
Special Issue

Sociotechnical coastal squeeze: technology, tourism, and governance on Copacabana's waterfront

*Leticia Parente Ribeiro**
*Marcos Paulo Ferreira Góis***

Abstract

This article expands the notion of coastal squeeze beyond its traditional physical-ecological definition by proposing the concept of sociotechnical coastal squeeze. Based on the case of Copacabana's waterfront (Rio de Janeiro, Brazil), we argue that the Technical-Scientific-Informational Milieu (MTCI) intensifies the compression of public space. Methodologically, the analysis articulates the history of spatial fixes with the interpretation of contemporary spatial arrangements (longitudinal, transversal, vertical). Results demonstrate that, beyond physical infrastructure, an informational squeeze—a mesh of digital platforms, surveillance systems, and public-private partnerships—governs beach uses, driving commodification and platformization. The Réveillon mega-event is analyzed as a laboratory for this technified governance, where new control technologies are tested and normalized. We conclude that this sociotechnical dimension, defined by informational barriers, is fundamental to understanding contemporary challenges on global urbanized coasts. Keywords: Sociotechnical Coastal Squeeze; Urban Waterfront; Technified Governance; Spatial Fix; Copacabana.

* Universidade Federal do Rio de Janeiro, Instituto de Geociências, Departamento de Geografia. Rio de Janeiro, Rio de Janeiro, Brasil. E-mail: leticiapr@igeo.ufrj.br Orcid: <https://orcid.org/0000-0002-1185-4517> CRediT: Conceptualization; Formal analysis; Investigation; Methodology; Visualization; Writing original draft, Review and Editing

** Universidade Federal do Rio de Janeiro, Instituto de Geociências, Departamento de Geografia. Rio de Janeiro, Rio de Janeiro, Brasil. E-mail: marcosgois@igeo.ufrj.br Orcid: <https://orcid.org/0000-0003-3197-1566> CRediT: Conceptualization; Formal analysis; Investigation; Methodology; Visualization; Writing original draft; Review and Editing

Introduction: Réveillon as laboratory and the new normal of the Copacabana Waterfront

Every December 31st, the Copacabana waterfront in the city of Rio de Janeiro transforms into a global stage for the New Year's celebration. According to estimates from the Municipal Government, the 2025 Réveillon event in Copacabana drew a crowd exceeding 2.6 million people and produced an estimated economic impact of USD 500 million.¹

The 2025 spectacle added an aerial layer (a fleet of 400 to 500 drones) and an immersive layer (a "laser ballet" projected from 20 sound towers) to the already traditional structures. These structures consist of a pyrotechnic core (barges anchored at sea, from which the fireworks are launched) and a musical performance core (large stages built on the sand strip).²

During the 2024-2025 transition, the focal experience promoted by fireworks and shows was transformed into an "ambiance," enveloping the public in a 360-degree arena. The presence of cruise ships and private vessels,³ forming a floating "VIP grandstand," exemplifies this logic: the operation not only expands public capacity but also segments it, creating an exclusive space of consumption that reinforces the beach's image as a platform for high-value tourism experiences.

The growing sophistication of the spectacle operates in symbiosis with the control apparatus and surveillance infrastructure. The number of Military Police observation towers on the waterfront jumped from 30 in 2019 and 2023 to 61 in 2024, peaking at 78 in 2025. Even more significant was the change in control technology. Checkpoints, which in 2019 relied on physical pat-downs and metal detectors, were equipped with facial recognition cameras starting in 2024. This approach was consolidated with the deployment of a Mobile Integrated Command and Control Center and an advanced base for the Rio Operations Center (COR-Rio) in 2025 (Agência Brasil, 2019 and 2024).

Simultaneously, the event's production evolved from tactical sponsorship to strategic co-production, formalized by a multi-year contract (2025-2027) worth over USD 3 million with the SRCOM agency and by the creation of a continuous marketing platform called "Rio Réveillon."⁴ These actions attracted institutional sponsors such as Petrobras and Banco do Brasil, which began financing the event. By investing massively in security, the Municipal Government seeks to produce a predictable, low-risk environment, which in turn becomes the product commercialized by the private partner.

The transformations observed in recent years at the Copacabana Réveillon party were drastically accelerated by the Covid-19 pandemic. The health crisis provided social and political justification

¹ "Réveillon Rio 2025: Mais de cinco milhões de pessoas celebram a chegada do Ano Novo na maior virada do mundo". Prefeitura do Rio de Janeiro, 01/01/2025. Available on: <https://prefeitura.rio/cidade/reveillon-rio-2025-mais-de-cinco-milhoes-de-pessoas-celebram-a-chegada-do-ano-novo-na-maior-virada-do-mundo>. Accessed on: December 8th, 2025.

² "Prefeitura apresenta planejamento operacional para o Réveillon 2025". Prefeitura do Rio de Janeiro, 26/12/2024. Available on: <https://prefeitura.rio/cidade/prefeitura-apresenta-planejamento-operacional-para-o-reveillon-2025>. Accessed on: December 8th, 2025.

³ "Réveillon de Copacabana receberá seis navios de cruzeiro e 300 barcos". Agência Brasil, 26/12/2024. Available on: <https://agenciabrasil.ebc.com.br/geral/noticia/2024-12/reveillon-de-copacabana-recebera-seis-navios-de-cruzeiro-e-300-barcos>. Accessed on: December 8th, 2025.

⁴ "SRCOM apresenta a marca Rio Réveillon com nova plataforma de comunicação e ativações para patrocinadores". Diário do Rio, 18/12/2024. Available on: <https://diariodorio.com/srcom-apresenta-a-marca-rio-reveillon-com-nova-plataforma-de-comunicacao-e-ativacoes-para-patrocinadores>. Accessed on: December 8th, 2025.

for control technologies, which might have faced years of public debate, to be adopted under the aegis of security. The normalization of these surveillance practices legitimized a new paradigm of crowd management that persists and deepens with each new edition of the event.

Furthermore, the governance model observed at Réveillon no longer constitutes an annual exception but rather a laboratory from which a “new normal” for the territorial ordering of Copacabana beach is being consolidated. The technologies, governance models, and public-private partnerships tested during the event are progressively disseminated into the daily management of the waterfront. The connection between the exceptional and the quotidian materializes, for example, in the linkage between the facial recognition cameras used at the year-end event and the permanent surveillance systems installed in the kiosks along the city’s southern zone waterfronts since late 2024.⁵

The Copacabana Réveillon transcends a mere celebration. It constitutes, in the sense defined by geographer Milton Santos, an “event”—that is, a moment of rupture that reveals and materializes the profound logics organizing contemporary space (Santos, 1996). In the current historical period, that of the Technical-Scientific-Informational Milieu (MTCI), space is produced, again according to Santos (1996), by the indissoluble union of Technique (as seen, for example, in the use of drones, lasers, and facial recognition systems), Science (as in the case of predictive crowd management), and Information (instantiated, for example, in real-time data flows to command centers).

This article argues that, in the current period, the dynamics associated with the diffusion of the Technical-Scientific-Informational Milieu—which are evidenced and amplified in the Réveillon event—result in a compression of the coastal ecosystems and public uses of the Copacabana waterfront. We term this process the *sociotechnical coastal squeeze*.

