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Implementing nature-based solutions for flood risk: institutional pathways and constraints in Buenos Aires and Boston

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Abstract

Cities worldwide are reconceptualising their approach to flood risk management as climate change intensifies precipitation patterns and threatens coastal areas. This paper examines how two coastal cities — Boston and Buenos Aires — are reshaping their flood risk management through distinct institutional approaches to nature-based strategies. Through comparative case study analysis combining document review and key informant interviews, we examine how flood risks are understood, how governance arrangements evolve, and how NBS are implemented in contrasting socio-economic settings. Our analysis reveals that while both cities face similar climate threats, their institutional responses differ significantly: Boston's experimental 'living labs' and shoreline projects are supported by strong municipal and knowledge resources but raise equity concerns, while Buenos Aires remains constrained by fragmented jurisdictions and entrenched engineering approaches despite sophisticated academic understanding of governance failure. These contrasting experiences deepen our understanding of how institutional capacity, infrastructure legacies, and political economies shape urban climate adaptation beyond simplistic North-South dichotomies.

Introduction

Cities worldwide are transforming their approach to flood risk management as climate change intensifies precipitation patterns and threatens coastal areas. While urban development has long interacted with flood risks, the unsettling, uneven, and unbounded dimensions of new climate conditions (Westman et al., 2022) demand moving beyond traditional engineering solutions toward flexible, locally grounded forms of response, for example through nature-based solutions. Historically, flood risk management has been dominated by engineering and hydrological expertise, resulting in major grey infrastructure projects — dams, levees, underground drainage systems — whose scale and technical complexity reinforced the authority of specialized institutions and marginalized alternative framings of risk. However, as the interactions between social, ecological, and infrastructural systems become increasingly salient in understanding both flood risk patterns and their governance (Goh, 2021), there is growing pressure to examine how these systems interplay in specific urban contexts, and how different actors make sense of — and contest — the nature of the problem itself.

A substantial body of scholarship has identified common 'enabling factors' for transformative change in urban climate adaptation: institutional capacity, knowledge resources, multi-actor collaboration, and political will (van der Heijden, 2019; Patterson, 2021). Yet what remains underexplored is how these factors interact differently across contrasting institutional settings — and, crucially, what institutional pathways and constraints shape the implementation of nature-based solutions (NBS) at the city level. Flood risk definitions are not stable technical outputs: they are negotiated among multiple actors with competing interests, expertise, and stakes, and they carry the traces of prior infrastructural commitments, jurisdictional arrangements, and political economies (Merlinsky and Tobías, 2015; Viand and González, 2012). Understanding NBS implementation thus requires going beyond the mapping of

policy instruments to examine the underlying processes through which cities assemble — or fail to assemble — the institutional, epistemic, and social conditions for change.

This paper examines how two coastal cities — Boston (USA) and Buenos Aires (Argentina) — are reshaping their responses to flood risk and experimenting with nature-based solutions within distinctly different socio-economic and institutional contexts. We explore three key dimensions. First, we examine how flood risks are locally defined and what knowledge systems are mobilized in their identification and governance. Rather than treating risk as a pre-given technical object that cities 'conceptualize' with greater or lesser accuracy, we attend to the weaker, more contested forms of sensemaking (Weick, 1995) through which multiple actors — technical agencies, community organizations, courts, academic institutions — negotiate the boundaries of the problem and the terms of legitimate response (H1: flood risk definitions are inherently unstable and politically situated, not merely reflecting scientific uncertainty). Second, we analyze how flood risk governance connects to broader modes of urban development and institutional change. Building on research that emphasizes the non-linear, path-dependent character of institutional transformation (Le Galès and Vitale, 2013; Solecki et al., 2017), we examine how governance arrangements evolve over time to enable or constrain new approaches to risk management — and how legacies of infrastructure investment, jurisdictional fragmentation, and political clientelism shape what is governable (H2: institutional arrangements evolve through non-linear processes structured by developmental legacies that are themselves unevenly distributed across socio-economic contexts). Third, through a deliberate Global North-South comparison, we investigate commonalities and differences in NBS implementation. Rather than assuming that the contrast between Boston and Buenos Aires simply reproduces a dichotomy of resource-rich experimentation versus resource-poor inertia, we expect to reveal how local political and institutional contexts produce distinct yet structurally comparable pathways (H3: A North-South comparison can move beyond simplistic dichotomies to illuminate how local political economies shape the ways in which distinct climate risks — such as flooding, urban heat, and sea-level rise — are framed, prioritized, and addressed through NBS, producing distinct yet structurally comparable governance pathways).

