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De- or Re-Colonising Climate Adaptation? Indigenous and Local Knowledge in the Climate Adaptation Machine

Cultural Heritage in Motion: Adaptive Mobile Cultures of (Semi)nomadic Indigenous People in Changing Climates

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ABSTRACT

Studies that explore the interconnection of cultural heritage, climate (im)mobilities and Indigenous ways of knowing in changing climates are rare. This article calls for reimagining and reframing this intersection in global climate governance. What existing studies have shown, and what we advocate exploring further, is that the mobile livelihoods or mobility practices of Indigenous mobile groups are more than an adaptation strategy or a fix for climate change. They embody meaning, rituals, ancestral guidance and ways of knowing nature, land, seas and the universe, connecting intangible and tangible dimensions of culture in relational ways. This paper conceptualises mobility not merely as a response to environmental changes and climatic stress but as a living heritage of Indigenous ways of knowing. To elaborate on the dynamics of the adaptive and mobile-oriented cultural expressions of Indigenous mobile groups in changing climates, we draw on four case studies of (semi) nomadic communities in Ethiopia, Senegal and Thailand to illustrate how the mobility practices of many Indigenous groups constitute mobile systems of observation, forecasting and ecological adaptation that embody centuries of empirical climate knowledge. Our case studies also illustrate how sedentary-focused sustainability projects that overlook adaptive mobile cultures can impinge on not only the mobility rights of historically mobile groups but also on their adaptive cultural practices. Hence, we demonstrate the need for integrating the peculiarities of mobile-oriented cultures in climate mitigation, adaptation and loss and damage policies to avoid maladaptive outcomes that threaten both livelihoods and cultural identity.

1 | Introduction

Conventional frameworks for addressing cultural change and loss in the context of climate risk have been critiqued for prioritising tangible, sedentary and often Western-centric forms of cultural heritage (Higgins 2022; Orr et al. 2021). Debates, proposed frameworks and actions on the protection and role of cultural

heritage in times of climate change, both in the context of the UN Framework Convention on Climate Change (UNFCCC) and UN Educational, Scientific and Cultural Organization (UNESCO), tend to lack a clear strategy for addressing the more intangible dimensions of cultural heritage, such as Indigenous knowledge, cultural practices or oral histories. They have also been critiqued for failing to recognise the deep connection between Indigenous

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cultural systems and their wider geographic and environmental context, particularly among historically mobile Indigenous groups (Higgins 2022; Telesetsky 2020).

In this article, we add to this debate by exploring what cultural heritage means for mobile-oriented cultures of Indigenous communities and by highlighting the significance of these mobile cultures for climate policy. Although the ecological stewardship of these historically mobile groups is widely acknowledged (see Chao and Enari 2021; Crowley et al. 2022; Eichler 2020; Higgins 2022), their unique mobile-oriented cultural heritage has not gained similar recognition or acknowledgement, especially in policy discourses around cultural loss and damage in changing climates. Some scholars (see Lindegaard and Sen 2022; Prout Quicke and Green 2018; Whyte et al. 2019) have explored and advocated for the mobility rights of historically mobile groups, especially for the fact that their mobilities are intricately connected to resilience or adaptation to changing environmental conditions. However, there is very little focus on the cultural dimensions of their environmental mobilities. Thus, mobile cultures remain largely overlooked when it comes to discussions at the cultural heritage-climate nexus.

Against the discourses that portray mobilities as crisis, this paper conceptualises mobility itself as heritage of knowledge and generational resilience. We argue that adaptive mobilities of historically mobile groups should be recognised as both cultural heritage and dynamic scientific assets. By framing mobility as cultural and epistemic assets rather than an adaptation deficit to an incidental process, we challenge the sedentary and technocratic orientations of mainstream climate (mobility) governance and heritage policy. In conceptualising and evidencing what cultural heritage means for historically mobile groups, we demonstrate the need for integrating the particularities and historicities of mobile-oriented cultures in climate mitigation, adaptation and loss and damage policies to avoid maladaptive outcomes that threaten both livelihoods and cultural identity. Historically mobile groups, such as pastoralists, coastal fishers and other (semi)nomadic communities, maintain cultural heritage and cultural practices that are deeply tied to their mobility. Often these mobile ways of living collide with large-scale sustainability projects put in place to attain mitigation, adaptation or other conservation policy goals, which are often sedentary in focus (cf. Adger et al. 2012; Mugambiwa and Rukema 2019; Whyte et al. 2019; Zhu et al. 2025).

To make sense of the nuanced, but also often conflicting, intersection of cultural heritage, mobilities and sustainability policy, we draw on case studies of four historically mobile Indigenous groups across land and sea: the Fulani pastoralists and Guet Ndar fishers in Senegal, the Nyangatom agro-pastoralists in Ethiopia and the Moken fishers in Thailand. We use these cases to explain how mobile-oriented and Indigenous ways of living intersect with, or could more prominently feature in, climate change discussions—especially in the discourses and policies of climate adaptation and cultural loss and damage. We propose that these mobile-oriented communities should be recognised as legitimate and valuable components of global cultural heritage and can in themselves be seen as part of climate policy frameworks in that they also play an essential role in, for example, climate adaptation. In doing so, this article seeks to contribute

to reimagining understandings and approaches to climate governance beyond dominant, more sedentary and often Western-driven approaches, by highlighting culture, heritage, adaptation and livelihoods from a mobile and largely Indigenous perspective (Chao and Enari 2021).¹

2 | (Mobile) Cultural Heritage in Changing Climates

Definitions regarding the concept of cultural heritage and what exactly it entails have evolved over time yet overall have retained a rather static character. Early conceptualisations of cultural heritage focused on monument-centric definitions based on physical structures, historical sites and artefacts that symbolised greatness or historical continuity, especially in European contexts (Blake 2008). According to Rouhi (2017, 7109), the globalisation of cultural heritage gained prominence following World War II, with the establishment of UNESCO in 1945 to enhance the efforts of protecting monumental sites of ‘universal’ value. Critiques of this Eurocentric and monumentalist heritage paradigm led to the inclusion of intangible forms of cultural heritage, such as oral traditions, rituals, skills, Indigenous practices and knowledge systems, especially from non-Western contexts (Arizpe 2015; Blake 2008). According to Arizpe (2015, 101), the 2003 UNESCO convention for the safeguarding of intangible cultural heritage emphasises the global concern for preserving living cultural expressions and practices that are tied to identity and memory. Contemporary perspectives on cultural heritage have therefore significantly changed from considering cultural heritage as merely a static monument or site to considering it to be a socio-political process of meaning-making (Anderson-Levitt 2012, 443).

However, their application has remained oriented to largely sedentarised elements of cultural heritage, be them tangible or intangible, often missing out on the more mobile forms cultural heritage can take, such as mobile livelihoods and knowledge systems. In this light, critical literature has shown how colonial histories have defined what counts heritage (Giblin et al. 2024; Nikolić and Jakovljević 2025). As Giblin and colleagues argue, the dominant Eurocentric frameworks of heritage evolved from authoritative enlightenment ideas that are passed through colonial legislations and institutions, ideas that relegate Indigenous relational ways of knowing. They added the need for a paradigm shift from postcolonial heritage regimes that have reproduced this ‘coloniality of authority’ by retaining Western templates of conservation and universal value to a ‘pluriverse of indigenous, culturally contextualised heritage understandings that challenge and decolonise the colonial universality of Western-derived heritage templates’ (Giblin et al. 2024, 1470).