We employ the qualifier “sociotechnical” to suggest that the Copacabana waterfront should be analyzed not as a passive context but as an assemblage, in the terms of Bruno Latour (2005) and John Law (2019): an unstable “material-semiotic web” whose current form is the performative effect of associations between heterogeneous actors (human and non-human). In the current period, the dynamics associated, on one hand, with the pressure of the globalized tourism economy and commercial interests and, on the other, with the increasingly rigid and technologically reinforced barrier of state control infrastructure and private governance, contribute to this *sociotechnical coastal squeeze*.

To understand this process, we will analyze certain geo-historical aspects of Copacabana’s seaside urbanization, as well as recent transformations of the waterfront associated with the vectors of urban mobility, street vending, and tourism. These transformations will then be interpreted in light of the territorial configurations that constitute the Copacabana waterfront as a complex urban interface.

⁵ “Orla Rio e Gabriel instalam mais de 150 câmeras na Zona Sul para reforçar segurança e turismo no Rio de Janeiro”. Orla Rio, 29/10/2024. Available on: <https://www.orlario.com.br/curiosidades/orla-rio-e-gabriel-instalam-mais-de-150-cameras-na-zona-sul-para-reforcar-seguranca-e-turismo-no-rio-de-janeiro>. Accessed on: December 8th, 2025.

The *coastal squeeze*: from infrastructural fixity to informational compression

The notion of *coastal squeeze* describes the narrowing of coastal habitats compressed between rising sea levels and the expansion of urban infrastructure. The academic literature (Doody, 2013; Pontee, 2013; Borchert *et al.* 2018; Lithgow, 2019; Silva *et al.*, 2020; Aguilar *et al.*, 2021) converges on the understanding that this “compression” is aggravated by long-term anthropic processes, such as the fixation of the coastline by constructions, which prevent the natural adaptation of ecosystems and result in their degradation.

Coastal urbanization is a central factor in this process, as human constructions—such as buildings, waterfronts, and ports—function as physical barriers that impede the natural migration of habitats, resulting in their loss. Tourism, as a vector of coastal urbanization, intensifies this dynamic because the construction of hotels and other infrastructure frequently occurs along the coastline, reinforcing the rigidity of the built barrier. Studies such as those by Lithgow *et al.* (2019) and Aguilar *et al.* (2021) demonstrate the strong correlation between tourism expansion and the aggravation of *coastal squeeze*.

A contradictory cycle is thus created, as tourism is affected by the very conditions it helps to produce. The reduction in beach width and the loss of ecosystems diminish the natural attractiveness of destinations, while greater vulnerability to extreme weather events increases the risk for tourism facilities. To mitigate these effects, coastal engineering interventions are employed, such as artificial beach nourishment (Doody, 2004). However, such measures are costly and do not always represent long-term solutions, potentially generating negative impacts in other areas (Pontee, 2011).

We propose, however, that the physical compression emphasized by the coastal squeeze concept, while fundamental, is today supplemented and intensified by an “informational squeeze.” While the physical squeeze is defined by the compression of the beach territory between engineering infrastructures and rising sea levels, the *informational squeeze* describes the compression of public uses and social practices exerted by the “technology stack” (Kitchin, 2016) that governs urbanized coastal zones today.

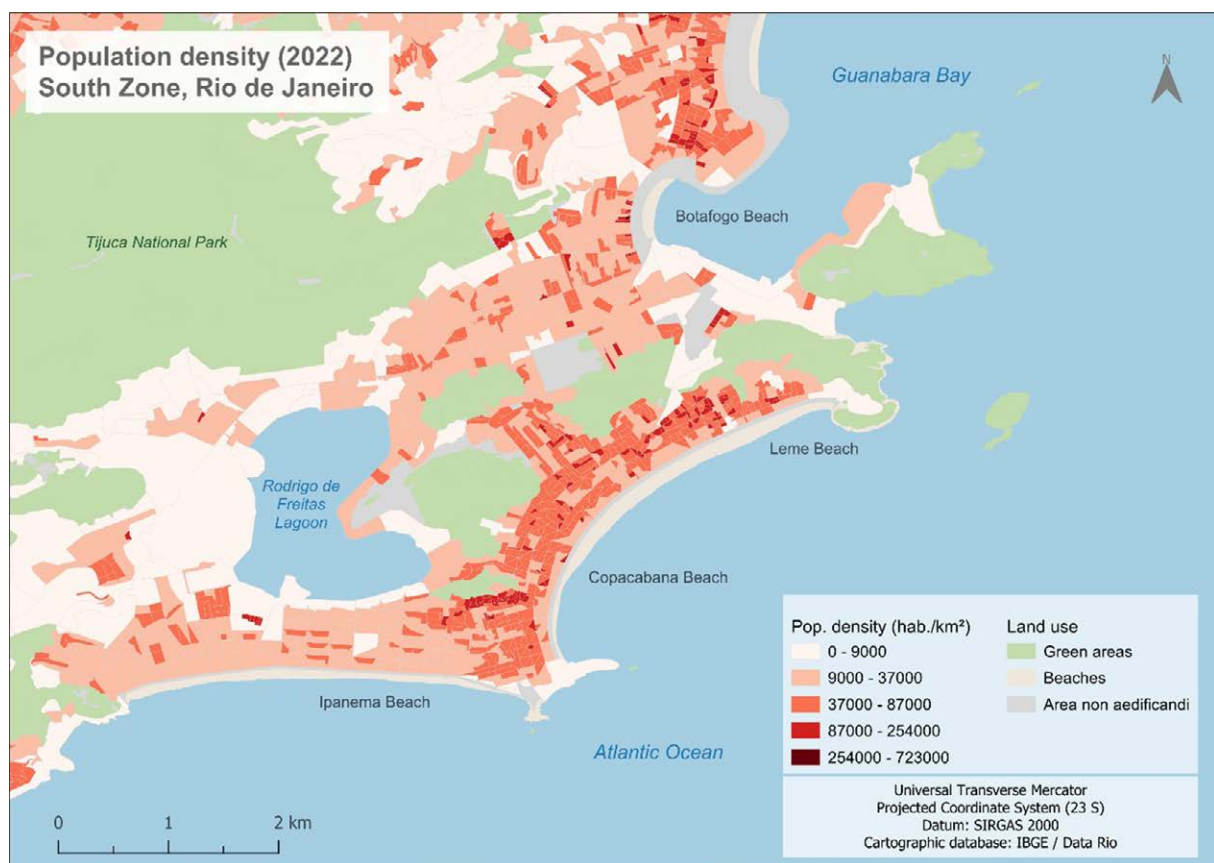
This informational squeeze does not compress the territory physically, but rather the actions permitted within it. It operates vertically through the layers of what Kitchin (2016) defines as the sociotechnical *assemblage*, formed by the association between: 1) the “material platform” (constituted, for example, by facial recognition cameras, sensors, and fiber optic cables); 2) the “data” and “algorithm” layers that monitor, manage, and regulate flows in real-time; and 3) the “interface,” which translates the beach into a manageable asset through control and consumption applications. “Technified governance” is, therefore, the engine of this informational squeeze.