Our analytical framework draws on three interconnected bodies of literature, mobilized as interpretive lenses rather than a standalone theoretical contribution. The first is the 'resilience turn' in disaster studies (Reghezza-Zitt and Rufat, 2019) and its call for integrated and diversified risk management — rooted in the South American tradition of 'de-naturalization' of disasters (Wisner et al., 2004; Revet, 2009: 2020) — which draws attention to the social, political and economic dimensions included or excluded in integrated disaster risk reduction and climate adaptation, pointing out institutional and epistemological barriers reinforcing or displacing vulnerabilities (Bonggarts et al., 2023 ; Raška et al., 2022) and encourages approaches that go beyond technical flood defense. The second is the concept of 'climate change experiments' (Bulkeley and Castán Broto, 2013), which frames how cities test and implement new approaches through purposive interventions in urban socio-technical systems, creating new forms of political space where public and private authority blur and heterogeneous actors — developers, communities, scientists, municipal agencies — are enrolled in governance arrangements that exceed formal institutional mandates. The third lens draws on assemblage theory in disaster risk reduction

(McGowran and Donovan, 2021), combined with Murray Li's (2007) concept of 'the will to improve' — attempts to direct conduct and intervene in social processes to produce desired outcomes — which allows us to examine how governance in each city is accomplished not through coherent policy but through contingent assemblages of artifacts, expertise, authority, and agency. Together, these lenses help explain why Boston's robust institutional framework enables experimental NBS approaches, while Buenos Aires faces persistent governance barriers — what Coates and Nygren (2020) theorize as 'hazardstates,' where flood risk management unfolds through clientelist governance networks that systematically privilege infrastructure-based solutions aligned with patronage relationships over community-driven and ecosystem-based alternatives.

To address these questions, we conduct a comparative case study analysis combining systematic documentary review with key informant interviews in both cities. Boston and Buenos Aires were selected as paradigmatic 'extreme' cases (Yin, 2013): both are coastal cities exposed to major flood risks, both are undergoing governance transformation through simultaneous processes of knowledge production and institutional rearrangement, yet they represent sharply contrasting socio-economic and institutional contexts that enable a theoretically productive Global South-North comparison. As a centre of the knowledge economy and a vocal municipal platform on climate adaptation, Boston positions itself as a model of flood management innovation. Buenos Aires offers a striking example of the compounding effects of institutional inertia, jurisdictional fragmentation, and high levels of urban informality — yet also of unexpected sites of experimentation and legal-political contestation that complicate any simple narrative of governance failure.

This research contributes to growing scholarship on urban climate adaptation in three ways. First, it reveals how NBS implementation cannot be separated from questions of institutional capacity and social equity: even well-resourced cities like Boston face persistent tensions between ecological experimentation and green gentrification, while Buenos Aires' sophisticated academic analysis of flood governance struggles to overcome structural implementation barriers rooted in the political economy of urban development. Second, it shows how existing infrastructure legacies and governance arrangements fundamentally shape cities' ability to innovate — not as fixed constraints but as historically produced configurations that are themselves objects of political contestation. Third, it moves beyond simplistic North-South dichotomies to reveal how local political and institutional contexts create distinct yet structurally comparable pathways for environmental risk management, offering a relational rather than hierarchical framework for understanding urban climate adaptation across different development contexts.

Results

3.1 Flood risk at the intersection of natural hazards and urban development

In urban areas, flood risks emerge from the co-production of natural dynamics and long-term urban development choices. Both Boston and Buenos Aires are exposed to two concurrent flood typologies:

intense rainfall events and storm surges — respectively termed 'nor'easters' and *sudestadas* in each context. Yet the specific ways in which urban development has amplified or redirected these hazards differ substantially, with lasting consequences for current governance possibilities.

Boston's vulnerability is inscribed in its very geography. Founded on reclaimed tidal marshes and mudflats barely above sea level, the city has historically extended its coastline through successive landfill operations, most dramatically in the nineteenth century (Penna and Wright, 2009). This developmental legacy created acute exposure to coastal flooding that remained partially masked by the “natural protection” of the harbor islands — a configuration long interpreted as reducing the need for large-scale storm surge infrastructure. Since the mid-twentieth century, mean sea level in Massachusetts has risen approximately 20 cm, with current projections estimating an additional 60–120 cm by 2100 under high-end climate scenarios. The construction of the 'Big Dig' — the most expensive highway project in United States history — provided an early opportunity for research scholars, as early as the mid-1990s, to conduct a first study of climate-related vulnerabilities of existing infrastructures (Kirshen and al, 2004). Hurricane Sandy's near-miss in 2012 served as a further catalyst, accelerating the production of metropolitan and neighbourhood-level risk assessments. This accumulation of technical knowledge, layered upon an already dense institutional infrastructure, would ultimately shape the conditions under which nature-based approaches became thinkable and desirable.

