2022) and represents one of the major poverty areas within the metropolis. Regardless of this inequality scenario, the municipality holds the fourth largest GDP in the state (IBGE, 2021), with a per capita value of R\$57,170.07. The industrial production at the Duque de Caxias Refinery (Reduc), operated by Petrobrás, accounts for 80% of Brazil's lubricant production, in addition to processing the largest volume of natural gas in the country. This generates significant revenue for the municipality through the collection of oil royalties.

Although Duque de Caxias ranks among the municipalities with the highest per capita tax revenue in the state, its Human Development Index (HDI) was classified as *Medium* in 2021, with a value of 0.711, placing it 49th in the state ranking—below the state median.

When considering the Income component of the HDI, the municipality ranks even lower, at 57th position.

Geographically, Duque de Caxias is in the Baixada Fluminense, at the foothills of the Serra do Mar, with a mangrove coastline bordering the Guanabara Bay. The municipality lies within the Guanabara Bay hydrographic region, the outlet for the main rivers that traverse the metropolis and is frequently affected by flooding.

The city is drained by three major hydrographic basins: Iguaçu-Sarapuá, Estrela, and São João de Meriti, in addition to other smaller continental catchments that drain directly into the bay. The rivers descending from the Serra do Mar do so along stepped gradients formed by fault lines. These rivers exhibit a torrential regime with significant erosive power. Upon reaching the lowlands, their flow becomes depositional, lacking an intermediate sediment transport phase between the slopes and the plains. The violently descending waters from the slopes encounter difficulty in draining across the plain due to the low terrain gradient, resulting in extensive flooded areas, such as swamps and marshes (Prefeitura de Duque de Caxias, 2017).

According to the diagnostic report prepared for the Municipal Sanitation Plan, the drainage difficulties in the municipality are primarily attributed to its geomorphological genesis. These natural conditions of floodplain formation are further compounded by unregulated urban development and a lack of basic infrastructure, which exacerbate the flooding issues. The soil sealing increases surface runoff, while the silting and obstruction of rivers with sediment and domestic waste diminish their drainage capacity. The frequent overflowing of watercourses is also affected by tidal fluctuations, thereby extending the duration of flood events (Prefeitura de Duque de Caxias, 2017).

The history of urban occupation in Duque de Caxias is closely tied to the establishment of petroleum-based industrial parks. The industry, by generating employment opportunities, attracted many low-skilled workers to occupy positions along the production chain. However, the strategy of locating industrial plants was not accompanied by a broader process of urban and regional planning to address housing and basic sanitation needs. This lack of integrated planning has contributed to the current scenario of pronounced social inequality.

According to Neves et al. (2019), between 2007 and 2016, Duque de Caxias experienced a significant expansion of its urban footprint, encroaching substantially upon areas of herbaceous vegetation. Beyond the direct suppression of vegetation resulting from urbanisation in Duque de Caxias, Neves et al. (2019) highlight a concerning trend: the direction of this urban expansion towards areas highly susceptible to flooding. This raises significant concerns regarding occupant safety, particularly given the region's known susceptibility to riverine flooding events (Britto, Quintslr and Pereira, 2019).

Despite environmental issues constituting the primary urban challenges in Duque de Caxias, the municipality's political and administrative culture continues to prioritise strategies for attracting industries at any cost, often without adequately assessing the associated benefits and drawbacks across various industrial sectors. Historically, public administration in Duque de Caxias has operated to serve the parochial interests of specific family groups, promoting ventures that have contributed minimally to the reduction of social inequality. Consequently, the socio-environmental outcomes in the region have generated hybrid risks, characterised by the superimposition of environmental threats such as floods, water and soil contamination from landfills and refinery leaks, atmospheric pollution originating from oil industry chimneys, and significantly substandard basic sanitation infrastructure.

By the early 2000s, the city was compelled to initiate an urban planning process, driven by Federal Law 10.257, known as the City Statute. The master plan was approved on 31st October 2006. In 2009, a study on the drafting process of the Municipal Urban Master Plan of Duque de Caxias highlighted that public participation was not adequately accommodated. It was observed that during over a six-month of plan elaboration, only 14 public meetings were held. Furthermore, some of these meetings were cancelled due to a lack of quorum.

