Salt, sea and flood

Assessing and responding to the uncounted costs of climate change loss and damage in Senegal

Ritu Bharadwaj, N Karthikeyan, Emmanuel Seck, Omar Cisse, Krishnamurthi Pichandi, Anna Ducros, Boubacar Fall, Angélique Bakhoum, Mohan Reddy and Swati Chaliha



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About the authors

Ritu Bharadwaj, director, climate resilience, finance and loss and damage, International Institute for Environment and Development (IIED).

N Karthikeyan, development economist.

Emmanuel Seck, executive director, Enda Energie; chair, Global Network on Disaster Risk Reduction (GNDRR); and United Nations Framework Convention on Climate Change Action (UNFCCC) Slow Onset Event Expert Member (SOE).

Omar Cisse, programme officer, adaptation and climate-risk management expert, Enda Energie.

Krishnamurthi Pichandi, development communication professional (climate change, biodiversity, water, agriculture, community media and education).

Anna Ducros, researcher, nature and climate finance, IIED.

Boubacar Fall, lecturer and researcher, Faculty of Science, Cheikh Anta Diop University, Dakar; expert in climate change adaptation; vice-president of National Committee on Climate Change (COMNACC), Senegal.

Angélique Bakhoum, research assistant in climate change and health, Enda Energie.

Mohan Reddy, climate policy expert (nature-based carbon markets, Nationally Determined Contributions, and climate mitigation and adaptation strategies).

Swati Chaliha, natural resource management professional, bridging policy and practice.

Corresponding author: Ritu Bharadwaj, ritu.bharadwaj@iied.org

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International Institute for Environment and Development
44 Southampton Buildings, London WC2A 1AP, UK
Tel: +44 (0)20 3463 7399
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Cover photo: Fishing boats in Kafountine, Senegal, where fishing grounds are being lost to salination and sea erosion. Credit: JordiRamisa/iStockphoto.

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Abbreviations

AFD	Agence Française de Développement (French Development Agency)
ANACIM	Agence Nationale de l'Aviation Civile et de la Météorologie (National Agency of Civil Aviation and Meteorology)
ASPIRE	Anticipatory Social Protection Index for Resilience
CEAS	Centre Écologique Albert Schweitzer (Albert Schweitzer Ecological Centre)
C-CIQ	Comprehensive Climate Impact Quantification
CMU	Couverture Maladie Universelle (Universal Health Coverage) programme
CNAAS	Compagnie Nationale d'Assurance Agricole du Sénégal (National Agricultural Insurance Company of Senegal)
CRI	Climate Risk Index
DGPSN	Délégation Générale à la Protection Sociale et à la Solidarité Nationale (General Delegation for Social Protection and National Solidarity)
DPC	Direction de la Protection Civile (Civil Protection Directorate)
ECOWAS	Economic Community of West African States
EM-DAT	Emergency Events Database
FGDs	Focus group discussions
FRLD	Fund for Responding to Loss and Damage
GDP	Gross domestic product
IPCC	Intergovernmental Panel on Climate Change
LDC	Least Developed Country
METE	Ministère de l'Environnement et de la Transition Écologique (Ministry of the Environment and Ecological Transition)
NGO	Nongovernmental organisation
NTFPs	Non-timber forest products
ORSEC	Organisation des Secours (Emergency Organisation Plan)
PNBSF	Programme National de Bourses de Sécurité Familiale (National Family Security Grant Programme)
RNU	Registre National Unique (Single National Register)
SHVI	Structural Household Vulnerability Index
SPI	Social Protection Index
XOF	West African CFA franc

Summary

Floods in Saint-Louis and salinity in Kafountine are already costing coastal households in Senegal a large share of their annual income, and most of this loss is not recorded anywhere. In Saint-Louis, water enters houses every rainy season. Work stops, children miss school and people fall ill. In Kafountine, salt has been damaging rice fields, wells, pasture and mangroves for decades, and some of that land cannot be restored. In both places, the households that lose most are the poorest. Their losses are in food, health, schooling and debt, which are not the losses that assessments usually capture. Some of this loss can still be prevented, some can be reduced if support reaches households before the hazard rather than after, and some is now permanent and needs a different kind of response. Senegal has the systems, programmes and payment systems to do all three, at a much lower cost than households now bear.

Senegal is a Least Developed Country (LDC). Its people and its economy are concentrated on a coast that is retreating by one to two metres a year. It faces rapid-onset hazards, such as floods and storm surges, and slow-onset hazards, such as salinisation, erosion and loss of biodiversity. The country has a national social registry, a cash transfer programme, universal health coverage and a disaster response plan. But these were designed for chronic poverty and for relief after an event. They were not designed to act before a flood or to respond to losses that build up over years. Senegal has submitted a request to the Fund for Responding to Loss and Damage (FRLD).[1] To support that request, and to design a response, the country needs to know what its communities are losing, who is bearing the loss and what would reduce it.

This report provides that evidence. Working with Enda Energie and the Senegal Ministère de l'Environnement et de la Transition Écologique (METE — Ministry of the Environment and Ecological Transition), with funding from the Agence Française de Développement (AFD — French Development Agency), we carried out participatory assessments, a survey of 424 households and six focus group discussions (FGDs) in two priority sites: the Pikine quarter of Saint-Louis, which faces rapid-onset impacts, and the villages of Abéné and Niomoune in Kafountine, Lower Casamance, which face-slow-onset impacts. We used the Comprehensive Climate Impact Quantification (C-CIQ) toolkit[2] to assess economic and non-economic losses and damages together, and the 3P framework (predisposing, precipitating and protective factors) to understand why some households lose more than others.

Vulnerability before the hazard

The two sites start from different positions. The mean Structural Household Vulnerability Index (SHVI) is 63.4 in Saint-Louis and 46.9 in Kafountine. In Saint-Louis, 37.8% of households are in the most vulnerable group, compared with 2.8% in Kafountine. Households in Saint-Louis are large, with 11.1 members on average; 42.6% are headed by women, 99.5% own no land and most earn their living in the informal economy on land that floods every year. Households in Kafountine own land, boats and livestock, but they live in mud houses without land title or with basic sanitation, and they depend on rice fields and fishing grounds that are being lost to salination and sea erosion.

When vulnerability and exposure are combined, 52.6% of households in Saint-Louis are both structurally poor and highly exposed to loss. In Kafountine the largest group, 67%, is exposed but still has assets and income to absorb the loss for now. But as salinisation damages those assets, more households will move into the most vulnerable group each year.

1 The FRLD operates under the UNFCCC to address the growing needs of vulnerable communities in developing countries facing the irreversible impacts of climate change. See www.frld.org
2 For more information about C-CIQ see Bharadwaj et al. (2024).

The two sites lose different things

In Saint-Louis, the loss is sudden and affects the home. In the last flood, 61.7% of households had their house damaged, 49.3% had a member fall ill, 61.2% went short of food and 27.9% of households with children saw the school year start late. Three in ten households had been displaced by floods in recent years, and 62.7% of respondents reported persistent sadness. In Kafountine the loss is slow and affects the land. Crop loss was reported by 73% of households, loss of income from soil degradation by 55.2% and loss of income from wider environmental degradation by 41.4%. Half of households said drinking water was not available. The median household had been losing income to soil degradation for ten years. Five islands near Niomoune that were once farmed have been abandoned because of salinity; Kouba estimates it has lost 30% of its farmland and Niomoune 45%. This land cannot be restored.

Fishing links the two sites. Every focus group reported that catches have fallen. Climate is behind three of the four reasons they gave. The sea off Northwest Africa has warmed by 0.3–0.5°C per decade, and round sardinella, the main fish species landed by the pirogue fishing-boat fleets, has moved north by about 181km per decade since 1995, into Mauritanian waters.

The poorest households lose most in food, health, schooling and debt

The households that lose the most in assets are not the most vulnerable. Among the least vulnerable households, 67.1% lost crops and 50.6% had abandoned land. Among the most vulnerable, almost none did, because they have no land to lose. For losses to people, the pattern is reversed. Among the most vulnerable, 52.9% went short of food, 51.8% had someone fall ill during the floods and 30.6% had a child start school late. Among the least vulnerable, the figures were 16.5% for going short of food and 0% for the latter two.

Regression analysis across all 424 households confirms this. A ten-point rise in the vulnerability index roughly doubles the odds that a household loses health, that a child loses schooling and that a member falls ill during floods. It raises the odds of food insecurity by about 70% and of debt by about 30%.

Displacement moves the loss rather than ending it

Three in ten households in Pikine have been displaced by floods in recent years. The survey also covered 48 households relocated from the coast to Khar Yalla, a site set up in late 2016 for families whose homes were destroyed by the sea. For these households, food scarcity rose from 45.3% to 69.8%, illness during floods rose from 15.1% to 49.1% and the mental distress score rose from 42.6 to 50.1. The site they relocated to also floods in the rainy season, has no school and is around 10km from the fishing grounds. Moving people out of a hazard zone without livelihoods, services or tenure moved their losses to a new place. At the same time, many households that would like to move cannot. A third of households in Saint-Louis and 18% in Kafountine said they would prefer to migrate but have no means to do so.

What the losses cost

The economic losses reported in the survey come to over 1.62 million West African CFA francs (XOF) per household in Saint-Louis and just over 478,000 XOF in Kafountine. This is equal to 214% and 48% of annual household income. In Saint-Louis, damage to housing alone is one and a half times annual income, and most of it has to be paid in the weeks after each flood. In Kafountine, the three losses linked to the land make up more than half of the total, and the part that recurs every year — income lost due to soil, environmental and biodiversity degradation — comes to about 16% of annual income, whether or not there is a flood. These figures do not include the non-economic losses to health, schooling, mental wellbeing, culture and belonging, which we measured but did not assign a value to in money terms.

Support comes after the loss

Access to social protection is very low. The mean Social Protection Index is 11.7 in Saint-Louis and 5.8 in Kafountine. The average household in Saint-Louis had access to about one of eight types of support, and the average household in Kafountine to fewer than one in two. Food assistance reached 37.3% of households in Saint-Louis and 11.6% in Kafountine. The support that exists comes after the flood, in the form of pumps, food and emergency cash. Households without national identity documents, tenants within shared concessions and families relocated to sites such as Khar Yalla are not covered at all.

Moving from evidence to action

Senegal does not need new institutions. It needs to link the ones it has to climate risk and respond with different strategies to address different types of losses and damages currently being experienced by the community.

- **Some losses can still be prevented or reduced.** In Saint-Louis this means drainage, dykes and land-use planning, with pumps, sandbags and cash positioned before the rains rather than requested after. In Kafountine, it means engineered dykes, salt-tolerant rice, water storage and livelihoods that do not depend on land. Early warning and a national loss and damage register should be built into local decision making.
- **Some losses happen every year and need support to arrive before they do.** The support through existing social protection programmes such as the Programme National de Bourses de Sécurité Familiale (PNBSF — National Family Security Grant Programme), the Couverture Maladie Universelle programme (CMU — Universal Health Coverage) and the Yokk Koom Koom economic inclusion programme should be provided before the crisis hits communities based on pre-agreed triggers. The national social registry should record climate exposure, finance should be arranged in advance and targeting should cover every household, including tenants, people without identity documents and displaced families. The economic case for acting early is strong. Covering the losses from a severe but plausible event through existing social assistance after the event would cost Senegal around US$848 million. Anticipatory support would cost around US$95 million and early investment in resilience around US$38 million.
- **Some losses are permanent.** Land and settlements that cannot be recovered need to be recognised as lost, with support for households to move into new livelihoods. Where relocation is planned, as for the Langue de Barbarie peninsular, it has to come with secure tenure, services and access to work.

Across all three types of responses, non-economic losses need to be recognised and addressed.

As an LDC, Senegal has priority access to the FRLD and direct access to the Green Climate Fund, and this report provides the household-level evidence that these funding requests require.

The evidence in this report also carries lessons for how loss and damage finance should be designed. Slow-onset losses need to be counted even though no single event triggers an assessment. Non-economic losses need to be assessed alongside economic ones, because they are where the poorest households lose most. And assessments based on the value of damaged assets will underestimate the needs of households that had little to lose but have the least ability to recover. The method used in this study addresses all these aspects, and provides an approach on how this could be done for other countries.

1 Introduction

1.1 Loss and damage is growing — and much is still not counted

Climate change is now causing harm that communities and countries can no longer avoid through adaptation. These are losses and damages. Loss and damage come from two kinds of hazard. Rapid-onset events such as floods, storm surges and cyclones strike suddenly and destroy homes, roads and crops within hours or days. Slow-onset processes such as sea-level rise, salinisation of land and water, coastal erosion, land degradation and loss of biodiversity develop over years and decades (UNFCCC, 2012). Both kinds of hazard cause economic losses that can be counted in money terms, such as damaged houses, lost harvests and lost fish catch. Both also cause non-economic losses that are harder to count but often matter more to the people affected, such as through displacement from ancestral land, loss of sacred sites, erosion of traditional knowledge, ill health and mental distress, and the breakdown of the social ties that people rely on in a crisis (UNFCCC, 2013).

The international response has started to take shape. The FRLD was agreed at the 2022 United Nations Climate Change Conference (COP27) in Sharm El-Sheikh and made operational at the 2023 UN Climate Change Conference (COP28) in Dubai. By July 2026, pledges to the FRLD had passed US$820 million. In its first call for funding requests, 119 developing countries submitted 176 requests worth around US$2.8 billion against an initial allocation of US$342 million, and the FRLD deferred its first approvals to December 2026 (FRLD, 2026). Estimates of what developing countries actually need run to hundreds of billions of dollars a year (Loss and Damage Collaboration, cited in Civillini, 2025). The gap between what is on offer and what is needed is very large, and it will not close unless countries make a strong case by clearly showing what they are losing, who is bearing the loss and what a response should look like.

This is where the evidence base is weakest. Most national assessments count damage to infrastructure and production after a disaster. They rarely capture the losses that build up slowly, the losses that fall on particular groups within a community, or the losses that have no market price. Slow-onset impacts are especially poorly recorded because there is no single event to trigger an assessment (Pörtner et al., 2022). As a result, country needs are understated, policy responses are designed around visible damage rather than lived experience, and the households most affected remain invisible in the systems meant to protect them. Our earlier work using the C-CIQ toolkit in Bangladesh, India and Mali showed that when economic and non-economic losses are assessed together at the household level, total losses can reach or exceed a household's annual income, and that the largest losses often sit in categories that conventional assessments do not measure at all (Bharadwaj et al., 2024a, 2024b, 2025, 2026).

1.2 Senegal is on the frontline of both rapid- and slow-onset hazard

Senegal is an LDC of 18.1 million people (ANSD, 2024), ranked 169 of 193 countries on the Human Development Index (UNDP, 2025). Its economy and its people are concentrated on a coast of a little over 700km. Around 60% of the population, 68% of gross domestic product (GDP) and 90% of industry are in the coastal zone (Cissé et al., 2024). The World Bank's Country Climate and Development Report for Senegal finds that over half of the population and two thirds

of GDP are in areas highly exposed to climate risk, and that without adaptation, climate impacts could reduce GDP by 9.4% by 2050 (World Bank, 2024).

The coast is retreating. Shoreline retreat of one to two metres a year is common along the Senegalese coast, and 31% of coastal departments fall in the high or very high vulnerability classes, mostly along a narrow coastal strip and in the low-lying river valleys and estuaries (Cissé et al., 2024). Behind the coast, salt is moving inland. In the estuaries of the Casamance and the Saloum, reduced river flow since the droughts of the 1970s has allowed seawater to push far upstream, turning rice land into salt flats and making wells brackish (Diatta et al., 2021). At the same time, flooding has become an annual event in low-lying towns. In October 2024, the Senegal River rose without rain and affected more than 55,600 people in 51 villages and 44 other sites in Saint-Louis, Matam, Bakel and Tambacounda regions, damaging more than 1,000 hectares of crops (OCHA, 2024).

These hazards fall on livelihoods that depend directly on land and sea. Fisheries provide an estimated 600,000 jobs and over 3% of GDP, artisanal fishing accounts for around 80% of the 500,000 tonnes landed each year, and fish is the main source of animal protein for most Senegalese households (IISD, 2025). The fishery was under pressure before climate change added to it. Senegal's own scientific assessment finds the main small pelagic stocks (sardinella, horse mackerel and bonga) overexploited, and in 2023 the national advisory committee rejected ten new industrial licence applications on those grounds (Gorez, 2023). The fisheries agreement with the European Union expired in November 2024 and was not renewed (EEAS, 2024). Rain-fed rice, market gardening and livestock support most rural households outside the cities. In the two study sites, the same households are affected by erosion, salinisation and flooding, and lose income, food and health at the same time.

Senegal has systems that could protect these households, but they were not built for climate shocks. The country has: a national social protection strategy, a Registre National Unique (RNU — Single National Register) of more than 540,000 poor households that is being expanded towards one million; a flagship cash-transfer programme, the Programme National de Bourses de Sécurité Familiale (PNBSF — National Family Security Grant Programme); a universal health coverage programme Couverture Maladie Universelle (CMU — Universal Health Coverage); and a school feeding programme (World Bank, 2026). Our readiness assessment of these systems using IIED's Anticipatory Social Protection Index for Resilience (ASPIRE) found strong policy foundations but weak delivery for climate risk: no early warning triggers built into social protection, no contingency financing set aside for anticipatory response, no portability of benefits for people who move, and total spending on social assistance of only 0.86% of GDP (Bharadwaj et al., 2023). Since 2024, the PNBSF has also been suspended while the RNU is audited and restructured, with payments announced to resume in early 2026 (Ndiaye, 2026). In other words, the safety net was largely absent during the period covered by this study.

Senegal therefore needs two things: a clear account of what climate change is already costing its coastal communities, in economic and non-economic terms, and a practical view of how existing policies, programmes and finance can be reshaped to respond. This report aims to provide both.

1.3 Why Saint-Louis and Kafountine?

The Senegalese Ministère de l'Environnement et de la Transition Écologique (METE — Ministry of the Environment and Ecological Transition) identified three priority areas for loss and damage assessment on the basis of their exposure to sea-level rise, coastal erosion, salinisation and flooding: the Casamance coast (Kafountine), the Saloum Delta (Palmarin, Joal and Dionewar) and northern Senegal (Saint-Louis). This prioritisation came out of the feasibility study on integrated coastal zone management funded by the AdaptAction programme of the Agence Française de Développement (AFD — French Development Agency). With support from AFD, the present study covers two of these priority areas, Saint-Louis and Kafountine. The Saloum Delta is being assessed in parallel with support from the International Development Research Centre (IDRC) and will be reported separately.

The two sites were chosen because they represent the two main types of climate impact in Senegal. Saint-Louis is a case of rapid-onset impacts (see Figure 1 and also Table 1 for a description of the main hazards at each site). Kafountine is a case of slow-onset impacts (see Box 1). In practice the two overlap, as Saint-Louis also faces long-term erosion and Kafountine also floods, and we treat them together in the analysis. But the distinction becomes important for the response. Rapid-onset events call for early warning, anticipatory action and fast relief. Slow-onset processes call for planned adaptation, livelihood transition and — at the limits of adaptation — relocation. A country preparing to access the FRLD needs evidence on both.