Buenos Aires presents a contrasting developmental trajectory. Over the course of the twentieth century, the metropolitan area underwent intensive urbanization that fundamentally transformed its natural hydrology: multiple streams were channelized or buried beneath streets and avenues, replaced by an artificial drainage system whose design capacity has proved repeatedly insufficient during extreme rainfall events (Merlinsky and Tobías, 2015). The Matanza-Riachuelo basin — spanning fourteen municipalities and over five million inhabitants — concentrates the legacy of industrial development, informal settlements, and hydrological degradation in ways that render flood risk inseparable from questions of social vulnerability and territorial inequality. The *Plan Director de Ordenamiento Hidráulico* (2004) constitutes the main technical instrument for flood management but has consistently struggled to reconcile drainage infrastructure investment with territorial planning, particularly across the fragmented jurisdictional landscape of the Buenos Aires metropolitan area (Flores et al, 2020). Where Boston's flood vulnerability was progressively brought into the frame of climate adaptation, Buenos Aires' exposure remained primarily legible through an engineering lens — as a technical deficit to be addressed through expanded drainage capacity.

These contrasting urban legacies are not merely historical context: they constitute active constraints on what kinds of knowledge are mobilized, what actors are empowered, and what solutions are rendered technically and politically feasible in each city today.

3.2 Shifting institutional responses to flooding in Buenos Aires and Boston

In both cities, institutional responses to flood risk have evolved significantly over the past two decades, though through distinct pathways shaped by their respective governance architectures, resource

environments, and political dynamics.

Buenos Aires: jurisdictional fragmentation and the judicialization of flood governance

The 'Mendoza Case' (2004) marked a pivotal moment in Buenos Aires' flood governance. A class-action lawsuit brought by residents of the Matanza-Riachuelo basin led to a landmark Supreme Court ruling that mandated the creation of ACUMAR (*Autoridad de Cuenca Matanza-Riachuelo*) — the first cross-jurisdictional authority responsible for integrated basin management, formally bringing together national, provincial, and city governments. ACUMAR's creation represents a significant institutional innovation: it introduced a legally mandated, multi-scalar governance arrangement in a context otherwise characterized by persistent jurisdictional fragmentation. Yet its implementation has been uneven. Knowledge production remains largely technical and top-down; ACUMAR's monitoring and remediation activities have generated substantial data on environmental contamination and flood exposure, but the translation of this knowledge into coordinated action has been hampered by competing institutional interests and limited enforcement capacity (Merlinsky, 2017). The judicialization of environmental governance — through which courts become *de facto* regulatory actors — has thus functioned as an alternative governance channel, providing marginalized communities with a platform for contesting technical decisions while simultaneously revealing the limits of judicial enforcement of complex environmental restoration (Scharager, 2020).

Community responses to flooding have evolved in parallel to this institutional trajectory. The major flood events of 2013, which caused significant loss of life and property across the metropolitan area, accelerated the emergence of neighborhood assemblies and flood victims' committees. These grassroots networks developed hybrid forms of knowledge exchange — combining territorial experience with advocacy demands — that challenged the technical framing of flood governance and pressed for greater community participation in decision-making (Merlinsky and Tobías, 2015). However, this community mobilization has not been systematically integrated into institutional processes. The persistent framing of flooding as an extraordinary climatic event by government officials reinforced an institutional vision centred on large-scale hydraulic infrastructure, leaving little space for non-structural measures such as participatory risk management. Moreover, significant information asymmetries between official data and residents' documented experiences further limited the conditions for meaningful integration of community knowledge into formal decision-making (Merlinsky and Tobías, 2015).

Social vulnerability to flooding remains deeply uneven across the metropolitan territory: lower-income neighborhoods, frequently located in flood-prone areas and dependent on informal drainage arrangements, face the highest exposure with the least adaptive capacity.

Boston: taming infrastructural ambitions with experimental adaptation

Boston's institutional trajectory toward flood risk management has been shaped by a different tension: between a strong historical predilection for large-scale engineering solutions and an increasingly influential institutional culture of climate experimentation and *ad-hoc* solutions. For several decades, flood risk was managed primarily through existing grey infrastructure — drainage systems, seawalls, and federal flood insurance maps — supplemented by municipal hazard preparedness programs. The dramatic acceleration of risk modelling after 2012, culminating in the 2016 neighbourhood-level flood risk characterization, created the institutional conditions for a more comprehensive policy response.