We will proceed from this conceptual expansion to analyze how the *coastal squeeze* phenomenon is instantiated on the Copacabana waterfront, in Rio de Janeiro.

The historical production of the waterfront: crises and spatial fixes of capital in Copacabana

Despite the loss of approximately 17,000 residents between the 2010 and 2022 census surveys,⁶ Copacabana remains one of the municipality's most populous neighborhoods and has one of its highest demographic densities (Figure 1). The neighborhood's concentration of population and tourism, reinforced in recent years by the advance of Airbnb-type ventures (Andrade *et al.*, 2024), is also reflected in a concentration of facilities and services created along the waterfront. This density of services and urban infrastructure is both a result and a determinant of the process of seaside urbanization, that is, the articulated production of spatial forms and social practices linked to the valorization and ordering of coastal zones (Vidal e Gomes, 2019). Initiated in the late 19th century, this seaside urbanization consolidated Copacabana beach as a laboratory for urban experimentation and an icon of *carioca* modernity (Parente-Ribeiro and Gomes, 2021).

Figure 1. Population density – Southern Zone of the municipality of Rio de Janeiro, 2022



Source: Prepared by the authors based on data from the Brazilian Institute of Geography and Statistics (IBGE) and Data-Rio, 2022.

⁶ According to the data from the demographic censuses compiled by Data-Rio, the population of the Copacabana neighborhood went from 146,392 in 2010 to 128,919 in 2022. The information is available on: <https://www.data.rio/apps/0486a2d8fdb241d68395c24e662c48bb/explore>. Accessed on: December 8th, 2025.

As a result of the seaside urbanization process, the Copacabana waterfront constitutes a consolidated urban infrastructural system, whose fixity contributes to the coastal squeeze phenomenon. However, this physical barrier is not a static structure but a provisional material-semiotic synthesis that temporarily stabilizes the “movement of association” among heterogeneous elements (Latour, 2005). Understanding it requires moving beyond the fixity of its forms to analyze it as a dynamic palimpsest, a temporary territorial configuration in which successive logics of capital accumulation are inscribed.

The historical evolution of the waterfront can be reinterpreted as a sequence of “spatial fixes,” a concept developed by David Harvey (2001). Each major transformation represents a temporary geographical and/or structural solution to a crisis of capital over accumulation. Simultaneously, each fix, by “fixing” capital into a new territorial configuration, generates new contradictions that, in turn, require future rounds of “creative destruction” and spatial reorganization.

This process will be analyzed based on three associated historical syntheses: 1) the city’s expansion in the first decades of the 20th century, 2) the artificial nourishment of Copacabana beach in the 1970s, and 3) the emergence of a new waterfront management model in the last decade of the 20th century.

The history of the waterfront as we know it begins with the first major crisis that capital faced in Rio de Janeiro in the late 19th century: a crisis of spatial limits. The urban core, compressed between the sea and the rocky massifs, offered few opportunities for new profitable investments, especially for real estate capital and elites seeking new spaces of social distinction. The seaside urbanization process, driven by the “urbanization/salubrity” dyad (O’Donnell, 2013), emerged as the spatial fix for this crisis, transforming a remote area into a new and lucrative frontier for accumulation. For this frontier to become accessible, a massive investment in fixed capital was necessary. The opening of the *Túnel Velho* (Old Tunnel) in 1892 and the subsequent creation of a streetcar network were the founding acts of this fix, “annihilating” the mountain’s spatial barrier and connecting the isolated periphery to the consolidated urban fabric.

The construction of *Avenida Atlântica* (Atlantic Avenue), approved in 1905 and inaugurated in 1908, was the main instrument to produce the waterfront as a modern and orderly space. More than just a thoroughfare, the avenue was a “regulatory device,” imposing a rational order on the coastline by establishing a clear boundary between private property and public areas, creating a “front” of high valorization (Parente-Ribeiro and Gomes, 2001).

The success of the first synthesis generated the conditions for its own crisis. By the mid-20th century, fixed capital (represented, for example, by the buildings, hotels, and *Avenida Atlântica* itself) was threatened by coastal dynamics. The periodic storm surges caused erosion and endangered the accumulated value, becoming a recurring “public problem” (Cefai, 2018). Simultaneously, the tourism model evolved into a mass phenomenon, and the original sand strip, 55 to 61 meters wide, became a bottleneck limiting the sector’s growth. The physical landscape was now inadequate for the new scale of accumulation.

The response to this double crisis was one of Brazil’s most ambitious urban engineering projects: the artificial beach nourishment, completed in 1971. The second historical synthesis of the Copacabana waterfront thus resulted from a “geomorphological fix” that used technology to, literally, produce new territory. The project, coordinated by the Superintendence of Urbanization and Sa-

nitiation of the State of Guanabara (SURSAN)⁷, involved dredging approximately 3.5 million cubic meters of sand, increasing the beach's width by an average of 85 meters. The work was accompanied by the duplication of *Avenida Atlântica* and the creation of the iconic boardwalk with landscaping by Roberto Burle Marx (Silva and Lins-de-Barros, 2021).

By widening the beach, the intervention created a buffer zone that protected pre-existing fixed capital and, simultaneously, generated a platform for the mass tourism economy, enabling the consolidation of mega-events like *Réveillon*.

Although presented as a work of public interest, the Copacabana landfill can be reinterpreted as a state subsidy to private capital. The State socialized the costs and risks of a highly complex intervention to, in practice, guarantee the security and valorization of private assets (hotels, apartments). The resulting gains, such as the exponential increase in real estate values and greater revenues for the event industry, were largely privatized. The geomorphological fix thus demonstrates the active role of the State in producing the spatial conditions necessary for capital accumulation.

The third synthesis began to take shape in the 1990s, when the waterfront's crisis was no longer physical, but rather one of governance and efficiency in value extraction. The landscape, although ample, was perceived as underutilized and disorganized from a commercial standpoint, a missed opportunity in the new global context of competition between cities and the rise of the "corporate city" model. The solution was a "regulatory fix," accompanied by a profound restructuring of the waterfront's management. The *Projeto Rio Orla* in 1992 represented the first step, restructuring the physical space to make it more conducive to organized consumption. The standardization of kiosks, the implementation of a bicycle path, and improved lighting were not mere aesthetic interventions; they were investments in a new "consumption infrastructure." Lighting, for example, extended the beach's commercial life into the nighttime, creating a new spatiotemporal frontier for accumulation (Lins-de-Barros and Parente-Ribeiro, 2018).

The culmination of this fix occurred with the transfer of the kiosks' management to the private concessionaire *Orla Rio Associados* in 1999, transforming the commercial use of public space into a private asset. The standardization of kiosks proved to be a key technology of accumulation: a uniform asset is easier to manage, price, and package into a large-scale concession contract, while simultaneously exerting social control by displacing informal economies that do not fit the model.

From geographical expansion to geomorphological production and regulatory restructuring, the historical sequence of spatial fixes resolved successive crises, but also produced a new one: that of physical space saturation. Having exhausted the possibilities of horizontal expansion and managerial optimization, the logic of accumulation now turns toward the vertical and informational intensification of the existing space. This transition establishes the foundations for the emergence of the *sociotechnical coastal squeeze*, a process that will be deepened by post-pandemic accelerations.