Box 1. Rapid-onset and slow-onset loss and damage

Rapid-onset events are hazards that develop over hours or days: floods, storm surges, cyclones, heatwaves. Their damage is visible and usually recorded. Slow-onset events are processes that develop over years or decades. The United Nations Framework Convention on Climate Change (UNFCCC) lists slow-onset events as sea-level rise, increasing temperatures, ocean acidification, glacial retreat, salinisation, land and forest degradation, loss of biodiversity and desertification (UNFCCC, 2012). Their impacts accumulate gradually, are rarely recorded as disasters and are easily attributed to other causes.

Rapid-onset and slow-onset events interact. In Saint-Louis, erosion and sea-level rise make every storm surge more destructive. In Kafountine, salinisation weakens the dykes and mangroves that once held back floods. This study looks at both, and at how they combine with pre-existing vulnerability to produce losses and damages.

Figure 1. Location of the two study sites, Saint-Louis and Kafountine



1.3.1 Saint-Louis: floods and storm surges at the mouth of the Senegal River

Saint-Louis is a city of 254,000 people (ANSD, 2024) built on a low-lying island and sand spit, the Langue de Barbarie, between the river and the Atlantic. The sea is steadily taking the spit, and Section 2.3.1 sets out how fast. Storm surges in August 2017 and February 2018 destroyed around 100 houses and displaced 2,600 people in the fishing quarter of Guet Ndar, the most densely populated part of the city (Cissé et al., 2022). A channel cut through the spit in 2003 to relieve river flooding has since widened into an opening several kilometres wide, which exposes the city to the tide. Displacement from the coast has happened in two ways. In late 2016, about 1,000 people whose homes had been destroyed by the sea were moved to a temporary site at Khar Yalla on the mainland, where many still live without services (Human Rights Watch, 2025). In 2018, the World Bank approved US$30 million to relocate nearly 10,000 people in 927 households living within 20 metres of the shore to a planned site at Djougop (World Bank, 2018). One other development affects fishing households. Production at the Greater Tortue Ahmeyim gas field off Saint-Louis began in December 2024, and fishers report being kept well beyond the official 500m exclusion zone around the platforms (Wetzels, 2026).

Our study area is the Pikine quarter on the mainland side of the city, including the neighbourhoods of Pikine Bas Sénégal, Pikine Eaux Claires, Fass Ngom, Sor Diagne, Sor Daga and Tableau Walo, together with the Khar Yalla resettlement site. Pikine was itself created by displacement. It was settled after the floods of 1957 drove families out of Guet Ndar and Diama Guène, and part of it sits on land that was formerly riverbed. It has since absorbed households relocated from the coast, and it floods every rainy season because it lies below the level of the river with no functioning drainage. Its economy is informal covering fishing, market gardening, small trade, transport and repair work. Almost no household owns land and very few residents hold formal jobs.

1.3.2 Kafountine: salinisation, coastal erosion and loss of land in Lower Casamance

Kafountine is a commune of fishing and rice-growing villages on the coast of the Ziguinchor region, between the Casamance estuary and the Gambian border. The Casamance is one of the most salt-affected river systems in West Africa. Since the droughts that began in the late 1960s and 1970s, reduced freshwater flow has let seawater move up the estuary and its side channels (bolongs), salinising and acidifying the mangrove rice fields that once fed the region (Barry, 2009; Diatta et al., 2021). Participants in the workshop held in Kafountine for this study confirmed that several islands formerly farmed, including Koufoukène, Lekhoul, Khintène, Elendeguène and Djimbodji, have been abandoned because of salinisation.

Our study covers two villages in the household survey and a third in the focus groups. Abéné is on the mainland coast. It is a fishing and tourism village whose beach, filao tree shelter belt (planted in 1985),[3] sacred kapok tree, and bird and turtle nesting sites are being lost to coastal erosion. Meanwhile, its rice fields and gardens behind the dunes are being lost to salt. Its fishing economy is large, with around 315 pirogues (traditional, handcrafted wooden canoes) operating from the village, each employing six people on average. Niomoune is an island reachable only by pirogue. Its rice land has been salinising progressively since the 1970s and sharply since around 2010. Freshwater comes from rainwater stored in containers and from cisterns installed by Enda Energie in 1994. By the end of the dry season, women must walk 1.5km for well water. Kouba, a second island village surrounded by bolongs, was covered in the FGDs and shares Niomoune's dependence on rice and river fishing. Table 1 summarises the study sites.

Table 1. The two study sites: Saint-Louis and Kafountine

	Saint-Louis (Pikine quarter)	Kafountine (Abéné and Niomoune)
Region	Saint-Louis, Northern Senegal	Ziguinchor, Lower Casamance
Type of hazard	Rapid onset: rainy-season and river flooding, storm surges, coastal erosion	Slow onset: salinisation of land and water, coastal erosion, loss of mangrove and forest biodiversity
Setting	Peri-urban, densely settled, part of a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage city	Rural coastal village (Abéné) and island village (Niomoune)
Households surveyed	209	215
Focus groups	4 (Pikine Eaux Claires, Khar Yalla, Sor Daga, Sor Diagne)	2 (Kouba, Niomoune)
Main livelihoods	Fishing, market gardening, small trade, transport, mechanics, livestock	Fishing and fish processing, rice, market gardening, tourism, non-timber forest products, oyster gathering
Origin of vulnerability	Settlement on former riverbed and flood plain, no drainage, informal housing and tenure	Loss of freshwater flow in the estuary since the 1970s, droughts, degraded dykes, isolation of islands
Existing responses	Organisation des Secours (ORSEC — Emergency Organisation Plan), motor pumps, sand, emergency cash and food, relocation of coastal households (Saint-Louis Emergency Recovery and Resilience Project — SERRP)	Traditional and food-for-work dykes, mangrove and filao planting, women's processing units, nongovernmental organisation support (Enda Energie, Centre Écologique Albert Schweitzer (CEAS — Albert Schweitzer Ecological Centre))

3 Shelter belts of the filao tree (Casuarina equisetifolia) are planted primarily to stop desertification and coastal erosion.

1.4 Research approach, methodology and purpose

To understand how rapid- and slow-onset climate impacts translate into loss and damage for households in Saint-Louis and Kafountine, we used a mixed research approach that combined participatory assessment, a household survey and qualitative interviews. The work was carried out by Enda Energie and IIED between March 2025 and July 2026, with METE as the institutional partner.

Fieldwork began with participatory community assessments in June 2025 in the Pikine quarter of Saint-Louis and in Abéné and Niomoune in Kafountine: 78 community members took part (24 in Pikine, 26 in Abéné and 28 in Niomoune), with separate sessions for women. Using transect walks, social and hazard mapping, matrix ranking, mobility mapping, historical timelines and perception mapping of institutions, communities identified the hazards they face, the losses that matter most to them, how they cope and which institutions support them. The losses they prioritised covered livelihoods, living conditions, health, culture and community life. These assessments provided the basis for selecting the loss and damage areas examined in the study, and they shaped the index structure, the questions in the household survey, and the indicators used in the analysis.

A household survey was then administered to 424 households across the two sites: 209 in the Pikine quarter of Saint-Louis, the rapid-onset case, and 215 in Abéné and Niomoune in Kafountine, the slow-onset case. It covered household demographics, housing, water and sanitation, livelihoods and assets, exposure to flooding, salinisation and erosion, losses experienced, health, food security, debt, migration and access to social protection. Six FGDs followed the survey, using a checklist that ran from climate impacts through livelihoods and living conditions to migration, culture and identity: four in Saint-Louis, in Pikine Eaux Claires, Khar Yalla, Sor Daga and Sor Diagne, and two in Kafountine, in Kouba and Niomoune. Key informant interviews were held with municipal authorities, technical services and nongovernmental organisations (NGOs). Details of the sample are in Appendix 1.

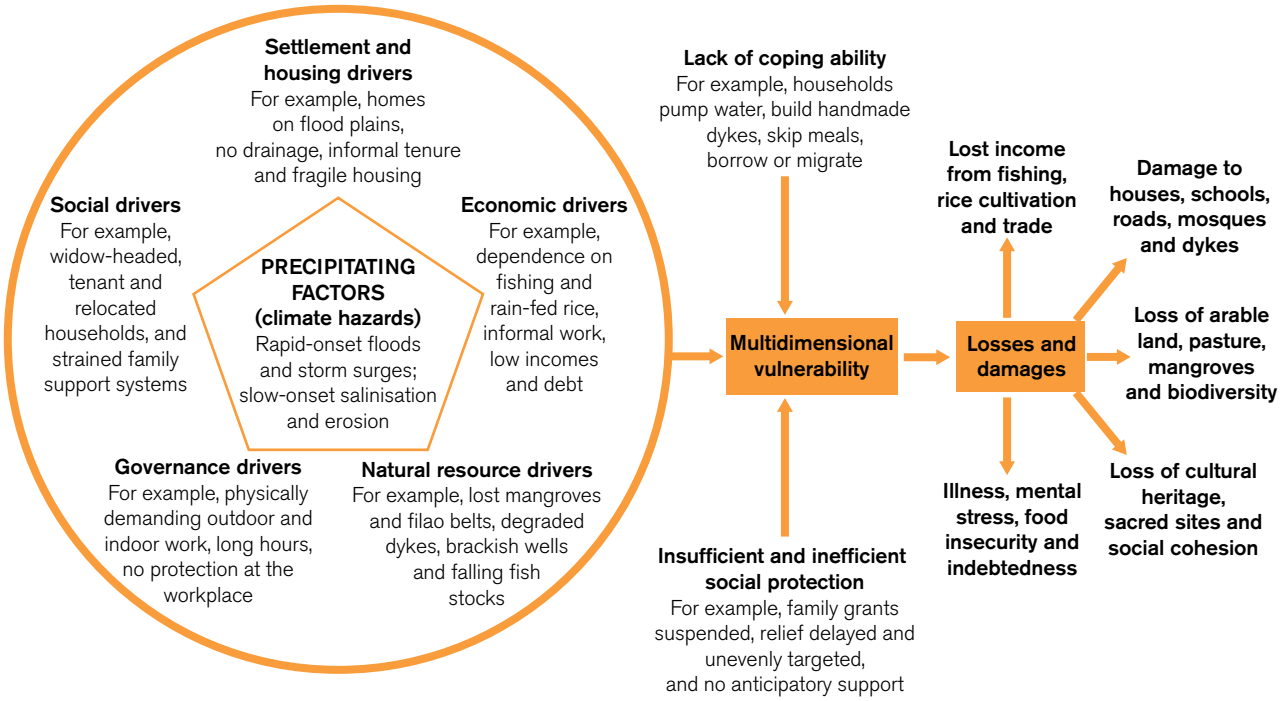
We used two analytical tools. The first is the C-CIQ toolkit (Bharadwaj et al., 2024a), which we developed to assess economic and non-economic loss and damage together and which we have applied in India, Mali and Bangladesh (Bharadwaj et al., 2024b, 2025, 2026). C-CIQ classifies losses across four domains — tangible and intangible, functional and intrinsic — and values them through a set of indices built from household data, so that losses with no market price, such as loss of cultural sites, social cohesion or mental wellbeing, can be assessed alongside lost income and damaged assets.

For Senegal, we developed indices under each domain specific to the two sites, drawing on the losses that communities had prioritised in the participatory assessments: loss of fishing and farming income, loss of arable land and pasture, damage to housing and infrastructure, loss of schooling, indebtedness, drudgery and loss of biodiversity under tangible–functional; distress migration, poor living conditions, loss of cultural identity and loss of heritage sites under intangible–functional; loss of life, malnutrition and food insecurity under tangible–intrinsic; and loss of physical and mental health under intangible–intrinsic. The full index structure is in Appendix 2.

This structure covers more losses than the eight we have presented as indices in Section 3.2. The eight (food insecurity, indebtedness, loss of health, loss of education, mental distress, cultural erosion, biodiversity loss and land degradation) are the losses for which the survey had a set of questions that could be scored from 0 to 100 for every household, and together they cover all four domains. The other losses are reported in a different form: as the share of households that experienced them (see Table 3 and the regression in Section 3.4), as money values (see Table 4), or as indicators that need administrative data and are kept in Appendix 2 for a national loss and damage register. Migration is both a loss and a response, and we have treated it separately in Section 3.5.

Figure 2 summarises the analytical framework, which traces the pathway from the drivers of vulnerability through climate hazards to the economic and non-economic loss and damage that households experience, and from there to the responses needed.

Figure 2. Research framework for assessing vulnerability and loss and damage in Saint-Louis and Kafountine



Source: adapted from Bharadwaj et al. (2024a)

The second tool is the 3P framework (predisposing, precipitating and protective factors), which organises the drivers of vulnerability into predisposing factors (the conditions that make some households more susceptible to loss before any hazard strikes), precipitating factors (the climate hazards that trigger loss) and protective factors (what reduces loss or helps recovery). We have measured each with an index built from the survey. This includes a Structural Household Vulnerability Index (SHVI) for predisposing factors, Climate Risk Index (CRI) for whether, and how hard, the hazards reached each household, and a Social Protection Index (SPI) for access to support. Combining the first two helped us identify the households that are both structurally vulnerable and highly exposed. Section 2 explains the framework and applies it to the two sites. Section 3 uses regression analysis to identify which of these factors best explain the losses households have reported.

On climate impact attribution, the survey recorded the losses households experienced from floods, storm surges, salinisation and erosion as households described them. We did not measure how much each of these individual hazards was due to climate change. In Saint-Louis in particular, the flooding of Pikine comes from rainfall and a rising water table on a site with no drainage, and the losses reflect the settlement pattern and the state of the drains as much as the hazard. Section 2.3.1 sets out the scientific evidence that these hazards are changing. The figures in this report should therefore be read as losses from climate-related hazards, which is what a loss and damage assessment needs to record, and not as a formal attribution of each loss to climate change.

The findings were validated with communities in Saint-Louis and Kafountine on 16 and 18 June 2026, and then discussed with sectoral ministries, local authorities, research institutions, civil society and development partners at a shared learning dialogue in Saly on 8 July 2026 and a national workshop at METE on 10 July 2026. The recommendations in this report were developed through those discussions, and draw also on our readiness assessment of Senegal's social protection system (Bharadwaj et al., 2023) and on what we have learnt from applying C-CIQ elsewhere.

The purpose of this research is to:

- Document, with the communities themselves, the full range of economic and non-economic losses and damages caused by rapid- and slow-onset climate impacts, including losses that are normally invisible in official assessments such as loss of biodiversity, cultural heritage, social cohesion and mental wellbeing
- Understand why some households in the same community lose more than others, by examining the vulnerabilities that predispose them to loss, the hazards that trigger it and the protective factors that reduce it
- Quantify economic and non-economic losses and damages at household level, so that Senegal has a tested and replicable method for estimating its loss and damage needs, and
- Co-develop with communities, local authorities and national stakeholders a set of practical and policy responses, and to show how existing social protection, disaster risk management and climate finance can be reshaped to deliver them.

The findings are meant for three audiences:

- The first is the government of Senegal (in particular METE), the Délégation Générale à la Protection Sociale et à la Solidarité Nationale (DGPSN — General Delegation for Social Protection and National Solidarity), and the municipalities of Saint-Louis and Kafountine, which need evidence to plan responses and to prepare funding requests to the FRLD and the Santiago Network.
- The second is AFD and other development partners working on adaptation and social protection in Senegal.
- The third is practitioners and researchers in other coastal LDCs facing the same combination of rapid- and slow-onset impacts, for whom the method used in this research is as relevant as the findings.

2

How underlying vulnerabilities interact with floods, salinisation and erosion

The same flood does not affect every household in Pikine the same way, and the same salt intrusion does not affect every household in Kafountine the same way. What differs are the conditions in which households live before the hazard strikes, the hazards they are actually exposed to, and the support they can draw on when loss occurs. To understand why some households lose far more than others, we have used the 3P framework, which examines how these three sets of factors interact.

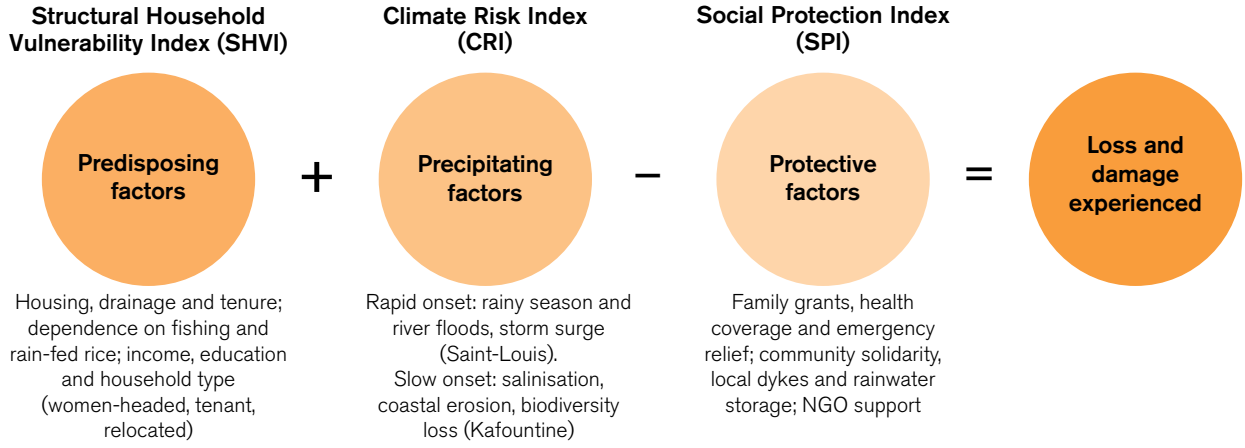
2.1 The 3P framework applied to Saint-Louis and Kafountine

Figure 3 presents the 3P framework as applied in this study. Predisposing factors are the conditions that make some households more susceptible to losses before any hazard strikes. In Saint-Louis, they include large households headed by women with no land and no formal work, settled on a riverbed with no drainage. In Kafountine, they include customary tenure without title, mud housing, basic sanitation, and dependence on rice and fishing. We have measured them through a SHVI built from the household survey.

Precipitating factors are the climate hazards that turn vulnerability and exposure into loss. In Saint-Louis, the main trigger is flooding during the rainy season and from the river, with storm surges on the coast. In Kafountine, it is the slow intrusion of salt into rice land and wells, coastal erosion and the loss of mangroves and forest. We measure whether, and how hard, these hazards reached each household through a CRI built from the direct losses each household reported (see Section 2.3.2).

Protective factors are the measures and systems that reduce loss when a hazard strikes or help households recover. They include family and neighbourhood solidarity, local practices such as dyke building and rainwater storage, NGO support and public programmes such as emergency relief, family security grants, health coverage and school feeding. We measured access of the community to these protective factors from government programmes and NGO support through an SPI.

Figure 3. Interaction of predisposing, precipitating and protective factors (3Ps)



Source: Bharadwaj et al. (2024a).