Similarly, Nikolić and Jakovljević (2025, 3–4) highlight that legal definitions of heritage remain grounded in androcentric and territorial notions of property and authenticity, marginalising gendered and Indigenous heritage epistemologies. Extending this critique to the adaptive mobile cultures of Indigenous people, Whyte et al. (2019, 325–327) show that colonial containment strategies deliberately curtailed Indigenous mobility traditions—treating motion as disorder—to impose settler spatial order. Such containment undermined Indigenous

adaptive mobilities, which have historically embodied adaptation and resilience to environmental variability. Recognising these as valuable cultural-scientific assets demands decolonial approaches that sustain, rather than restrict, Indigenous mobility practices as vital for adaptation and justice in changing climates.

The need to preserve cultural heritages in the context of global warming is increasingly acknowledged in climate change debates, especially in adaptation and loss and damage discourses—with an increasing focus on non-economic loss and damage (Boyd et al. 2017; Higgins 2022; Preston 2017; Telesetsky 2020). There is a transdisciplinary consensus on the importance of cultural heritages in effective climate adaptation (Crowley et al. 2022; Fankhauser et al. 2014; IPCC 2022; Serdeczny et al. 2017), also in reducing vulnerabilities to changing climates (Carmichael et al. 2020; Higgins 2022; Riesto et al. 2021). Conventional adaptation policies that overlook crucial cultural practices influencing how communities interpret and respond to climate change could lead to maladaptive outcomes that threaten cultural heritage (Brewer and Riede 2018; Webster 2023). For example, using the case of the 2004 Cyclone Heta and resulting adaptation efforts on Niue Island—a small, self-governing island in the South Pacific—Adger et al. (2012) explain that, despite the cyclone causing extensive damage to both cultural artefacts and infrastructure, adaptation efforts were focused on rebuilding physical and economic infrastructure. Meanwhile, the failure to address the cultural loss weakened community cohesion and resilience capabilities, ultimately undermining the cultural sustainability of the Niuean people (Adger et al. 2012, 114–115).

Another common ground in the studies of cultural heritage and climate change is the increasing concern for preserving cultural heritage and/or compensating for its loss and damage, especially among vulnerable communities. In cultural loss and damage debates, tangible and intangible cultural heritages are commonly and broadly grouped into the non-economic loss and damage category (Serdeczny et al. 2017). This is because—as with other non-economic impacts like life, health, displacement, territory, knowledge, biodiversity and ecosystem services—it is difficult to quantify cultural heritage with a market price (Johansson et al. 2022). This difficulty has also led to a lack of definitive frameworks to assess or compensate for cultural loss and damage (see Boyd et al. 2017; Dorkenoo et al. 2022; Higgins 2022; Preston 2017; Telesetsky 2020; van Schie et al. 2024). Another complicating factor is the fact that cultural losses span the economic and non-economic losses dichotomy, further confounding their quantification, categorisation, and compensation (Dorkenoo et al. 2022, 6). This has led to scholars such as van Schie et al. (2024), who examine the relocation of flood-affected communities in Bangladesh, to argue that the dichotomy of economic and non-economic losses is ‘false’ and harmful because it risks oversimplifying the complexities of loss and damage around cultural heritage. According to their explanation, the loss of land in the flood-affected communities is categorised as economic but the associated loss of traditional practices, oral histories and sacred spaces remains non-economic. This highlights the complex and intertwined nature of climate loss and damage, and how difficult it is to ensure holistic compensation and recovery efforts.

At the same time, it is acknowledged that Indigenous cultural heritage plays a role in adapting to climate risk and is central to rethinking human–nature relations that govern dominant approaches to addressing and understanding climate change adaptation (Chao and Enari 2021). Mobilities play an important role in that equation. There has been a growing line of research showing how or under what circumstances mobilities, such as nomadism but also other forms of migration, have proven to be vital adaptation strategies (Farbotko et al. 2018; Sakdapolrak et al. 2023; Sakdapolrak et al. 2024).

Nomadism is thereby an evolving concept deeply shaped by historical, cultural and colonial debates which requires critical unpacking. Nomadism is broadly defined as both a way of living (Amzat and Razum 2018) which entails phases of moving and staying (following seasons or other cycles and rhythms to sustain a living) and a form of identity sometimes attributed from outside through processes of *Othering* but also from inside through self-attributions. The concept has been criticised for its frequent generalising, essentialistic application to various Indigenous societies without recognising distinctions (Noyes 2000; Bogue 2004; Katzer 2021), for its shortcomings on relating nomadism with state theory (Honeychurch 2015; Sabdenova 2019), and implicit normative dimensions that can perpetuate stereotypes and misrepresentations of nomadic peoples. Understanding these complexities is essential for a more nuanced understanding of nomadism and related mobilities in contemporary discourse. We use this term at times in this article because of its enduring analytical and discursive relevance, not only as a self-identification claimed by many mobile communities but also in the understanding of an evolving and contested category.

In the debate on the mobilities of pastoralists or other (semi-)nomadic groups, less attention has been given to the cultural dimensions of these mobilities and how they are actively intertwined with dimensions of cultural heritage and mobile Indigenous knowledge systems, such as knowledge related to cosmology, the marine environment or the wider terrestrial landscape. For example, Whyte (2019) refers to the displacement of the Quinault Indian Nation in the United States due to rising sea levels as an example of how science-policy frameworks neglect their mobile adaptation, cultural heritage and relational ontologies of Indigenous peoples. Based on a systematic literature review on climate change and cultural heritage, Orr et al. (2021) also note that climate–cultural heritage research is centred around European-built heritage and archaeological sites, indicating a sedentary bias. They observe a biased neglect of non-European and intangible cultural heritage, especially Indigenous cultural practices tied to land and water, often being mobile in nature.

The overwhelming emphasis on Western-centric technocratic and sedentary science-policy approaches creates imbalances in global adaptation governance strategies. Mugambiwa and Rukema (2019) remark that colonial legacies and Western paradigms that define Zimbabwean national climate policies overlook important Indigenous adaptation techniques. They argue that local strategies like rainwater harvesting, Indigenous weather forecasting and agricultural practices are often neglected in national climate policies. Jackson et al. (2023) explain how Western power and knowledge shape adaptation

discourse to influence who is seen as vulnerable and who governs their adaptation. Focusing on the UNFCCC, they explain that apart from global adaptation interventions being Western-centric and technocratic, there are colonial presupposed subjectivities of Global South victims of climate change and their perspectives. Making a similar observation, Amo-Agyemang (2022) notes that while Western science interprets the migration of the Frafra nomadic community in Ghana as a sign of “vulnerability” to a damaged planet, the Frafra themselves interpret it as precisely the opposite—‘an indication of their resilience and adaptive capacity’ (13). All this is to say that loss and damage governance is often shaped by Western-dominated power and knowledge dynamics that marginalise Global South perspectives.