⁷ State of Guanabara (1960–1975): A former Brazilian federative unit corresponding to the city of Rio de Janeiro. Established after the national capital moved to Brasília, it functioned as a city-state until merging with the surrounding State of Rio de Janeiro in 1975.

Post-pandemic accelerations: intensification of uses and digitalization of the Waterfront

The Covid-19 pandemic functioned as a catalyst for transformations on the Copacabana waterfront, generating a dual movement. On one hand, the health crisis reinforced the centrality of the beach as a space for leisure and sociability, making it even more valued in the collective imagination (Góis *et al.*, 2022). On the other, social distancing measures paralyzed the beach economy, severely impacting traditional workers, such as *barraqueiros* (beach stall operators) and itinerant vendors, who saw their source of income temporarily disappear (Laurindo-Santos *et al.*, 2020).

The gradual reopening, marked by protests and negotiations between street vendors and the Municipal Government, did not signify a return to the previous state, but rather the consolidation of a new level of use and dispute over the space. The economic shock drove an accelerated adaptation and reorganization of beach commerce. The crisis forced the rapid digitalization of transactions, with the mass adoption of payments via PIX and the use of social media for marketing and conducting deliveries (Laurindo-Santos *et al.*, 2020).

A reorganization of business models and political representation was also observed. The *mateiros* (the traditional mate tea vendors) organized into an association and secured the first formal licenses for their category (Baranda-Oliveira, 2023), while the *barraqueiros* (stalls) deepened their integration with the tourism chain, establishing partnerships with travel agencies (Laurindo-Santos, 2025).

The valorization of open spaces in the post-pandemic period (Abdullah *et al.*, 2023; Marvin *et al.*, 2023) attracted not only the usual beachgoers and workers but also new and powerful economic agents. Hotels, tourism companies, and the Municipal Government itself began to see the waterfront as a frontier for expanding their services—installing equipment, promoting events, and establishing partnerships that increased the density of activities, amplifying the pressure on an already “compressed” territory.

The expansion of economic interests on the waterfront after the acute phase of the Covid-19 health crisis is concentrated, above all, in three vectors: mobility, commerce, and tourism. Although active throughout the entire process of seaside urbanization in the Copacabana neighborhood, the current historical phase of the Technical-Scientific-Informational Milieu and post-pandemic accelerations have entailed a profound reorganization of the systems of objects and systems of actions articulated based on the logics characterizing these vectors.

The vectors of the sociotechnical squeeze: mobility, commerce, and tourism

Mobility as a vector of connection and segmentation of flows

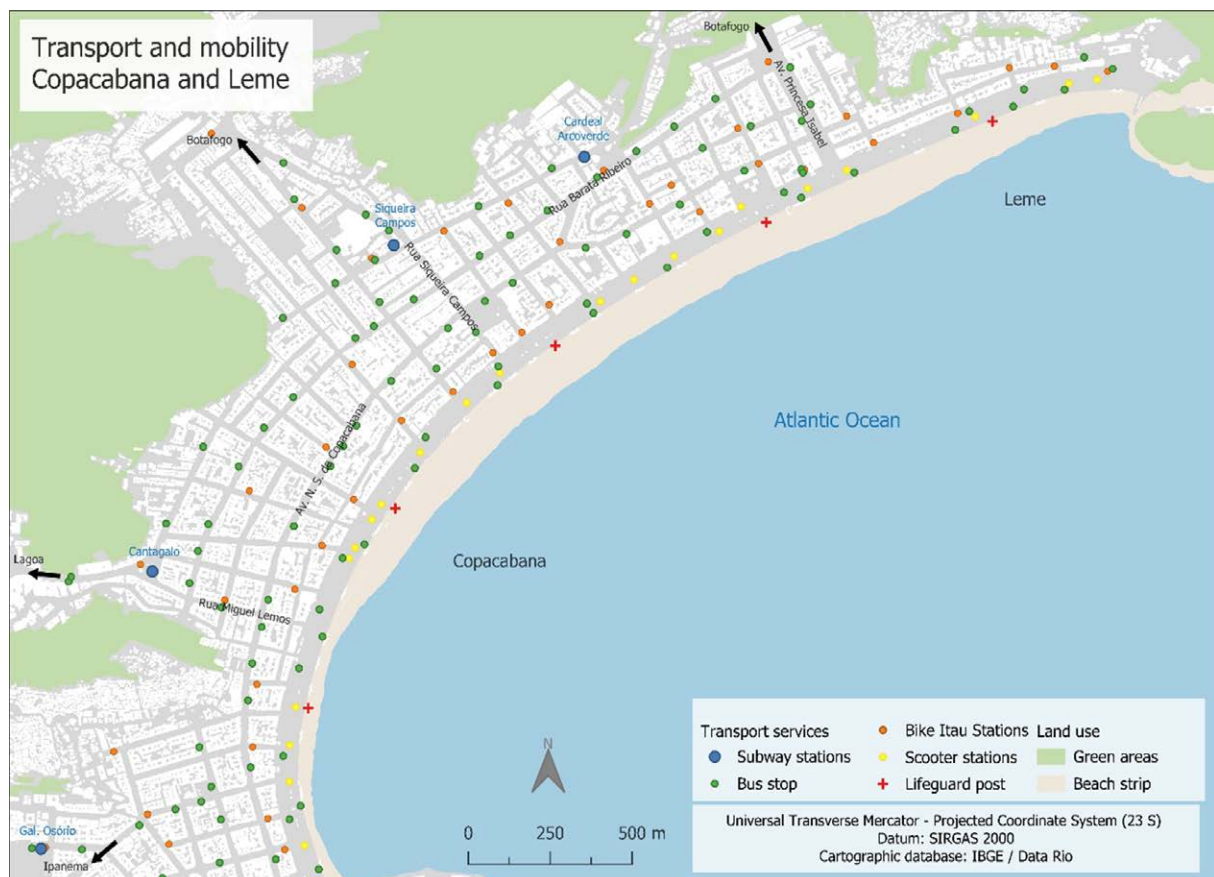
Historically, the consolidation of Copacabana as a tourist destination was tied to the evolution of its mobility systems. From the arrival of streetcars in the late 19th century, through the primacy of the automobile with *Avenida Atlântica*, to the expansion of buses and the arrival of the metro, each new transportation system reconfigured the accessibility, land value, and usage patterns of the waterfront, progressively integrating it more fully with the metropolis (Abreu, 1997; O'Donnell, 2013).

During the 1980s, the expansion of urban bus lines broadened access to the neighborhood for different segments of the population from Rio de Janeiro and the surrounding state. This new

configuration permitted the intensification of informal economic activities on the beach—such as street vending and seasonal services—and contributed to the popularization of the beach space, without, however, diminishing the tensions and disputes over the waterfront’s use. Today, bus stops run along almost the entire length of the Copacabana neighborhood, especially *Avenida Nossa Senhora de Copacabana* and *Rua Barata Ribeiro*, serving as a means of articulation between the city’s South, North, and West Zones (Figure 2).