The 3P framework can also be understood alongside the hazard, exposure and vulnerability framing used by the Intergovernmental Panel on Climate Change (IPCC). In IPCC terms, these include predisposing factors (the household's vulnerability before the hazard), precipitating factors (the hazard as it actually reached the household, which covers both hazard and exposure), and protective factors (the support a household can draw on from outside, such as programmes, relief and community help).

The IPCC framing brings the first and third of these together under vulnerability. We keep them apart because they are changed by different kinds of action, over different periods. Tenure, landlessness, household size and the location of a house are structural conditions that only shift over years, through land, housing and urban policy. Whether a grant arrives before the rains, whether a tenant is on the registry or whether a pump is in place before the water comes can be changed within a programme cycle. Keeping the two separate allows the analysis to show how much of a household's loss comes from where it started, how much from what hit it and how much from the absence of support, and this is the basis for the recommendations in Section 4. The result of the three factors together is the losses and damages that a household experiences, which Section 3 measures through C-CIQ.

The sections that follow give the findings on each factor. Section 2.2 examines the predisposing factors and the SHVI, Section 2.3 the hazards, how they have changed and how households are exposed to them, Section 2.4 the protective factors, and Section 2.5 brings vulnerability and exposure together.

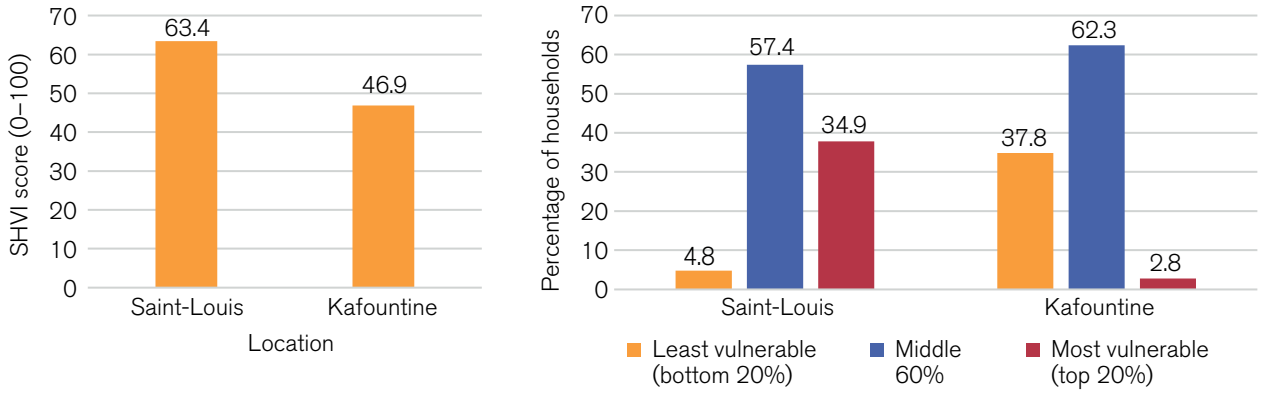
2.2 Predisposing factors: who was vulnerable before the hazard struck?

The SHVI combines the household characteristics that shape a household's ability to withstand a shock. This includes the composition and education of the household, its land, assets and income, and the quality of its housing, tenure and sanitation. The index runs from 0 to 100, with higher values indicating greater structural vulnerability. To compare households, we classified them into three groups on the basis of their score across the whole sample: the least vulnerable (the bottom 20% of scores), the moderately vulnerable (the middle 60%), and the most vulnerable (the top 20%).

2.2.1 Structural vulnerability is much higher in Saint-Louis

The two sites differ sharply. The mean SHVI is 63.4 in Saint-Louis and 46.9 in Kafountine. Figure 4 shows what this means for the distribution of households. In Saint-Louis, 37.8% of households fall in the most vulnerable group and only 4.8% in the least vulnerable. In Kafountine, the picture is reversed: 34.9% of households are in the least vulnerable group and only 2.8% in the most vulnerable. The moderately vulnerable group is of similar size in both, at 57.4% in Saint-Louis and 62.3% in Kafountine.

Figure 4. SHVI and distribution of households by structural vulnerability group, by site

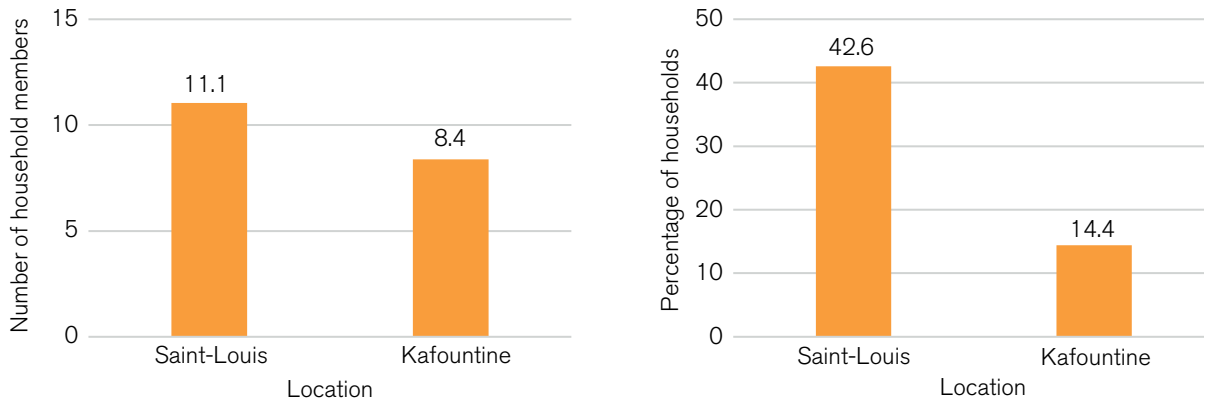


The difference in SHVI is reflected in analysis of all parameters under predisposing factors. Households in Saint-Louis start from a weaker position than households in Kafountine. The next subsections show why.

2.2.2 Household composition and education

Households in Saint-Louis are larger and more often headed by women. The mean household has 11.1 members in Saint-Louis and 8.4 in Kafountine. Women head 42.6% of households in Saint-Louis, three times the share in Kafountine, at 14.4% (see Figure 5). These two features create vulnerability when a flood hits. A household of 11 needs more food and cash each day than a household of eight. If most of that money comes from one person, and that person is a woman working in petty trade or fish processing, there is no contract, no paid leave and usually no savings to fall back on. When floods close the market or stop the fish landings for two or three weeks, her income stops completely, but the household still has to eat. It runs out of money sooner than a smaller household with two or three earners, and turns to borrowing, selling assets or cutting meals.

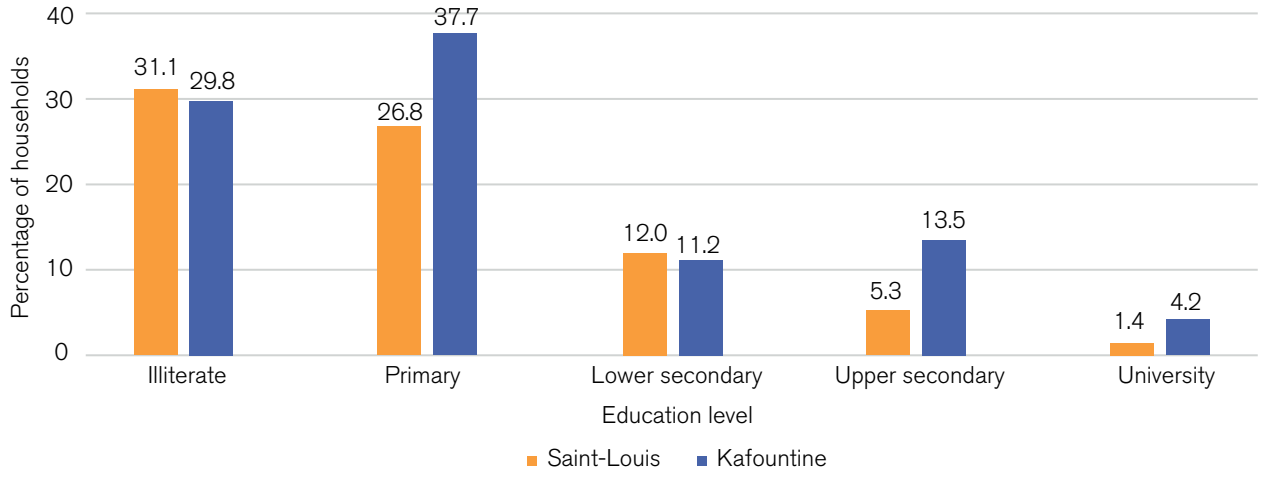
Figure 5. Average household size and percentage of households headed by women, by site



The focus groups explained the issues faced on the ground by more vulnerable households. In Sor Daga, women traders stay home during floods to bail out and clean the house instead of going to market, cook on tables and bricks or serve cold meals, and reported exhaustion and stress with no rest. In Niomoune, the well is 1.5km from the houses, and women said the fatigue of fetching water had reduced the time they could spend on gardening and trading. Women processors relocated from Guet Ndar to Khar Yalla now pay 4,000 XOF a day to travel to the processing sites and back, whereas they walked before. Women's income is the first to go when a hazard strikes, and a household headed by a woman has no second income to fall back on.

Education levels are low at both sites and slightly better in Kafountine (see Figure 6). Around three in ten household heads cannot read or write, 31.1% in Saint-Louis and 29.8% in Kafountine. Beyond that, the two diverge: 37.7% of household heads in Kafountine completed primary school and 13.5% upper secondary, compared with 26.8% and 5.3% in Saint-Louis. Only 1.4% of household heads in Saint-Louis have been to university, against 4.2% in Kafountine. Low education limits the move into less exposed work and makes it harder to deal with the paperwork that social protection access requires.

Figure 6. Education of the household head, by site



2.2.3 Livelihoods, land, assets and income

The two sites have very different economies (see Figure 7). In Kafountine, agriculture is the main source of income for 58.6% of households, with livestock at 9.8%, fishing at 6% and non-agricultural work at 21.4%. In Saint-Louis almost no household depends on agriculture (0.5%). Non-agricultural work, mostly small trade, transport and repair services, is the main source for 30.1%, fishing for 12.4% and livestock for 6.2%, and the remainder rely on casual labour and other irregular sources.

Figure 7. Main source of household income, by site

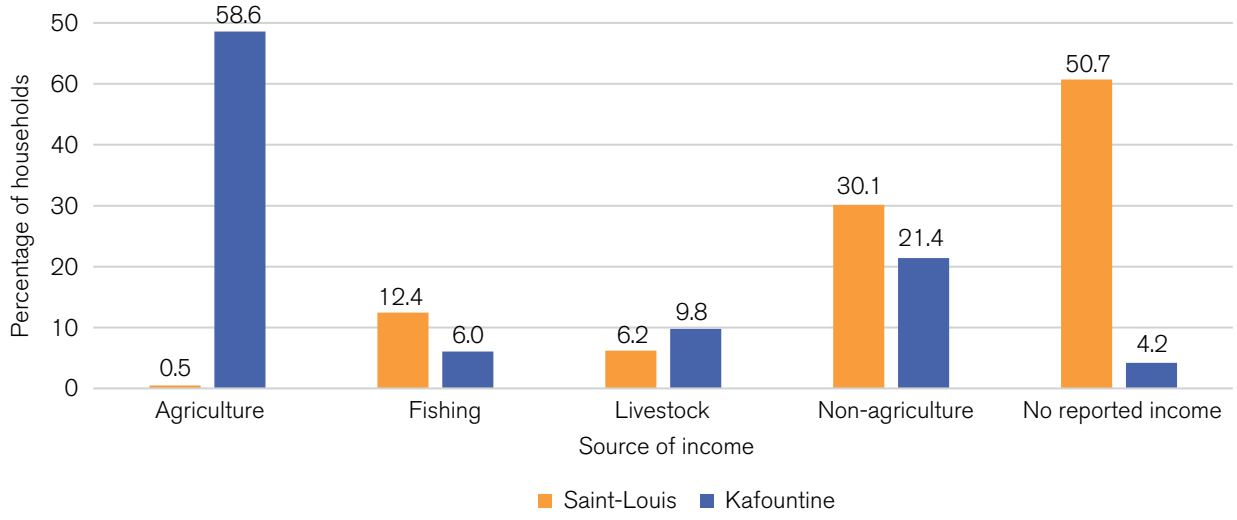


Figure 8 shows what households own and what also forms their livelihood source. Almost every household in Saint-Louis is landless, 99.5%, compared with 15.3% in Kafountine, where the median holding is around 2 hectares. Boats are owned by 32.6% of households in Kafountine and 14.4% in Saint-Louis, and livestock by 59.5% and 40.7%, respectively. Income follows the same pattern. Mean annual household income is 986,000 XOF in Kafountine (around US$1,640) and 758,600 XOF in Saint-Louis (around US$1,260), and the Saint-Louis income is shared among a larger household (see Figure 9).

Figure 8. Landlessness, boat ownership and livestock ownership, by site

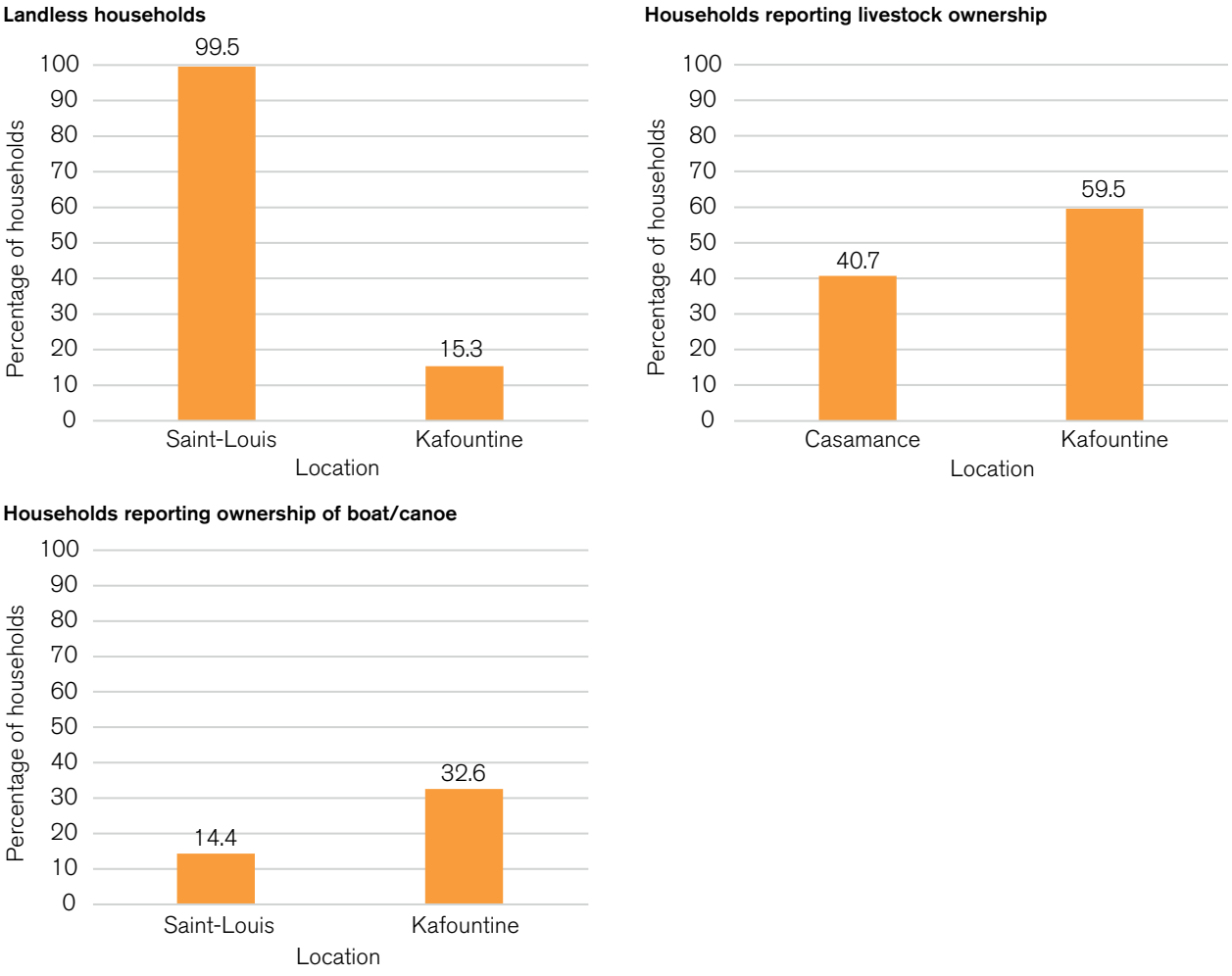
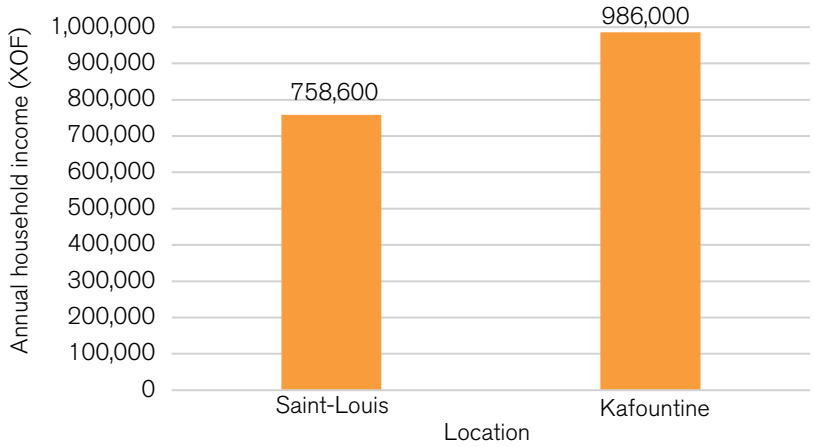


Figure 9. Mean annual household income, by site



Households in Kafountine are farmers and fishers. They own land, boats and animals. Households in Pikine are mostly landless labourers and traders in the informal economy, and they own few productive assets. This shapes what each group loses when a hazard strikes. In Kafountine, the main losses are to crops, animals and equipment. In Saint-Louis, the main losses are income losses when work stops, damage to the house and illness.

Fishing links the two sites. Every FGD said that catches have fallen year after year. Participants gave four reasons, and climate was one of them. The first reason, given at every site, was industrial and foreign fishing. Local waters no longer hold fish, the stocks have moved north into Mauritanian waters, and trawlers destroy gear and leave no young fish. The second was wind and storms in the rainy season, which keep pirogues on shore. The third was rising salt in the rivers, which has reduced mangrove and river fish. Three of the Saint-Louis groups reported this as well as the two Kafountine groups. The fourth, reported at Khar Yalla, is the exclusion zone around the gas platforms off Saint-Louis. Fishers who

can afford it now follow the fish to Mauritania, Casamance and Guinea-Bissau and pay for fuel, licences and food for the trip. Those who cannot, as in Kouba, give up fishing altogether.