Meanwhile, the prowess of Indigenous mobile groups in ecological stewardship and knowledge systems in changing climates has been increasingly acknowledged in both academic and non-academic debates (Chao and Enari 2021; Crowley et al. 2022; Eichler 2020; Higgins 2022; Mugambiwa and Rukema 2019; Whyte 2019). Many studies have shown that diverse local responses rooted in natural resource-based livelihoods and Indigenous-led adaptation strategies offer adaptation lessons of global relevance and applicability in different cross-cultural and environmental contexts (Schlingmann et al. 2021). In the most extreme form, policies may frame mobility strategies developed over centuries as maladaptive, enforcing further sedentarisation of historically mobile groups (Lindegaard and Sen 2022), essentially cutting them off from their cultural heritage (Whyte et al. 2019).

At the same time, however, there is comparatively little attention to potential conflicts between mitigation/adaptation projects put in place by national and international policy actors and localised understandings of human mobility as a way to adapt to a changing climate. From the broader resettlement and adaptation literature, we know how such projects can result in forced relocation or displacement (see Marino and Ribot 2012; Scudder and Tortajada 2012; van Voorst and Hellman 2015). Far less understood is how these climate change projects conflict with mobile adaptation strategies; specifically, those from Indigenous groups, where mobility represents an inherent part of their culture, and for whom, the places affected by such projects are an integral part of their cultural heritage. Similarly, Yumagulova et al. (2023) highlight that Indigenous perspectives on climate mobilities bring to the forefront issues of mobility justice and self-determination, emphasising that externally imposed relocation and adaptation projects often reproduce colonial dispossession rather than supporting resilience. Their work demonstrates that safeguarding Indigenous adaptation practices requires recognising mobility not as a deficit but as a cultural and political right tied to heritage, land and identity. This mobile-oriented cultural meaning of space and place is not only confined to hosting certain cultural artefacts but also includes relations with the landscape, nature, ancestral worlds and mobility routes that are inscribed in many places. Studies that explore the interconnection of cultural heritage, climate (im)mobilities and Indigenous ways of knowing in changing climates are rare. In the remainder of this article, we will explore this intersection further and reflect on its role in climate governance.

3 | Methods: A Decolonial Co-Production Approach

This study adopts a comparative, multi-sited ethnographic design to examine adaptive mobile cultures across land and sea. Our intention is to address the cultural-climate dimensions of mobility while challenging the sedentary bias in mainstream heritage and adaptation research (Büscher and Urry 2009; Marcus 1995). Four Indigenous communities were purposively selected for our research: Fulani pastoralists and Guet Ndar fishers in Senegal, Nyangatom agro-pastoralists in Ethiopia and Moken sea-faring peoples in Thailand. These cases represent contrasting ecological settings, from arid rangelands to coastal seascapes with varying degrees of mobility. Selection criteria include (1) long-standing cultural and socio-economic dependence on mobility, (2) exposure to climate change impacts and conservation interventions affecting mobile-oriented heritage and (3) availability of local/Indigenous collaborators. Together, the case studies allow the exploration and comparison of how pastoral, agro-pastoral and maritime mobilities navigate adaptation, mobile livelihood assets and cultural continuity in changing climates.

3.1 | Fieldwork, Data Collection and Analysis

Between January and April 2025, extensive ethnographic fieldwork was conducted in all four sites. Researchers carried out participant observation, field walks, informal dialogues and more than 20 narrative interviews per community with elders, women, youth, local leaders and government representatives. Recognising the sensitivity of climate-related loss, the team worked closely with community leaders to build trust and create safe spaces for dialogue. Group sessions were organised in both homogeneous and mixed formats to encourage open expression without social or political repercussions. These engagements explored how mobility decisions, resource management and intergenerational knowledge transmission intersect with climate change and cultural identity. Observations also documented rituals and social interactions that express mobile heritage in daily life.

In collecting data, we followed a decolonial co-production approach that treats research as a relational and ethical practice rather than just an extractive exercise. Ethics in this study are understood and applied through transparency and accountability, a continuing commitment to reciprocity and shared authority with Indigenous collaborators and research participants (Smith 1999; Chao and Enari 2021; Giblin et al. 2024). To the extent possible, research activities were co-developed with Indigenous partners and local organisations in Senegal, Ethiopia and Thailand through open dialogues that defined priorities and expectations. Engagements followed the principles of free, prior and informed consent, ensuring that participants understood the aims, risks and benefits of the study. Information was provided in local languages, and consent was obtained in writing and/or orally. Participants retained full autonomy to stop or withdraw from the research at any stage before publication. The wishes of those who want anonymity are also respected in this paper. Data analysis followed an iterative and collaborative process integrating qualitative field data, Indigenous

ecological knowledge and secondary literature. Main thematic focus in our analysis includes mobile livelihood assets, adaptive mobile-oriented cultural heritages and social organisation, climate-induced (im)mobility practices, mobility-restriction and sedentary-focused sustainability initiatives and Indigenous knowledge and adaptation pathways across the case studies.

3.2 | Background on Cases

3.2.1 | Guet Ndar Fishers in Coastal Senegal

Guet Ndar is a densely populated coastal settlement situated in the Langue de Barbarie, a narrow sand spit between the Atlantic Ocean and the Senegal River mouth in Saint-Louis, Senegal. The Guet-Ndariens, one of the largest artisanal fishing communities in West Africa, rely almost exclusively on small-scale fisheries. Their livelihood system is inherently mobile, shaped by ecological dynamics, transboundary fishing routes near the Mauritanian border and ancestral traditions (Sall et al. 2021). Fishing in Guet Ndar is not only a means of subsistence but also a cultural identity, passed down through generations and embedded in daily life (Sall 2023; Zickgraf 2022). The community's physical vulnerability—located below sea level and exposed to coastal erosion and flooding—further intensifies the precariousness of their mobility-dependent livelihoods. As we illustrate in Section 4, Guet Ndar fishers now face mounting mobility constraints due to climate-induced marine changes and marine protected areas (MPAs).

3.2.2 | Fulani Pastoralists in Northern Senegal

The Fulani, a historically mobile Indigenous group spread across the Sahel, have practised pastoral transhumance for centuries. Their seasonal movements across ecological zones are guided by ancestral knowledge of rainfall patterns, grazing conditions and social organisation (Bruijn and Dijk 2003; Ndiaye 2016). In Senegal, Fulani communities are concentrated in the Ferlo Valley, a semi-arid region unsuitable for large-scale agriculture but critical for dry season grazing. Their pastoral mobility is not merely functional, but a core part of Fulani identity intertwined with deep interaction with nature and spiritual practices. However, contemporary adaptation and conservation projects in the historical grazing areas, especially under the Great Green Wall, have encroached on traditional grazing corridors and pasturelands. These interventions risk undermining the Fulani ecological knowledge, resilience and mobile cultural systems.

3.2.3 | Nyangatom Agro-Pastoralists in South-Western Ethiopia

The Nyangatom, a semi-nomadic agro-pastoralist community, reside in Ethiopia's Lower Omo Valley, an ecologically and culturally rich region between the Omo and Kibish rivers. The Nyangatom have long practised a system of transhumance, river-bank cultivation and seasonal mobility across territories shaped by environmental rhythms, intergroup relations and social rituals. Their livelihood system and food security depend on flood-recession farming made possible by the seasonal dynamics of the

Omo River and their livestock (Carr 2017). However, adaptation projects and large-scale developments such as the completion of the Gibe III dam and commercial agricultural projects have disrupted these cycles, threatening the ecological and cultural viability of their practices. With approximately 250 settlements and seasonal camps, the Nyangatom continue to adapt but face increasing constraints from land loss, border conflicts and policy interventions that disregard their knowledge systems.