Then, in the 1990s and 2000s, the inauguration of the *Cardenal Arcoverde* and *Siqueira Campos* metro stations inserted Copacabana more integrally into the metropolitan transport system, reinforcing its centrality and making access to the beach even more efficient, especially for tourists and workers who circulate daily through the city. In addition to the two stations mentioned, Copacabana also benefits from two other stations—*Cantagalo* and *General Osório*—which connect the neighborhood to other areas of the city, while also segmenting the flows of visitors and workers that occupy its beach arc (Figure 2).

Figure 2. Transportation and Mobility System – Copacabana and Leme, Rio de Janeiro, 2025.



Source: Prepared by the authors based on data from Data-Rio, Bike Itaú, and Whoosh, 2025.

More recently, micromobility systems, such as public bicycle rentals and electric scooters, have begun to play a symbolic and functional role in renewing the neighborhoods’ urban image. These services, promoted through public-private partnerships, enhance the tourist experience by offering light and sustainable travel along the waterfront. Although accessible to some extent to the local

population, these systems primarily cater to a middle- and upper-class visitor profile, reinforcing urban marketing strategies that reposition the city as a modern, connected, and ecological tourist destination. Like the other urban mobility services, bicycles and scooters are regularly distributed throughout the neighborhoods, but with a high concentration on the blocks near the beach arc.

The evolution of urban mobility systems in Copacabana has not only shaped forms of access and circulation through the neighborhood, but has also structured the economic uses of the coastal strip. By connecting infrastructure, tourism, and land valorization, these systems have contributed to the consolidation of a beach economy model that is highly dependent on mobility and permanently tensioned between public and private interests.

Beach commerce: from regulated fixity to the circuits of the urban economy

The monumental artificial beach nourishment project in Copacabana, completed in 1971, represented more than an engineering solution: it produced new territory, inaugurating a cycle of disputes for its economic appropriation. This space reconfigured beach commerce, which, historically, had been sporadic and restricted to elite establishments (Parente-Ribeiro and Gomes, 2021). With the massification of beach use, an itinerant and informal commerce emerged, and its repression by public authorities through “crackdown operations” (*‘rapa’*) (Teixeira, 2024) proved insufficient after the widening of the sand strip.

The vast spatial subsidy for the informal economy forced the State to rethink its control strategies. In the 1970s, commercial logic transitioned from mobility to fixity, with vendors demarcating and occupying specific locations (Teixeira, 2024). This transition soon configured itself as a “public problem,” in the terms of Daniel Cefai (2018), eliciting complaints of “unfair competition” from established merchants and allegations of disorder from authorities. Paradoxically, fixity, initially seen as the problem, was co-opted as a tool of governance: a fixed point is more legible and, therefore, easier to register, inspect, and tax.

A long process of negotiation, conflict, and selective repression culminated in the gradual regulation of commerce, consolidated by legal milestones such as Law N°. 804 of 1985, which authorized the executive branch to grant fixed points on the sand strip to the *barraqueiros* (Teixeira, 2024). This regulation process consolidated a clear stratification of commerce on the waterfront, materializing the theory of the two circuits of the urban economy by Milton Santos (2004).

On the sand strip, the *barraqueiros* (stalls) were established, operating under an individual concession model and characterized as family businesses with low capital and intensive labor, typical traits of the lower circuit. On the boardwalk, meanwhile, the kiosks, managed by the concessionaire *Orla Rio* and operated on a corporate model, represent the upper circuit, demanding high capital investment and relying on permanent and complex infrastructures. Copacabana beach thus became a microcosm of the urban economy, where the two circuits coexist in a visible relationship of complementarity and competition (Figure 3).

This ecosystem, which moves approximately USD 650 million annually and concentrates 34% of the 2,189 licensed beach merchants in the municipality (Laurindo-Santos, 2025), is not an enclave. Its circuits connect the waterfront to a vast metropolitan network of production, logistics, and labor, extending from depots in favelas to supply centers, becoming an inseparable component of Copacabana’s “tourism product.”

The post-pandemic scenario, as we have seen, intensified the disputes for the economic exploitation of the waterfront. The “boom” in sand sports, such as beach tennis, introduced a new actor that demands large areas, heightening the competition for territory with the *barraqueiros*. In response, the public authorities launched a new and rigorous waterfront ordering decree in May 2025. The measure generated immediate protests from workers, forcing the city to relax some rules and demonstrating that the regulation of the beach remains a field of intense negotiation and dispute, now reconfigured by the recent technological, economic, and social accelerations.

Figure 3. Commerce and Service Facilities – Copacabana and Leme, Rio de Janeiro, 2025.



Source: Prepared by the authors based on data from Data-Rio, 2023 and OpenStreet MAP, 2025.

Tourism as a platform: technified governance and the production of the waterfront-product

The tourism vector of the Copacabana-Leme beach arc, consolidated as a national symbolic reference, has been strategically repositioned as a central asset for the city’s marketing. This transition materializes in space through a dense infrastructure of services (kiosks, hotels, stalls) that converts the waterfront into a “product,” the management of which is guided by the logic of urban entrepreneurialism. This model reconfigures the beach economy, where international tourism, which is capital-intensive and focused on mega-events, interacts with domestic tourism articulated by more flexible and informal networks.

The post-pandemic dynamic accelerated the convergence of these circuits. Formal actors, notably the hotel chains, expanded their operations onto the sand strip by acquiring kiosks, installing exclusive equipment, and forming partnerships with regularized *barraqueiros*. This advance institutes a governance by interdependence: formal capital co-opts and standardizes services from the lower circuit, extending its brand and quality control over a public space. The beach begins to operate as a platform, a hierarchical commercial ecosystem that, although integrating different agents, privileges the scale and predictability of formal businesses.

This platformization is enabled by a regulatory fix aligned with the “corporate city” model. The transfer of the waterfront’s management to private concessionaires, such as *Orla Rio Associados* (Andreatta, 2019), represents the institutionalization of this logic. In this context, the standardization of equipment and the successive regulations of street vending are not neutral acts of ordering, but rather tools that make the public space legible and suitable for large-scale commercial management. The State acts as a market facilitator, preparing the ground for private exploitation and the production of mega-events, such as *Réveillon* and international concerts, which temporarily reconfigure the entire local dynamic.

The sustainability of this waterfront-product ultimately depends on a sophisticated layer of “technified governance” (Graham and Marvin, 2022). The progressive installation of monitoring cameras, sensors, and facial recognition systems—many operated via public-private partnerships—transforms the beach into a showcase of technological control. Major events function as urban laboratories where these devices for crowd management and behavioral modeling are tested at high intensity, before being normalized into daily management. This infrastructure, centralized in command hubs like COR-Rio, produces an environment of security and predictability that is, in itself, a commercializable product. It is this capacity for control that diminishes risk for investors and sponsors, guaranteeing the conditions for the waterfront’s operation as a global consumption platform.