The published evidence supports this account. It also shows that climate is behind three of the four reasons. The fish have moved north because the sea has warmed. Sea surface temperature off Northwest Africa has risen by 0.3–0.5°C per decade over the past 40 years. Round sardinella, the main species landed by the pirogue fleets, has moved its range north by about 180km per decade since 1995. In 1995, 38% of the stock was north of Cape Blanc, on the Mauritanian border. By 2015, it was 65% (Sarré et al., 2024). When fishers in Guet Ndar say the fish have gone to Mauritania, this is what has happened. Fishing pressure has made it worse. Senegal's own scientific assessment finds the main small pelagic stocks (sardinella, horse mackerel and bonga) overexploited (Gorez, 2023). In January 2024, the government negotiated 500 Mauritanian licences for Guet Ndar fishers, at 11,135 XOF each, so that they could fish legally in the waters where the stocks now are (Ministry of Fisheries and Maritime Economy, 2024). Projections made before the shift was measured had already put the cost to West Africa at a 21% fall in the value of catches and a 50% fall in fishing jobs by the 2050s (Lam et al., 2012).

The rough seas that keep pirogues on shore in the rainy season also show up in the data, though the change is small. Wave heights along Senegal's southern coast, which includes Kafountine, have risen by about 1.2cm per decade over the last 40 years. Most of the rise is between June and October, at about 2cm per decade, when swells from the South Atlantic reach the coast. On the northern coast the rise is half that (Samou et al., 2023). At Saint-Louis the bigger change is the sea level. It rose by 3.5mm a year between 1994 and 2015. The number of days a year on which a high tide and high waves together can flood the low river mouth has been rising by about one day a year, and Guet Ndar is the most exposed quarter (Cissé et al., 2022).

The salt in the rivers has been created due to different reasons at the two sites. In Saint-Louis, the change is recent and partly man made. In October 2003, a channel four metres wide was cut through the Langue de Barbarie to relieve flooding. Within eight months it was 800m wide, and by 2013 more than 5km. It opened the lower Senegal River to the sea. Salt levels in the estuary rose by 77% between 2003 and 2006; the river no longer turns fresh in the rainy season, freshwater fish have declined and sea fish have taken their place (Fall, 2025). In Casamance, the change is older and comes from rainfall. The droughts of the 1970s and 1980s made the Casamance River saltier upstream than at its mouth and killed mangroves along its banks. Rainfall has recovered since the 1990s; the river has become less salty and mangroves have grown back across the region (Descroix et al., 2020). What the island villages described is something else: salt moving into rice fields since around 2010 as dykes fail and the tide comes in. That process has not stopped. Local rice now covers only 30–40% of what people eat in Casamance (Diatta et al., 2021).

Production at the Greater Tortue Ahmeyim gas field began in December 2024. The official exclusion zone is 500m, but fishers report being kept several kilometres from the platforms. A complaint by Saint-Louis fishing organisations was accepted for examination under the Organisation for Economic Co-operation and Development (OECD) guidelines in February 2026 (Wetzels, 2026). Climate change is therefore impacting on fishing-based livelihoods that were already depleted and contested. We report the fall in catches as a loss that climate is making worse, not as a loss caused by climate alone.

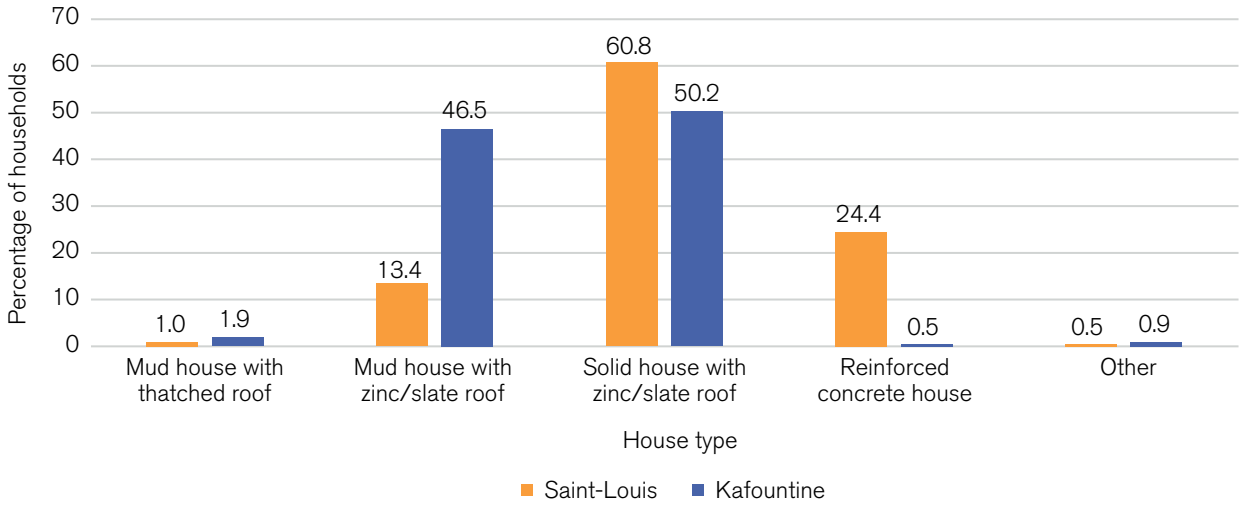
2.2.4 Housing, tenure and sanitation

Housing conditions show the opposite pattern. Households in Saint-Louis live in more solid houses than those in Kafountine (see Figure 10). In Saint-Louis, 60.8% live in a house with solid walls and a zinc or slate roof and 24.4% in a reinforced concrete house. Only 13.4% live in a mud house with a zinc roof. In Kafountine, 46.5% live in a mud house with a zinc roof and 50.2% in a house with solid walls, and almost none in concrete.

The difference is not a sign that households in Pikine are better off. It is a result of where they live. Pikine stands on a former riverbed and floods every year. Mud walls soak up standing water and collapse, so a mud house in Pikine does not last. Households have no choice but to build in cement blocks or concrete, and those who can afford it raise the foundations, or build a second storey as a refuge (see Section 2.5). The cost of a solid house is a cost that the flood imposes on the households. In Kafountine, where the hazard is salt rather than standing water, a mud house with a zinc roof still serves, and therefore half of the households live in such houses.

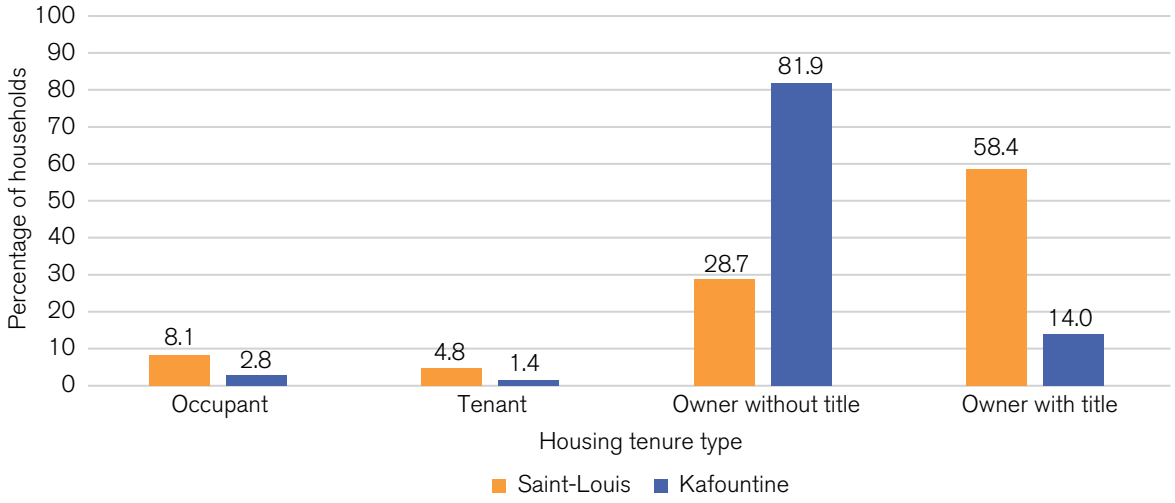
Solid walls give only partial protection, because the water still enters the house each rainy season. As Section 2.3 shows, 61.7% of households in Saint-Louis reported damage to their house in the last event.

Figure 10. Type of house, by site



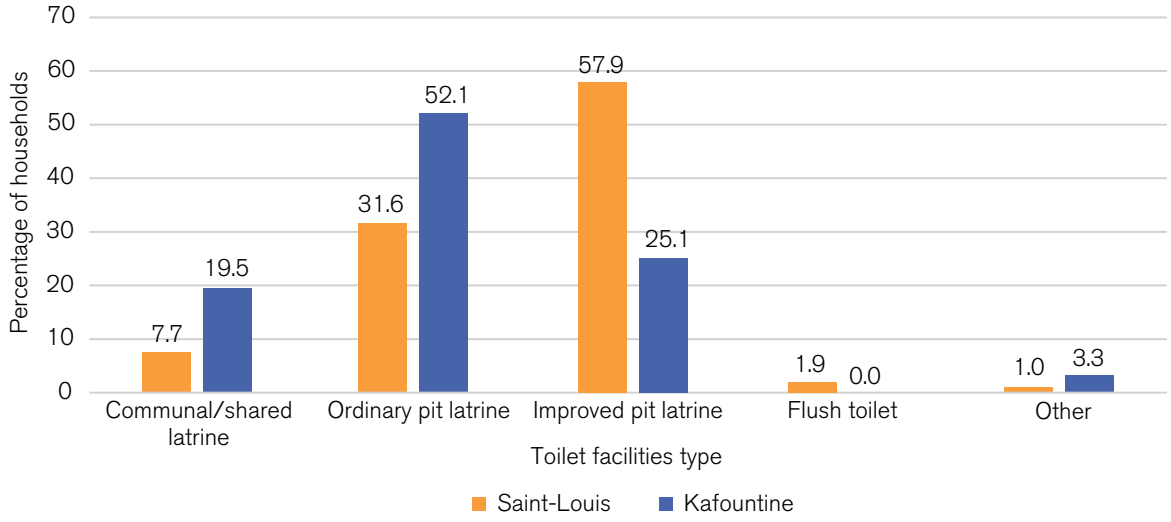
Tenure also differs (see Figure 11). In Saint-Louis, 58.4% of households own their house with a title, 28.7% own without title and 12.9% are tenants or occupants. In Kafountine, 81.9% own houses without a title under customary arrangements and only 14% hold a title. Lack of title excludes households from formal upgrading and relocation schemes, and in Pikine it is the reason many houses have no planning permission and no claim when the municipality plans drainage works. In Box 2, we share the example of Khar Yalla in Saint-Louis and what resettlement has meant for residents there.

Figure 11. Housing tenure, by site



Sanitation is basic at both sites and worse in Kafountine (see Figure 12). In Saint-Louis, 57.9% of households have an improved pit latrine and 31.6% an ordinary pit latrine, while 7.7% share a communal latrine. In Kafountine, 52.1% have an ordinary pit latrine, 25.1% an improved one and 19.5% share. In Pikine, pit latrines and septic tanks flood during the rainy season and overflow into the streets. Communities linked this directly to the diarrhoea, skin infections and malaria they reported after each flood. In Kafountine, the concern is the water table, which pit latrines drain into and which is already becoming brackish.

Figure 12. Toilet facilities, by site



Box 2. Khar Yalla: relocation that moved vulnerability rather than reducing it

Khar Yalla is a resettlement site on the mainland side of Saint-Louis. It was set up in late 2016 for about 1,000 people from the Langue de Barbarie whose homes had been destroyed by the sea, and was meant to be temporary (Human Rights Watch, 2025). Nine years later they are still there.

The focus group at Khar Yalla described what the move has cost them. The relocation site itself floods in the rainy season, so households moved from the risk of the sea to the risk of standing water. It is around 10km from the fishing grounds and processing sites at Guet Ndar, Goxu Mbacc and Santhiaba, so men leave at 6am and return at 10pm, and some have given up fishing. Women processors pay 4,000 XOF a day in transport where before they paid nothing, and the group linked this routine to rising strokes among women members. There is no school on site. The nearest is 2km away, and parents keep children at home due to costs and safety reasons. Electricity connection costs 130,000 XOF and half the households are not connected. Pit latrines fill as the water table rises, and they have to pay 25,000 XOF each time to empty it. All 68 households describe themselves as poor, none own land, and every household has a member who has migrated. Children raised at the site cannot swim, and drownings have occurred when they visit the old neighbourhood.

Human Rights Watch reached the same conclusions in 2025 and found that Khar Yalla households were left out of the World Bank-financed relocation to Djougop that rehoused families displaced in 2017 and 2018 (Human Rights Watch, 2025). The Khar Yalla group's own request was to be relocated again, to a site with services. Khar Yalla shows that moving people out of a hazard zone without livelihoods, services or tenure reproduces the vulnerability it was meant to end.

2.2.5 What the predisposing factors show

The two sites have two different profiles of vulnerability. Saint-Louis has households that are poor in structure. They are large households, and many are headed by women. They have no land and few productive assets. Their incomes are lower and their education is lower. Most earn a living in the informal economy, and they live on land that floods every year. Their houses and their tenure are better than in Kafountine, but that counts little when the water comes into the house each rainy season. Kafountine has households that are better off in assets and income. They have land, boats and livestock. But they live in mud houses and with basic sanitation. Their living depends on rice fields and fishing grounds, and the salinity and the sea are destroying both. The index shows the same contrast within each site. In Saint-Louis, the most vulnerable fifth of households score 78.7 and the least vulnerable fifth score 44.7. In Kafountine, the most vulnerable score 64.5 and the least vulnerable score 29.6. The least vulnerable households in Saint-Louis are therefore about as vulnerable as the moderately vulnerable households in Kafountine. These differences shape what each group loses when a hazard strikes.

2.3 Precipitating factors: hazards, exposure and their impact

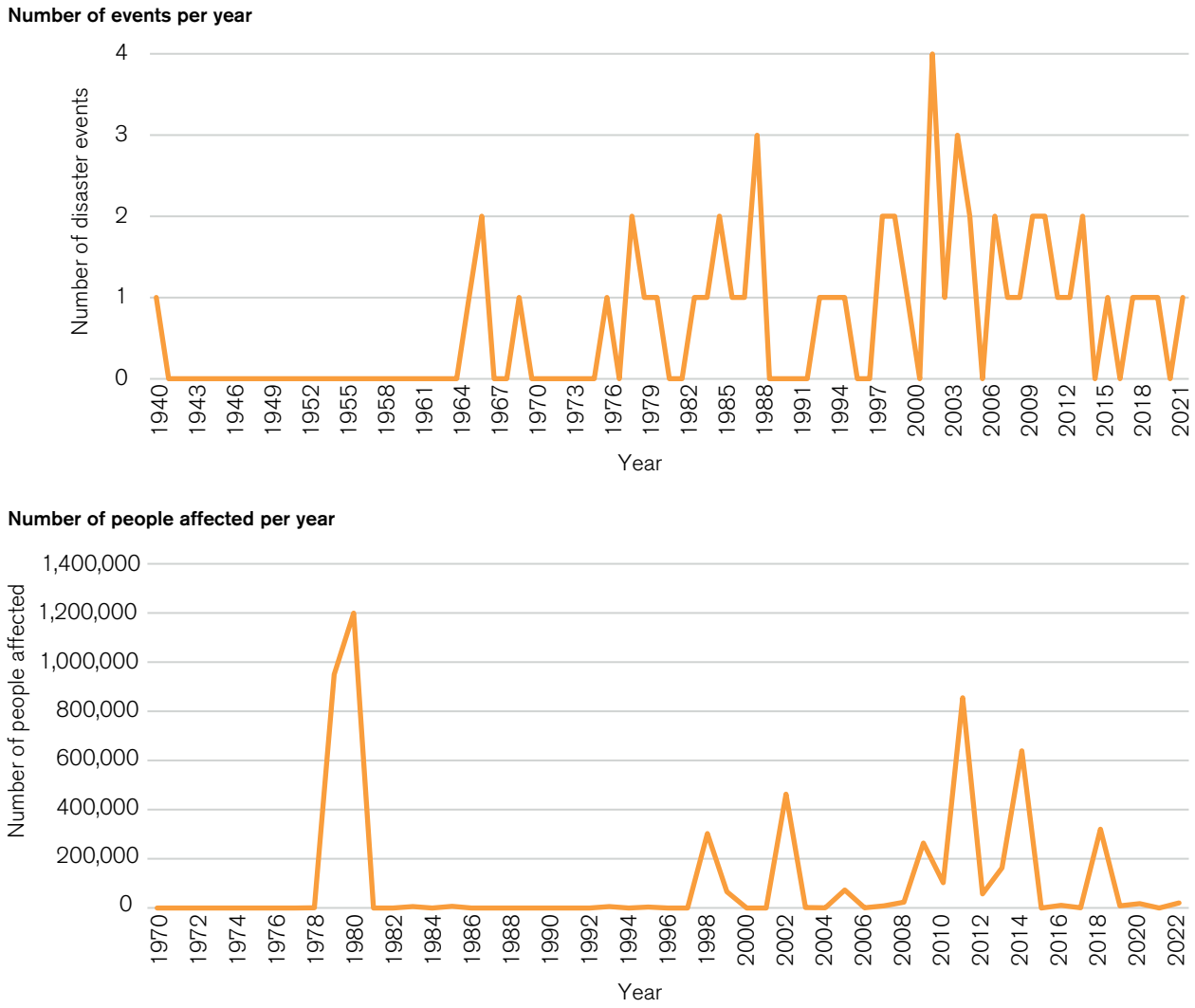
Within the 3P framework, the climate hazards are the precipitating factors that turn vulnerability and exposure into loss. This section looks first at how the hazards have changed, and then how they have impacted households, using the CRI.

2.3.1 How hazards are changing

Participants in all six FGDs felt that extreme events had become both more frequent and more severe. Five groups said that some form of damaging event now occurred every year. The national disaster record points in the same broad direction.

We analysed the disasters recorded for Senegal in the Centre for Research on the Epidemiology of Disasters (CRED) Emergency Events Database (EM-DAT) between 1940 and 2022 (see Figure 13). EM-DAT includes an event if it results in at least ten deaths, affects at least 100 people, or leads to an official declaration of emergency or a request for international assistance. Nine disasters were recorded between 1940 and 1979, fewer than one every four years. Between 1980 and 1999, the database records 17 events, or close to one a year. A further 28 were recorded between 2000 and 2022. At least one disaster occurred in 18 of those 23 years. The shift described in the focus groups, from a major event occurring occasionally to some form of disaster in most years, is also visible in the national record since 2000.

Figure 13. Disasters recorded in Senegal between 1940 and 2022



Source: authors' calculations based on EM-DAT (CRED), www.emdat.be

The number of people recorded as affected has also increased (see Figure 13). Between 1978 and 2022, disasters in EM-DAT affected an estimated 5.6 million people in Senegal. Around 2.2 million were affected during the 2010s alone. This was more than the combined total for the 1990s and 2000s, approximately 380,000 and 830,000 people, respectively and comparable with the numbers affected during the severe drought years of 1979 and 1980. The largest annual totals were recorded in 2011 (855,000 people), 2014 (640,000), 2002 (463,000), 2018 (320,000), 1998 (303,000) and 2009 (264,000).