3.2.4 | Moken Sea Nomads in Thailand

The Moken, traditionally semi-nomadic sea people of the Andaman Sea, have historically lived aboard boats, moving seasonally between islands and coastal areas in Thailand and Myanmar. Known locally as 'Chao Lay' or sea people, they include culturally related groups such as the Moklen and Urak Lawoi. The Moken's mobile lifestyle followed the monsoon cycle, with temporary land shelters constructed during stormy seasons and returned to the sea once weather permits (Arunotai 2006). The Moken have lived in close intra-action (Barad 2007) with their environment, drawing on rich ecological knowledge passed down through oral traditions. However, climate-related changes such as rising sea levels, declining fish stocks and unpredictable weather patterns now intersect with restrictive conservation policies and sedentarisation efforts (Bennett et al. 2014; Nidhinarakoon et al. 2023; Thawonsode et al. 2015). These forces have not only altered traditional mobility patterns but have also eroded key elements of Moken cultural heritage and social structure.

4 | Dynamics of Mobile Cultures in Changing Climates

In the analysis that follows, we explain the socio-economic significance of mobile livelihoods (4.1), the social embeddedness of mobility practices and cultural expressions (4.2), the impacts of climate change on traditional mobility patterns and knowledge systems (4.3) and the frictions between adaptive mobile cultures and sedentary-focused sustainability projects (4.4).

4.1 | Socio-Economic Significance of Indigenous Mobile Livelihoods

Indigenous mobile livelihoods such as pastoralism, agro-pastoralism and artisanal small-scale fisheries are not only subsistence practices but culturally embedded and sophisticated socio-economic systems. Their mobility is foundational to the economic vitality, food security, and cultural heritage of many Indigenous communities. In Senegal, Fulani pastoralism plays a central role in national economic development. The livestock sector contributes an estimated 4%–8% to Senegal's GDP (Eeswaran et al. 2022), with Fulani pastoralists supporting food security through the mobile production of cattle, goats, sheep and milk, as well as the trade of hides and skins (Ohiri and Kazeem 2024). This system is sustained by seasonal transhumance, which enables efficient use of scarce resources (pasture, land and water) across semi-arid ecosystems (Adriansen 2008, 2020). A Fulani pastoralist in northern Senegal explained that

they follow the rain and pasture always so their animals can survive and that ‘without the movement, animals would not survive’ (Ferlo Valley, April 2025).

This interdependence of mobility, seasons and economy is also reflected in Ethiopia where Nyangatom agro-pastoralists navigate the arid landscape of the South Omo valley through adapted mobile livelihoods, combining livestock herding with flood-recession agriculture along the Omo River and rain-fed cultivations of sorghum, maize and lentils. Agro-pastoralism is of significant socio-economic importance in both the regional and national context. Livestock trade and its post-processing sector contributes to 16%–20% of Ethiopia’s GDP (Gebeyehu 2022). In recent years, the integration of the Nyangatom into local and national markets has significantly increased driven by the opening of a livestock market in the main town Kangaten, an increasing number of traders coming from the Ethiopian highlands and an improved infrastructural connection especially since 2018. Concomitantly, new processes such as early signs of urbanisation impact the Nyangatom on a social and cultural level as one of our interview partners vividly explained. ‘Some people no longer follow our cultural values and norms. There have been several changes in our community. One of the most harmful changes is the introduction of alcohol’ (Nyangatom elder, South Omo, February 2025). This has caused serious problems, including marital breakdowns, domestic violence and even killings. In addition, some Nyangatom are selling their livestock and other properties to buy alcohol; a behaviour that usually was only exhibited during times of extreme droughts and hunger.

Similarly, on the coast of Senegal, the artisanal fishing economy of Guet Ndar exemplifies the socio-economic embeddedness of maritime mobility. Fishing is not only the community’s main income source but also a generationally transmitted way of life deeply tied to territorial movement and cultural identity (Sall 2023; Zickgraf 2022). Artisanal fisheries contribute over 80% to Senegal’s fishery sector, playing a critical role in employment and food security (see Diedhiou and Yang 2018; N’Souvi et al. 2021). For Guet-Ndariens, mobility is at the heart of this economy, as access to the sea determines both livelihood and social rhythm. During one of our fieldwork, a community elder pointed out: ‘look around, everywhere is dull because we have not been to go on the sea for the past 12 days [because of stormy sea]...fishing is our life, without fishing our people will suffer’ (Guet Ndar, March 2025). Guet Ndar women further emphasised their dependence on the men’s mobility; fish processing, drying, smoking and selling hinge on the rhythms of marine access, so disruptions to fishers’ mobilities cascade across household economies and community resilience. The moken sea nomads also embody mobility as cultural and ecological practice. Traditionally, living aboard *kabang* boats and navigating the Andaman Sea seasonally. They sustained livelihoods through sustainable marine harvesting, using techniques rooted in communal resource sharing and environmental stewardship (Arunotai 2006). Yet industrial fishing, restrictive conservation regimes, sedentarisation policies, border controls with Myanmar and campaigns of *Thaiization* increasingly constrain their adaptive mobility. Despite limited exceptions for border crossing, interviewees noted that these policies, together with Christian missionary interventions on islands like Phayam,

endanger their sustainable marine heritage and traditional ways of life.

4.2 | Mobile-Oriented Cultural Expressions and Social Organisation

Mobility is not only an economic strategy or an adaptive mechanism among the mobile Indigenous communities. It is a lived cultural practice that shapes identity, social structure and ways of knowing the environment. Across our four case studies, mobile-oriented communities express culture through seasonal rhythms, oral traditions, artisanal knowledge and ritual life. These expressions are embedded in spatial and ecological movements, encoded in social norms and Indigenous ways of knowing that are empirically transmitted through generations. Among the Fulani pastoralists of Senegal’s Ferlo Valley, cultural identity is inseparable from movement. Cattle herding is not only an economic activity but a source of symbolic value, status and social cohesion. As encapsulated in the Fulani saying, ‘a Fulani without cattle is like a woman without jewellery’ (Adriansen 2002). Livestock are markers of personal and collective worth, and the Fulani culture thrives through mobile-oriented socio-norms: oral traditions, pastoral festivals, music, clan-based governance and folk narratives all circulate within networks of seasonal transhumance (Adebayo 1991; Ndiaye 2016; Raay 1974).

The Fulani system of *Pulaaku* (individual conduct) and *Ndimaagu* (communal ethics) reinforces values of humility, resilience, discipline and spiritual attunement with nature (Cheve et al. 2023). Their herding calendars, elaborately carved staffs, nomadic architectural huts (made from grasses and tree branches) and calabash craft all express a mobile worldview—aesthetic and handy on the move. Elders play a key role in transmitting this knowledge across generations, while the tribal leaders (*Ardos*) mediate communal grazing arrangements and inter-clan dispute resolution. In Ethiopia, the Nyangatom agro-pastoralists also express their culture through a mobile lens. Livestock, particularly cattle, are described as the main asset for savings, a reserve for contingencies, and a source of subsistence and current income. It is also integral to their social identity and even ‘heroism’ with increasing herd sizes. Similar to the Fulani, the Nyangatom also have a saying ‘A Nyangatom cannot be a man of the society without livestock ownership’ (Gebeyehu 2022, 52). The traditional equipment and social practices of the Nyangatom are expressions of their mobile culture. Their houses and settlements can be built and dismantled within a few days and moved to other locations with more favourable conditions; the Nyangatom men are all equipped with a traditional wooden head rest (*Ekicholong*)—also used as a stool—so that wherever they go they can rest and sleep. Calabashes and herding sticks are an integral part of their traditional equipment, which makes them ready to travel or move at any time.