The anatomy of the sociotechnical squeeze: spatial arrangements as interpretive keys

The geographical analysis of the sociotechnical system that territorially configures the Copacabana waterfront can be guided by the interpretation of three complementary types of spatial arrangements: longitudinal, transversal, and vertical. Far from being merely descriptive categories, these arrangements function as axes of interpretation that reveal the functional and symbolic complexity of this territory. They articulate systems of objects (technical networks, equipment, buildings, vehicles, etc.) and systems of actions (the social, economic, and political practices that give them meaning), as proposed by Milton Santos (1996). By articulating these three axes, it is possible to apprehend the beach not as a residual natural space, but as a complex urban interface, intensely produced and continuously reorganized by economic, political, and technological dynamics, thereby qualifying the coastal squeeze process based on its sociotechnical dimension.

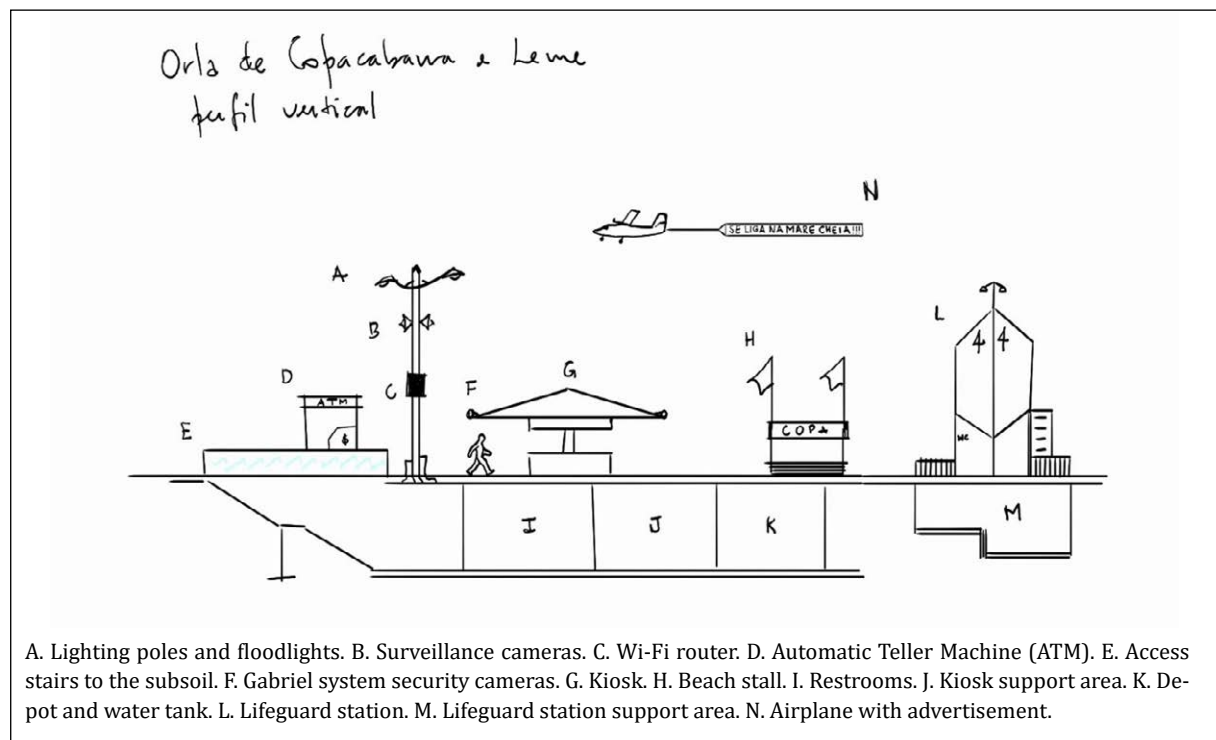
The longitudinal arrangements, which follow the beach arc, reveal a dual logic of standardization and differentiation. Historically, the seaside urbanization process produced continuous and distinct zones—the avenue, the boardwalk, and the sand strip—establishing a linear order and a spatial classification of uses. This logic is intensified today by the diffusion of the Technical-Scientific-Informational Milieu. The standardization of kiosks under the concession model, the regularity of the lifeguard stations, the continuity of the bicycle path, and the recent installation of a continuous Wi-Fi network and surveillance systems integrated into the kiosks create a digital and observational continuum along the entire waterfront. This standardization is not just an organizational choice; it functions as a precondi-

tion for managing the waterfront as a platform, where a uniform and predictable environment is more easily digitized, monitored, and packaged into commercial and control products.

The transversal arrangements, in turn, reveal how the waterfront articulates with the neighborhood and the rest of the metropolis, connecting it to local and global flows. In the mobility vector, these arrangements are mediated by metro stations, bus lines, and micromobility systems that channel beachgoers and segment the occupations of the beach. The commerce vector, meanwhile, is organized based on supply chains that sustain the beach economy and materialize the interpenetration of the two circuits of the urban economy (Santos, 2004).

As detailed by Laurindo-Santos *et al.* (2020), the logistics of the beach stall (lower circuit) commerce is a prime example of this form of spatial organization. The legislation requiring the nightly removal of stall modules activates a network of informal depots and garages in streets adjacent to the waterfront. Beverage supply operates on a dual temporality: emergency purchases at nearby supermarkets and stock purchases at distant wholesalers. Regarding the tourism vector, the post-pandemic period has seen intensified connections between the hotel chains, the kiosks, and the occupations on the sand strip. In the lower circuit, *barraqueiros* are investing in articulation with small-scale tourism agents to attract visitors from other municipalities in the state of Rio de Janeiro and from bordering states, demonstrating a new transversal articulation between the lower circuit on the sand and the metropolitan tourism economy (Laurindo-Santos, 2025).

Finally, the analysis of the waterfront's vertical arrangements unveils the hidden density of the beach-infrastructure (Figure 4). On the surface, extending into the airspace, visible elements such as lighting poles (A), surveillance cameras (B, F), Wi-Fi routers (C), kiosks (G), beach stalls (H), and airplanes with advertising banners (N) compose the "scene" of consumption, leisure, and control. In the subsoil, an invisible network of restrooms (I), depots (K), and support areas for the kiosks (J) constitutes the essential infrastructure that guarantees the system's operability.



Source: Prepared by the authors based on fieldwork conducted on the Copacabana waterfront in 2024 and 2025.

The vertical arrangements of the waterfront also instantiate the “technology stack” mechanism that, according to Kitchin (2016), constitutes the contemporary urban sociotechnical assemblage. At the base is the “material platform”: the “trench of concrete, cables, and sensors.” Operating above it are the “code platform,” “data,” and “algorithm” layers, such as the facial recognition and logistics software that feed COR-Rio. At the top, visible to the user, is the “interface”: the Wi-Fi routers, information totems, and the kiosks’ consumption applications.

In this sense, the barrier compressing coastal ecosystems is not just the wall of buildings, but a deep and technified informational infrastructure that makes space dependent on technological systems and susceptible to centralized forms of governance.

Beyond engineering: the informational squeeze and the future of urban coastal zones

The analysis of the Copacabana waterfront’s spatial arrangements highlights the emergence of a new synthesis that redefines the very concept of the “spatial fix.” While previous fixes (with the opening of tunnels and the artificial beach nourishment) constituted classic *spatial fixes*—stabilizations of fixed capital to resolve crises—the current synthesis responds to the saturation of physical space differently. In this new synthesis, (provisional) stability is no longer guaranteed by the concrete of engineering works, but by informational and regulatory intensification.