EM-DAT has two important limitations for this study. First, it records events large enough to meet national or international reporting thresholds. A flood that fills the streets of Pikine during the rainy season may not appear in the database unless it affects enough people or prompts an official emergency response. Much of the recurring flooding described by households in Saint-Louis is therefore absent from the national record.

Second, EM-DAT is designed mainly to record identifiable events with a beginning and an end. Salinity affecting a rice field or a well in Kafountine is a slower process and cannot easily be assigned a precise date. Such gradual losses are unlikely to be captured. To understand how hazards are changing at the two study sites, we therefore considered the national data alongside scientific research and the experiences reported by households.

In Saint-Louis, the scientific evidence points to growing coastal risk. Cissé et al. (2022) estimate that sea level rose by approximately 3.5mm a year between 1994 and 2015. Over the same period, the annual time during which coastal water reached extreme levels increased by about one hour a year. This amounts to almost one additional day of exposure over the full study period. Guet Ndar, where the 2017 and 2018 storm surges did most damage (see Section 1.3), was identified as the neighbourhood most exposed to coastal flooding.

Long-lasting storms add to this risk. The coastal storm that began in February 2018 lasted for 27 days, making it the longest recorded event in the series beginning in 1993 (Cissé et al., 2026).

River flooding remains a separate threat. In October 2024, the Senegal River overflowed following heavy rainfall, affecting around 55,600 people across 51 villages and 44 other sites in the Saint-Louis and Matam regions (OCHA, 2024).

Pikine faces a different form of flooding. As Section 1.3 describes, it lies on a former riverbed without working drainage, so its flooding comes mainly from heavy rainfall and the rising water table rather than from the sea, and water can remain in the neighbourhood for two or three months (see Section 2.3.2). Saint-Louis is therefore exposed to several hazards at once: coastal flooding and erosion, river flooding, intense rainfall and groundwater flooding. These processes have different causes, but their effects overlap within the same area.

In Kafountine, change has been slower but no less damaging. It reflects both the long-term effects of reduced freshwater flows and the growing influence of the sea. The droughts of the 1970s and 1980s cut the flow of freshwater into the Casamance estuary so far that it became ‘inverse’, with some upstream waters more saline than those closer to the sea (see Section 1.3). Rainfall has partly recovered since the 1990s, average salinity has fallen, and mangroves have regenerated in some areas (Descroix et al., 2020). Yet the island communities continue to report the loss of cultivable land to salt, on the scale described in Section 2.3.2.

The available evidence does not allow us to identify a single source of this continuing salinisation. It does, however, suggest that seawater may now play a larger role in the lowest fields and wells. This is an interpretation based on two findings: salinity in the estuary has declined as rainfall has recovered, yet communities continue to report that salt is spreading into previously cultivable land.

Rising seas and changing wave conditions provide a plausible mechanism. Average wave heights along Senegal’s southern coast increased by approximately 1.2cm per decade between 1980 and 2021. During the boreal summer, when rice is growing in the fields, the increase was closer to 2cm per decade (Samou et al., 2023). Higher water levels and stronger waves can push seawater over or through the dykes that protect rice fields.

The marine environment is also becoming warmer. Since the early 1980s, sea surface temperatures off Northwest Africa have risen by up to 0.4°C a decade, with the fastest warming around Cape Blanc on the Mauritanian coast north of Senegal. Between 1995 and 2015, the northern limit of round sardinella, the most important species for Senegal’s small-scale fishers, moved north by about 180km a decade, and the share of the stock found north of Cape Blanc rose from 38% to 65% (Sarré et al., 2024). Climate change is not the only pressure on the fishery, but it is adding to the effects of overfishing and other environmental changes described in Section 2.2.

The household survey provides a similar picture of more frequent and persistent disruption. We asked households to identify the year of the most recent flood that had affected them. In Saint-Louis, 166 of the 203 households that answered named either 2024 or 2025, the year in which the survey was conducted. For most households, therefore, the most recent flood had occurred during the current or immediately preceding rainy season.

In Kafountine, 110 of the 162 households that answered also named 2024 or 2025. Many of the remaining households identified 2019 or 2000. This suggests a pattern of occasional large floods rather than the near-annual flooding described in Saint-Louis.

Households were also asked whether their locality was affected by drought, rainfall deficits, irregular rainfall or salinisation. Every household in Kafountine reported at least one of these changes, as did 77% of households in Saint-Louis.

Salinisation was the most widely reported change. It was identified by 90.2% of households in Kafountine and 49.3% in Saint-Louis. Irregular rainfall was reported by 74.4% and 50.7% respectively, while rainfall deficits were reported by 66% and 37.3%, respectively. Fewer than 2% of households at either site described the change simply as drought. People spoke instead of rain arriving at the wrong time or in smaller amounts, and of salt entering fields and wells that had previously been fresh.

Changes in fodder availability provide further evidence of the effect on livelihoods. Of the 133 households in Kafountine that answered this question, 104 said that fodder had declined over the preceding ten years. Ninety households gave a climate-related explanation, and 88 of them identified salinisation.

Land abandonment was also widely reported: 94 households in Kafountine, close to half of those engaged in farming, said that farmers in their locality had abandoned land because of salinisation, drought or changing rainfall, while 42 said that some farmers had left agriculture altogether.

Reports of salinisation in Saint-Louis are also consistent with the changes documented in the Senegal River estuary. Since the Langue de Barbarie breach was opened, the estuary on which the city depends for fishing and water has become considerably more saline.

The three sources of evidence tell a consistent, though more nuanced, story. Large disasters recorded at the national level now occur most years, while many damaging local events are even more frequent and never enter the national database. In Saint-Louis, coastal, river, rainfall and groundwater hazards increasingly overlap. In Kafountine, the more gradual spread of salt is reducing the productivity of land, water and fisheries. The following subsection examines how much of this loss individual households have experienced.

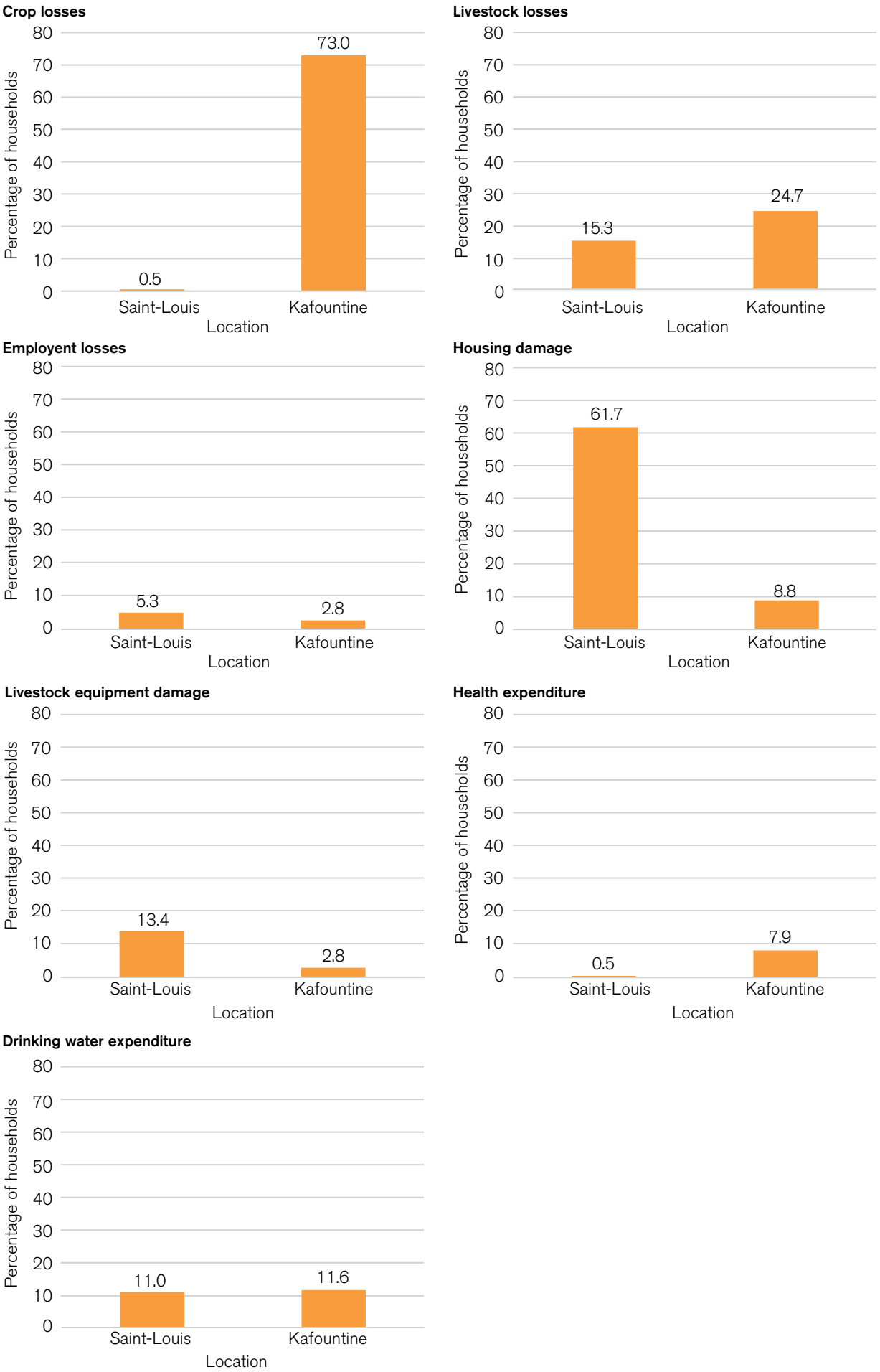
2.3.2 Exposure to climate loss: the Climate Risk Index

We used the CRI to measure which households the hazard actually impacted, and how badly. We could not measure flood depth or salinity for each house or field through a household survey, and in any case the flood or the salt intrusion is more or less the same across a site. The difference between one household and another lies in where they are. In Pikine, it depends on whether the house is on the old riverbed or at a low point where the water collects because there is no drainage. In Niomoune, it depends on whether the salt has got into that family's field. The survey cannot see this directly, so we have used the damage that households reported as an indication that the hazard had reached them.

The index has been built from seven such effects reported by the households for the reference period: crop loss, livestock losses, employment loss, housing damage, loss of equipment and tools, health spending caused by water hardship, and having to fetch or buy drinking water during drought. It runs from 0 to 100, and a higher score means the household was hit harder. In this section we use it together with the SHVI to identify the households that the hazard reached from those that it did not. We do not use it to explain losses in Section 3. The regression there uses structural vulnerability alone as the explanatory variable, and the loss indices in Section 3.2 are built from other parts of the survey.

Figure 14 shows how the two sites differ. Kafountine's exposure is agricultural. Crop loss from climate was reported by 73% of households in Kafountine and by almost none in Saint-Louis (0.5%) (given they are mostly landless). Livestock losses were reported by 24.7% in Kafountine and 15.3% in Saint-Louis, and health spending caused by water hardship by 7.9% and 0.5%, respectively. Saint-Louis's exposure is to the house and its contents. Housing damage was reported by 61.7% of households in Saint-Louis and 8.8% in Kafountine, and loss of equipment and tools by 13.4% and 2.8%, respectively. Employment loss from climate was low at both sites, 5.3% in Saint-Louis and 2.8% in Kafountine, and around one household in nine at both sites had to find drinking water elsewhere during drought.

Figure 14. Households reporting each type of climate-related loss, by site

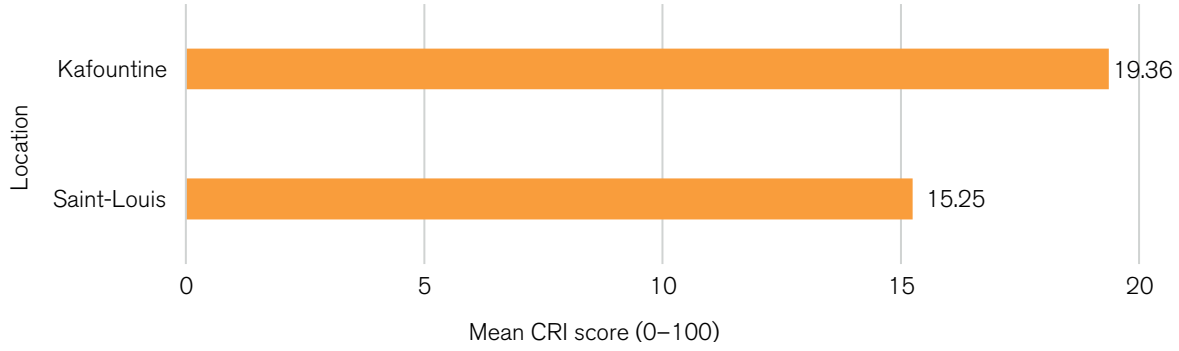


The FGDs explain the reason behind the survey findings. In Saint-Louis, 61.7% of households reported damage to their house. All four focus groups described the same sequence of events after heavy rain. There is no working drainage, so water stagnates in the streets and houses for two to three months. Disease outbreaks typically follow and people cannot move about, and trade and work stop. Health centres cannot be reached in August and September. Ambulances and taxis are not able to enter the water, so the sick have to be taken on foot or by cart. Two classrooms at Charles Niang school in Sor Diagne cannot be used for teaching as they were used as the flood shelter. Mosques cannot be reached after heavy rain. The outbreak of Rift Valley fever in 2025 shows what standing flood water can lead to. It began in Saint-Louis region after an unusually heavy rainy season and caused 360 confirmed cases and 21 deaths across the country (Dall, 2026).

In Kafountine, 73% of households reported crop loss. The two island groups described the land going out of use for cropping, year by year. Kouba estimated that 30% of its farmland has been lost to salt. Niomoune put its loss at around 45% over the last 15 years. Rice yields in Kouba have fallen from around three tonnes to ten sacks. Both villages now grow rice only for their own use and even that is not sufficient and they have to buy imported rice to meet the rest of their requirement. In Niomoune, fields that can no longer be farmed are being used as pasture. Salinity is therefore also contributing to poverty. Households that once sold rice now have to buy it, when income itself is declining. The same change is recorded across the region. Local rice now covers only 30–40% of what people eat in Casamance (Diatta et al., 2021).

On the index, exposure is somewhat higher in Kafountine. The mean CRI is 19.3 in Kafountine and 15.3 in Saint-Louis (see Figure 15). As with the SHVI, we grouped households by their CRI score (the least exposed 20%, the moderately exposed 60% and the most exposed 20%). The least exposed households at both sites reported no climate loss at all in the reference period. The most exposed had a mean score of 35.7 in Saint-Louis and 36.6 in Kafountine, so the households at the top of the range are equally exposed at the two sites. The difference between the site mean score comes from the moderately exposed group, which scores 19.3 in Kafountine and 13.4 in Saint-Louis.

Figure 15. Mean CRI by site and exposure group



Two things need to be noted here. First, the CRI covers losses that households are able to see and count. It captures damage to crops, animals and houses, which farming and fishing households and house owners are able to report. Households that have no land, no boat and no assets of their own get a lower score on the index, even when flooding impacts their livelihoods and health. This index on its own therefore does not provide the full picture of what the poorest households lose, and should be read together with the SHVI and with the loss indices in Section 3, where we have covered the losses that impact the poorest households the hardest, in terms of loss of food security, health and schooling. Second, irrespective of slow- or rapid-onset events, exposure impacts are high at both sites with eight in ten households reporting at least one climate-related loss.

2.4 Protective factors: what currently protects households from loss

The third element of the 3P framework is protection. Senegal has a wide social protection system, described in Section 1.2: the RNU, the PNBSF family grants, the CMU and Plan Sésame (Sesame Plan) health schemes,[4] school feeding and emergency relief under the ORSEC plan (Organisation des Secours — Emergency Organisation Plan). This section looks at how much of it reached the households we surveyed.

4 Plan Sésame (Sesame Plan) is a social health policy introduced by the Senegalese government in 2006 to provide free medical care at public health facilities for citizens aged 60 and over.

2.4.1 Access to support and social protection

We asked households whether they had received support under eight types of programmes in the past year. These include food assistance, cash transfers, school feeding, school supplies, agricultural extension, veterinary or fisheries extension, economic assistance and health coverage.

Our analysis shows low coverage at both sites and lowest in Kafountine. Food assistance had reached 37.3% of households in Saint-Louis but only 11.6% in Kafountine. Cash transfers had reached 28.7% in Saint-Louis but only 9.8% in Kafountine. Every other type of support reached fewer than one household in seven at either site: veterinary or fisheries extension (14.8% and 7.9%, respectively), school supplies (4.8% and 6.1%), economic assistance (4.3% and 4.7%), and school feeding (3.8% and 4.2%). No household in Saint-Louis and only 2.3% in Kafountine had received agricultural extension, in a site where 58.6% of households depend on farming.

The higher coverage of food and cash in Saint-Louis matches what communities told us in the participatory assessment. Relief comes after each flood, in the form of food, pumps, sandbags and emergency cash. Nothing comes before the flood and very little comes between floods. In Kafountine the loss is gradual, so there is no event that sets off relief, and the family grants, foodgrain and school materials that households used to receive had been suspended (see Section 1.2). Slow-onset loss falls almost entirely outside the system.

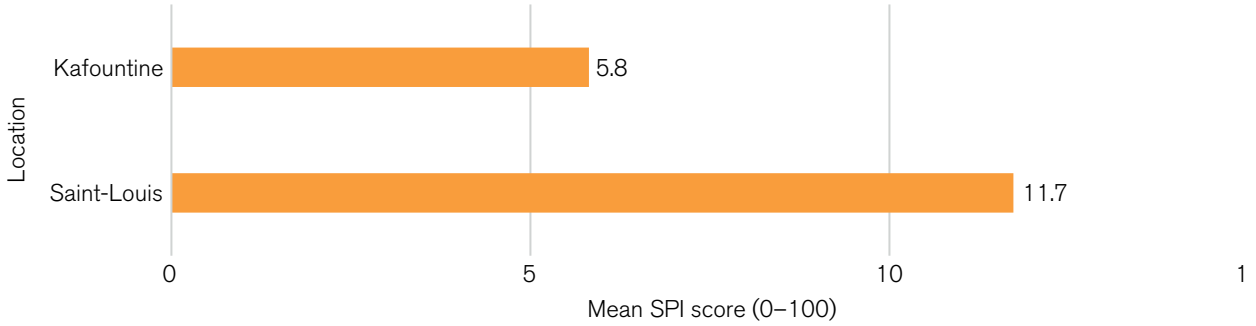
The FGDs described the same support and the same gaps. The support consists of motor pumps installed by the fire service, fuel given by the municipality and by private individuals, and food, detergent, mosquito nets and sandbags from the social protection agencies. In Casamance, it consists of dykes supported by the World Food Programme (WFP) and mangrove planting by NGOs. Communities pay for a large part of their own flood response. Households put money together to buy fuel for the pumps, clear the channels themselves and fill low points with rubble. Participants mentioned the same gaps at every site. There is no planning before the rains, so action comes too late to make a difference. There is no follow up and the efforts are mostly temporary. Targeting is weak, so the households that were actually affected are not always the ones reached. At Pikine Eaux Claires and Khar Yalla, people without national identity documents are left out of all assistance.