One of the most flagrant indicators of inadequate participation was the fact that the Master Plan was voted upon without public presence and without the inclusion of amendments.

Nonetheless, Duque de Caxias has a set of social movements that were structured in the 1980s. In 1983, the Municipal Federation of Residents' Associations of Duque de Caxias (MUB) was created at a meeting attended by 27 residents' associations. The MUB emerged in a context in which several popular movements and community organizations were organized in the municipality, such as residents' associations, CEBs (Base Ecclesiastical Communities) and the Friends of the Neighbourhood Movement. These movements were organized during the military dictatorship, with their main causes being the fight for democracy, the right to health, basic sanitation, education and housing. A few other movements that also focused on environmental issues were also organized. However, the various local governments resisted the democratization of public management through participatory processes.

The process of the plan shows this local government unwillingness, demonstrating the extent to which the administration is refractory to the concept of planning and regulating the territory through public debate. Such planning typically reveals conflicts and establishes rules for reconciling different urban land uses. Without stringent regulation, any type of enterprise can establish itself in the municipality, which offers minimal or no restrictions on activities that could cause environmental damage. In the case of Duque de Caxias, there is a discernible lack of concern on the part of governmental authorities regarding whether new ventures embraced by the municipality as an economic strategy conflict with public health considerations.

The land-use zoning imposed by the Duque de Caxias Master Plan was not revised within the stipulated 10-year period for its renewal. Amendments to the Master Plan have been enacted through complementary laws whenever the administration deems it necessary to alter provisions to accommodate specific political projects. Between October 2006 and May 2025, the Master Plan's text has been subjected to 14 alterations. All these changes have specifically modified land use to permit the economic exploitation of areas that were frequently designated as areas of environmental interest or subject to occupation restrictions. Out of the 14 modifications to land use within the Master Plan enacted by the municipality, five pertain to the suppression or reduction of the delimitation of Special Environmental Interest Zones to accommodate Special Business Zones. Furthermore, two complementary laws relate to the intensification of land use in Controlled Occupation Zones, reclassifying them as urban expansion areas. This paper reports on the community mobilisation in São Bento concerning the land-use changes affecting a parcel of land. This area was decoupled from the São Bento Environmental Protection Area and subsequently reclassified as a business interest zone.

In 2014, faced with the imminent construction of a multi-activity complex that included a shopping centre, office towers, and an aparthotel planned for the last remaining green area in the central region of Duque de Caxias at the time, the local population, recognizing the scale of the initiative, organized in opposition, creating the Forum of Resistance to the shopping mall named FORAS.

From the perspective of promoting greater public participation in city management and pressuring municipal authorities to prioritize the interests and needs of the population, FORAS positioned itself against the construction. It denounced its various social, cultural, urbanistic, and environmental impacts of the project and proposed, instead, the creation of an urban park. This park would contribute, among other things, to preserving the city's memory.

The chosen format for organizing this initiative was a People's Forum—a space where various organizations and grassroots movements could participate without losing their unique identities. Institutions involved in this process included among others: local cultural associations, environmental movements, feminist movements, Federation of Residents' Associations of Duque de Caxias (MUB); the Forum of Communities Affected by the Petroleum and Petrochemical Industry near Guanabara Bay (FAPP-BG); the State Union of Education Professionals (SEPE); the Duque de Caxias Oil Workers' Union (SINDIPETRO-CAXIAS); the National Movement for Housing Rights (MNLN); the National Union of Black Men and Women in Duque de Caxias (UNEGRO) and Catholic Church leaders and members.

During the movement against the shopping mall, meetings were held with public authorities, workshops were conducted in schools, and participation in municipal participatory councils and conferences was emphasized. Other activities included publishing educational booklets, organizing public hearings, distributing pamphlets, graffiti campaigns throughout the city, and filing public civil actions. The Institute of Urban and Regional Planning and Research (IPPUR-UFRJ) was a key partner of FORAS, contributing activities to enhance public discourse, equipping activists with the technical knowledge necessary for effective dialogue and advocacy with local authorities.

