

Climate variability, adaptation and mobility in Senegal: A multicausal analysis of selected hotspots

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Abstract

Mobility is increasingly conceptualised as a possible form of climate adaptation, yet migration interacts with other adaptive responses that operate through different actors, scales and degrees of agency. This article examines how climate variability and adaptation interventions have interacted in shaping mobility and immobility in Senegal since the Great Drought of the 1970s, through an analysis of selected hotspots: Rufisque, Lac Rose and Saint Louis. Combining a multicausal and multiscalar perspective with a historical and qualitative hotspot-based approach, the analysis considers climate-related (im)mobilities as embedded in historical adaptation strategies and discusses their impact, together with other, more recent, adaptive responses, including infrastructural adaptation and planned relocation. It emerges that adaptive capacity varies across actors, dimensions and spatial and temporal scales, and that in some contexts adaptation may redistribute rather than reduce vulnerability. Moreover, household-level adaptive practices may become embedded in broader processes of territorial transformation. The article therefore argues for analysing climate mobility and other adaptive responses within a wider multiscalar and multicausal perspective, focusing on how different responses reshape the conditions under which people can move, remain and sustain viable livelihoods.

Introduction

Throughout human history, environmental and climate variability has contributed to shaping the geographical patterns of human adaptation, including through migration (Piguet 2013). Migration, often seasonal, has represented a major adaptive response to environmental change for centuries, even millennia (Ionesco, Mokhnacheva and Gemenne 2017). Yet human mobility is rarely a direct response to environmental change alone. Rather, it emerges from the interaction of climate variability with socio-economic inequalities, political responses to environmental risk and historically established mobility patterns.

Senegal provides a particularly relevant context in which to investigate these interactions. Since the Great Drought of the 1970s, changing rainfall regimes, coastal erosion and environmental degradation, together with the local effects of broader political and economic processes, have transformed livelihoods across the country and contributed to internal and international migration. These transformations, however, have unfolded within a society in which mobility has historically represented an ordinary livelihood strategy rather than an exceptional response to crisis. Understanding contemporary climate-related mobility in Senegal therefore requires attention not only to environmental change, but also to the historical, political and economic conditions through which mobility and immobility are produced.

Migration has increasingly been conceptualised as one possible form of adaptation to climate change. As Gemenne and Blocher (2017) point out, climate change can erode people's adaptive capacity, altering their relationship with the territories they inhabit and, in some circumstances, increasing their propensity to migrate. Migration can help protect human well-being when livelihoods are threatened by present or

anticipated climate pressures (Pelling 2011). Rural migration, in particular, may diversify household livelihood strategies, reduce pressure on local resources, facilitate social remittances and operate as a form of informal insurance where livelihoods depend strongly on natural resources and relatively regular climate patterns (Gemenne and Blocher 2017; Zickgraf 2018; Salerno et al. 2024). The relationship between adaptation and mobility, however, is not as linear as it may appear. For instance, the mobility of some household members may enable others to remain in place, while immobility may constitute an active response to environmental change (Zickgraf 2018; Black et al. 2022). At the same time, the capacity to migrate, to remain or to choose between the two is unevenly distributed. Environmental stressors affect territories and social groups differently and intersect with multiscalar political, economic and social processes that shape adaptive agency and, consequently, (im)mobility options (Piguet, Pécoud and de Guchteneire 2011; Salerno et al. 2024).

Migration, like other forms of adaptation, cannot therefore be assumed to reduce vulnerability uniformly. Adaptive strategies may expand the options available to households and communities, but their effects vary across actors, places and scales. This becomes particularly relevant when historically embedded forms of adaptation, such as household migration, interact with institutionally driven measures including planned relocation and technocratic infrastructural interventions. These responses differ substantially in terms of actors, objectives, spatial scales and degrees of agency, yet they may coexist within the same territories and influence one another.

This article brings scholarship on climate-related mobility into dialogue with research on climate adaptation by examining these processes within a territorial and historical framework. It asks: “How have climate variability and adaptation interventions interacted in shaping mobility and immobility in selected Senegalese hotspots since the Great Drought?” In addressing this question, the article builds on the migration-as-adaptation perspective while considering other modes through which adaptation is pursued at different territorial scales, including relocation and technocratic engineering strategies.

The analysis focuses particularly on how these different adaptive practices interact with historically produced patterns of mobility, livelihoods and vulnerability. It does not simply ask whether a specific strategy constitutes successful adaptation; rather, it examines how different responses reshape the conditions under which people are able, encouraged or compelled to move or remain. This requires attention to who adapts, through which practices or interventions, at what scale and with what degree of agency, as well as to the effects of these processes on vulnerability and adaptive capacity.

From this perspective, adaptation is neither an external nor an inherently beneficial response to environmental change. Rather, it takes place within historically produced socio-economic inequalities and development trajectories, and its consequences may differ between social groups and territories and may become visible at different spatial or temporal scales.