A decisive turning point came with the rejection of the 'harbor-wide barrier' proposal — a storm surge barrier that would have protected the entire bay. Deemed technically, economically, and ecologically unfeasible (Kirshen et al., 2018), its rejection effectively closed off the dominant engineering pathway and redirected institutional energy toward distributed 'shoreline projects' along the city's 47-mile coastline. As only 20% of the coastline is owned by the municipality and State’s regulations guarantee public access to the shoreline, any adaptive project requires the involvement of various stakeholders. *Climate Ready Boston* thus constitutes not merely a climate adaptation plan but a governance experiment: it formally engages the municipality to hybrid blue-green-grey infrastructure approaches, elevates community participation as a design requirement, and creates the opportunities of emerging spaces of collaboration between municipal agencies, academic institutions, private developers, and neighbourhood organizations. However, this novel set of planning practices remain precarious, as more traditional stakeholders intervene locally: an ongoing study by the U.S Army Corps of Engineers offers to revisit and recalculate risks and infrastructure opportunities, paving the way for potential important federal funds for infrastructural adaptation.

The institutional reorientation is both enabled and complicated by Boston's position as a knowledge-economy hub. The presence of major research universities and consultancy firms provides an unusually dense ecosystem of technical expertise, financial resources, and experimental capacity. Yet this same concentration of resources has reinforced pre-existing asymmetries: the governance of flood adaptation is largely orchestrated through expert-led networks whose community engagement mechanisms, despite genuine efforts, remain uneven. The institutional innovation of *Climate Ready Boston* is real; so is the unevenness of the political economy within which it operates.

3.3 NBS implementation: contrasting barriers and opportunities

Boston: proliferation, variation, and the equity paradox

Nature-based solution experimentation has proliferated across Boston harbor over the past decade, supported by the institutional backing of the municipality and the resource environment of the

knowledge economy. Yet the label 'NBS' encompasses a heterogeneous field of practices whose aims, ecologies of knowledge, and distributional implications differ substantially.

Some initiatives prioritize ecosystem restoration and long-term ecological function: the Stone Living Lab, organized around Boston Harbor, combines scientific monitoring, educational programming, and experimental NBS designs — including 'living seawalls' and 'cobble berms' — in a model that positions the harbor itself as a shared laboratory. Others are anchored in individual development projects: Clippership Wharf in East Boston, a high-end residential development, incorporates an award-winning 'living shorelines' design that celebrates the site's tidal functions while simultaneously enhancing private real estate value. The 'Emerald Tutu' project represents a third trajectory: a modular offshore floating wetland system developed through deep collaboration with local communities and youth programs, explicitly designed to combine ecological function, public access, and co-production of knowledge.

The case of East Boston — historically an environmental justice community, characterized by high immigrant population and persistent underservice by public infrastructure — is particularly revealing. The same approach of hybrid-solutions boom that has generated ecological experiments across the harbor has also intensified existing 'green gentrification' pressures (Anguelovski et al., 2019): shoreline adaptation projects raise property values and attract capital, threatening to displace communities whose flood vulnerability is compounded by socio-economic precarity. Meanwhile, the demand for NBS is shared across communities, but their feasibility may be limited because of spatial, ecological or regulatory constraints. Common regulatory and financing constraints cut across these different NBS trajectories. The historical depth of Boston's landfill-based development means that adding sediment or modifying the shoreline triggers regulatory processes originally designed for commercial development — treating ecological restoration as a form of 'artificialization' subject to the same permitting requirements as for-profit infrastructure. Financing structures compound this regulatory fragility: NBS projects are funded either through high-end housing cross-subsidies or through flood mitigation grants requiring cost-efficiency demonstrations, creating structural incentives that favour sites of high property value and technically legible risk reduction over the places and communities with the greatest adaptive needs (Table 1).

Table 1
Typology of flood response actors in Boston

Actor	Scale / Geography	Degree of state involvement	Type of intervention	Knowledge regime
Boston Harbor now	Metropolitan (harbor)	Community-led (partnership with the municipality and State)	Socio-organisational (advocacy, sensitization)	Hybrid co-produced
BPDA- Boston planning	Municipal (Boston)	State-led (municipal)	Urban planning, flood adaptation regulation, hybrid (grey infrastructures and NBS)	Technical-expert
Climate Ready Boston	Municipal (Boston)	State-led (municipal)	Knowledge production, socio-organisational (strategy, coordination)	Technical-expert
Emerald Tutu	Metropolitan (harbor)	Community autonomous (+ academic)	NBS experimentation, advocacy	Hybrid Community /experimential - academic
FEMA	National - State	State-led (federal)	Knowledge production, land regulation (NFIP)	Technical-expert
Mystic River Watershed Association	Metropolitan (river watershed)	Co-produced (municipal + NGO + community)	Socio-organisational (advocacy, sensitization), NBS experimentation	Hybrid co-produced
Office of Coastal Zone Management	State	State-led (Massachusetts)	Knowledge production, coastal regulation, subsidies provider	Technical-expert
Real Estate producers	Local (Clippership Wharf)	Partner (regulation)	NBS-experimentation, legitimation	Technical-experts
Stone Living Lab	Metropolitan (harbor)	Academic (municipality collaboration)	NBS-experimentation, advocacy	Hybrid co-produced
USACE	National - State	State-led (federal+ municipal)	Knowledge production, grey and hybrid infrastructures	Technical-expert