2.4.2 The Social Protection Index

To bring these results together, we built an SPI. It is the share of the eight types of support that a household reported having access to, scaled to 100. The scores are very low (see Figure 16). The mean SPI is 11.7 in Saint-Louis and 5.8 in Kafountine. In simple terms, the average household in Saint-Louis had access to about one of the eight types of support, and the average household in Kafountine to less than one in two. Most households at both sites had access to none.

They confirm what our readiness assessment found at national level. The programmes and the registry exist, but in these two sites very few households received any support before a hazard struck, and only some received support afterwards.

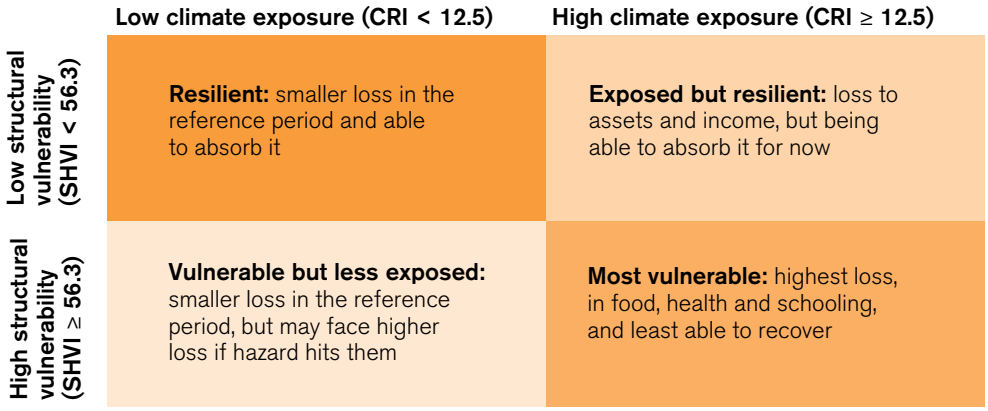
Figure 16. Mean SPI, by site



2.5 Assessing vulnerability and exposure for four types of households

The three sets of factors (3Ps) act together, and they put households in four different positions. A household with low structural vulnerability that is rarely exposed to a hazard is in the best position. A household that is exposed but has assets and support to fall back on is in a second position. A household that is structurally vulnerable but rarely exposed is in a third. A household that is vulnerable and exposed at the same time, with no protection, is in the worst position of all. To find out how many households are in each position, we combined the two indices SHVI and CRI.

Figure 17. Classification of households by structural vulnerability and climate exposure

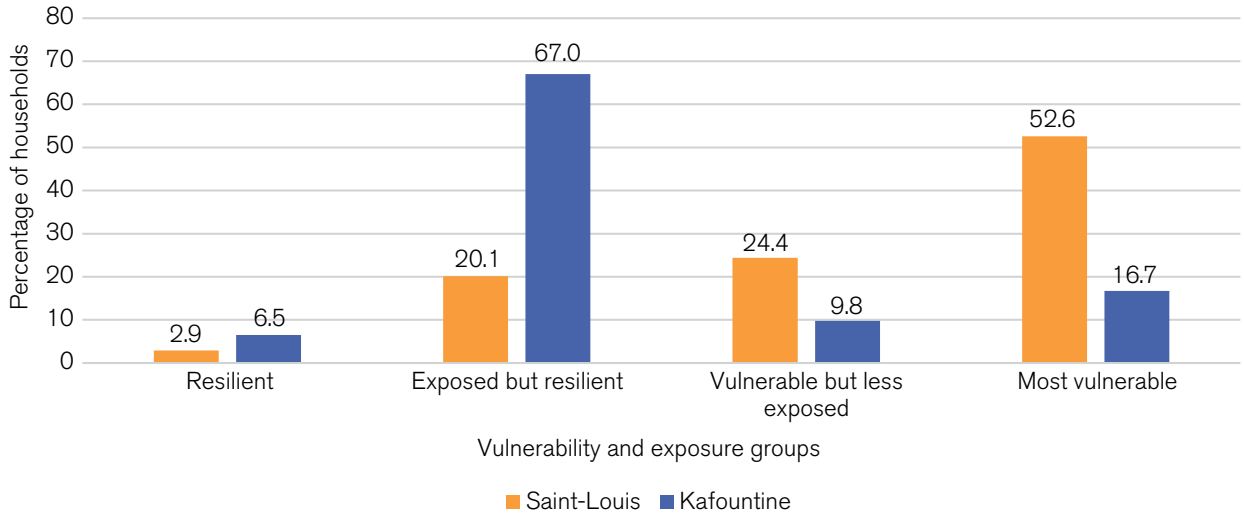


This classification is different from the three groups used earlier in this section. In Sections 2.2 and 2.3 we divided households into the least, moderately and most vulnerable, and the least, moderately and most exposed, using the bottom 20%, the middle 60% and the top 20% of scores. Here we use a framework to put both indices together. We took the median score on each index across all 424 households, which is 56.3 on the SHVI and 12.5 on the CRI. Households above the median on the SHVI were classed as having high structural vulnerability and households below it as having low structural vulnerability. Households at or above the median on the CRI were classed as having high climate exposure and households below it as having low climate exposure. Each cut therefore divides the sample into two halves of equal size.

Putting the two indexes together gives four groups, shown in Figure 17. Resilient households have low vulnerability and low exposure. Exposed but resilient households have low vulnerability and high exposure. They are affected by the hazard but have the assets and income to absorb it. Vulnerable but less exposed households have high vulnerability and low exposure. They are structurally poor but reported little climate loss in the reference period. Most vulnerable households have high vulnerability and high exposure at the same time.

Figure 18 shows which categories the households at the two sites fall into. In Saint-Louis, more than half of all households (52.6%) are in the most vulnerable group. They are structurally poor and exposed to loss at the same time. Another 24.4% are vulnerable but less exposed, and 20.1% are exposed but resilient. Only 2.9% are resilient. In Kafountine, the largest group by far is exposed but resilient, at 67%. These are the farming and fishing households that reported crop and livestock losses but still have land, boats and income to absorb them. Only 16.7% of Kafountine households are in the most vulnerable group, 9.8% are vulnerable but less exposed and 6.5% are resilient.

Figure 18. Distribution of households across the four vulnerability and exposure groups, by site



The focus groups also show how households in the different groups respond. In Saint-Louis, households with money build. They raise the foundations, add a metre of fill and a concrete slab against the water table, or build a second storey to move up to when the water comes. The poorest households fill low points with rubble and wait for the municipality, an NGO or a well-wisher to send a pump. In Kafountine, the two responses are closer to each other, because most households can build a dyke or borrow land, but the poorest households have to resort to migration/displacement. The better-off households are able to pay for protection that lasts for years. The poorest households can only manage from one flood to the next, and some of them move away. Both groups understand the risk they face. What separates them is whether they have the money to do something about it.

The comparison also shows why the two sites need different responses. In Saint-Louis, a large number of structurally poor households live in an area that floods every year. They have few assets and little support. Reducing their losses means reducing their exposure, through drainage, dykes and land-use planning, and delivering support before the rains rather than after. In Kafountine, most households still have land, boats and animals, and this is what allows two thirds of them to cope for now. Salinisation is slowly taking these assets away, and each year more households move from the exposed but resilient group into the most vulnerable group. Reducing their losses means protecting the land and water from salination, and helping households build livelihoods that do not depend on them.

3

What households lose: economic and non-economic loss and damage

Section 2 shows who is vulnerable at the two sites and what they are exposed to. This section shows what they lose. We first present the full pattern of losses across the four C-CIQ domains, using the survey and the community assessments. We then analyse who bears each type of loss, using the non-economic loss and damage indices by vulnerability grouping, and what the losses cost in money. After that we have presented the statistical relationship between structural vulnerability and each type of loss using regression modelling.

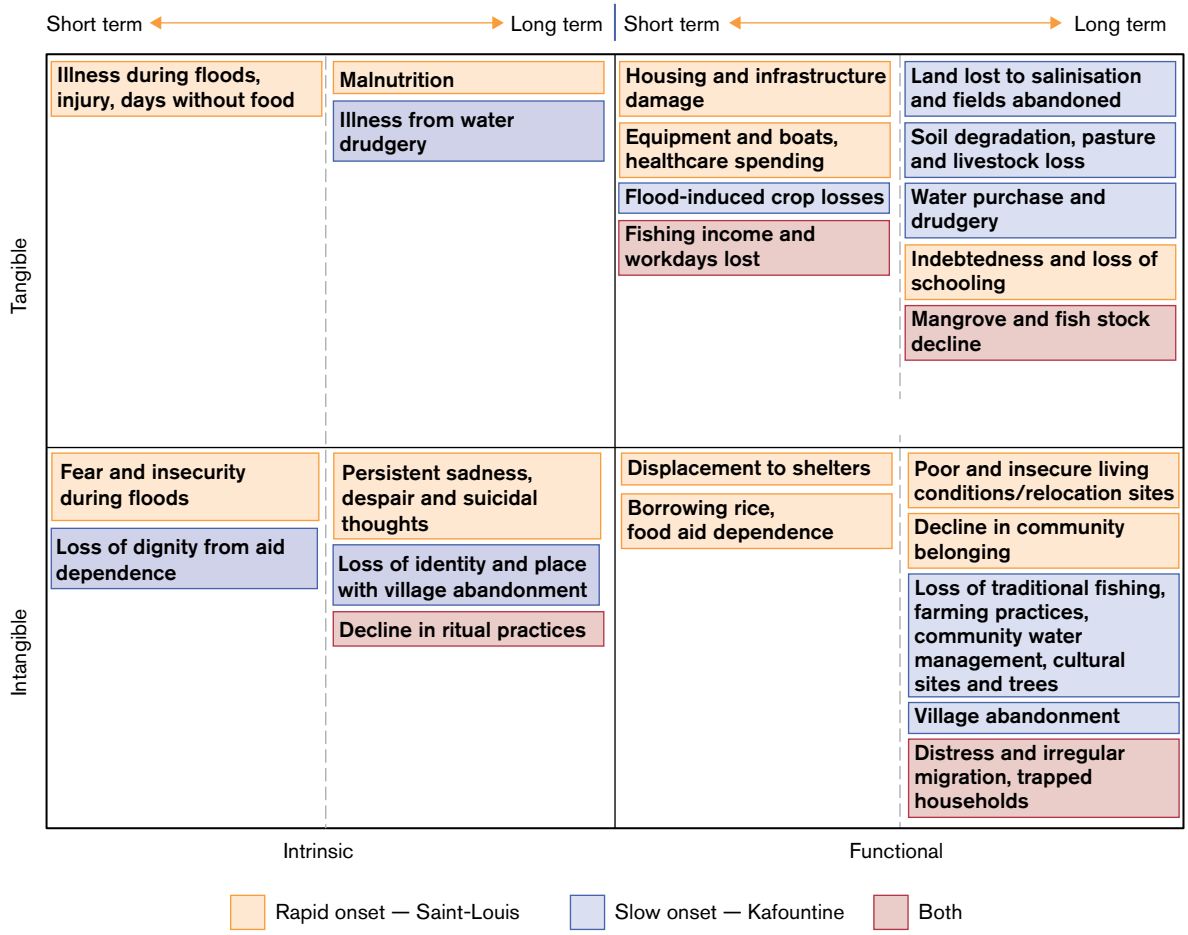
3.1 The pattern of loss at the two sites

The C-CIQ framework categorises loss and damage along two dimensions. The first is the tangibility dimension, which asks whether a loss is tangible or intangible. A tangible loss is one that can be seen and counted, such as a damaged house or a lost harvest. An intangible loss is one that cannot be counted, such as distress or the loss of a way of life. The second is the value dimension, which asks whether what was lost had a functional or an intrinsic value. A functional value is one that served a purpose, such as earning an income or getting to school. An intrinsic value is one that mattered in itself, such as health, dignity or belonging. Together the two dimensions give four domains of loss: tangible–functional, tangible–intrinsic, intangible–functional and intangible–intrinsic.

The economic and non-economic distinction used by the UNFCCC does not map one-to-one onto these four domains. Economic losses are those that have a market price, and they fall mainly in the tangible–functional domain: houses, equipment, crops, land and income. Non-economic losses are those that are not commonly traded in markets, and they are found in all four domains. Illness and hunger are tangible and intrinsic, displacement and the loss of practices are intangible and functional, distress and dignity are intangible and intrinsic, and some tangible–functional losses, such as missed days of schooling and biodiversity loss, are also non-economic because no market price is attached to them. Indebtedness is tangible–functional and economic. We have included it among the indices in Section 3.2 because it is the main way the poorest households absorb economic loss and it typically does not get captured in asset-based loss assessments.

The framework also places each loss in time, from the days after an event to the years that follow. Figure 19 places the losses identified in Saint-Louis and Kafountine in these four domains, and the colours show the site where each loss was reported.

Figure 19. Economic and non-economic loss and damage in Saint-Louis and Kafountine, by C-CIQ domain



Three things can be seen from Figure 19. The first is that the losses in Saint-Louis are mostly short term and the losses in Kafountine are mostly long term. When Pikine floods, houses are damaged, work stops, people fall ill and families move into shelters within a few days. In Kafountine, salt takes away land, pasture, water and fish stocks gradually over the years. The second is that Saint-Louis has more losses in the intrinsic domains, such as illness, injury, hunger, fear and distress. The losses in Kafountine are mostly in the functional domains, because they come through the assets and resources that households use to make a living. The third is that only a few losses are found at both sites. Loss of fishing income, workdays lost, decline of mangroves and fish stocks, decline in ritual practices and distress migration were reported at both sites. Almost everything else belongs to one site or the other. In this section we have explained each of these four domains of losses.

3.1.1 Tangible and functional loss: houses, land and income

These are the losses that can be counted and that affect how households earn their living. In Saint-Louis, the biggest loss is to the house. Section 2 reported that 61.7% of households had their house damaged in the last flood. Among the households that reported damage, the most common forms were water damage to walls and floors, damage to the roof, and the destruction of equipment: 26 households reported that part of the house had collapsed and 22 that the whole house had been destroyed. Damage to the house is also damage to the place of work, because in Pikine much of the small trade, food preparation and fish processing that women do is done at home or in the lane in front of it. The participatory assessment explained what happened after these events. Drivers are not able to take their vehicles out for one or two days, trade slows down, transport becomes more expensive, and households that are not able to cook go without a cooked meal. In Saint-Louis, 44 households (21.1%) said they had not been able to go back to work after the last flood, and another 31 (14.8%) took more than a month to do so.

In Kafountine, the biggest loss is to the land. Crop loss from climate was reported by 73% of households (see Section 2). The survey also asked about the slower changes behind that figure. Of the households that answered the questions on soil, more than two thirds agreed or strongly agreed that soil moisture, fertility and productivity had declined and that erosion had increased. Loss of income from soil degradation was reported by 55.2% of households in Kafountine, and

loss of income from wider environmental degradation, which includes the loss of mangroves, fish and forest, by 41.4%. In Saint-Louis the figures were 3.9% and 15.3%. Households in Kafountine described these as losses that have gone on for a long time rather than the result of a single event. The median household had been losing income to soil degradation, and to environmental degradation, for ten years. Water is the other loss that was mentioned often. Half of the households in Kafountine (49.8%) said that drinking water was not available, compared with 12% in Saint-Louis. In Niomoune, the wells turn brackish by May. Rainwater stored in containers runs out before the end of March, and after that households depend on the cisterns installed in 1994 and pay a small fee for their upkeep. The participatory assessment recorded that people fall ill more often because of the lack of clean water, and bone and joint pain was named in particular.

Two tangible losses fall mainly on the poorest households in Saint-Louis. The first is debt. Among the households that were willing to answer, 38.7% in Saint-Louis had an outstanding debt, compared with 23% in Kafountine. At both sites the most common reason for borrowing was to meet daily needs, followed by health and food. Most loans came from traders and input suppliers or from family and friends, and very few from banks. The second is schooling. In Saint-Louis, 27.9% of households with school-age children said that the school year had started late in the past three years because of flooding. No household in Kafountine reported this. Of the households in Saint-Louis that were affected, 29 said their child had missed more than two weeks of school and 22 believed the child had fallen behind. The participatory assessment listed the late opening of schools and a high rate of school dropout among the main flood problems in Pikine.

3.1.2 Intangible and functional loss: displacement, dependence and loss of practices

These losses affect what households are able to do. In Saint-Louis, the first of them is displacement. Of the households in Pikine that answered the question, 30.2% had been displaced by floods in recent years. Those who were displaced stayed in tents or under plastic sheeting, in community camps, with relatives, or in schools and mosques. The survey also sampled 48 households that had been permanently relocated from the coast, and Box 2 describes what that relocation has cost them.

The second is dependence on others. Rice is the staple food at both sites, but households get it in different ways. In Kafountine, 57.9% of households still grow most of their own rice and 40.6% buy it. In Saint-Louis, 91.3% buy it, and 64.9% said that borrowing was their second source of rice, compared with 6.9% in Kafountine. Borrowing rice from the shopkeeper each week is how a household in Pikine gets through the flood months, and it is one of the reasons that debt is so common. Section 2.4 showed that 37.3% of households in Saint-Louis had received food assistance. Seen from the other side, this means that a third of households now depend on aid arriving after each flood.

In Kafountine, the intangible–functional losses are the practices and institutions that were built around rice and the river. Around half of households at both sites agreed that traditional foods are eaten less often than before (57.9% in Saint-Louis and 50.7% in Kafountine) and that cultural or ritual practices have declined (40.7% in Saint-Louis and 46% in Kafountine). In Niomoune and Kouba, the loss can be seen on the ground. Rice fields on the islands that fed the villages for generations are now covered in salt and no longer farmed. Five neighbouring islands that were once farmed, Koufoukène, Lekhoul, Khintène, Elendeguène and Djimbodji, have been abandoned altogether because of salinisation (see Section 1).

The households that have stayed have had to find other work. The participatory assessment in Kafountine recorded that after the rainy season men now take up work as masons, drivers and mechanics. These are jobs that were done only by people from outside the village until a few years ago. A decline in the sense of belonging to the community was reported by 34.9% of households in Saint-Louis and 16.3% in Kafountine. In Pikine, the assessment linked this to disputes between neighbours over floodwater pushed from one house into the next, and to the lack of help between concessions when no one has the means to give it.

3.1.3 Tangible and intrinsic loss: illness, injury and hunger

These are losses to the person that can be counted, and they are concentrated in Saint-Louis. In Kafountine, 28 households reported illness linked to salinisation. Half of the households in Saint-Louis (49.3%) had a member fall ill during the last floods. The illnesses were mostly caused due to standing water. Malaria or dengue was reported by 80 households, respiratory illness by 30, diarrhoea by 28, malnutrition by 25 and skin infections by 24. The 103 households that spent money on healthcare during the last flood spent about 60,000 XOF on average. Getting to a medical centre was worse. Only 54 households in the whole sample said that emergency transport was available during floods, and the participatory assessment recorded the sick and the dead being carried by cart, wheelbarrow or on people's backs to the main road or to the mosque.