This also raises questions of justice. Just as climate change impacts are unevenly distributed – disproportionately affecting populations and regions that have contributed least to greenhouse gas emissions – the same inequality may be reproduced in, and potentially reshaped by, the ways adaptation

is implemented. A territorial perspective, combined with a multicausal and multiscalar approach, allows to understand not only who is vulnerable to environmental change, but also who gains adaptive capacity through particular responses, who bears their social and environmental costs and how the possibilities of moving or remaining are distributed across people and places. Territorial and mobility justice become interpretative lenses through which the differentiated consequences of adaptation can be examined, rather than as outcomes assumed in advance.

The article develops this argument in four sections. The first presents the research approach and analytical framework, combining a multicausal and multiscalar understanding of climate-related mobility with a historical, qualitative and hotspot-based perspective. The second reconstructs the historical trajectories through which mobility, climate variability and territorial change have interacted in Senegal, with particular attention to the Great Drought and its long-term consequences. The third examines selected hotspots in the Southern Niayes region and Saint Louis, focusing on migration, infrastructural protection and planned relocation as differently scaled and differently governed adaptive responses. The fourth brings these cases into comparison to examine how adaptation may produce both mobility and immobility, how its effects vary across actors and scales, and under what conditions it may alter the distribution of vulnerability and adaptive capacity. The conclusion summarises the implications of these findings for climate-mobility and adaptation research.

Research approach: adaptation, mobility and territorial change

This article investigates the multicausal and multiscalar relationships between climate variability, adaptation and human (im)mobility in Senegal, with particular attention to the long-term territorial consequences of both historically embedded adaptive practices and more recent institutionally driven interventions. In doing so, it engages with one of the research directions identified by Ferris (2020), namely the need to investigate the “long-term consequences of slow-onset events”. These consequences are approached here from a human geography perspective, as territorial processes emerging through the interaction of environmental change, socio-economic vulnerability and different forms of adaptation.

The analytical approach combines two complementary perspectives. First, it adopts the multicausal and multiscalar understanding of the nexus between climate change, socio-economic vulnerability and migration proposed by Baldwin, Fröhlich and Rothe (2019). This perspective avoids treating environmental change as an isolated driver of mobility and instead situates (im)mobility within broader historical, political, economic and social processes. Second, the article follows the historical, qualitative and hotspot-based approach identified by Piguet (2022), using selected Senegalese contexts to examine how these relationships have developed over time. The selected hotspots are the southern Niayes, including Rufisque and Lac Rose, and Saint Louis, at the northern end of the Niayes region.

Building on the migration-as-adaptation perspective, the analysis examines the interaction between historically established household mobility strategies and more recent institutionally driven responses

such as planned relocation and infrastructural interventions. These responses involve different actors, operate at different spatial and institutional scales and entail different degrees of agency. The comparison therefore examines how they interact with existing livelihoods, vulnerabilities and territorial relations, and how they reshape adaptive capacity and the possibilities of moving, remaining and sustaining viable livelihoods.

These processes are situated within longer histories of uneven socio-economic development and environmental change, consistent with the framework of Anthropocenic mobilities (Whyte, Talley and Gibson 2019). Territorial and mobility justice thus emerge as interpretative lenses through which their differentiated consequences across people and places can be examined.

The article is based mostly on secondary data and empirical and theoretical literature on environmental change, migration, adaptation and socio-economic transformations in Senegal. This material is used to reconstruct relationships between environmental change, mobility practices, development trajectories and adaptation interventions from the Great Drought to the present.

The discussion is also informed by the author's previous fieldwork in Senegal, although primary data do not constitute the principal empirical basis of this article and have been published elsewhere. Interviews, focus groups and participant observation were conducted in Senegal in May 2021. Fieldwork material is used here selectively to complement the literature-based analysis and to provide locally grounded perspectives on several adaptive practices and their perceived consequences.

The analysis does not assume a linear causal relationship between climate change and migration, nor does it seek to evaluate the effectiveness of individual adaptation interventions. Instead, it uses the selected hotspots to examine how different forms of adaptation are embedded in longer-term territorial transformations and interact with historically established mobility patterns. The aim is thus to contribute to climate-mobility scholarship by shifting analytical attention from migration as an adaptive outcome alone towards the relationships between different adaptive responses and the conditions they create for mobility, immobility, vulnerability and adaptive capacity.

Historical trajectories of mobility, climate variability and adaptation in Senegal

Understanding contemporary climate-related mobility and adaptation in Senegal requires situating them within longer-term processes of territorial, environmental and socio-economic change. Mobility did not emerge in the country as a response to contemporary climate change or to recent adaptation policies. Internal and seasonal migration have historically formed part of household strategies for managing livelihood uncertainty and climate variability.

The Great Drought of the 1970s represented a major turning point in these strategies since it interacted with already established patterns of mobility and with wider political and economic transformations, contributing to changes in the destinations, duration and functions of migration. Mobility and

environmental change must therefore be read as interconnected historical processes that progressively reshaped the conditions under which Senegalese households and territories could adapt.