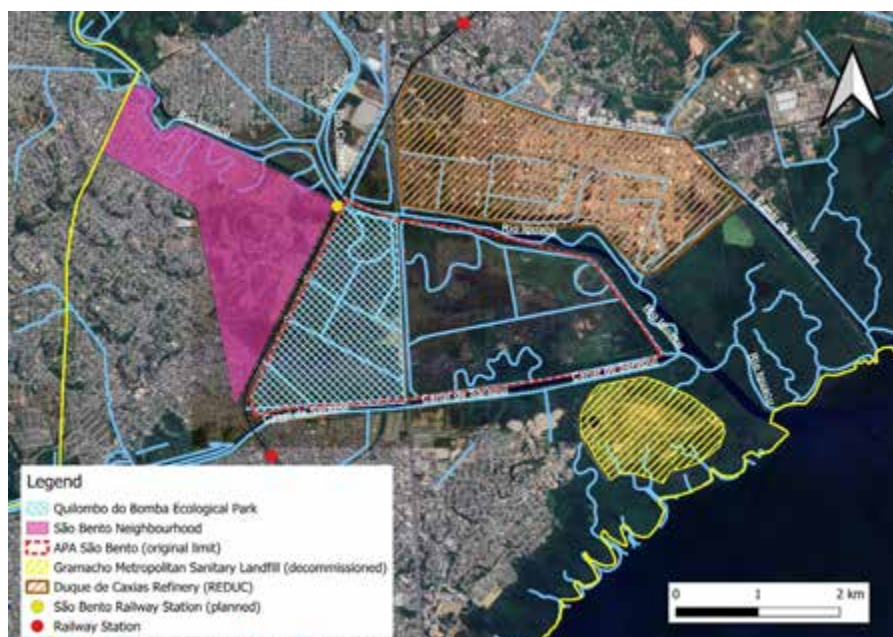
The movement organized by FORAS was victorious, bringing the conflict beyond the city's boundaries, to the extent that, to this day, the Central Park Caxias project has not been realized. In the process, FORAS established itself as a unifying force for major grassroots movements in the city, advocating for community libraries, protecting the city's historical heritage and the environment, and fighting for urban rights. Despite an unfavorable political climate in the city, FORAS members remained vigilant regarding new projects, denouncing the predatory occupation of public lands and deforestation.

Another critical moment of mobilization arose in response to the 2018 Metropolitan Urban Development Plan proposals for Duque de Caxias, which sought to promote logistics activities in the municipality, compromising environmental quality. One proposal that faced significant opposition involved an area known as "Campo do Bomba", in the São Bento neighbourhood, which will be explained in the following section.

The fight for Campo do Bomba preservation

The São Bento neighbourhood, situated between the estuaries of the Iguaçu and Sarapuí rivers, was historically part of the São Bento Farm. This land was transferred by the Ministry of Agriculture to the National Institute of Colonization and Agrarian Reform (INCRA) upon its establishment in 1970. A portion of this region now constitutes a Municipal Environmental Protection Area (APA de São Bento). The São Bento APA is divided into the eastern part and western part. The eastern part, under the possession and supervision of the Navy, has different communities settled by the Ministry of Agriculture, the State Government, social movements, and militia members who illicitly sold Union lands without the knowledge of the National Institute for Colonization and Agrarian Reform. The western contains archaeological and historical heritage sites and one of the last remaining fragments of the Atlantic Forest in close proximity to the municipality's urban centre (Figure 1)

On October 27, 2006, the then-mayor of Duque de Caxias enacted Law No. 2003/2006, which excluded the areas known as Campo do Bomba 1 and Campo do Bomba 2 from the São Bento Environmental Protection Area (APA). Together, these areas covered approximately 315 hectares. The justification for this exclusion was unclear.



São Bento neighbourhood has long been regarded as a metropolitan sacrifice zone, owing to its location adjacent to the Duque de Caxias Refinery (REDUC) and the former metropolitan landfill of Gramacho. The APA de São Bento is highly valued by the local population, serving as a natural barrier against atmospheric pollution emanating from REDUC and acting as a buffer zone against the risk of chemical leaks from the industrial area. Furthermore, it plays a critical role in the region's hydrological dynamics by absorbing a portion of the flow from the Iguaçu and Sarapuí rivers, thereby mitigating the effects of flooding in the Baixada Fluminense lowlands.