Hunger followed the same pattern. Food was scarce during or after the last climate event for 61.2% of households in Saint-Louis and 14.4% in Kafountine. Days without a proper meal were reported by 60.3% in Saint-Louis and 7.4% in Kafountine, and at least one whole day without eating by 23.9% and 0.9%, respectively. In Pikine, the assessment recorded households skipping meals during floods, and residents listed child deaths among the problems that floods bring. In Kafountine, hunger is mostly linked to season rather than with a climate event. Household heads described the lean months before the harvest as the time when the reserves run out and they borrow to buy food. Both are food insecurity, but they happen at different times and for different reasons, and they need different responses (see Section 4).

3.1.4 Intangible and intrinsic loss: distress, dignity and identity

These are the losses that cannot be counted but they matter to individuals. The survey asked each respondent how often they had experienced eight symptoms of distress during and after the climate event. Persistent sadness, often or very often, was reported by 62.7% of respondents in Saint-Louis and 23.7% in Kafountine. Suicidal thoughts were reported by 14.8% in Saint-Louis and 12.6% in Kafountine; 30 respondents said the symptoms left them unable to work, and only eight of the 424 were receiving any treatment.

Two more losses were named by the communities. One is dignity. At both sites, households said that depending on relief, on borrowing and on the goodwill of others was a loss in itself. The other is loss of identity and place. In Kafountine, the abandonment of islands and fields breaks the link between families and the land their grandparents gave them. In Niomoune, every family holds plots that were passed down in this way. Relocated households in Saint-Louis described a loss of the same kind. Children who have grown up at Khar Yalla cannot swim, despite being from a fishing community (see Box 2). The decline in ritual practices was reported at both sites. This is a functional loss because a ritual that no longer takes place is a loss to the community's sense of who it is.

3.2 Who bears the loss?

Figure 19 shows what each site has lost. It does not show which households within each site lose the most. To answer that question, we built eight loss and damage indices from the survey: seven for non-economic losses and one for assessing indebtedness (see Section 3.1), following the C-CIQ index method. We then compared them across the three vulnerability groups defined in Section 2: the least vulnerable, the moderately vulnerable and the most vulnerable. The reason for these eight is explained in Section 1.4. Each index runs from 0 to 100, and a higher value means a greater loss. Table 2 gives the results by site.

Table 2. Economic and non-economic loss and damage indices by site and vulnerability group (0 to 100)

Index	Saint-Louis: least vulnerable	Saint-Louis: moderately vulnerable	Saint-Louis: most vulnerable	Kafountine: least vulnerable	Kafountine: moderately vulnerable	Kafountine: most vulnerable
Food insecurity	36.7	49.4	48.5	4.9	8.0	33.3
Indebtedness	6.1	25.6	36.2	11.6	10.0	43.0
Loss of health	0.0	45.0	49.7	0.0	0.0	0.0
Loss of education	0.0	20.3	23.2	0.0	0.0	0.0
Mental distress	44.7	50.8	46.3	29.4	31.7	30.2
Cultural erosion	67.1	59.7	57.6	51.9	50.0	57.9
Biodiversity loss	30.9	56.5	55.9	68.6	69.7	63.0
Land degradation	10.0	35.9	34.4	71.3	75.5	50.0
Number of households	10	120	79	75	134	6

Table 2 shows a clear contrast. Losses affecting people and household wellbeing generally become more severe as vulnerability increases. In Saint-Louis, the food insecurity index rises from 36.7 among the least vulnerable households to 48.5 among the most vulnerable. Over the same range, the indebtedness index increases from 6.1 to 36.2, the health index from 0 to 49.7, and the education index from 0 to 23.2. A similar pattern can be seen in Kafountine, where the

food insecurity index rises from 4.9 to 33.3 and the indebtedness index from 11.6 to 43. Across both sites, therefore, the households already facing the greatest vulnerability are also more likely to experience hunger, debt, illness and disruption to their children's education when a hazard occurs.

Losses involving land and the natural environment follow a different pattern. They do not consistently increase with household vulnerability and, in some cases, are lower among the most vulnerable households because they do not own assets. In Kafountine, for example, the land degradation index falls from 71.3 among the least vulnerable households to 50 among the most vulnerable, while the biodiversity index declines from 68.6 to 63.0. In Saint-Louis, however, the least vulnerable households record the lowest scores for both indicators.

These findings should not be interpreted as evidence that poorer households are less affected by environmental loss. Rather, the indices partly reflect what households own or have access to. Less vulnerable households are more likely to have land, pasture, boats or access to mangrove resources and are therefore able to report losses associated with them. A landless household in Pikine may report no land degradation for the same reason that it reports no crop loss. That is because it has no land or crops to lose. This does not mean that the household is unaffected by the hazard, but that the effects are experienced through other aspects of its wellbeing and livelihood.

Table 3 shows the same two patterns across the whole sample, using the share of households in each vulnerability group that reported each loss.

Table 3. Households reporting each loss, by vulnerability group

Loss	Most vulnerable (%, out of 85 households)	Moderately vulnerable (%, out of 254 households)	Least vulnerable (%, out of 85 households)
Losses to the person and household			
Food scarce during climate events	52.9	39.4	16.5
Whole day without eating	24.7	12.2	0.0
Illness during floods	51.8	23.2	0.0
School start delayed by flooding	30.6	12.2	0.0
Housing and infrastructure damage	42.4	38.2	17.6
Displaced by floods	11.8	9.4	4.7
Employment loss due to climate	7.1	3.5	2.4
Losses to productive assets and resources			
Crop loss	0.0	35.8	67.1
Land abandoned because of climate	1.2	20.1	50.6
Livestock deaths from climate events	4.7	16.9	17.6
Fish-catch decline attributed to climate	2.4	11.0	32.9
Income loss from soil degradation	1.2	24.4	48.2
Income loss from environmental degradation	17.6	28.0	41.2
Decline in fish and seafood species	42.4	69.7	89.4

The contrast between the groups is striking, but it operates in different ways. Among the most vulnerable households, 52.9% experienced food shortages, 51.8% reported that someone in the household had fallen ill during the floods, and 30.6% had a child whose entry into school was delayed. Among the least vulnerable, the corresponding figures were 16.5%, 0% and 0%.

The pattern is reversed for losses involving natural resources and productive assets. Among the least vulnerable fifth, 67.1% reported crop losses, 50.6% had abandoned land, and 32.9% had experienced a climate-related decline in fish catch. Among the most vulnerable, the corresponding figures were 0%, 1.2% and 2.4%. Some of this contrast reflects

differences between the two study sites. Most households in the most vulnerable group are located in Saint-Louis, while most of those in the least vulnerable group are in Kafountine. However, as Table 2 shows, the same broad pattern is also visible within each site.

The policy implication of this is important. The households reporting the greatest asset losses are not necessarily those facing the greatest vulnerability. Households with land, livestock or boats have productive assets that can be damaged or lost, and these losses are readily recorded. Households with few or no such assets may appear to have lost less, even though they experience more severe consequences in the form of hunger, illness, interrupted schooling and rising debt. Assessments that focus only on the value of lost assets risk overlooking these households. Responses designed around asset replacement may also fail to reach them. We have covered this issue in Section 4 on how responses should be framed to support most vulnerable.

3.3 What does the loss cost?

We estimated the monetary value of the economic losses reported in the survey using the same approach as in the earlier studies in Mali (Bharadwaj et al., 2025) and India (Bharadwaj et al., 2024a). For each type of loss, households were asked to estimate, in XOF, the value of what they had lost during the most recent event. For continuing losses, such as income foregone because of soil degradation, they were asked to estimate the loss over the preceding year.

The figures presented here are averages across all surveyed households at each site. Where a household did not report a particular loss, its value for that item was recorded as zero. The results therefore represent the loss borne by the average household across the study site, rather than the average among affected households alone. To show the scale of these losses, they are also expressed as a proportion of average annual household income at each site. As in the Mali study, event-related figures refer to the most recent event year and are not annual averages calculated over several years. The results are presented in Table 4.

Table 4. Economic loss and damage per household, by site

Type of loss	Saint-Louis (XOF)	Kafountine (XOF)	Saint-Louis (% of annual income)	Kafountine (% of annual income)
Annual household income	758,584	986,000		
Housing and infrastructure damage from floods	1,146,543	12,465	151.1	1.3
Fishing income lost to floods	75,311	34,228	9.9	3.5
Crop loss from floods	21,531	43,370	2.8	4.4
Crop loss from rainfall deficit and salinisation	–	101,483	0.0	10.3
Income lost through inability to work	69,187	47,878	9.1	4.9
Healthcare spending during floods	29,601	–	3.9	0.0
Spending on drinking water (annual)	20,236	23,132	2.7	2.3
Income lost to environmental and biodiversity degradation (annual)	66,675	71,489	8.8	7.3
Income lost to soil degradation (annual)	8,373	81,717	1.1	8.3
Medical costs of serious injury	36,477	10,403	4.8	1.1
Potential income lost after the death of a breadwinner	100,897	22,795	13.3	2.3
Outstanding debt	47,421	29,176	6.3	3.0
Total loss and damage	1,622,252	478,136	213.9	48.5

The estimated total comes to 1,622,252 XOF per household in Saint-Louis and 478,136 XOF in Kafountine. These amounts are equivalent to 213.9% and 48.5% of average annual household income, respectively. Put differently, the combined losses reported by the average household in Saint-Louis amount to more than two years of income. In Kafountine, they are equivalent to almost half of one year's income.

The composition of these losses differs markedly between the two sites. In Saint-Louis, damage to housing and infrastructure dominates, amounting to 1,146,543 XOF per household. This represents just over 70% of the total estimated loss and is equivalent to 151% of average annual household income. It reflects the repeated costs faced by households when floodwater enters their homes, as described in Section 2.2. Other substantial losses include potential income foregone following the death of a breadwinner (100,897 XOF), fishing income lost because of floods (75,311 XOF), and income lost when household members were unable to work (69,187 XOF). Flood-related healthcare spending added a further 29,601 XOF per household.

In Kafountine, no single item accounts for most of the total. Instead, losses are spread across land-based livelihoods and the natural resources on which they depend. Crop losses associated with rainfall deficits and salinisation averaged 101,483 XOF per household. Income losses linked to soil degradation amounted to 81,717 XOF, while environmental and biodiversity degradation accounted for a further 71,489 XOF. Households also reported 47,878 XOF in income lost through an inability to work and 43,370 XOF in flood-related crop losses. Taken together, the three losses most directly linked to land and environmental degradation amount to 254,689 XOF per household, just over half of the total estimated loss in Kafountine.

The timing of these losses also differs. In Saint-Louis, much of the financial burden arises in the immediate aftermath of a flood. At a time when earnings may already have stopped, households must find money to repair their homes and replace damaged possessions. In Kafountine, a substantial share of the loss is gradual and recurring. Annual income losses associated with soil, environmental and biodiversity degradation total 153,206 XOF per household, or about 16% of average annual income. These losses are likely to continue from year to year, even when there is no major flood. A one-off relief payment following a disaster may help with some of the immediate costs faced in Saint-Louis, but it does little to address the continuing erosion of livelihoods in Kafountine.

Even these estimates do not capture the full cost to households. They exclude the non-economic losses discussed in Section 3.1, including disrupted schooling, ill health, mental distress, and the loss of cultural practices and a sense of belonging. We have quantified these losses but have not assigned a money value to them. If we had, the loss suffered by households would be higher still than the figures shown here.

3.4 What drives the loss?

As structural vulnerability increases, losses affecting people and household wellbeing become more pronounced, while reported losses of land and productive assets tend to decline. Those findings were based on comparisons among three groups of households. We therefore examined the relationship across all 424 households, looking at each type of loss separately. The purpose was to establish the strength of these relationships and whether they were likely to reflect more than chance variation.

3.4.1 Assessing how the likelihood of each loss changes with structural vulnerability

Each loss recorded in the survey has a binary outcome. A household either reported experiencing it or did not. We used binomial logistic regression to examine how the likelihood of each loss changed with structural vulnerability. The same model was estimated separately for each of the 23 types of loss, ranging from crop loss to disruption of education. In every model, the SHVI was the explanatory variable, entered in units of ten points, so that every result describes the change in the odds of a loss for a ten-point rise in vulnerability. Using a consistent model allowed the results to be compared across different losses. Box 3 provides further details.

The regression analysis tells us two things: whether a loss becomes more or less common as vulnerability rises, and how strong that association is. This is expressed through an odds ratio.

Box 3. How we tested the relationship between vulnerability and loss

Our analysis used survey data from 424 households. For each household, the survey recorded whether it had experienced 23 types of loss during or following the most recent climate-related event. These covered: livelihoods and productive assets, including crops, land, livestock, fishing, equipment and employment; damage to housing and infrastructure; food insecurity, illness, injury and death; land and biodiversity degradation; debt and displacement; and losses involving education, health, mental wellbeing and culture.

The purpose was to identify the losses most strongly associated with structural vulnerability across the sample. A separate binomial logistic regression was estimated for each outcome, using the SHVI as the explanatory variable. This provided a consistent basis for comparing the direction and strength of the relationships across different types of loss. The model was specified as:

$$\text{logit}[P(Y_i = 1)] = \alpha + \beta_1(SHVI_i/10)$$

where:

$Y = 1$: the household experienced the particular loss
$Y = 0$: the household did not experience the loss
$P(Y = 1)$: probability that the household experienced the loss
$\text{logit}[P(Y = 1)]$: the log of the odds of the loss, which is the scale on which the model is estimated
α: constant or intercept
β_1: estimated effect of the SHVI
SHVI/10: the SHVI divided by ten, so that a one-unit change is a ten-point rise in vulnerability

The odds ratio is calculated as $\exp(\beta_1)$. Because the index entered the model in units of ten points, the odds ratio is directly the proportional change in the odds of the loss for a ten-point rise in vulnerability. A p-value below 0.05 is treated as evidence of a statistically significant relationship.

Most models used all 424 households. Two losses were only asked of the households they could apply to: land abandonment was estimated among the 212 households practising agriculture, and soil-related income loss among the 259 households that answered the question. Two outcomes, death due to disaster and cultural erosion, could not be estimated as no household reported a disaster-related death, and every household registers some cultural erosion, so there is nothing for the model to compare.

An odds ratio of 1 means that there is no association between vulnerability and the reported loss. A value above 1 means that the odds of reporting the loss increase as vulnerability rises. For example, an odds ratio of 1.3 means that the odds are 30% higher, while an odds ratio of 2 means that they are twice as high. A value below 1 means that the odds decrease. An odds ratio of 0.7 means that they are 30% lower, while a value of 0.5 means that they are half as high.

The size of the odds ratio shows the strength of the association. The further the value is from 1, the stronger the association. However, odds are not the same as the percentage of households experiencing a loss. The actual change in the number of households depends on how common the loss was to begin with. For example, if 20 out of 100 households report illness during a flood, doubling the odds would increase the estimated number to about 33 out of 100, not 40 out of 100.

The p-value tells us how strong the statistical evidence is for the association. A p-value below 0.05 is treated as statistically significant. This means that the pattern observed in the survey would be relatively unlikely if there were no association between vulnerability and that loss.

3.4.2 What the results show

Table 5 shows how the odds of reporting each loss change when a household's vulnerability score rises by ten points. The losses are grouped according to whether they become more common, less common, show no statistically clear association with vulnerability, or were reported by so many households that the model cannot separate them. The results reinforce the two broad patterns identified in Section 3.2.

Table 5. Structural vulnerability and the odds of reporting different losses: logistic regression results

Type of loss	Households reporting the loss (number in model)	Odds ratio for a ten-point rise	Statistical evidence	What the result means
Losses that increase with vulnerability				
Loss of health	103 (424)	2.05	Very strong ($p < 0.001$)	Odds are approximately twice as high
Illness during floods	103 (424)	2.04	Very strong ($p < 0.001$)	Odds are approximately twice as high
Loss of education	61 (424)	2.02	Very strong ($p < 0.001$)	Odds are approximately twice as high
Serious injury due to disaster	4 (424)	2.54	Some evidence ($p < 0.05$)	Odds are about 2.5 times as high, but the estimate is based on only four cases
Food insecurity (composite index)	187 (424)	1.70	Very strong ($p < 0.001$)	Odds are about 70% higher
Food scarcity (household went short of food)	159 (424)	1.44	Very strong ($p < 0.001$)	Odds are about 44% higher
Infrastructure damage	148 (424)	1.33	Very strong ($p < 0.001$)	Odds are about 33% higher
Indebtedness	113 (424)	1.30	Very strong ($p < 0.001$)	Odds are about 30% higher
Losses that decrease with vulnerability				
Soil-related income loss	104 (259)	0.58	Very strong ($p < 0.001$)	Odds are about 42% lower
Land and soil degradation	253 (424)	0.58	Very strong ($p < 0.001$)	Odds are about 42% lower
Decline in fish catch	73 (424)	0.59	Very strong ($p < 0.001$)	Odds are about 41% lower
Crop or yield loss	75 (424)	0.61	Very strong ($p < 0.001$)	Odds are about 40% lower
Land abandonment (farming households)	95 (212)	0.70	Strong ($p < 0.01$)	Odds are about 30% lower
Livestock deaths	62 (424)	0.74	Strong ($p < 0.01$)	Odds are about 26% lower

Type of loss	Households reporting the loss (number in model)	Odds ratio for a ten-point rise	Statistical evidence	What the result means
No statistically clear association				
Employment loss	17 (424)	1.19	Not statistically significant ($p = 0.32$)	The survey does not provide clear evidence that this loss changes with vulnerability
Equipment and tool loss	34 (424)	1.12	Not statistically significant ($p = 0.35$)	The survey does not provide clear evidence that this loss changes with vulnerability
Reported by almost every household				
Biodiversity loss	416 (424)	1.45	Not statistically significant ($p = 0.13$)	Reported by 98% of households, so the model has too few households without the loss to compare
Mental distress	402 (424)	0.65	Strong ($p < 0.01$)	Reported by 95% of households; the result rests on the 22 households that reported none and should not be read as evidence that distress falls with vulnerability
Could not be estimated				
Death due to disaster	0 (424)	–	No cases	No household reported a disaster-related death
Cultural erosion	424 (424)	–	No variation	Every household registers some cultural erosion under the current coding

Losses affecting people and household wellbeing become more common as vulnerability rises. A ten-point increase in vulnerability approximately doubles the odds of reporting loss of health, illness during floods or disruption to education. Food insecurity also has a strong association with vulnerability. The odds of scoring on the composite food insecurity index are about 70% higher for every ten-point increase, and the odds of the household having gone short of food are about 44% higher. The corresponding increases are around 33% for infrastructure damage and 30% for indebtedness.

The estimate for serious injury suggests a particularly large increase in the odds. However, only four surveyed households reported a serious injury. The result is consequently unstable and should not be used as a basis for policy decisions without further evidence.

The pattern is reversed for losses involving land and productive assets. As vulnerability increases, households are less likely to report soil-related income loss, land degradation, declining fish catches, crop losses, land abandonment or livestock deaths. For example, a ten-point increase in vulnerability is associated with about 40% lower odds of reporting soil-related income loss, crop loss or a decline in fish catch, and, among farming households, about 30% lower odds of reporting land abandonment.