The Nyangatom are socially structured in generational age sets, which take over different social roles. The elders called the *Elephants* remain in the main villages deliberating on when and where to move livestock; the Ibex serve as herders and warriors; Ostriches act as scouts moving even in rival territories; while the younger Antelopes and Buffaloes serve as messengers, a task increasingly replaced by mobile phones. Their calendar aligns

with two main seasons: *Akoporo* (rainy season, February–July) and *Akamu* (dry season, July–January). Living in an ecological setting shaped by shifting seasonality has shaped four sociocultural pillars: deep human–livestock relations, sorghum cultivation as cultural identity, commons-based resource management that is informed by observations of clouds, animal behaviour, astrological constellations and past experiences and a culture of sharing (cf. Tröger et al. 2011; Blau 2021).

In Guet Ndar, similar cultural rhythms of movement unfold across sea and sand. Centuries of artisanal navigation have fostered a mobile maritime culture rooted in craftsmanship such as pirogue building, decorative net-making and inherited fishing toolkits that function as living artefacts of identity (Deme et al. 2021). Social organisation, practices and planning are also mobile-oriented: meetings follow natural or prayer times rather than fixed hours. As Ka Moussa, a field assistant, explained, ‘people are always on the move, or doing different things, no one expects that everybody will converge at the same time... when you are asked to come in the morning, you come and wait patiently for others to join you before the meeting starts’. Relatedly on the mobile configuration of social practices, in a focus group discussion with some Guet Ndar youth, a fisherman explained that ‘that’s why it’s hard to form community [development or action] groups...the people you see today might be gone tomorrow’ (Guet Ndar, March 2025). Annual regattas, religious festivals and sea rituals reinforce these mobile temporalities, linking livelihood practices, spirituality and community continuity through varying sea wayfaring dynamics.

Similarly, as boat-dwelling sea nomads of the Andaman Sea, the Moken lived most of the year aboard kabang boats, moving with the tides and monsoon patterns (Arunotai 2006). As their lifestyle is intimately connected with the sea, there is a saying that Moken children can swim before they learn to walk. Their oral traditions, folktales and rituals form the bedrock of their identity. These have been preserved through intergenerational storytelling and seasonal festivals that are organised based on when people move or stay. One of the most powerful of these is Lo Bong, the Festival of Spirit Poles, which brings communities together to honour ancestral spirits before seasonal migrations (Ivanoff 2001): ‘The ceremony normally takes place during the fifth month of the year. The date is determined by the spirit medium, who observes the moon and tides since the ceremony involves boats. The purpose of the Lobong Ceremony is to pray for a good fishing season and safe sea voyages. The Lobong pole represents a family unit, symbolizing parents and children for health and well-being’ (Moken men in Surin Island, January 2025). Other tangible expressions of their culture include woven baskets, hut architecture and finely crafted fishing gear, whereas intangible heritage includes rites such as sharing food with spirits or asking tree deities for permission before cutting wood (Boutry and Ivanoff 2024; Na Pombejra 2003).

These Indigenous mobility practices and traditions are not merely responses to resource scarcity and exploration; they also represent cultural journeys that have helped in sustaining knowledge, social organisation and resilience. However, their ‘beyond-human’ intra-action and intimate relationship with the environment reflects a holistic mode of knowing that is increasingly under threat (cf. Chao and Enari 2021). Climate change

and sedentarisation pressures disrupt not only their mobility practices but also their Indigenous epistemologies, especially in the more-than-human world (Arunotai 2017; Daly et al. 2022).

4.3 | Climate Change and the Disruption of Indigenous Mobility Practices and Knowledge Systems

Across our case studies, the impacts of climate change are becoming increasingly visible in the form of altered landscapes, disrupted seasonal rhythms and strained ecological systems. For communities whose ways of life and cultural identities are intimately tied to movement over land or sea, these changes are not only environmental but also existential. They unsettle the foundations of mobility-based cultural knowledge, unsettle traditional calendars and force shifts in livelihood strategies that threaten both resilience and heritage.

In terms of the direct threats from climate change-related risks, rising sea levels and coastal erosion directly threaten settlements or initiate population displacements of the Guet Ndar on the sandbanks of Saint-Louis (see Barange et al. 2014; Zickgraf 2022). For example, the 2003 flooding in the region led to the loss of life and properties, prompting the authorities to initiate a resettlement campaign for Guet Ndar settlers that are within 20 m of a new embankment after the flooding (Fieldwork, March 2025). In a focus group discussion in Guet Ndar, some elders explained how rising sea temperature has disrupted seasonal fish breeding, movement and availability. As Oumar Seye put it: ‘fishing is no longer what it used to be, we used to know where the fish were, now the water is too hot for some species of fishes, the noble and expensive fishes are no longer available’ (Guet Ndar, March 2025). Another elder added that because of this challenge, Guet Ndar fishers now have to move farther and stay on the sea for longer periods before they can have a good catch. Fish stocks are shifting, declining in both volume and species diversity due to ocean warming, pollution and climate-induced ecosystem disruption (cf. Lam et al. 2012; Zickgraf 2022). These changes have impacted the mobility practices of Guet Ndar fishers, either preventing them from going on the sea or forcing them to move into dangerous or restricted areas of the ocean.

In the Ferlo Valley of Senegal, the Fulani pastoralists face a different but equally destabilising pattern. Once-flexible mobility routes are increasingly constrained by prolonged droughts, desertification and shifting grazing conditions. Water points dry up sooner and pastures do not regenerate quickly like in the past. One of the Fulanis that was interviewed on the move remarked that: ‘In the past, the transhumance system used to be occasional and mainly for selling milk to make money, but now because of little rainfall and less pasture, we have to move more frequently, not for money, but for the survival of their animals’ (Ferlo Valley, April 2025). In southern Ethiopia, the Nyangatom agro-pastoralists also report growing uncertainty in their ecological and cultural rhythms. Rising temperatures, shortened or absent rainy seasons and recurring droughts are deserting the rangeland, weakening livestock and undermining the crop cultivation (Ayal et al. 2018; Bogale and Erena 2022; Carr 2017). Research in 2021 from one of

our co-authors found that 92% of Nyangatom households perceived a decline in pasture quality and 80% reported a drop in herd size, mostly due to erratic rainfall and emerging diseases (Gebeyehu et al. 2021).