In 2017 Duque de Caxias government announced a project to build in the Campo do Bomba area a new State Central Supply Market (CEAERJ), and it requested INCRA to donate the land to the municipality. The Municipality initiated a process of landfilling the area, thereby suppressing native vegetation. Concerned by the potential consequences of this undertaking, FORAS initiated a political mobilisation against the project arguing the environmental role of the area, and the negative consequences of its occupation.

The municipal government's idea was to build the new State Central Market to replace the old one located in Rio de Janeiro suburb since the 70's. The Association of Ceasa Merchants were against the change. The decision concerning the relocation of CEASA was under the state government's responsibility, and the project from Caxias municipality wasn't approved. But the idea of giving an economic function to the area remained.

Between 2017 and 2018 the state government developed the Integrated Urban Development Strategic Plan for the Metropolitan Region of Rio de Janeiro (PDUI/RMRJ). Discussion groups were created to address different subjects, followed by integration discussion groups that consolidated scenarios and subsequently the proposals for priority actions included in the plan. One of these actions concerned the Campo do Bomba area.

The project was part of the subprogram "Living in the Metropolis," and it aims to mitigate flooding in the Iguaçu-Sarapuí River basin through macro-drainage interventions in the Campo do Bomba area. The metropolitan project was aligned to the municipal interests to give to this area an economic use. It aimed to install a canal between the Iguaçu and Sarapuí rivers to reduce the over flood of the two rivers. This canal would ensure the flood mitigation function, thereby allowing the remaining (3,000,000 m² of Campo do Bomba) to be utilized for industrial, logistical, and other purposes (Consórcio Quanta-Lerner, 2018).

The project mobilized FORAS that organized meetings to discuss the metropolitan plan projects to Duque de Caxias. But until then, the occupation of Campo do Bomba was only a non-developed project. The situation changed. With the approval of the guidelines included in the Metropolitan Plan, the government of Duque Caxias took up the project to give the area an economic purpose, now in the form of a logistics centre, similar to CEAERJ. A bidding process was conducted, and the area was granted to the territory's winning consortium—the sole bidder.

When the landfilling of the area began, in 2020, members of FORAS (researchers, environmentalists, lawyers and fishermen) began to meet every week to discuss strategies for action against the landfill. The dispute ended up in the Federal Public Ministry (MPF), which requested that the work be suspended and that studies be carried out to assess the impacts it could cause. The land is, in fact, owned by the National Institute for Colonization and Agrarian Reform (Incra), a federal agency, and ceded to the municipality. Due to the non-compliance with clauses of the donation agreement that conditioned the donation to a socio environmental project to the area, and the accomplishment of the social function of the land- a principle of Brazil's Constitution- the Federal Public Prosecutor's Office, ordered the reversal of the donation term.

Although the Public Prosecutor's Office successfully suspended any ongoing interventions by the municipality in the area, the local government maintained its agenda. In 2021, Duque de Caxias, presented a reformulated project, including a study for the channel between Iguaçu and Sarapuí river, elaborated by an expert in hydrology, which was responsible for the Iguaçu Sarapuí River Basin Plan, elaborated within a contract with the state government's environmental agency (INEA).

In march 2021 a public hearing was conducted by the Federal Public Prosecutor's Office and mediated by Federal Prosecutor Júlio José Araújo Júnior. It included the participation of representatives from the Duque de Caxias municipal government, the Rio de Janeiro State Environmental Agency (INEA), the National Institute for

Colonization and Agrarian Reform (INCRA), the Public Defender's Office, and civil society—comprising teachers, residents, and individuals connected to social movements. The hearing was held remotely via the YouTube platform and streamed live. At that time, due to the health emergency caused by COVID-19, it was not possible to hold in-person public hearings to prevent the spread of the disease.