2.1 Mobility as a historically embedded adaptive practice

Human mobility in Senegal has been described by Sakho (2018) as a “continuous displacement of people” around the Senegal River valley, towards the coastal cities and through the so-called *bassin arachidier* (peanut basin) in the Kaolack region, where peanut cultivation expanded during French colonisation. International migration emerged during the colonial period, initially through the departure of the *tirailleurs sénégalais* during World War I and later through labour migration towards France and other French colonies in West and Central Africa (Sakho 2018).

Internal mobility, however, has historically played an even more significant role in Senegalese livelihoods, with seasonal intra-rural migration allowing rural households to supplement agricultural income during the dry season since independence (Diallo 2025). These movements were generally embedded in livelihood systems based on continued relations with the places of origin rather than constituting definitive departures from rural areas. From the 1970s onwards, structural adjustment policies contributed to a transformation of these patterns by reducing rural employment opportunities. Longer and sometimes permanent rural-to-urban migration increased, expanding participation in informal and low-skilled urban labour markets (Gueye, Fall and Tall 2015).

The expansion of urbanisation in Senegal, as elsewhere in West Africa, has nevertheless not resulted in the disappearance of rural-urban connections. Internal migration has instead strengthened socio-economic networks linking rural and urban areas, rooted in forms of social and territorial solidarity that become particularly important during periods of economic crisis (Ninot and Sakho 2021; Cissokho et al. 2024). Zingari et al. (2022) similarly emphasise that contemporary Senegal has been shaped by extensive internal mobility and describe the interaction of national, regional and global economic, professional, environmental, social, family and cultural variables as producing a system of “constant geographical and social mobility”.

Consequently, mobility should not be understood exclusively as movement away from vulnerable territories. Rural-urban and intra-rural movements have contributed to the formation of networks through which households diversify income and redistribute resources while maintaining strong relations with their places of origin. Mobility and immobility thus become relational components of the same household response to livelihood uncertainty, with the movement of some household members enabling others to remain.

International migration represents an extension of these wider geographies of mobility, contributing to the expansion of territorial networks and potentially providing economic resources and social recognition to migrants and their households (Carling et al. 2013). Following the transformation of internal migration patterns during the 1970s, international movements increasingly developed through a two-step trajectory, initially from rural to urban areas and subsequently towards destinations abroad

(Sakho 2018; Giacomelli et al. 2022). More restrictive European migration policies since the early 2000s have also contributed to reshaping these trajectories, including through the emergence of risky irregular routes such as the maritime journeys towards the Canary Islands commonly associated with the expression *Barça-Barsakh* (Zingari et al. 2022; Giacomelli et al. 2022, 2023).

Yet international migration remains only one component of a broader system of Senegalese mobility. Regional and internal movements are statistically more relevant. Black et al. (2022: 15) describe West Africa as characterised by an “emic culture of migration [...] based on a long history of mobility”. Data from the 2013 national demographic survey similarly showed that only a small proportion of Senegalese migrants had moved internationally during the previous five years (ANSD 2014). These patterns highlight the importance of analysing South–South and internal mobility alongside more visible intercontinental migration (Zickgraf 2018).

Climate variability has long been intertwined with historical mobility patterns, with rapid-onset environmental events producing displacement, while slower transformations progressively affecting livelihood possibilities and thus altering mobility decisions. Rural populations have historically relied on temporary or selective labour mobility to manage changing environmental and economic conditions (Sakho et al. 2019). In many cases, environmental and demographic pressures have resulted in selective internal migration, through which the movement of some household members helped families maintain their presence in their traditional territories (Sakho et al. 2019). Evidence from fieldwork conducted in Senegal in 2021 similarly includes accounts of selected household members moving towards the Dakar area during the 1980s while maintaining family connections with their places of origin.

Seen from an adaptation perspective, this historical trajectory is important because it shows that mobility constituted an adaptive response long before climate adaptation policies emerged. Accordingly, contemporary climate adaptation policies do not enter an empty field: they interact with historically established systems through which Senegalese households have long negotiated climatic variability, economic uncertainty and territorial change.

2.2 The Great Drought and the changing territorial conditions of adaptation

The adaptive significance of these mobility patterns changed substantially from the late 1960s onwards, when the Sahel entered the period commonly referred to as the Great Drought of the twentieth century. Sub-Saharan Africa is among the regions most exposed to the combined impacts of climate variability, socio-economic vulnerability and dependence on climate-sensitive livelihoods. Desertification, soil and coastal erosion, biodiversity loss and declining agricultural productivity interacted with poverty, demographic growth and uneven access to protective infrastructures, producing highly differentiated forms of vulnerability (Capozzi et al. 2018; Azzarri and Signorelli 2020). These processes illustrate the multicausal and multiscale nature of climate-related vulnerability rather than a direct relationship between climatic change and human mobility.

Between the 1970s and the 1990s, annual rainfall in parts of the Sahel declined by up to 50 per cent (Bader and Latif 2011; Lebel et al. 2018; Ndong 1995), and the drought extended into regions that had traditionally been relatively humid, including Casamance. In Senegal, declining rainfall was accompanied by reduced coastal aquifer recharge, saltwater penetration into major estuaries and increasing soil erosion through runoff and wind. These processes significantly affected vegetation cover, grazing areas and agricultural production, contributing to severe food insecurity and encouraging movement towards wetlands and major urban centres (Durand 1977; Ndong 1995; Lebel et al. 2018).