During our most recent fieldwork, we could hear how strong the impacts of climate change are perceived across our case studies, and their resulting impacts on cultural activities. For instance, one of the interviewed elders in Nyangatom remarked that 'In the past, we had more livestock, and we produced cheese and butter (Akimet). People were friendly to the environment, and rituals were regularly conducted. But today, livestock and people are dying more frequently' (South Omo, March 2025). The Nyangatom also described how climate change impacts their culture. 'When drought approaches, there is hunger and famine, which affects our ceremonies' (Elder, March 2025). For example, *Akunumnum*, the ceremony for the beginning of the rainy season and the return of the herders from the dry season pastures, is no longer celebrated. '*It has stopped because of hunger and food insecurity. In the past, it was celebrated every year [...]; when the land was productive, harvests were good, and livestock were healthy* (Nyangatom women, March 2025). Overall, the decreasing availability of water and rain has become an existential topic for the pastoralists in our case studies. Nyangatom women emphasized that "*the rain is now unpredictable and erratic...when we plant crops, they dry up because the rain is not consistent*" (South Omo, March 2025). In relating how the low and unpredictable rainfall has impacted their culture, most of the pastoralists interviewed in the Ferlo Valley remarked that 'pastoralism is all about rain, pastoralism is dying [due to lack of rain] so is our culture' (Ferlo Valley, April 2025).

The changing rainfall patterns or shifting seasons have further socio-cultural implications. The Nyangatom calendar, for example, is not working anymore (cf. Tröger et al. 2011) and younger generations are questioning the traditional knowledge expressed in this calendar as *Lomaruk*, the cloudy month, is not so cloudy anymore and *Lochoto*, the muddy month, is not so muddy anymore. This shows that climate-related environmental changes are not only threatening livelihoods but are severing or distorting the reliability of generational ecological knowledge. We found similar results also in Senegal where the younger fishers in Guet Ndar are also beginning to question traditional calendars, weather cues and fish breeding patterns that no longer align with observed realities. One of the youths remarked that 'these days, we rely on information from our friends on where there is fish, then we go there' (Guet Ndar, March 2025). Similarly, a Fulani elder interviewed in March 2025 in the Ferlo Valley explained that they still see the astrological signs that help them predict the weather, but the weather patterns no longer align with such astrological signs. She explained that there is a constellation of seven stars called '*thaccuki*' usually in the West but annually disappears for 40 days to reappear in the East to mark the beginning of the rainy season (her explanation of the *thaccuki* conforms with the constellation of the Pleiades). According to her, when *thaccuki* reappears in the past, rain usually will begin the next day, but these days it can take up to 2 months to see a drop of rain after its reappearance. These experiential observations of changing climates show how the mobile Indigenous people are deeply attuned to their environment. However, as weather patterns defy traditional markers,

younger generations begin to doubt the authority of Indigenous knowledge and oral traditions weaken.

Along the Andaman Sea in southern Thailand, there are clear indications of the effects of climate change, including increasing sea temperatures, rising sea levels, coastal erosion and fluctuations in seasons and weather patterns (Bennett et al. 2014; Limsakul et al. 2024). The Moken on Surin and Phayam islands describe dramatic changes in the ocean's behaviour: more frequent storms, irregular tides, vanishing fish species and stronger winds that disrupt traditional navigation and harvesting patterns. '[Sea products are] much harder to find [for] food now. The water levels don't drop as they used to. Normally, during low tide, the corals would be exposed, making it easy to collect shellfish and other marine creatures. But now, even on the first, third, or fifteenth day of the lunar cycle, the water remains high. It's unusual' (Moken on Surin Island, January 2025). Their deep environmental attunement is based on generations of oral knowledge, such as watching waves, reading the sky and sensing animal behaviour. The Moken have a rich vocabulary for winds, reflecting their deep connection to the sea and natural environment. Their traditional knowledge categorises winds based on direction, seasonal patterns, and associated weather phenomena. The changing climate also affects their cultural knowledge of seasonal forecasting. As the late adult Morgan told us, 'In the past, we could tell right away when the rainy season was about to start because the *balad* wind would blow around the fourth or fifth month. When the *takon* wind came from the north, it meant the rainy season was over. We could sail to make a living far away. These days, though, the wind hasn't come at the right times. It comes late sometimes... early sometimes, and lasts a long time, or a short time... unpredictable' (Moken on Phayam Island, March 2025).

These disruptions are not simply about ecological degradation or declining productivity. They are about the displacement of knowledge systems, the disruption of cultural rhythms and the loss of coherence between environment and culture. For example, in explaining how environmental changes have impacted the Fulani solidarity and resource-sharing norms, a Fulani interviewed while moving through the Ferlo Valley sadly remarked that 'it is not in the tradition of a Fulani man to deny another Fulani access to grazing area, that is no longer the case, everyone is protecting the little (pasture) they have within their locality' (Ferlo Valley, 2025). Climate change, in this sense, does not only produce loss and damage in material terms. It is impacting social relations and destabilising how Indigenous communities remember the past, orient to the present and anticipate the future.

4.4 | Frictions Between Adaptive Mobile Cultures and Sedentary-Focused Sustainability Projects

While Indigenous mobile communities have historically demonstrated adaptive capacity to environmental change through strategies like rotational grazing, seasonal fishing or agropastoral flexibility, their resilience is increasingly challenged not only just by climate change but also by sedentary-focused conservation, mitigation, adaptation and development policies that disrupt historical mobility practices. Across our cases,

state-led infrastructure, environmental enclosures and adaptation projects often ignore mobility as a cultural and ecological logic, producing new vulnerabilities and eroding mobile heritage. In Senegal's Ferlo Valley, Fulani pastoralists face renewed sedentarisation pressures under the Great Green Wall (GGW), an initiative intended to curb desertification by planting trees across the Sahel (Goffner et al. 2019). The GGW's implementation often disregards pastoral spatial needs: fenced tree plots now block ancestral grazing corridors and access to water points critical to transhumance. As Ndiaye (2016) notes, such interventions can cause *maladaptation* when Indigenous land-use systems are restricted without consultation, compounding existing pressures from drought and land degradation. Similar dynamics emerge in Guet Ndar, where fishers confront shrinking access zones due to marine protected areas (MPAs) and restrictive fishing boundaries, especially in the Mauritanian waters. While MPAs serve vital biodiversity goals in warming oceans, they often impose blunt spatial boundaries that do not align with Indigenous mobility practices of tracking seasonal migration of fish. Interestingly, an experienced fisher in Guet Ndar claimed that MPAs in Mauritanian waters are not the reason why they have more fish in their waters, but rather the favourable geographical features like rocky continental shelf that enhance fish breeding and availability (Fieldwork, March, 2025). For the Guet Ndar fishers, they no longer have access to their rocky continental shelf known as Diattara because of a new gas exploration platform.

The assumption in many sustainability or adaptation projects that communities are or should become sedentary and the faith in top-down solutions is also seen in Ethiopia's South Omo Valley, where a long history of top-down interventions has disrupted agro-pastoral mobility. In the late 1970s, adaptation projects introduced *Prosopis juliflora* to combat desertification. Though initially promoted for its benefits as a drought-resistant plant, the shrub became invasive, encroaching on grazing land, blocking cattle pathways and even overgrowing sacred sites such as in Kibish, once central for Nyangatom ceremonies (Halabo and Berisso 2021). 'Lopoliso (*Prosopis juliflora*) is our enemy nowadays' (Nyangatom women, in Kibish, 2021). Today, it has spread throughout the whole region. 'The trees have taken over the land, choking out the grass. The thorns are poisonous, and the land has become bushy and unusable' (Nyangatom elder, South Omo Valley, March 2025). The expansion of national parks, including Omo and Mago National Parks, has also reduced grazing access, ignited land disputes and further marginalised the pastoral logic of seasonal movement. The construction of the Gibe III dam marked a turning point. As explained by the Nyangatom elephants (elders), the dam dramatically altered the hydrology of the Omo River, disrupted flood-recession agriculture and was followed by large-scale agricultural plantations that enclosed communal range lands.