Buenos Aires: a fragmented landscape of governance experiments

While NBS remain marginal to Buenos Aires' dominant flood management architecture, the city and its metropolitan region are not characterized by uniform institutional inertia. A closer analysis reveals a heterogeneous landscape of actors operating at different scales, through different knowledge regimes, and with varying degrees of state involvement. Mapping this diversity is analytically essential: it reveals not the absence of innovation but its fragmentation — and the structural conditions that prevent fragmented experimentation from scaling into systemic transformation.

Drawing on our documentary and interview data, we propose a comparative typology of flood response actors in Buenos Aires, varying along two principal axes: (1) the degree of state involvement versus community autonomy, and (2) the type of intervention, ranging from grey/engineering approaches to NBS/ecosystem-based to socio-organisational strategies (Table 2).

Table 2
Typology of flood response actors in Buenos Aires

Actor	Scale / Geography	Degree of state involvement	Type of intervention	Knowledge regime
ACUMAR	Inter-jurisdictional (Matanza-Riachuelo basin)	State-led (national + provincial + municipal)	Grey infrastructure + hybrid NBS pilots	Technical-expert, top-down
GCBA Plan Director	Municipal (Buenos Aires city)	State-led (municipal)	Grey (drainage infrastructure)	Technical-expert
COMIREC	Local (Costanera Sur coastline)	Hybrid (state agency + civil society oversight)	NBS/ecosystem-based (ecological buffer, reserve management)	Hybrid technical-community
Foro Hídrico Lomas	Sub-metropolitan (Lomas de Zamora, Cuenca Baja Matanza)	Community-autonomous (limited state engagement)	Socio-organisational (advocacy, rights-based demands, monitoring)	Community/experiential
Proyecto Hábitat Claypole	Local (Claypole, Almirante Brown municipality)	Co-produced (municipal + NGO + community)	Hybrid (informal settlement upgrading with flood drainage components)	Hybrid co-produced
Neighborhood assemblies (post-2013)	Local (various municipalities)	Community-autonomous, adversarial to state	Socio-organisational (collective action, legal claims)	Community/experiential
UBA research centers (FADU, FCEyN)	Metropolitan	Academic (arm's-length from policy)	Knowledge production (none direct)	Technical-critical

This typology reveals a consistent structural pattern: the actors with greatest institutional resources and state authority — ACUMAR, the municipal *Plan Director* — remain predominantly anchored in grey infrastructure approaches, with NBS appearing only at the margins of their mandates as pilot projects or 'co-benefits.' Conversely, the actors most oriented toward NBS and socio-ecological integration — COMIREC, the Foro Hídrico, Proyecto Hábitat Claypole — operate at the community scale with limited resources and fragile institutional recognition. The University of Buenos Aires research network occupies a distinct position: generating sophisticated critical analyses of governance failure and institutional fragmentation, yet structurally disconnected from the policy processes it analyses (Viand and González, 2012).

This configuration operationalises what Coates and Nygren (2020) describe as 'hazardstates': a governance landscape in which flood risk management is not simply absent or technically deficient, but is actively assembled through clientelist networks and infrastructure-based patronage that systematically crowd out community-driven and ecosystem-based alternatives. The gap between academic knowledge production and NBS implementation is not merely a problem of information or expertise diffusion — it reflects the structural position of knowledge actors within a political economy that continues to prioritize visible, large-scale infrastructure as a resource for political capital. Buenos Aires thus demonstrates not the failure of urban climate governance, but its particular political form: fragmented, asymmetric, and profoundly shaped by the legacies of uneven urban development.

Discussion

The comparative analysis of flood risk governance in Boston and Buenos Aires reveals three interconnected findings that advance our understanding of how institutional contexts shape — and are shaped by — the implementation of nature-based solutions under conditions of intensifying climate risk.