The Great Drought was not the first major drought of the twentieth century – important episodes had already occurred during the 1910s and 1940s – but its duration and intensity produced particularly significant territorial consequences. More than 80 per cent of the years between 1968 and 2004 were characterised by substantial rainfall deficits (Ozer and Ozer 2005), and the drought affected not only annual agricultural production but also longer-term ecological conditions, water availability and the viability of established rural livelihood systems.

Since the 1990s, rainfall has become more regular in parts of the Sahel, while heavy rainfall events have become more frequent. Combined with rising temperatures and changing land use, this variability has contributed to recurrent flooding and displacement, producing overlapping drought and flood risks (Lebel et al. 2018).

These environmental transformations have coincided with rapid demographic growth and urbanisation. Dakar and the wider urban region centred on Dakar, Thiès and Touba have become major destinations for internal migration (Cissokho et al. 2021; ANSD 2020). Growing demand for land, water and infrastructure, agricultural expansion and insufficient urban planning have meanwhile contributed to new forms of environmental pressure and exposure (Ozer and Ozer 2005; IPCC 2022).

The relationship between environmental change and mobility in Senegal is therefore recursive rather than linear. Climate variability contributes to changing livelihood conditions and may encourage movement, but mobility itself becomes part of broader territorial transformations. Migration towards urban and coastal areas may expand access to employment and income while simultaneously increasing demand for land, water and infrastructures in receiving areas. Urban growth, changing land use and environmental degradation may in turn generate new forms of vulnerability and new pressures towards mobility. It is moreover expected that future climate pressures are likely to interact with already transformed livelihood systems, settlement patterns and territorial inequalities (Trisos et al. 2022).

The Great Drought should therefore be understood not simply as an environmental event that generated migration, but as a critical moment in a longer transformation of Senegalese adaptive strategies. It altered the resource base on which many rural livelihoods depended, intensified and redirected existing mobility patterns and contributed to demographic and economic concentration along the coast. At the same time, development policies, urbanisation and changing land use progressively transformed both areas of origin and destinations. Contemporary adaptation interventions consequently operate within territories that have already been reshaped by decades of environmental change, mobility and uneven

socio-economic development. The following section examines how migration, relocation and infrastructural interventions interact within these historically transformed adaptive landscapes.

Adaptation in interaction: evidence from selected Senegalese hotspots

The historical processes discussed above have transformed both the mobility patterns and the territorial conditions within which adaptation takes place in Senegal. Since the Great Drought, increasing population concentration along the coast has intersected with climate variability, (unplanned) urbanisation, coastal erosion and growing pressure on natural resources, while adaptation has increasingly become a field of institutional intervention.

Using the hotspot-centred perspective suggested by Piguet (2022), together with the multicausal and multiscalar approach identified by Baldwin, Fröhlich and Rothe (2019), this section examines how different adaptive responses interact within specific territories. Namely, the following cases analyse how household mobility, infrastructural interventions and planned relocation interact within these transformed territories, through different actors, scales and degrees of agency. In Rufisque, infrastructural protection has been combined with migration and relocation and can contribute to the capacity of exposed populations to remain in place. At Lac Rose, internal migration initially provided access to livelihood opportunities but became embedded in broader processes of demographic, environmental and economic transformations. In Saint Louis, an intervention designed to reduce flood risk generated new environmental vulnerabilities, while planned relocation altered access to livelihoods and produced contested patterns of movement and return. Taken together, these cases suggest that adaptation outcomes depend not simply on the type of intervention adopted, but on its interaction with existing territorial relations, livelihood practices and forms of agency.

3.1 Rufisque: infrastructural adaptation and the capacity to remain

The Niayes, a coastal strip extending from the Cap Vert Peninsula, where Dakar is located, northwards to Saint Louis, historically constituted one of Senegal's most productive agricultural areas. Up to the 1970s, the region was characterised by relatively abundant vegetation and agricultural land, but was progressively affected by the Great Drought and changing rainfall regimes. Reduced rainfall, combined with growing human use of groundwater, contributed to a substantial decline in the coastal aquifer, while persistent drought and demographic pressure altered vegetation and water availability.

From the 1980s onwards, dune stabilisation programmes introduced drought-resistant species such as *filao* (*Casuarina equisetifolia*), which proved effective in stabilising parts of the coastline (Tappan et al. 2004). Despite these environmental transformations, the Niayes have remained one of Senegal's most productive horticultural areas, accounting for a large share of national production and experiencing an expansion of cultivated land (Marfurt, Haller and Bottazzi 2023).

Population pressure along the coast had already begun to increase during the relatively wet 1960s and accelerated further with internal migration during and after the Great Drought (Ndong 1995). This demographic growth interacted with increasing demand for land, water and vegetation, and contributed to the transformation of a coastal environment already affected by changing climate conditions.