During the hearing, the representative of the municipal government argued that Campo do Bomba wasn't fulfilling a social function and that there was a risk of the area becoming a "slum." He states that economic development will prevent a disorderly occupation and will create about 50,000 jobs and an increase in tax revenue for the municipal administration. The municipality also emphasized the area's strategic location, adjacent to the Washington Luís Highway and near the Duque de Caxias petrochemical hub. The government's project shows a cluster of plots occupied by warehouses with highly waterproofing. The study conducted by the expert for the canal that will prevent the floods and allow a non-residential occupation of the area was not presented.

The proposal of the municipal representative was contested by FORAS members, who presented studies showing the importance of Campo do Bomba as a sponge site, absorbing water from flood water from rivers and preventing worsening flooding in the surrounding occupied area. The population living around Campo do Bomba considers that the site already fulfils its social function, which is its ecological function. The climate change impacts were highlighted. Sarapuí and Iguaçu rivers are silted up due to mud and trash, which hinders water drainage during rainfall. The progressive rise in sea level caused by climate change is expected to further worsen this situation because both rivers have a configuration highly prone to flooding. When it rains, the sea acts as a wall holding back the flow and preventing the floodwaters from receding. In the coming years, climate change could increase rainfall volumes by up to 30%.

To counter the potential occupation of Campo do Bomba, FORAS organized a petition to transform the area into a state-protected park. The document was presented to deputies in the Legislative Assembly of the State of Rio de Janeiro, leading to the proposal of a bill by a deputy who embraced FORAS's cause, presented in the Legislative Assembly in the end of august 2021.

In the process of the drafting of a bill, this representative organized three public hearings in 2021 at the Legislative Assembly, attended by representatives from the Caxias municipal government, FORAS, INCRA, the Federal Public Prosecutor's Office, and INEA, all of whom were given the right to speak. During the debate in the public hearing in September 2021 the representative of Duque de Caxias mentioned the project of the canal between the two rivers, but did not present it. The representative of the State Environmental Agency, INEA, stated that the area is highly complex and requires technical studies conducted by a multidisciplinary team to issue the Environmental Technical Opinion. These studies are necessary because the area involves an entire ecosystem, including fauna and flora; however, such studies have not yet been conducted by the state agency. It was emphasized that, due to the proximity of the Sarapuí and Iguaçu Rivers and its coastal location near Guanabara Bay, the region functions as a floodplain, it was important to conduct a more detailed study of the area's hydrological behavior. This study should outline the advantages and disadvantages of implementing the Duque de Caxias government project, as well as all environmental consequences. This instrument will then be reviewed by INEA, and after analysis by the technical team, a decision will be made regarding the area.

The Campo do Bomba's community planning

Concurrently, within the political discourse and community leadership mobilisation, Bill No. 4773/2021 was submitted to the Legislative Assembly in 2019, proposing the establishment of the Quilombo do Bomba State Park in the area. However, the bill remains under discussion, and the ultimate designation of the area is still uncertain. The name of the park was chosen by FORAS members because the site was also home to the Quilombo do Bomba. Quilombos are settlements established by escaped enslaved people (known as quilombolas) in Brazil during the colonial period. These communities were often formed in remote areas and served as places of resistance, refuge, and self-determination. Quilombo do Bomba was part of the most famous quilombo complex in Rio de Janeiro, known as the Hydra of Iguaçu, a reference to the mythical monster and the river that crossed the settlement. To this day, residents find ancient artifacts in the surrounding area. For researchers, building on Campo do Bomba is equivalent to permanently burying the memory of the place.

Given the local community's recognition that the land's social function should be maintained as an environmental protection area and considering the context of climate change and the already observed alterations in natural phenomena, the community has sought partnerships to assist them in developing an alternative proposal for the land parcel. Despite the existence of the Bill for park creation, the community fears that the proposed urban and landscape design may not adequately consider aspects they value. In this regard, a local effort was made to establish contact with the Federal University of Rio de Janeiro's Faculty of Architecture and Urbanism, seeking academic cooperation with residents in preparing a preliminary study for a viable park in the area.

Within the scope of the Professional Master's Programme in Landscape Architecture, a design studio course facilitated the development of a preliminary study for the Quilombo do Bomba Ecological Park. The professors and students implemented a participatory design process. Members of FORAS participated in all the studio classes and lectures on water sensitive cities and nature-based solutions. Field work and discussions with the community were held in numerous meetings.