The first finding concerns the relationship between knowledge production and governance change. In both cities, the transformation of flood risk management has been driven not simply by new technical information about climate hazards, but by the emergence of new epistemic spaces in which different forms of knowledge — scientific, experiential, legal, community-based — are brought into contested proximity. In Boston, the rejection of the harbor-wide barrier constitutes a paradigmatic instance of what Bulkeley and Castán Broto (2013) term 'climate change experiments': a purposive intervention in the city's socio-technical systems that, at least temporarily, foreclosed an established governance pathway and opened new political space for distributed, hybrid approaches. This reorientation is not merely technical; it required the active enrollment of heterogeneous actors — municipal agencies, academic institutions, community organizations, private developers — into a shared experimental framework in which the harbor itself became a site of governance innovation. The proliferation of NBS projects across Boston harbor is thus best understood not as the rational diffusion of superior solutions, but as the product of a particular institutional configuration that makes experimentation politically legible and materially resourced. This has lasting effects: the ongoing study of USACE is careful to align with these local demands and reconfigurations, by acknowledging and further studying the possibility to develop "natural and nature-based features" into their proposed infrastructures (McQueen et al. 2025).

In Buenos Aires, the relationship between knowledge and governance operates through a fundamentally different circuit. The academic sector — particularly through research centres at the University of Buenos Aires — has produced sophisticated critical analyses of flood governance failure, documenting the mechanisms of jurisdictional fragmentation, clientelist infrastructure allocation, and social vulnerability that reproduce flood risk in lower-income areas (Viand and González, 2012; Merlinsky, 2017). Yet this knowledge circulates largely within academic networks rather than feeding into policy cycles, reflecting a structural decoupling between knowledge production and institutional authority. The judicialization of environmental governance — through which legal proceedings in the *Mendoza* case generated ACUMAR

and its subsequent monitoring regime — represents a partial exception: courts have functioned as alternative channels through which critical knowledge about environmental harm has been translated into binding institutional mandates. That this translation has been incomplete and contentious (Scharager, 2020) underscores rather than undermines the point: in contexts where formal planning processes are captured by clientelist logics, legal activism becomes one of the few available mechanisms for converting critical knowledge into governance change. This dynamic resonates with broader patterns in Latin American environmental governance, where the judicialization of socio-environmental conflict has become a structurally significant — if institutionally fragile — pathway for communities to contest technical decisions that reproduce rather than reduce vulnerability (Ferro, 2016).

The second finding concerns the governance pathways through which — or against which — NBS are assembled. Boston exemplifies what Murray Li (2007) terms the 'will to improve' enacted through a heterogeneous assemblage: the *Climate Ready Boston* framework orchestrates a diverse coalition of actors across sectoral and institutional boundaries, enrolling technical expertise, philanthropic capital, regulatory authority, and community participation in a governance project whose coherence is produced through continuous negotiation rather than bureaucratic command. This assemblage is genuinely experimental in Murray Li's sense — it operates through the strategic mobilization of knowledge and agency toward outcomes that are themselves subject to revision — and it generates real institutional innovation. Yet it also concentrates authority in the hands of actors who are already resourced to participate: well-funded academic institutions, established environmental organizations, and private developers whose involvement in NBS projects is contingent on the alignment of ecological and economic value. The consequence is what Anguelovski et al. (2019) identify as green gentrification: in East Boston, shoreline adaptation projects that deliver ecological co-benefits simultaneously may reinforce displacement pressures in a community whose flood vulnerability is inseparable from its socio-economic precarity. The equity tensions embedded in Boston's NBS assemblage are not incidental to its institutional form — they are structural features of a governance model that enlists market mechanisms and private investment as primary vehicles for climate adaptation.

In Buenos Aires, the governance of flood risk corresponds more closely to what Coates and Nygren (2020) theorize as 'hazardstates': political formations in which flood risk management is not merely technically deficient but is actively organized through clientelist networks that align infrastructure investment with patronage relationships rather than technical assessments of vulnerability. The persistence of grey infrastructure approaches — despite the demonstrated limitations of engineering solutions and the growing availability of NBS alternatives — reflects not institutional inertia in a simple sense but the continued political productivity of large-scale visible infrastructure as a resource for electoral mobilization and territorial control. The fragmented landscape of community-led and civil society NBS initiatives documented in our typology represents a genuine counter-movement, but one that operates at the margins of a governance architecture whose core logics remain oriented toward infrastructure-based political exchange. The 'will to improve' in Buenos Aires is not absent; it manifests through the sustained efforts of community networks, advocacy organizations, and academic researchers who contest the dominant framing of flood risk and propose alternative approaches. What is

absent is the institutional architecture — formal authority, resource allocation mechanisms, and cross-jurisdictional coordination — that would allow this counter-movement to scale beyond local and alternative experimentation.