The characteristics of the current waterfront governance model are the segmentation of publics, the commodification of every square meter of the waterfront, the platformization of services, the production of immersive “experiences,” and the assembly and disassembly of ephemeral structures for events. This model is sustained by a hyper-connectivity that allows for the permanent sensing and reading of individual and collective behaviors.

The phenomenon of the *sociotechnical coastal squeeze* manifests, therefore, not only in physical compression but in an “informational squeeze.” The barrier to public use is no longer just the hard infrastructure, but a mesh of regulations, registries, applications, and surveillance systems that govern who can be in space, how, and when.

The Copacabana waterfront, with its complex interface between natural ecosystems and built space, serves as a paradigm for thinking and acting upon the future of global urban coastal zones. The processes observed here—the fusion of mass tourism, technified governance, and urban marketing, and the management of public space as a commercial asset—are not a local particularity. They point to a global trend. Understanding the dynamics of the sociotechnical coastal squeeze in Copacabana thus offers a crucial lesson for other cities whose urban beaches face similar pressures, converting them into vital arenas where the very definition of what constitutes a public space in the 21st century is forged and contested.

Funding

FAPERJ - Carlos Chagas Filho Foundation for Research Support of the State of Rio de Janeiro

References

- ABDULLAH, Adam. *et al.* Re-arranging the urban: Forms, rhythms, politics. **Transactions of the Institute of British Geographers**, v. 48, n. 4, p. 718-744, 2023. Available on: <https://rgs-ibg.onlinelibrary.wiley.com/doi/epdf/10.1111/tran.12604>. Accessed on: March 3rd, 2025.
- ABREU, Mauricio de Almeida. **Evolução urbana do Rio de Janeiro**. 3. ed. Rio de Janeiro: IPLANRIO, 1997. 147 p.
- AGUILAR, Pedro; MENDOZA, Edgar; SILVA, Rodolfo. Interaction between Tourism Carrying Capacity and Coastal Squeeze in Mazatlan, Mexico. **Land**, [s. l.], v. 10, n. 9, p. 900, 2021. Available on: <https://doi.org/10.3390/land10090900>. Accessed on: July 16th, 2025.
- ANDRADE, Josiane N.; ARAUJO, Cristina P.; CRISTINO, Claudio T. Incidência e repercussões do AIRBNB: o caso do Rio de Janeiro. **Oculum Ensaios**, v. 21, e245479, 2024. Available on: <https://doi.org/10.24220/2318-0919v21e2024a5479>. Accessed on: March 3rd, 2025.
- ANDREATTA, Verena (ed.). **Do Rio Orla à Orla Conde: os projetos que transformaram a frente marítima da cidade do Rio de Janeiro**. Rio de Janeiro: Rio Books, 2019. 336 p.
- BARANDA-OLIVEIRA, Caio. O comércio ambulante de mate, limonada e biscoito Globo nas praias cariocas: uma análise a partir dos circuitos da economia urbana. In: EUGEO CONGRESS, 9., 2023, Barcelona. Anais. Barcelona: EUGEO, 2023.
- BORCHERT, Sinéad. M. *et al.* Coastal wetland adaptation to sea level rise: Quantifying potential for landward migration and coastal squeeze. **Journal of Applied Ecology**, v. 55, [s. n.], p. 2876-2887, 2018. Available on: <https://besjournals.onlinelibrary.wiley.com/doi/epdf/10.1111/1365-2664.13169>. Accessed on: March 3rd, 2025.
- CEFAÏ, Daniel. Público, Socialização e Politização: reler John Dewey na companhia de George Herbert Mead. In: CORRÊA, Diogo Silva *et al.* (orgs.). **Crítica e pragmatismo na Sociologia: Diálogos entre Brasil e França**. São Paulo: Annablume Editora, 2018.
- DOODY, J. Pat. Coastal squeeze: an historical perspective. **Journal of Coastal Conservation**, [s. l.], v. 10, [s. n.], p. 129-138, 2004. Available on: [https://doi.org/10.1652/1400-0350\(2004\)010\[0129:CSAHP\]2.0.CO;2](https://doi.org/10.1652/1400-0350(2004)010[0129:CSAHP]2.0.CO;2). Accessed on: March 3rd, 2025.
- GÓIS, Marcos Paulo Ferreira de *et al.* Scenarios of social isolation during the first wave of the COVID-19 pandemic in Rio de Janeiro, Brazil. **Geographical Research**, v. 60, n. 1, p. 29-39, 2022. Available on: <https://pmc.ncbi.nlm.nih.gov/articles/PMC8652489/pdf/GEOR-60-29.pdf>. Accessed on: April 4th, 2025.
- GRAHAM, Stephen; MARVIN, Simon. Splintering Urbanism at 20 and the “Infrastructural Turn”. **Journal of Urban Technology**, [s. l.], v. 29, n. 1, p. 169-175, 2022. Available on: <https://www.tandfonline.com/doi/epdf/10.1080/10630732.2021.2005934?needAccess=true>. Accessed on: March 3rd, 2025.
- HARVEY, David. Globalization and the “Spatial Fix.” **Geographische Revue**, [s. l.], v. 8, [s. n.], p. 23-30, 2001. Available on: https://publishup.uni-potsdam.de/opus4-ubp/frontdoor/deliver/index/docId/2251/file/gr2_01_Ess02.pdf. Accessed on: April 4th, 2025.
- KITCHIN, Rob; PERNG, Sung-Yueh (eds.). **Code and the City**. London: Routledge, 2016. 260 p.
- LATOUR, Bruno. **Reassembling the Social: An Introduction to Actor-Network-Theory**. Oxford: Oxford University Press, 2005. 311 p.
- LAURINDO-SANTOS, Julia Valentin *et al.* Efeitos e desafios da pandemia da Covid-19 para a economia de praia: o caso do negócio de barracas no Rio de Janeiro, Brasil. **Costas**, v. 2, n. 2, p. 263-286, 2020. Available on: <https://revistas.uca.es/index.php/costas/article/view/9034/9114>. Accessed on: April 4th, 2025.
- LAURINDO-SANTOS, Julia Valentin. **A organização espacial do negócio de barracas das praias de Copacabana e Leme (Rio de Janeiro, RJ)**. Dissertação (Mestrado em Geografia) – Programa de Pós-Graduação em Geografia, Instituto de Geociências, Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2025.
- LAW, John. Material Semiotics. Milton Keynes: The Open University, 2019. Available on: www.heterogeneities.net/publications/Law2019MaterialSemiotics.pdf. Accessed on: Oct. 20th, 2025.
- LINS-DE-BARROS, Flavia; PARENTE-RIBEIRO, Leticia. **How Much Is a Beach Worth: Economic Use and Vulnerability to Coastal Erosion: The Case of Ipanema and Arpoador Beaches, Rio de Janeiro (Brazil)**. In: LEAL FILHO, Walter; FREITAS, Leonardo Esteves de (eds.). **Climate Change Adaptation in Latin America: Managing Vulnerability, Fostering Resilience**. Cham: Springer, 2018. Available on: https://doi.org/10.1007/978-3-319-56946-8_13. Accessed on: March 3rd, 2025.