As a result, the local population prioritised five key strategies to be integrated within the park's spatial framework.

Water Strategy

Given that flooding and sanitation are central issues in the neighbourhood, the population advocated for these problems to be primarily addressed with nature-based solutions. Initially, however, the completion of the unbuilt dikes from the Projeto Iguaçu and the expansion of polder areas along the Sarapuí and Iguaçu rivers were proposed. Recognising that urban occupation no longer permits the river's original meandering, engineering methods are necessary to ensure the local population's safety from floods.

In contrast to the landfilling proposed by the municipality, the community favoured excavating the area to create a large detention basin, allowing the interlinking of both rivers for promoting flow control in both river basins. Excavation would enable the construction of various cells at different elevations, which would be inundated as river levels rise. The objective is to retain this water during peak flow periods and gradually release it after the crisis subsides. Furthermore, the excavation aims to establish a constant water surface across a significant portion of the terrain for planting phytoremediation species, accelerating water purification processes.

For the neighbourhood, the installation of water distribution, sewage, and drainage networks is a key guideline. During this process, there is a strong demand for replacing asphalt with permeable pavements and installing rain gardens to reduce the volume of surface runoff from rainwater.

Green Strategy

The green strategy is intrinsically linked to drainage issues, particularly concerning the maintenance of dike structures and the role that vegetation plays in soil stability and permeability levels.

The project anticipates the restoration of riparian forests along the rivers through planting on dike slopes. The aim is for roots to stabilise the slopes while creating a continuous tree canopy along the dike to facilitate genetic material transit via fauna. The dike structure must also support the passage of dredging tractors, with accessible points to the river for maintaining the macro drainage channel.

In addition to the dike strategy, the Quilombo do Bomba Ecological Park area is traversed by Furnas' high-tension energy distribution infrastructure. The "non aedificandi" (no-build) zone beneath the power lines has the potential to be utilised as a strategy for promoting corridors to form a system of green areas and interconnect conservation units within the Baixada Fluminense.

Furthermore, part of the territory could also be used for establishing urban gardens, mitigating issues related to food security in the area.

Mobility Strategy

Considering the precarious conditions in the area, the widespread absence of private vehicle ownership in the neighbourhood, and the need for access to the job market, the São Bento population demanded accessible (physically and financially) public transport for the project. Research conducted by students, based on community

statements, revealed a historical plan for a train station within the neighbourhood at the perimeter of the Quilombo do Bomba Ecological Park. This proposal was subsequently incorporated into the preliminary study.

The devised strategy was to utilise the tops of the dikes that connect to the railway line as a large cycle path, allowing flow from the neighbourhood to the train station and the centre of Rio de Janeiro. This cycle path would reach other Baixada Fluminense municipalities, such as Belford Roxo and São João de Meriti, potentially increasing the use of urban trains, mitigating greenhouse gas emissions from bus use, and influencing a modal shift among car owners.

The dikes would be structured with appropriate paving and shaded by the planned riparian forest. Additionally, the station could be located on the banks of the Iguaçu River, which was historically navigable and has the potential to integrate with fluvial transport to Guanabara Bay. For the consolidation of bicycle use, residents highlighted the need for bicycle parking associated with the new station, as well as the implementation of shared bicycle stations for access by those who do not own one.

Mobility also encompasses the redesign of local streets, incorporating level, permeable, and shaded pavements.

Regional integration was also considered by incorporating the Park as a connecting route between the São Bento neighbourhood and the Pilar and Jardim Gramacho neighbourhoods, as well as with the Washington Luís Highway, through suspended walkways and viewpoints constructed at their intersections. In this sense, these walkways, which would also include cycle paths, would allow residents of São Bento and Pilar easy access to facilities such as the Federal Institute of Rio de Janeiro, located in Jardim Gramacho, an area currently "distant" due to various existing spatial fragmentation elements: the railway line, rivers, impenetrable land parcels, etc.