In southern Thailand, the Moken sea nomads face similar marginalisation under state-led conservation efforts. Government efforts to protect marine ecosystems have included the creation of marine national parks across the Andaman Sea; these areas overlap with traditional Moken routes and resource zones (Suzuki 2015). While such parks are intended to preserve biodiversity, they often criminalise customary fishing and mobility patterns of Indigenous communities. On this, a Moken man

remarked that 'Our lives have gotten harder. Some sea creatures we used to catch for food or sale are now protected, and we can no longer collect them in the areas where we used to' (Surin Island, November 2024). Alongside this, state sedentarisation policies—framed as development and welfare—have resettled Moken populations in fixed villages, discouraging their sea-based livelihood systems.

These examples of sedentary-focused sustainability or development initiatives reveal a recurrent pattern: adaptation, development, and conservation initiatives, while often well-intentioned, tend to be shaped by sedentary assumptions that ignore the logics of mobility. Whether in the forests of Ferlo, the land and rivers in South Ethiopia, or the waters of the Andaman Sea, sustainability projects that fail to consult or include Indigenous mobile communities often result in exclusion, dispossession, and cultural dislocation. Beyond the Indigenous mobile groups constantly finding ways to adapt to these top-down mobility-restriction projects, we found little evidence of active political engagement or grassroots mobilisation across our case studies to elaborate on how they contest these restrictions with the authorities. What we observed is that, rather than organised activism, the politics of their adaptive mobility emerge through daily acts of negotiation, such as deciding when and where to move, whom to include in collective grazing arrangements, negotiations with destination/hosting communities and how to navigate state-imposed conservation boundaries. These micro-politics of mobility represent grounded forms of environmental citizenship and change management that warrant recognition within local and broader climate-governance debates. Meanwhile, as our case studies further illustrate below, mobility is not a barrier to sustainability; their adaptive mobility is a form of it.

5 | Discussion

This study has examined the variegated relationships between cultural heritage, climate (im)mobilities and Indigenous ways of knowing in changing climates. Drawing on our four case studies, we have demonstrated that the mobilities of Indigenous mobile groups are not merely a livelihood strategy but an essential component of cultural identity, resilience and ecological stewardship. To narrow down our arguments and illustrations from our case studies, we identify four critical insights for transdisciplinary reflection, with emphasis on the need to integrate mobile-oriented cultural heritage into climate governance frameworks.

Our first and fundamental insight is the need to **recognise mobile-oriented cultural heritage in climate governance**. A central argument in this paper is that the cultural heritage of historically mobile groups is no less significant than the conventionally recognised sedentary cultural heritage. However, policy discourses around cultural loss and damage, including within the UNFCCC and UNESCO, prioritise tangible, place-based heritage over mobile and dynamic cultural expressions (Higgins 2022; Orr et al. 2021). Our case studies illustrate how Indigenous mobile groups have maintained elaborate nature-focused and adaptive mobile cultural systems. For instance, the Fulani pastoralists' *Pulaaku* and *Ndimaagu* socio-cultural codes emphasise endurance, self-discipline and ecological

stewardship that are deeply tied to their transhumant lifestyles (Adriansen 2008; Cheve et al. 2023). Similarly, the Guet Ndar fishers' maritime traditions and Indigenous ecological knowledge, such as their ability to predict fish movements through lunar and marine indicators, exemplify how their cultural heritage is both intangible and adaptive (Sall et al. 2021). Yet, these dynamic mobile-oriented cultural expressions remain overlooked in climate governance frameworks, limiting opportunities for protecting or compensating for their loss. Recognising mobile-oriented cultural heritage requires a paradigm shift in climate governance where Indigenous mobility practices are not framed merely as survival strategies but as valuable cultural and ecological assets that are worth safeguarding.

The second critical insight from this study is the **interwoven nature of economic and non-economic loss and damage** in the adaptive mobile culture heritage of our case studies. The loss and damage associated with climate change is typically categorised into economic (loss of income, land or infrastructure) and non-economic (cultural loss, loss of identity and spiritual degradation) domains (Serdeczny et al. 2017). However, this binary division is unsuitable and inadequate to capture the full extent of losses experienced by the Indigenous mobile groups in our case studies. For example, the economic losses of the Guet Ndar fishers, due to industrial overfishing and restrictive conservation policies that limit access to traditional fishing zones, also have their non-economic dimension. Their losses are also deeply cultural, as they erode generational fishing knowledge, rituals and identity (see Walker and Giacomelli 2024). Similarly, the Fulani's loss of transhumant routes due to conservation projects like the Great Green Wall initiative is not just an economic issue; it also threatens their socio-ecological system, disorganising their traditional governance structures, seasonal grazing knowledge and social cohesion (cf. Ohiri and Kazeem 2024). For the Nyangatom losing cattle and rangeland is not only an economic loss but also a loss of status and identity.

In line with van Schie et al. (2024) on their explanation of the harmful categorisation of economic and non-economic losses and damage in changing climates, we argue that the economic versus non-economic loss and damage framework should be reconsidered to acknowledge the intertwined nature of cultural and livelihood losses. Sedentary-focused sustainability initiatives that restrict movement—whether through national park expansions and rangeland enclosures (in the Nyangatom case) or marine conservation efforts (the Moken and Guet Ndar fishers)—directly undermine the adaptive capacities of the historically mobile communities. We support the argument that enhancing their mobility practices as a critical coping and adaptive strategy has become more imperative considering the increasing climate variabilities that have exacerbated risks among the mobile groups (see Adriansen 2008). That is, increasing climate variability may mean more mobility, not less.

The third insight from this study concerns the **structural inequalities and the political economy of (im)mobilities beyond climate change risks**. As we highlighted in some of our case studies, there are broader structural and political-economic factors that shape the mobility practices of mobile groups. In many cases, the governance of (climate) mobility is often embedded within local and global policies (such as land use and rights,

fishing rights and pastoral regulations or agricultural extraction activities) that enhance inequalities and marginalisation of Indigenous groups (Mugambiwa and Rukema 2019; Whyte 2019). As explained in the case of the Guet Ndar fishers, restrictive migration policies in Europe and exploitative fishing agreements with industrial trawlers from the Global North have exacerbated mobility injustices, pushing many young fishers to embark on dangerous migration journeys across the Atlantic (Walker and Giacomelli 2024). With dwindling economic opportunities from artisanal fishing, many young fishers resort to irregular migration, using the same pirogues traditionally employed for fishing to move irregular migrants to Europe, especially through the Canary Islands. Similarly, the Fulani's transhumant routes are increasingly constrained by state-imposed grazing restrictions and securitised narratives that depict them as threats to national stability (Houessou et al. 2019; Olamide Sowale 2024). These examples illustrate how climate (im)mobility is embedded within broader political and economic structures that perpetuate mobility injustices.