Rufisque illustrates these overlapping dynamics. The loss of vegetation during the Great Drought increased the exposure of parts of the coastline to erosion, affecting local livelihoods and contributing to both migration and relocation. Some families moved independently, while others were relocated inland through programmes promoted by the municipal administration. Mobility in this context therefore included different forms and degrees of agency, ranging from household migration strategies to institutionally organised relocation.

Coastal protection provides another adaptive response. Sea walls and similar engineering interventions are institutionally driven and technologically intensive measures intended to reduce exposure to coastal erosion (Ndour et al. 2018). Fieldwork findings from Rufisque indicate that such measures should not automatically be understood as externally imposed interventions opposed to locally driven adaptation. Residents describe coastal protection as an important means “pour vivre avec” (to live with) climate change and to reduce the need for further migration.

The experience of Rufisque complicates any straightforward association between technocratic adaptation and local opposition, showing that infrastructural protection may increase adaptive capacity by reducing exposure, while allowing residents to maintain livelihoods and territorial relations. It also shows that the institutional or technological character of an intervention does not determine its effects in advance: its adaptive significance depends on how the intervention interacts with existing vulnerabilities, territorial relations and local understandings of what constitutes a viable response to environmental change.

3.2 Lac Rose: mobility as adaptation and cumulative territorial pressure

Lac Rose, located in the southern Niayes, provides a different example of the relationship between mobility and adaptation. During the 1970s and 1980s, the area became an important destination for internal migrants attracted by employment opportunities in salt extraction and tourism. The development of the Paris-Dakar rally, which ended at the lake from 1979 onwards, contributed to a tourist economy that supplemented income from salt harvesting and other local activities.

These opportunities changed substantially over time. Following increasing geopolitical instability in Mauritania, the rally changed route in 2007, contributing to the decline of the tourism economy around the lake. According to fieldwork findings, salt extraction had already become less profitable than in previous decades. In the 1980s, the lake was larger and less saline, and local residents recall that fishing was still possible. Persistent drought and intensive water use for irrigation subsequently contributed to shrinking the lake, while growing numbers of workers increased competition within the salt sector.

Internal migration towards Lac Rose represents a livelihood strategy through which households sought access to economic opportunities. Yet the context within which this strategy operated progressively changed. Population growth increased demand for land and water, particularly for agriculture, while the wider basin became increasingly incorporated into agribusiness and extractive activities, including cement, zircon and phosphate production. Infrastructure development and unmanaged domestic and industrial waste have added further pressure on the area (Marfurt, Haller and Bottazzi 2023).

These transformations make Lac Rose a particularly clear example of the multicausal and multiscale character of adaptation. Migration is but one component of a much wider process involving climate variability, resource use, market change, industrial activities and infrastructure development. At the same time, the case shows how a strategy that expands livelihood opportunities for individual households may become embedded in cumulative pressures that progressively transform the resources on which those opportunities depend.

The adaptive significance of mobility consequently varies according to both time and scale. Migration towards Lac Rose increased household adaptive capacity by providing access to employment and income, while demographic growth, water extraction, agricultural expansion and other economic activities contributed to changing territorial conditions. Adaptive capacity at the household level may therefore coexist with increasing vulnerability at a broader territorial scale.

Lac Rose shows that household adaptive practices operate within dynamic socio-environmental systems, and their outcomes cannot be assessed independently of other processes occurring in the same territory or at wider scales, highlighting the need for multiscale and multicausal analysis.

3.3 Saint Louis: infrastructural adaptation and the production of new vulnerability

Saint Louis, situated at the northern end of the Niayes, provides a contrasting example of institutionally driven adaptation. In 2003, heavy rainfall increased the flow of the Senegal River and threatened the historic city with severe flooding. Local authorities responded with a top-down engineering solution by opening a channel through the Langue de Barbarie, the narrow peninsula separating the river estuary from the Atlantic Ocean, in order to allow floodwaters to reach the sea more rapidly.

The intervention addressed an immediate and serious risk, but its longer-term consequences extended well beyond its initial objective. The channel, locally known as *la brèche*, progressively widened after its construction, allowing increasingly saline ocean water into the lagoon and altering the hydrological and ecological dynamics of the estuary. Coastal erosion intensified, affecting flora, fauna and human settlements and activities, such as fishing and tourism.

The village of Doune Baba Dieye provides one of the most visible examples of these transformations. Located south of Saint Louis, it was progressively affected by coastal erosion and was eventually submerged in 2019 following the interaction of recurrent storm surges with the transformations

generated by *la brèche*. Its inhabitants were displaced inland. The village chief, Monsieur Diagne, subsequently drew national and international attention to the disappearance of the settlement, accompanying journalists and researchers to the submerged site to communicate the local effects of the climate crisis and of the engineering intervention put in place.

He also engaged in community reforestation. This example of local adaptation practice differs in actors, knowledge and scale from the engineering interventions promoted by state and international institutions. It demonstrates that multiple forms of adaptation can coexist within the same hotspot, rather than constituting two entirely separate responses.