LITHGOW, Debora. *et al.* Exploring the co-occurrence between coastal squeeze and coastal tourism in a changing climate and its consequences. **Tourism Management**, [s. l.], v. 74, [s. n.], p. 43-54, 2019. Available on: <https://www.sciencedirect.com/science/article/abs/pii/S0261517719300342>. Accessed on: March 3rd, 2025.

MARVIN, Simon. *et al.* Post-pandemic cities: An urban lexicon of accelerations/decelerations. **Transactions of the Institute of British Geographers**, v. 48, n. 3, p. 452-473, 2023. Available on: <https://rgs-ibg.onlinelibrary.wiley.com/doi/epdf/10.1111/tran.12607>. Accessed on: April 4th, 2025.

O'DONNELL, Julia. **A invenção de Copacabana: Culturas urbanas e estilos de vida no Rio de Janeiro (1890-1940)**. Rio de Janeiro: Zahar, 2013. 256 p.

PARENTE-RIBEIRO, Leticia; GOMES, Paulo Cesar da Costa. A orla de Copacabana: fronteira da balnearização no Rio de Janeiro no início do século XX. **Terra Brasilis** [Online], n.16, 2021. Available on: <https://journals.openedition.org/terrabrasilis/pdf/9537>. Accessed on: April 4th, 2025.

PONTEE, Nigel. Reappraising coastal squeeze: A case study from the NW England. Proceedings of the Institution of Civil Engineers, **Maritime Engineering Journal**, [s. l.], v. 164, n. 3, p. 127-138, set. 2011. Available on: <https://doi.org/10.1680/maen.2011.164.3.127>. Accessed on: March 3rd, 2025.

PONTEE, Nigel. Defining coastal squeeze: A discussion. **Ocean & Coastal Management**, [s. l.], v. 84, [s. n.], p. 204-207, 2013. Available on: <https://www.sciencedirect.com/science/article/abs/pii/S0964569113001786?via%3Dihub>. Accessed on: March 3rd, 2025.

PREFEITURA DO RIO DE JANEIRO – SUBDEI/SMDEIS. **Economia das praias do Rio**. Estudo Especial n. 4, 2022. Available on: https://observatorioeconomico.rio/wp-content/uploads/sites/5/2022/03/Estudo-Especial_Economia-da-Praia.pdf. Accessed on: April 4th, 2025.

SANTOS, Milton. **O espaço dividido: os dois circuitos da economia urbana nos países subdesenvolvidos**. São Paulo: Edusp, 2004. (Originalmente publicado em 1979). 431 p.

SANTOS, Milton. **A Natureza do Espaço: Técnica e Tempo, Razão e Emoção** São Paulo: Edusp, 2006. (Originalmente publicado em 1996). 260 p.

SILVA, Rodolfo. *et al.* A Framework to Manage Coastal Squeeze. **Sustainability**, [s. l.], v. 12, n. 10610, 2020. Available on: <https://www.mdpi.com/2071-1050/12/24/10610>. Accessed on: April 4th, 2025.

SILVA, Priscila Linhares da; LINS-DE-BARROS, Flavia Lins de. A alimentação artificial da Praia de Copacabana (RJ) após 51 anos: Transformações geomorfológicas e dinâmica atual. **Terra Brasilis** [online], n. 16, 2021. Available on: <https://journals.openedition.org/terrabrasilis/pdf/9980>. Accessed on: April 4th, 2025.

TEIXEIRA, João Antonio Bragança. **“Como posseiros, foram se instalando”**: o processo de fixação do comércio ambulante no município do Rio de Janeiro (1901-1985). Dissertação (Mestrado em Geografia) – Programa de Pós-Graduação em Geografia, Instituto de Geociências, Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2024.

VIDAL, Laurent; GOMES, Paulo Cesar da Costa. Entre la ville et la mer, entre la France et le Brésil: penser la balnéarisation. **Confins** [online], n. 39, 2019. Available on: <https://journals.openedition.org/confins/17850>. Accessed on: April 4th, 2025.

Coastal squeeze sociotécnico: tecnologia, turismo e governança na orla de Copacabana

Resumo

Este artigo expande a noção de *coastal squeeze* para além da sua tradicional definição físico-ecológica, ao propor o conceito de *coastal squeeze sociotécnico*. A partir do caso da orla de Copacabana (Rio de Janeiro), argumentamos que o Meio Técnico-Científico-Informacional (MTCI) intensifica a compressão do espaço público. Metodologicamente, a análise articula a história dos “ajustes espaciais” (*spatial fixes*) com a interpretação de arranjos espaciais contemporâneos (longitudinais, transversais e verticais). Os resultados demonstram que, além da infraestrutura física, uma “compressão informacional” (*informational squeeze*) — uma malha de plataformas digitais, sistemas de vigilância e parcerias público-privadas — governa os usos da praia, impulsionando a comodificação e a plataformização. O megaevento do *Réveillon* é analisado como um laboratório para essa governança tecnificada, onde novas tecnologias de controle são testadas e normalizadas. Conclui-se que esta dimensão sociotécnica, definida por barreiras informacionais, é fundamental para a compreensão dos desafios contemporâneos em costas urbanas globais.

Palavras-chave: Coastal Squeeze Sociotécnico; Orla Urbana; Governança Tecnificada; Ajuste Espacial; Copacabana.

Coastal squeeze sociotécnico: tecnología, turismo y gobernanza en la orilla de Copacabana

Resumen

Este artículo amplía la noción de *coastal squeeze* más allá de su tradicional definición físico-ecológica, al proponer el concepto de *coastal squeeze sociotécnico*. Basado en el caso de la orilla de Copacabana (Río de Janeiro, Brasil), argumentamos que el Medio Técnico-Científico-Informacional (MTCI) intensifica la compresión del espacio público. Metodológicamente, el análisis articula la historia de los “ajustes espaciales” (*spatial fixes*) con la interpretación de arreglos espaciales contemporâneos (longitudinales, transversales y verticales). Los resultados demuestran que, más allá de la infraestructura física, una “compresión informacional” (*informational squeeze*) — una malla de plataformas digitales, sistemas de vigilancia y alianzas público-privadas — gobierna los usos de la playa, lo que impulsa la comodificación y la plataformización. El megaevento de *Réveillon* se analiza como un laboratorio para esta gobernanza tecnificada, donde se prueban y normalizan nuevas tecnologías de control. Se concluye que esta dimensión sociotécnica, definida por barreras informacionales, es fundamental para comprender los desafíos contemporâneos en las costas urbanas globales.

Palabras clave: Coastal Squeeze Sociotécnico; Orla Urbana; Gobernanza Tecnificada; Ajuste Espacial; Copacabana.

Timeline of the Manuscript

- ✓ Received: September 2025
- ✓ First Review: September 2025
- ✓ Second Review: October 2025
- ✓ Accepted for Publication: October 2025
- ✓ Author revision: November 2025
- ✓ Grammar, Spelling and ABNT review: December 2025
- ✓ Author revision: December 2025
- ✓ Published on December 2025