The third finding moves us beyond the risk of reproducing simplistic North-South dichotomies that would oppose Boston's resourced experimentation against Buenos Aires' constrained inertia. Both cities exhibit significant path-dependence: the developmental legacies of landfill-based expansion in Boston and hydraulic channelization in Buenos Aires continue to structure what interventions are technically feasible, what regulatory frameworks apply, and what institutional actors hold authority over contested shorelines. In both cities, the implementation of NBS triggers conflicts at the intersection of ecological, economic, and social interests that cannot be resolved by technical expertise alone. And in both cities, the communities facing the highest flood exposure — lower-income, historically underserved neighborhoods in East Boston and the informal settlements of the Matanza-Riachuelo basin — remain the most difficult to reach through the governance arrangements nominally designed to protect them. The equity challenge of urban climate adaptation is not a problem of insufficiently inclusive participation processes: it is a structural feature of governance systems in which the distribution of adaptive capacity reproduces and reinforces pre-existing patterns of socio-economic inequality.

These findings carry practical implications for cities seeking to implement NBS for flood risk management. They suggest that the viability of NBS is inseparable from the broader governance context in which it is attempted: technical solutions designed for institutional environments characterized by strong municipal capacity, diverse funding mechanisms, and engaged civil society cannot be straightforwardly transferred to contexts where these conditions are absent or actively undermined. They also suggest that the equity dimensions of NBS implementation — who bears the costs of adaptation, who captures its co-benefits, and whose knowledge counts in its design — require explicit and early attention rather than retrospective correction. The Buenos Aires case demonstrates that NBS innovation can emerge from unexpected sources — community networks, legal processes, academic advocacy — even in the absence of strong state support; the Boston case demonstrates that state or city-enabled experimentation is not sufficient to ensure equitable outcomes.

This study has limitations that future research should address. The focus on city-level governance processes may underweight the role of national policy frameworks and international funding mechanisms in shaping local adaptation capacity. The comparison of two cities, while analytically productive, cannot capture the full diversity of institutional configurations through which NBS governance unfolds globally. Longitudinal research tracking the social and ecological trajectories of specific NBS projects — in particular, the long-term distributional effects of shoreline adaptation in East Boston and the conditions under which ACUMAR's hybrid pilots achieve sustained implementation — would deepen the understanding of mechanisms that this study can only partially illuminate. Comparative research extending the framework to other Global South cities with different governance trajectories would test and refine the analytical categories developed here.

Ultimately, this research demonstrates that transforming urban flood risk management requires more than the identification of technically superior solutions. It requires building — and contesting — the institutional and political conditions under which such solutions can be implemented equitably, at scale, and in sustained engagement with the communities whose lives and livelihoods are most at stake. The contrast between Boston and Buenos Aires illuminates this challenge not as a problem of development level, but as a problem of governance: of how cities assemble the authority, knowledge, and collective will to act on what they already know.

Methods

Research design and case selection

This study employs a qualitative comparative case study design, selected for its capacity to illuminate how institutional contexts shape governance processes that are not amenable to quantification or controlled comparison (Yin, 2013). Our object of inquiry — the institutional pathways through which cities implement nature-based solutions for flood risk — is irreducibly contextual: it involves the intersection of formal policy frameworks, informal political arrangements, knowledge systems, and territorial histories that can only be grasped through sustained engagement with specific settings. A comparative design allows us to generate analytical leverage by examining how similar pressures — intensifying flood risk, growing international recognition of NBS, pressure for climate adaptation — produce divergent outcomes across contrasting institutional environments.

Boston and Buenos Aires were selected as paradigmatic 'extreme' cases (Yin, 2013): cities that represent contrasting poles along the dimensions theoretically relevant to our inquiry, thereby maximizing the analytical visibility of the mechanisms we seek to understand. Both cities are coastal, exposed to compound flood risks (storm surge and rainfall flooding), and have undergone significant governance transformation in recent years. Their contrast lies in the institutional conditions of this transformation. Boston represents a high-income, knowledge-economy context with robust municipal institutional capacity, dense networks of academic and technical expertise, and strong alignment between climate adaptation discourse and municipal political identity. Buenos Aires represents a middle-income, highly unequal metropolitan context characterized by multi-scalar jurisdictional fragmentation, infrastructure deficits concentrated in lower-income areas, clientelist governance dynamics, and a significant gap between academic knowledge production and policy implementation. This contrast does not reproduce a simple North-South hierarchy — both cities face structural tensions between environmental innovation and social equity, and both exhibit unexpected sites of institutional creativity — but it does allow us to examine how socio-economic and institutional context shapes what governance arrangements become thinkable, feasible, and durable.

The comparison was further justified by the availability of a sufficiently rich documentary record and interview access in both settings, and by the authors' combined expertise across both urban contexts.

Fieldwork was conducted in two phases: Buenos Aires (2023–2024) and Boston (2023–2024), with follow-up documentary analysis extending through early 2025.

Data collection

Data collection combined two primary sources: systematic documentary analysis and semi-structured interviews with key informants.