The opening of *la brèche* provides a particularly clear example of how adaptation may redistribute rather than reduce vulnerability. From the perspective of protecting the historic city from an immediate flood threat, the intervention had a clear adaptive objective. Its effects, however, altered environmental conditions elsewhere along the estuary and contributed to new forms of exposure for coastal ecosystems and communities.

This case does not point at evaluating whether the engineering intervention “succeeded” or “failed”. Rather, it highlights how benefits and costs may occur at different scales, and contends that assessing the result of an adaptation intervention requires attention not only to the hazard against which it is designed, but also to the territorial distribution of its longer-term consequences.

3.4 Planned relocation, constrained agency and return in Saint Louis

The northern part of the Langue de Barbarie illustrates a further dimension of the relationship between adaptation and mobility. Coastal erosion continues to affect fishing communities despite additional protective measures, including a coastal wall funded by the Senegalese state and the French Development Agency. The wall itself has altered the relationship between settlements and the sea, limiting access to a resource that is simultaneously the basis of local livelihoods and an important element of social and cultural life.

Planned relocation has been introduced as another response to increasing coastal exposure. Fishing households have been moved inland to a settlement intended to provide greater protection from erosion. The relocation site, however, is poorly connected by public transport, lacks important services and infrastructures and is itself situated in an area exposed to flooding when the Senegal River overflows. What is more, its distance from the sea also disrupts access to fishing livelihoods.

Its very name, Khar Yallah (meaning “waiting for God”) captures the dissatisfaction associated with the site. Fieldwork observations indicate that some relocated residents prefer to return to precarious coastal dwellings rather than remain in the resettlement area. Their countermovement back to their delabrated houses should not be interpreted simply as a refusal to adapt or as an irrational preference for

environmental risk. Rather, it highlights a tension between institutional definitions of safety and local understandings of what makes a place viable.

Planned relocation may reduce exposure to one environmental hazard while simultaneously increasing other forms of vulnerability. For fishing households, moving away from an eroding coastline can improve physical safety but reduce access to the sea, employment, social networks and cultural connections. Adaptive capacity therefore encompasses more than the reduction of physical exposure.

The case also highlights differences in agency between forms of adaptive mobility. Historically established migration strategies may involve household decisions over who moves, where and for how long, even when those choices are strongly constrained by economic and environmental conditions. Planned relocation, by contrast, is institutionally organised and significantly reduces local agency and control over the destination and conditions of movement. Subsequent return to the coast can therefore be read as a form of counter mobility through which residents attempt to recover access to livelihoods and territorial relations disrupted by relocation.

Khar Yallah demonstrates why (planned) mobility itself may not always serve as a measure of adaptation. Moving people away from an exposed territory may reduce immediate risk without necessarily increasing their overall capacity to adapt. Conversely, returning to an environmentally vulnerable location may restore livelihood opportunities while increasing physical exposure. The adaptive significance of mobility and immobility consequently depends on the wider set of social, economic and territorial relations within which they occur.

Discussion: adaptation, (im)mobility and changing configurations of vulnerability

The cases examined in the previous sections illustrate different ways in which mobility, immobility and adaptation become interconnected within territories undergoing environmental and socio-economic change. They challenge the idea of a simple and linear relationship between adaptation and mobility, by showing that similar mobility outcomes may result from different adaptive processes, while similar forms of intervention may have different consequences depending on the territorial and social contexts in which they are implemented.

It follows that the relationship between climate-related mobility and adaptation is better understood by shifting attention away from movement as an outcome in itself and towards the conditions under which different forms of adaptation affect people's possibilities to move, remain and maintain viable livelihoods. Such a perspective also requires moving beyond a simple distinction between locally embedded and institutionally driven adaptation. The Senegalese cases indicate that actors, scales, degrees of agency and existing territorial relations are central to understanding why adaptive responses produce different outcomes.

4.1 Mobility and immobility as relational adaptive outcomes

A first finding concerns the relationship between mobility and immobility. As discussed in Section 2, migration has long constituted part of Senegalese household strategies for dealing with livelihood uncertainty and climate variability. Selective mobility helps diversifying income and distributing risk across household members and places, while simultaneously contributing to the capacity of other members to remain in their territories of origin. Mobility and immobility are therefore not necessarily alternative or opposing outcomes; rather, they emerge as complementary adaptation strategies.

The case studies reinforce this point. In Rufisque, infrastructural protection is valued by some residents precisely because it may reduce the need for further migration and allow continued residence. Adaptation in this case may support staying. Planned relocation in Saint Louis produces the opposite form of intervention: mobility represents the institutional adaptive response to environmental exposure. Yet the return of some relocated residents towards coastal settlements indicates that institutionally produced mobility does not necessarily correspond to an improvement in their living conditions.