Social and Environmental Development Strategy

Throughout the discussions concerning the preliminary design of the Quilombo do Bomba Ecological Park, the need to integrate the area into the community's daily life was frequently highlighted, ensuring the space would not be occupied by housing or economic activities incompatible with the proposed model. To achieve this, the strategy would involve the urbanisation of the land's periphery as a mechanism to protect its ecological functions while simultaneously endowing the periphery with public uses necessary for the local community.

One frequently cited demand was for a creche (daycare centre). This is due to the high incidence of households headed by women in the area, and their need to secure childcare for young children to enable economic activity. The 2022 census indicates that the São Bento, Pilar, and Jardim Gramacho neighbourhoods have 52.40%, 51.75%, and 52.77% female-headed households, respectively.

In addition to a daycare centre, the necessity of a community centre for meetings of various organised groups lacking a formal meeting space was mentioned. This community centre could also host courses and lectures for the community and provide an area for exhibiting local artisanal production.

The periphery should also include leisure areas not hegemonically used by men and boys, as is often the case (e.g., multi-sport courts, skate parks). Instead, it should feature meeting areas for the elderly, spaces for caregivers adjacent to playgrounds, and playgrounds with specific equipment for different age groups.

The park's needs program also included the use of environmental education-promoting furniture, where air quality sensors, rain gauges, and anemometers could be installed, or which could narrate the local community's history. In this sense, the Quilombo do Bomba Ecological Park could be concretely integrated into residents' lives, reinforcing local identity.

Housing and Urban Infrastructure Strategy

While much of the discussion revolved around the preliminary design of the Quilombo do Bomba Ecological Park and the integration of this new space into local dynamics, reflection on the concrete reality of the population was recurrent and important for incorporating aspects related to residents' living conditions into the project guidelines.

To enable the strategies described previously, articulated action through housing policy is crucial. The population residing on top of the dikes, who are the primary victims of annual floods, must be relocated to new housing. Consequently, this housing must be within the neighbourhood's perimeter so that the population does not lose social ties with their neighbours or their solidarity network, nor lose the benefits of the park to be realised due to their own resettlement.

For the consolidated areas of the São Bento neighbourhood not within environmental risk zones, the guideline is the implementation of water, sanitation, and drainage infrastructures. As it is an INCRA area, the community's land regularisation process could also be initiated through a REURB-S process, where public investments would be directed towards installing this basic infrastructure.

Conclusions and Future Developments

This paper discusses how organized social participation can build alternative projects for climate adaptation. The literature analysed on the subject highlights the role of the local level in constructing adaptation agendas and the importance of social participation in shaping these agendas. However, it also underscores the challenges of participation in contexts of socio-environmental vulnerability, where social actors are deprived of power, and their capacity to influence decision-making remains a limiting factor. Government practice continues to be largely resistant to the demands of the population, as the local political arena for climate adaptation is a contested space where competing interests collide.

Urban and environmental projects that impact areas vulnerable to climate change and claim to mitigate these effects are often top-down initiatives, disregarding the experiences, knowledge, and interests of those living in these areas. One way to counter these projects is through the creation of collective adaptation projects, built by forming alliances.

The case study focuses on the municipality of Duque de Caxias, where the local government lacks both institutional capacity and political will to address the climate emergency. On the other hand, there are organized social movements in the region that address this issue and oppose government projects that negatively impact the environment and increase the local population's vulnerability to the effects of climate change.

Beyond mere opposition, these social movements strive to propose alternative projects to official initiatives, where climate adaptation becomes a crucial aspect. To achieve this, strategic alliances are formed to provide the projects with technical and political support. It is within these alliances and the articulation built in the territory that the concept of collective adaptation lies.

The paper analyses the construction of a collective adaptation project by social movements in São Bento, Duque de Caxias in alliance with progressive political actors, the Federal Public Prosecutor's Office, and the university. The project addresses a context where socioeconomic vulnerability combines with vulnerability to flooding. It emerged as a counterpoint to another project, driven by dominant economic interests and supported by municipal and state government spheres, which overlooked local demands.