The last insight akin to a call for action is the need for **integrating the Indigenous knowledge component of adaptive mobile cultures into climate governance frameworks**. The Indigenous knowledge systems embedded within mobile cultures offer invaluable insights for climate adaptation. Across all four case studies, generational ways of knowing or Indigenous knowledge systems emerge as vital yet undervalued sources of climate resilience. These systems are not abstract repositories of information but embodied, practiced and transmitted through intergenerational learning, ecological observation and lived experience (O'Donoghue et al. 2019). Rooted in movement and the intimate rhythms of land, sea and seasonal cycles, they provide empirically tested models of adaptive living for the Indigenous mobile groups. However, as shown across our cases, these dynamic knowledge systems face mounting threats: threats not only from climate change itself but also from top-down adaptation frameworks that disregard mobility as a mode of knowing.

The Moken see nomads, for instance, have long relied on their extensive knowledge of tides, currents and marine biodiversity to navigate environmental uncertainties (Na Pombajra 2003). Their adaptive strategies of constructing floating houses that can withstand rising sea levels demonstrate how Indigenous knowledge can inform sustainable adaptation strategies in often marginalised groups. However, as remarked by Arunotai (2017), conservation policies in Thailand have largely ignored such indigeneity, prioritising national park expansions over Indigenous resource management practices. The Nyangatom agro-pastoralists' knowledge of flood-recession agriculture and seasonal mobility routes has historically allowed them to adapt to climatic shifts and to use the ecosystem in a very efficient but sustainable way (Carr 2017). The construction of the Gibe III dam, however, has disrupted their adaptive cycles, replacing Indigenous ecological governance with top-down, technocratic development models.

In Guet Ndar, fishers' ethno-scientific knowledge blends empirical marine ecology with lunar cycles, seasonal winds and spiritual insights (Deme et al. 2021). Our respondents described reading the moon to anticipate tides, observing wave patterns for weather shifts and interpreting water colour to locate pelagic fish. Among the Fulani pastoralists of Senegal, Indigenous

knowledge systems guide transhumance across vast arid landscapes. Herders interpret ecological cues—animal behaviour, plant phenology, cloud patterns and traditional calendars—to decide when and where to move (cf. Adriansen 2008, 2020). As one elder explained, ‘Our animals can tell us when it is time to move... if you listen, they will lead you to water before you see it’ (Ferlo Valley, April 2025). Fulani resilience also derives from diversified herds, water management skills and ethical codes such as *Pulaaku* and *Ndimaagu*, which emphasise restraint and collective responsibility (Napogbong et al. 2020; Ndiaye 2016). Increasingly, pastoralists integrate agro-pastoral and market-oriented practices, such as rotational sheep fattening and *louma* (mobile market) trading, reflecting flexibility without loss of cultural identity (Houessou et al. 2019).

Together, these examples show that mobile Indigenous cultures represent dynamic repositories of environmental science and adaptive capacity. Yet, the erosion of environmental knowledge and predictability coupled with sedentarised governance initiatives threatens to fragment intergenerational knowledge transmission. As younger generations lose confidence in traditional cues and rituals, Indigenous ecological wisdom, and the mobility that sustains it, risks fading. Rethinking climate governance through a decolonial lens thus requires recognising and safeguarding these adaptive mobile knowledge systems as living cultural heritage. A critical question, however, remains how can Indigenous knowledge systems be integrated into climate governance in their originality or without losing their values? In line with Chao and Enari (2021), we argue for a participatory and decolonial approach to climate governance that respects and involves Indigenous epistemologies of historically mobile groups. This involves incorporating Indigenous knowledge and the peculiarities of mobile cultural practices into policy discussions and also ensuring that Indigenous communities have decision-making power in adaptation, mitigation and loss and damage initiatives.

6 | Conclusion

We have demonstrated in this study that the mobility practices of historically mobile groups are not just a response to climate change or variability but are integral components of their cultural heritage, resilience and ecological stewardship. Fifteen years after the Cancun Agreements recognised human mobility in climate change governance, this study explores the intersection of cultural heritage, Indigenous mobility practices and sedentary-focused adaptation policies in changing climates. We argue that existing frameworks remain inadequate in addressing the nuanced cultural dimensions of climate mobilities of Indigenous mobile groups. Drawing on case studies from Senegal, Thailand and Ethiopia, we highlighted the tensions between Indigenous mobility practices and dominant governance approaches and frameworks, which tend to prioritise sedentary, place-based approaches to climate adaptation and cultural heritage preservation. The prioritisation of sedentary resilience strategies risks resulting in maladaptive outcomes that undermine the adaptive capacities and mobile cultures of the Indigenous mobile groups.

We also identify four key insights from this following study: (1) the need to recognise and include mobile-oriented cultural

heritage in climate governance frameworks, (2) the unsuitability of the economic versus non-economic loss and damage dichotomy in aptly capturing the realities of mobile-oriented cultural losses, (3) the role of underlying structural inequalities and governance dynamics in shaping mobility (in)justice beyond climate change and (4) the importance of integrating Indigenous knowledge of mobile groups recognising mobile-oriented cultural into climate governance in a way that values their Indigenous agency. Recognising the mobility of the historically mobile groups as a cultural and ecological asset, rather than a problem to be fixed, can pave the way for more just and effective adaptation strategies. Ultimately, we advocate for a decolonial approach to rethinking climate mobility governance through the lens of adaptive mobile cultures, as this offers an inclusive path towards equitable and sustainable climate governance.

Throughout the case studies, we illustrated that mobility practices of mobile people are not the problem, but rather they are under-recognised adaptive solutions. The mobile communities are not just vulnerable to climate variability in their mobility practices; they are also ecological key knowledge holders and resilience-builders. Their mobility practices, though increasingly precarious, represent centuries of lived adaptation to complex and changing ecosystems. However, we caution against over-attributing all mobility shifts to climate change alone. In many cases, it is the indirect impacts of climate change, including conservation or adaptation projects designed with sedentary assumptions, which significantly undermine mobile systems. Hence, with our paper, we support the call to rethink climate governance in ways that move beyond technocratic adaptation to embracing decolonial, mobility-sensitive and culturally grounded approaches that are context-specific, adaptive and inclusive, avoiding unnecessary disruptions to adaptive mobile cultures. Ultimately, aligning with the mobility-justice perspective advanced by Yumagulova et al. (2023) and the calls for decolonial epistemological pluralism (Chao and Enari 2021; Giblin et al. 2024), this study demonstrates that understanding, recognising and safeguarding adaptive mobile cultures in climate (mobility) governance entails more than reforming existing institutions; it also requires redistributing epistemic authority towards those whose worlds are mobile-oriented. Reframing mobility as a cultural-scientific asset not only diversifies epistemologies of (im)mobilities and climate adaptation but also affirms the reparative and decolonial potentials of heritage governance that values motion and relational knowledge in mobilities.

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Data Availability Statement

The authors have nothing to report.

Endnotes

¹ We coined the term *adaptive mobile cultures* to describe heritage systems grounded in historically mobile ways of life. Terms such as ‘cultural heritage in motion’, ‘(semi-)nomadic’ and ‘mobile indigenous groups’—generally acceptable to the indigenous groups and scholars we have worked with in this study—are used in this paper not for essential categorisation but as descriptive and analytical terms for foregrounding the relational and fluid understanding of diverse modes of mobility and its cultural dimensions.

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