These cases caution against using either mobility or immobility as an indicator of adaptive success. Remaining in place may reflect increased capacity to live with environmental change, as the Rufisque evidence suggests, but it may also involve continued exposure to risk. Similarly, relocation may reduce exposure while disrupting access to livelihoods and socio-cultural relations. It emerges that greater attention should be given to the conditions under which these outcomes occur, and how they affect the agency of the local households and communities to choose between a range of options. Mobility decisions are always connected to environmental, economic and political conditions, but the degree and form of control over movement vary substantially. Examining adaptation through the lens of (im)mobility requires attention not only to movement itself but also to who initiates it, who controls its conditions and what alternatives remain available.

4.2 Adaptive capacity across actors, dimensions and scales

A second finding concerns the scale at which adaptive outcomes are assessed. Adaptation is commonly associated with an increase in the capacity of individuals, households or communities to respond to environmental change. The Senegalese cases suggest, however, that such capacity should not be evaluated at a single scale or through a single dimension of vulnerability.

Lac Rose provides a particularly useful example. Internal migration towards the area historically offered access to employment in salt extraction and tourism and could increase the livelihood options available to migrant households. Over time, however, demographic growth became embedded in a wider transformation involving water extraction, agricultural expansion, industrial activities, infrastructure and

environmental degradation. An adaptive practice at the household level can coexist with environmental and economic transformations that alter the conditions of adaptation at a broader territorial scale.

A different scalar tension emerges in Saint Louis. The opening of *la brèche* responded to the immediate need to protect the historic city from flooding. Its subsequent widening, however, altered environmental conditions along the Langue de Barbarie and across the wider area, contributing to the expansion of territorial impacts at a larger scale, affecting ecosystems and coastal settlements. The adaptive benefits and costs were therefore located in different places.

Planned relocation adds another dimension to this problem. Moving fishing households inland may reduce their exposure to coastal erosion while simultaneously affecting access to the sea, transport, services, livelihood opportunities and cultural ties. Physical exposure and livelihood vulnerability may therefore move in different directions. An intervention can improve one dimension of adaptive capacity without necessarily improving others.

These examples suggest that questioning whether adaptation reduces vulnerability is insufficient unless accompanied by further questions – vulnerability to what, for whom, where and over what period of time? – since adaptive capacity is not necessarily distributed uniformly across the individuals, communities and territories affected by an intervention.

4.3 From vulnerability reduction to vulnerability redistribution

The comparison between the cases highlights that adaptation may modify the distribution of vulnerability between actors and territories.

The evidence supports this interpretation most clearly in Saint Louis. The *brèche* was opened to address a specific flood risk, but its environmental effects extended to other areas and communities. Planned relocation similarly changes the configuration of vulnerability rather than simply eliminating it: exposure to coastal erosion may decrease, while livelihood insecurity, infrastructural deficiencies or other environmental risks may become more significant. In these cases, adaptation changes both the location and the form of vulnerability.

Rufisque provides an important counterpoint. There, infrastructural adaptation is not described by residents as an externally imposed tool but is instead understood as supporting the possibility of remaining in place. This comparison cautions against treating technological or top-down adaptation as inherently maladaptive. The consequences of an intervention depend on how it interacts with local environmental conditions, livelihoods and territorial relations.

Lac Rose introduces another point. The case does not demonstrate a direct transfer of vulnerability produced by a specific adaptation intervention. Rather, it shows how household-level adaptive mobility becomes embedded in cumulative territorial processes involving multiple actors and pressures. It therefore supports a broader relational understanding of adaptive capacity.

Taken together, the cases suggest that adaptation may have distributive effects that remain obscure when its effectiveness is evaluated only in relation to the population, hazard or location explicitly targeted by an intervention. Vulnerability may be reduced for some actors while persisting or increasing for others; it may be displaced spatially, or transformed from environmental exposure into livelihood insecurity.

This distinction also helps move beyond a binary opposition between technocratic and socio-cultural forms of adaptation. Institutionally driven measures can support local adaptive capacity, as the Rufisque case indicates, while locally initiated practices cannot be assumed to be universally effective or transferable. The more relevant distinction concerns how different adaptive responses interact with existing vulnerabilities, territorial relations and forms of agency, and how their consequences are distributed across people and places.

4.4 Adaptation and territorial justice

Once adaptation is examined in terms of these differentiated effects, questions of justice interact with questions of adaptive capacity. Climate vulnerability is unevenly distributed because environmental pressures interact with socio-economic inequalities and historically differentiated access to resources. The cases examined here suggest that interventions undertaken in response to climate change may themselves become part of this uneven geography.

Territorial justice provides one possible lens through which to interpret these processes. Rather than treating justice only as a question of unequal exposure to climate change at a global scale, a territorial perspective draws attention to how adaptive benefits, costs and capacities are distributed between places and populations. The Saint Louis case is particularly relevant in this respect because the protection of one area and the changing vulnerability of others become territorially connected. Planned relocation similarly raises questions about who determines which territories are considered safe or viable and which dimensions of everyday life are taken into account in making such decisions.

This perspective also intersects with mobility justice (Sheller 2018; Walker and Giacomelli 2024), highlighting how the ability to leave, the possibility of staying safely, the capacity to return and the power to influence the conditions of relocation are not equally available to all actors.