Government's project prioritizes economic development in a narrow sense and seeks to promote the installation of large-scale logistics infrastructure. This would require landfilling an area that, until recently, was part of an environmental protection zone and which plays a critical ecological role, providing natural mechanisms for mitigating environmental impacts. On the other hand, there is the counterproject from the São Bento community, which values environmental preservation and integrated socio-environmental development. This vision is embodied in the proposal for the Parque Ecológico Quilombo do Bomba, a community-led plan that seeks recognition of the area's ecological function as its social function, using the site as a space for sustainable climate adaptation.

Despite social mobilization and legal actions, the legal status and fate of contested areas such as Campo do Bomba remain uncertain, depending on the outcomes of political and technical processes at various levels of government. There remains an urgent need for in-depth technical studies carried out by multidisciplinary teams. The future development of vulnerable areas such as Duque de Caxias will depend on the ability of social movements and communities to overcome local political resistance, foster public debate, and defend development models

that integrate climate adaptation, environmental preservation, and basic social needs — as opposed to models focused exclusively on unregulated economic growth.

References

Adger, N. Barnett, J., Chapin, F. S., and Ellemor, H. (2011). This Must Be the Place: Underrepresentation of Identity and Meaning in Climate Change Decision-Making. *Global Environmental Politics*, 11 (2), 1–25.

Britto, A. L. QuintsIr, S., Pereira, M. S. (2019). Baixada Fluminense: Fluvial and Social Dynamics in the Constitution of a Territory. *Revista Brasileira de História*. 39 (81) May-Aug.

Confederação Nacional dos Municípios (2025). Estudo Panorama dos Desastres no Brasil.2013-2014.[Online] available at: <https://cnm.org.br/biblioteca/exibe/15657>

Casa Fluminense (2024). Relatório Casa Fluminense: panorama sobre a crise climática na metrópole.[Online] available at: <https://casafluminense.org.br/wp-content/uploads/2024/05/Dados-e-informacoes-sobre-Justica-Climatica-Casa-Fluminense.pdf>

Consórcio Quanta-Lerner (2018). Plano Estratégico de Desenvolvimento Urbano Integrado da Região Metropolitana do Rio de Janeiro – PDUI/RM do Rio de Janeiro. Rio de Janeiro.[Online] available at: <https://www.modelarametropole.com.br>

Holland, B. (2017): Procedural justice in local climate adaptation: political capabilities and transformational change, *Environmental Politics*, 26(3), 391–412.

Instituto Brasileiro de Geografia e Estatística. (2022). Censo Demográfico 2022. Rio de Janeiro: IBGE.

Instituto Brasileiro de Geografia e Estatística. (2021). Duque de Caxias <https://cidades.ibge.gov.br/brasil/rj/duque-de-caxias/panorama>

Neves, L. V., Beser de Deus, L. A., Oscar Júnior, A. C. S., Fernandes M. C. (2019). Mudanças de Uso e Cobertura da Terra e Áreas Suscetíveis à Inundação – Estudo de Caso do Município de Duque de Caxias/RJ. *Revista do Departamento de Geografia, Universidade de São Paulo*. Volume 37, pp. 30-43.

OECD (2023). Climate adaptation: why local governments cannot do it alone. *Environment Policy Paper No. 38*. [Online] available at: https://www.oecd.org/en/publications/climate-adaptation-why-local-governments-cannot-do-it-alone_be90ac30-en.html

Ottinger, G., (2013). *Refining expertise: how responsible engineers subvert environmental justice challenges*. New York: NYU Press.

Pelling, M., (2011). *Adaptation to climate change: from resilience to transformation*. London: Routledge.

Prefeitura de Duque de Caxias (2017). Plano Municipal de Saneamento Básico. [Online] available at: https://www.inea.rj.gov.br/wp-content/uploads/downloads/SEAS/PMSB_DUQUE_DE_CAXIAS.pdf

Satterthwaite, D. Archer, D. Colenbrander, S., Dodman, D. Hardoy, J. Mitlin, D. Patel, S. (2020). Building Resilience to Climate Change in Informal Settlements, *One Earth*, Volume 2, Issue 2, pp. 143-156.

Wannewitz, M and Garschagen, M (2023). Collective adaptation to climate change. *Current Opinion in Environmental Sustainability*, Volume, 61:101248