Documentary analysis drew on a purposive corpus of policy documents, planning reports, legal decisions, documentation of engagement processes, and grey literature identified through institutional websites, archival searches, and interview-based snowballing. For Buenos Aires, core documents included the *Plan Director de Ordenamiento Hidráulico* (GCBA, 2004 and subsequent revisions), ACUMAR annual reports and remediation plans (2010–2024), the Supreme Court ruling and associated judicial monitoring reports in the *Mendoza* case, and planning documents from the municipalities of Lomas de Zamora and Almirante Brown. For Boston, key documents included the *Climate Ready Boston* plan (2016 and 2021 update), the harbor-wide barrier feasibility assessment (Kirshen et al., 2018), shoreline projects engagement and technical reports from the Boston Planning and Development Agency and the US Army Corps of Engineers, and project documentation from the Stone Living Lab, Clippership Wharf, and Emerald Tutu initiatives. Peer-reviewed academic literature on flood governance in both cities was reviewed systematically and used both as a secondary empirical source and as analytical context. Documents were analyzed inductively for content related to risk framing, actor constellations, governance arrangements, and NBS rationales.

Semi-structured interviews were conducted with a purposive sample of key informants in each city, selected to cover the principal actor categories identified in our analytical framework: municipal and metropolitan government officials, technical staff from regulatory and planning agencies, representatives of civil society organizations and community groups, academic researchers, and private-sector actors involved in NBS projects. In Boston, interviews were conducted between June and October 2024 (N = [INSERT]); in Buenos Aires, between [INSERT DATES] (N = [INSERT]). Interviews lasted between 45 and 90 minutes. In Boston, interviews were conducted in English; in Buenos Aires, in Spanish. All interviews were recorded and transcribed with participants' informed consent. Where participants requested anonymity, they are cited by institutional role and interview date. Where named citation was permitted, full attribution is provided. Interview protocols were reviewed for ethical compliance in accordance with the authors' institutional requirements.

Analytical approach

Analysis proceeded through an iterative process of cross-case thematic coding, guided by the three analytical lenses developed in the Introduction — the resilience turn and de-naturalization tradition, climate change experiments, and assemblage theory — while remaining open to emergent themes.

An initial round of open coding was applied independently to the documentary and interview corpora for each city, generating a preliminary set of themes related to risk sensemaking, actor configurations, knowledge-policy dynamics, and NBS rationales. A second round of focused coding organized these themes around the three dimensions structuring our research questions: (1) how flood risk is locally defined and by whom; (2) how governance arrangements have evolved over time and what legacies constrain or enable change; and (3) how NBS are positioned, implemented, and contested in each context. A third analytical pass involved systematic cross-case comparison, seeking both structural parallels — shared mechanisms operating across different institutional environments — and divergences that illuminate the role of context in shaping governance outcomes.

The three theoretical lenses were operationalized as follows. The resilience turn and de-naturalization literature sensitized our coding to how vulnerability is distributed across social groups and whether governance processes acknowledge or obscure the social production of risk. The climate change experiments framework directed attention to the experimental, provisional, and politically contested character of NBS initiatives — to who authorizes experimentation, through what institutional mechanisms, and with what distributional consequences. The assemblage and 'will to improve' lens guided analysis of how governance is accomplished through heterogeneous coalitions of actors, artifacts, and knowledge forms, and how the aspiration to govern flood risk is translated — or fails to be translated — into concrete technical and political interventions.

Analytical rigour was ensured through multiple strategies. Triangulation across documentary and interview sources allowed us to cross-check claims about institutional arrangements and actor positions, and to identify discrepancies between formal policy framings and reported practice. Member-checking was conducted with selected informants in both cities, who reviewed draft analytical interpretations for factual accuracy and plausibility. The comparative structure of the analysis served as a further validity check: explanatory claims that held in one city were tested against the contrasting case, and apparent anomalies were used to refine interpretive categories rather than dismissed.

Data availability

The data that support the findings of this study are not publicly available due to privacy and ethical restrictions governing interview material but are available from the corresponding author on reasonable request. Policy documents and grey literature cited in the analysis are publicly available through the institutional sources referenced in the bibliography.

Declarations

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Contribution

FF and CRT contributed to the conceptualization, methodology, formal analysis, data curation, writing of the original draft, review and editing, and visualization. FF and CRT contributed to the conceptualization, methodology, formal analysis, data curation, review and editing.

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Ethics statement

This study was performed in accordance with the Declaration of Helsinki. The research protocol, including interview procedures and data management, was reviewed and unanimously approved by the Research Ethics Committee (Comité d'éthique de la recherche, CER) of the Paris Institute of Political Studies (Sciences Po), Opinion no. 2025-064, issued on 20 March 2025. Informed consent was obtained from all interview participants prior to data collection. Where participants requested anonymity, they are cited by institutional role and interview date.

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