The cases analysed do not provide a comprehensive assessment of territorial justice in Senegal, nor do they support reducing adaptation outcomes to a single justice framework. They do, however, indicate the importance of asking who gains adaptive capacity through specific interventions, who bears their social and environmental costs, and how the effects are distributed spatially. Territorial justice can therefore be understood as a way of interrogating the differentiated consequences of adaptation.

More broadly, bringing climate-mobility scholarship into dialogue with adaptation research makes these interactions visible. Migration is not simply one possible outcome of environmental change, and institutional adaptation is not an external response operating independently from existing mobility systems. Both participate in the ongoing transformation of territories and of the conditions under which

people can move, remain and sustain livelihoods. Analysing their interaction therefore shifts the focus from whether migration is a successful form of adaptation towards the broader question of how different forms of adaptation reshape adaptive possibilities across people and places.

Conclusion

This article has examined how climate variability and different forms of adaptation have interacted in shaping mobility and immobility in selected Senegalese hotspots since the Great Drought. The analysis confirms that mobility cannot be understood as a direct response to environmental change. Mobility in Senegal is historically embedded in household and territorial strategies and has long contributed to managing livelihood uncertainty and climate variability. Contemporary environmental pressures and adaptation interventions therefore operate within mobility systems and territorial relations that predate them.

Bringing migration into the same analytical framework as planned relocation and infrastructural adaptation also shows that different adaptive responses cannot be evaluated through mobility outcomes alone. Migration of some may enable other household members to remain in their places of origin; infrastructural protection may support the capacity to stay in environmentally exposed areas; planned relocation may reduce physical exposure while constraining access to livelihoods; and return to exposed territories may restore livelihood opportunities while reintroducing environmental risk. Moving and remaining are therefore relational and context-dependent outcomes rather than indicators, in themselves, of successful or unsuccessful adaptation.

The cases further suggest that adaptive capacity is differentiated across actors, dimensions and scales. An intervention that reduces a particular form of exposure may have different consequences for livelihoods, social relations or other territories, while household-level adaptive strategies may become embedded in broader processes of territorial transformation. The analysis of the Senegalese hotspots evidences the need to pay attention to whose adaptive capacity is affected, in which ways and at what spatial and temporal scales.

In some of the cases examined here, adaptive interventions involve changes in the distribution of vulnerability. The Saint Louis case shows how the effects of an intervention designed to reduce risk in one location may extend beyond the territory initially protected, while planned relocation illustrates how reducing environmental exposure may coexist with new livelihood and infrastructural vulnerabilities. Lac Rose, on the other hand, highlights tensions between household-level adaptive strategies and changing territorial conditions rather than a transfer of vulnerability.

These findings extend the migration-as-adaptation perspective by shifting attention from the question of whether migration constitutes a successful adaptive response towards the interactions between different forms of adaptation. Migration, relocation and infrastructural interventions may coexist within a territory, encompassing different actors, scales, objectives and degrees of agency, and contributing to reshaping the conditions under which people can move, remain and sustain viable livelihoods.

Understanding climate-related mobility consequently requires examining not only environmental pressures and migration decisions, but also the wider adaptive options within which those decisions are made.

This perspective also helps identify the relevance of territorial and mobility justice. If adaptive benefits, capacities and costs differ across people and places, adaptation raises questions about who is able to influence the conditions of mobility and immobility and whose understandings of safety, livelihood and territorial viability are incorporated into adaptation decisions. The cases analysed here do not provide a comprehensive assessment of territorial justice in Senegal, but they indicate why such questions should form part of future research on climate adaptation and mobility.

The analysis has several limitations. The selected hotspots are concentrated along the Dakar-Saint Louis coastal corridor and cannot capture the full diversity of dynamics occurring in Senegal's more arid inland regions or in cross-border mobility towards neighbouring countries. The qualitative material collected in 2021 also offers a time-bound perspective on rapidly evolving processes. Future research should therefore extend this comparative approach to other Senegalese and West African contexts and examine more systematically how emerging adaptation interventions interact with historically embedded mobility patterns. Greater attention to the perspectives of people who remain, return or resist relocation could also contribute to a fuller understanding of the relationship between adaptive capacity, agency, immobility and mobility justice in contexts of slow-onset environmental change.

Declarations

Compliance with Ethical Standards

Research involving human participants: The fieldwork conducted in Senegal in May 2021 as part of the EU-funded *End Climate Change, Start Climate of Change* project involved interviews, focus groups and participant observation. The project was not subject to review by an ethics committee or institutional review board.

Informed consent: Written informed consent was obtained from all interviewees and focus group participants prior to their participation in the research. Separate written consent for the use of photographs and audiovisual recordings was obtained from all individuals who were photographed or recorded.

Conflict of Interest

The author declares that she has no conflict of interest.

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Data Availability

The qualitative material underpinning this study is not publicly available in order to protect participant confidentiality, but is available from the corresponding author on reasonable request and subject to the terms of participant consent. Policy, legal, and documentary sources are cited and publicly available.

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