This apparently counterintuitive result does not mean that more vulnerable households are protected from environmental or livelihood losses. It reflects, at least in part, what households own or can access. Households with fields, pasture, boats or livestock have assets that can be damaged or lost. Households without these assets cannot report losing them. Almost every surveyed household in Pikine is landless, as discussed in Section 2.2. The result for crop loss therefore reflects differences in land ownership and access, as well as differences in exposure to climate hazards.

Equipment and employment losses appear across the vulnerability range. A fisher may lose a pirogue, while a small trader may lose the table or tools needed to earn an income. Neither shows a clear association with vulnerability.

Three losses were reported by almost every household, and for these the model did not provide a conclusive result. Biodiversity loss was reported by 98% of households at both sites and therefore does not separate households with different vulnerability scores. Cultural erosion was registered by every household, so no comparison was possible. Mental distress was reported by 95% of households. The model returns lower odds for more vulnerable households, but the result rests on the 22 households that reported no distress at all, and it should not be read as evidence that distress falls as vulnerability rises. Two thirds of respondents in Saint-Louis reported persistent sadness (see Section 3.1). Distress is experienced across the community rather than being confined to the most vulnerable households.

The findings on health and education deserve particular attention. Both become markedly more common as vulnerability rises, yet neither is adequately addressed by the support currently available at the two sites. Assistance following floods generally consists of food, pumps, sandbags and cash, as described in Section 2.4. This assistance is valuable, but it does not compensate for lost schooling or provide sustained support for illnesses caused or aggravated by prolonged exposure to flood water.

The policy implication is that while crop insurance, livestock support and rebuilding grants remain important for households that lose productive or physical assets, the most vulnerable households also need support that protects people and their wellbeing, alongside these measures. This includes cash and food before the rains, accessible healthcare during and after floods, and practical support that allows children to remain in school. Section 4 considers what would be required to put this broader approach into practice.

3.5 Migration and displacement

Migration is a response to loss, and it is also a loss in itself. In the year before the survey, 29.2% of households in Saint-Louis and 10.7% in Kafountine had a member migrate for work. The destinations differ. Of the 60 households in Saint-Louis that named a destination, 31 said outside Senegal and 28 said another region of Senegal. Of the 23 in Kafountine, six said outside Senegal, ten said elsewhere in the region and seven said another region. Among the 37 households with a member abroad, 22 named Spain, nine named Mauritania, and the rest named France, Italy, The Gambia or another country. Of the 37, 27 or 73% said the migrant had travelled by an informal or irregular route, by boat or overland. Saint-Louis is one of the departure points on the Atlantic route to the Canary Islands, which received a record 46,843 people in 2024 (Al Jazeera, 2025).

For the most part, households did not describe these journeys as climate migration. When asked why the member had left, 29 of the 37 international migrant households gave the lack of local employment and 17 gave the need to support the family. Seven gave low agricultural income or falling fish stocks, and five named climate impacts directly. This fits the account of the fishery industry in Section 2.2, where the fall in catches was put down to industrial fishing, storms, salinity and the gas platforms together. So, climate is a stress multiplier or one of several pressures behind the decision to leave.

However, there are also many households that would like to migrate but are not able to. Of the households with no migrant, 33.6% in Saint-Louis and 18.2% in Kafountine said that migration would be preferable but was not possible. Almost all of them gave money as the reason (49 of the 50 in Saint-Louis and 26 of the 35 in Kafountine). When asked what not being able to migrate meant for the household, 28 of the 35 in Kafountine and 21 of the 50 in

Saint-Louis said food insecurity. These are the trapped households, who are too poor to leave and too exposed to stay. Displacement within Saint-Louis also varies with vulnerability. Flood displacement was reported by 13.9% of the most vulnerable households, 22.5% of the moderately vulnerable and 40% of the least vulnerable.

Displacement does not end loss. The survey included 53 displaced and migrant households, 48 of which had been relocated from the coast to sites such as Khar Yalla. For these households, it compared conditions at the place of origin with conditions at the place of relocation. Food scarcity rose from 45.3% of households to 69.8%. Days without a proper meal rose from 34% to 60.4%, illness during floods from 15.1% to 49.1%, and households without a secure title to their home from 43.4% to 79.2%. The mental distress score rose from 42.6 to 50.1. Relocation moved these households from the risk of the sea to the risk of standing water, and it moved them away from the fishing grounds, schools and services that they depended on (see Box 2). For the planned relocation of more households from the Langue de Barbarie, the lesson is that a site without livelihoods, services and tenure moves the loss to a new place rather than reducing it.

4 Recommendations

Our assessment of economic and non-economic loss and damage in Saint-Louis and Kafountine shows two different routes to the same outcome. In Saint-Louis, floods and storm surges destroy homes, roads, schools and livelihoods in a matter of days, every year. In Kafountine, salinity and the sea destroy rice fields, wells, beaches, mangroves and the sites that carry the community's identity, gradually each year. In both places, the households that lose most are those that were already vulnerable before the hazard struck, especially tenants and widow-headed households in Pikine, island households and women farmers in Kafountine, and families that have already been displaced once.

Well-designed social protection can act as both a safety net and a route to recovery, preventing households from falling deeper into vulnerability while helping them rebuild and adapt. But in Senegal, while social protection programmes are there, they do not reach the households when they need it most. Family security grants were suspended during the study period, health coverage under the Sesame Plan was irregular, and emergency relief arrived late, was unevenly targeted and limited to pumping water out of houses. Our readiness assessment of Senegal's social protection system found the same pattern at national level. There are sound policies, a registry of vulnerable households and programmes with national reach, but no early warning triggers, no pre-arranged finance and weak delivery at the last mile: the final, critical gap between a national or regional response and the actual person or community at risk (Bharadwaj et al., 2023). The recommendations below aim to close these gaps. They address both the immediate losses households face and the structural drivers of risk, and they are built on what communities in Saint-Louis and Kafountine and stakeholders at the national workshops recommended they needed.

The losses assessed through this study are of three kinds, and they need three kinds of response. Some can still be prevented or reduced, such as the flooding of houses in Pikine and the further spread of salt into the fields of Kafountine. Some happen every year and cannot be prevented in the short term, such as the food shortages, illness and debt that follow each flood, and these need support that arrives before the loss rather than after it. Some are permanent. Five islands near Niomoune are no longer inhabitable, Kouba has lost around 30% of its farmland, and the households relocated to Khar Yalla are not going back. For these, the response is to recognise the loss and help households develop new livelihoods. Relocation cuts across all three. It reduces exposure to the sea, but Box 2 shows that at Khar Yalla it created new losses in food, health and distress, so a relocation has to be judged by the losses it creates as well as the ones it prevents. Adaptation and responses to loss and damage are therefore not separate efforts. They are different stages of the same work, from preventing a loss, to supporting households while it happens, to helping them when it cannot be undone. The recommendations below cover all three stages.

While these recommendations are made for Senegal, they hold lessons for other LDCs facing the same combination of rapid- and slow-onset impacts.

4.1 Match responses to hazards: anticipate floods, adapt to salinity

Rapid- and slow-onset impacts need different responses, and the current responses in both study sites are reactive. Communities in Saint-Louis described relief being provided after the water had entered the house. Communities in Kafountine described dykes rebuilt by hand each year by them and abandoned rice fields because of salinity, where no programme has come to support them to recover. Participants at the national workshop made the same point. The

adaptation measures in place remain essentially emergency responses, and what is needed is prevention and planned adaptation built around the specific vulnerability of each place.

For Saint-Louis, the priority is to stop floodwater from reaching the house and to act before it does. Communities and the municipality identified a shortlist of measures that would reduce losses quickly, such as: completing and maintaining the stormwater drainage network, with screens to stop waste blocking the channels; reinforcing the dyke that protects the Pikine and Guinaw Rail; enforcing the ban on building in non-aedificandi (not to be built upon) zones and giving residents of Pikine the title deeds they need for neighbourhood upgrading; and managing solid waste so that it does not end up in the drains. These are municipal responsibilities but they need finance from the national level and linked to the ORSEC emergency plan, so that pumps, sandbags and cash are positioned before the rains rather than requested after them.

For Kafountine, the priority is to hold back the salt and to help households live with what has already been lost. Communities identified rainwater storage, community forests and mangrove and filao replanting, dykes with hydraulic regulation designed on the basis of proper studies rather than rebuilt by hand, and water committees to manage wells and boreholes. On the livelihood side, they asked for salt-tolerant rice varieties, support from the Société de Développement Agricole et Industriel du Sénégal (SODAGRI — Senegalese Agricultural and Industrial Development Company) for lowland rice, halophyte crops on land that cannot be recovered, processing units for non-timber forest products (NTFPs), beekeeping, and fish and oyster farming to take pressure off declining catches. For the island villages, where salinisation has already led to abandonment of several settlements, the national workshop asked for a dedicated study of island vulnerability and for eco-housing before it expands to other villages.

Locally led adaptation approaches will be needed for building longer-term resilience in locations exposed to both rapid-onset and slow-onset events. It will give local institutions, women's cooperatives and community organisations the authority and the funds to decide how resources are used, and it would build on what is already working such as the concession system, women's processing groups, land lending between families, shared wells and collective labour. It also needs to be inclusive. In both sites, the people with least say in local decisions — tenants, relocated households, women and young people — were those losing most. In Table 6, we have set out the measures that communities and stakeholders prioritised, organised by the type of resilience capacity that each can build.

Table 6. Locally prioritised measures to reduce loss and damage in Saint-Louis and Kafountine

Capacity	Saint-Louis (rapid onset)	Kafountine (slow onset)
Absorptive: withstand the shock	Pre-positioned pumps, sandbags and emergency cash before the rainy season; temporary shelter in schools planned in advance; screens and cleaning of drains before the rains; emergency access routes for the sick and for burials	Rainwater storage tanks and cisterns; grain and seed reserves; emergency repair of dykes after breaches; pirogue (boat) access for emergencies on the islands
Adaptive: adjust livelihoods and settlements	Completion and maintenance of drainage; reinforcement of the Pikine and Guinaw Rail dyke; enforcement of building rules and regularisation of tenure; support to fishers and market gardeners to recover assets	Engineered dykes with hydraulic regulation; salt-tolerant and lowland rice; halophyte crops; mangrove and filao restoration; community forests; processing of NTFPs; beekeeping; fish and oyster farming; water committees
Transformative: change the underlying risk	Climate risk integrated in the municipal development plan and land-use planning; sanitation project completed; planned relocation with services for households in Khar Yalla and other non-aedificandi (not to be built upon) zones	Island vulnerability study and plan; eco-housing and paved access; integrated tourism with eco-guides; land and water governance across the estuary; recognition of losses that cannot be recovered and support for households to move into new livelihoods

Source: community validation workshops, Saint-Louis and Kafountine, June 2026; shared learning dialogue and national workshop, July 2026.

4.2 Build early warning and loss and damage data into local decision making

Section 2.3 showed how recent and how widespread the hazards are. In Saint-Louis, 166 of the 203 households that answered said their most recent flood was in 2024 or 2025, and in Kafountine 90.2% of households reported salinisation. None of this information is held by any institution in a form that could trigger a response. Anticipatory action and planned adaptation depend on reliable, local information on what hazard is coming and what impact it might have. Senegal already has parts of this early warning system. The national meteorological agency, Agence Nationale de l'Aviation Civile et de la Météorologie (ANACIM — National Agency of Civil Aviation and Meteorology), produces seasonal and short-range forecasts. The Food Security Commission has been developing a satellite-based drought trigger with World Bank support. The health system, through its district health offices, tracks the cases of malaria, diarrhoea, skin infections and, from 2025, Rift Valley fever that follow each flood season in Saint-Louis. Each of these is a source of evidence on climate impacts. But the forecasts do not reach households in Pikine or Niomoune in a form they can act on, the drought trigger does not cover floods or coastal hazards, the health records are not used to track or attribute the health costs of flooding, and none of them is connected to the programmes that could deliver support (Bharadwaj et al., 2023).

The national workshop asked for these sources to work together, for example: for ANACIM's rainfall, temperature and sea-level records to be compared with what communities have reported, so that the changes people describe, such as shorter rainy seasons or more frequent storm surges, are confirmed by measured data; for district health records to be used to track the diseases that follow floods; and for a national mechanism to monitor and geolocate loss and damage, so that the country has a record it can plan against and use that to request funds from the Green Climate Fund and the FRLD.

We recommend three key steps:

- Develop multi-hazard early warning capability that covers rainy season and river flooding, storm surges and coastal erosion, not only drought, and that is connected to the social protection delivery system so that a forecast crossing an agreed threshold can lead to release of support to the community before crisis hits them. The Bangladesh flood forecasting system, which triggered cash to vulnerable households before the river peaked, shows that this can be done with existing hydrological data (Bharadwaj et al., 2025).
- Create a national loss and damage register, built on the indicators developed in this study, that records economic and non-economic losses by household, village and hazard. The C-CIQ indices give Senegal a base structure on which this can be built.
- Pre-identify at-risk households in the most vulnerable locations. In Senegal, the single national register RNU already records which households are poor. But it does not yet record which households are exposed to floods, salinisation or coastal erosion. Adding this information to the register would let programmes identify, before the next event, who is at risk from which hazard and where. The data can be collected and checked through the same village and district assemblies that already validate the register, so the process can remain locally grounded, trusted by the communities and low cost (Bharadwaj et al., 2023).

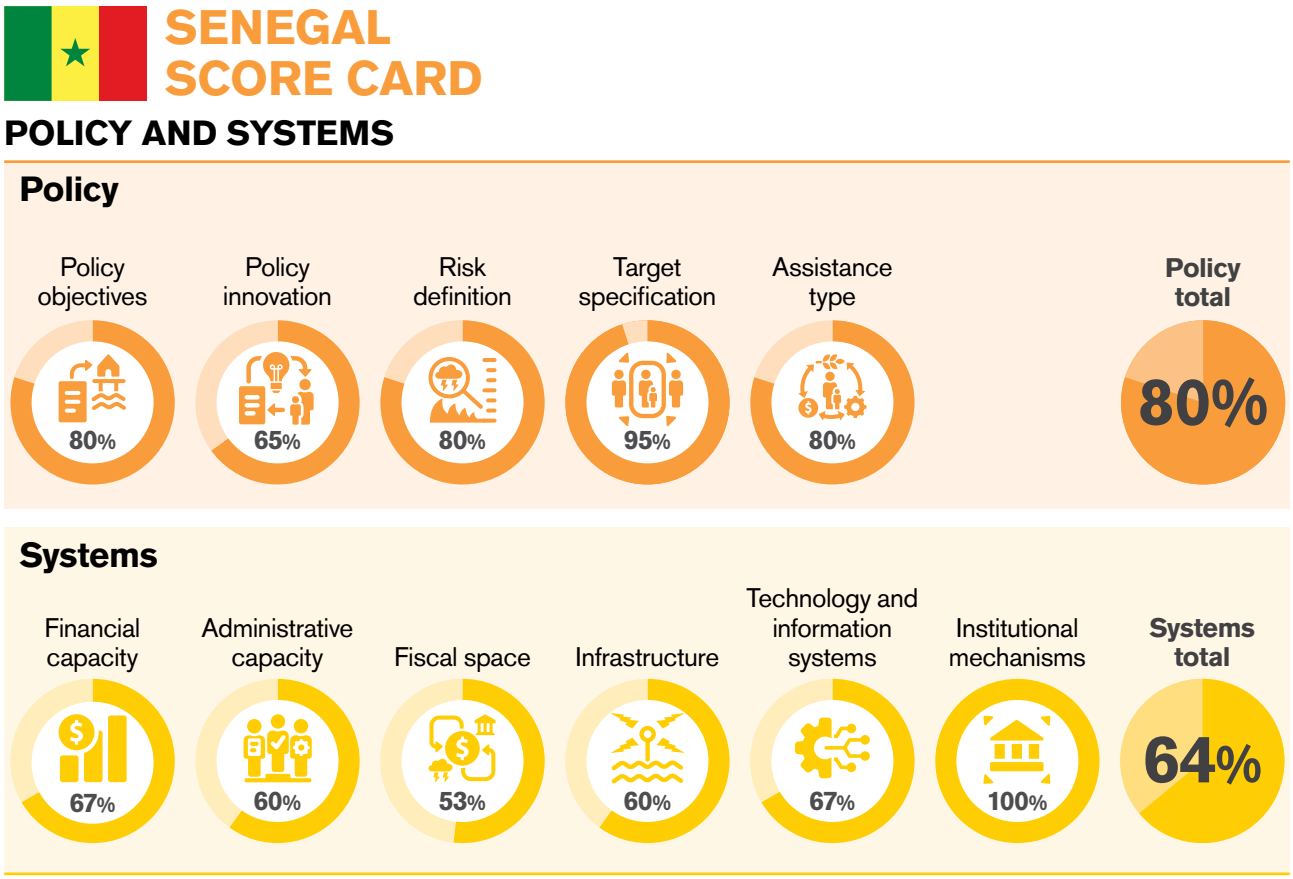
All three steps, however, depend on local knowledge and local capacity, which is where the current system is weakest. Forecasts, registers and triggers are only useful if the information flows both ways. The residents of Fass Ngom in Saint-Louis know which lanes are flooded first and which households cannot get out; the women of Niomoune know which wells turn brackish and when the dykes are close to failing. This knowledge should feed the early warning system, the loss and damage register and the register of at-risk households, and the people who hold this knowledge — community volunteers, women's groups, village assemblies and municipal staff — should be trained to read forecasts and act on them. This is the intervention that requires the least cost in the whole system, and is the part most often left out.

4.3 Make social protection anticipatory and shock responsive

Section 2.4 showed that the average household in the two sites had access to one of eight types of support or fewer, and that what came arrived after the flood. Section 3.4 showed that the losses that rise fastest with vulnerability are health, schooling, food and debt. These are the type of losses that social protection can address if designed and delivered effectively. Senegal already has a strong social protection system that can be used to provide support for anticipatory climate resilience. The RNU is mandatory for all social programmes and is validated by more than 15,000 village and district assemblies. The PNBSF reaches over 355,000 beneficiaries in all 14 regions with a quarterly grant of 35,000 XOF, and its beneficiaries are entitled to free health coverage through the CMU. Yokk Koom Koom is an economic inclusion and productive safety net initiative that has been scaled to around 48,500 households with cash, training and financial inclusion. Digital payments made through the DigiPOS payment platform have reached 14,500 beneficiaries in Sédhiou. An interministerial steering committee coordinates the sector, and the World Bank has financed the system with successive credits totalling US$328 million (Bharadwaj et al., 2023). The policy itself prioritises anticipatory response and defines trigger points for drought.

However, what is missing is the connection between different parts of this social protection system. Our ASPIRE assessment scored Senegal's policy framework at 80% but its systems at 64%, and its three main programmes between 33% and 39% on design for climate risk (see Figure 20). There is no early warning system linked to delivery, no pre-agreed trigger or scalability provision in any major programme, no climate vulnerability data in the RNU, no contingency budget attached to the trigger points the policy defines, and no coordination mechanism across the six crisis response programmes the country has identified (Bharadwaj et al., 2023).

Figure 20. ASPIRE readiness assessment of Senegal social protection policy and system to deliver anticipatory support

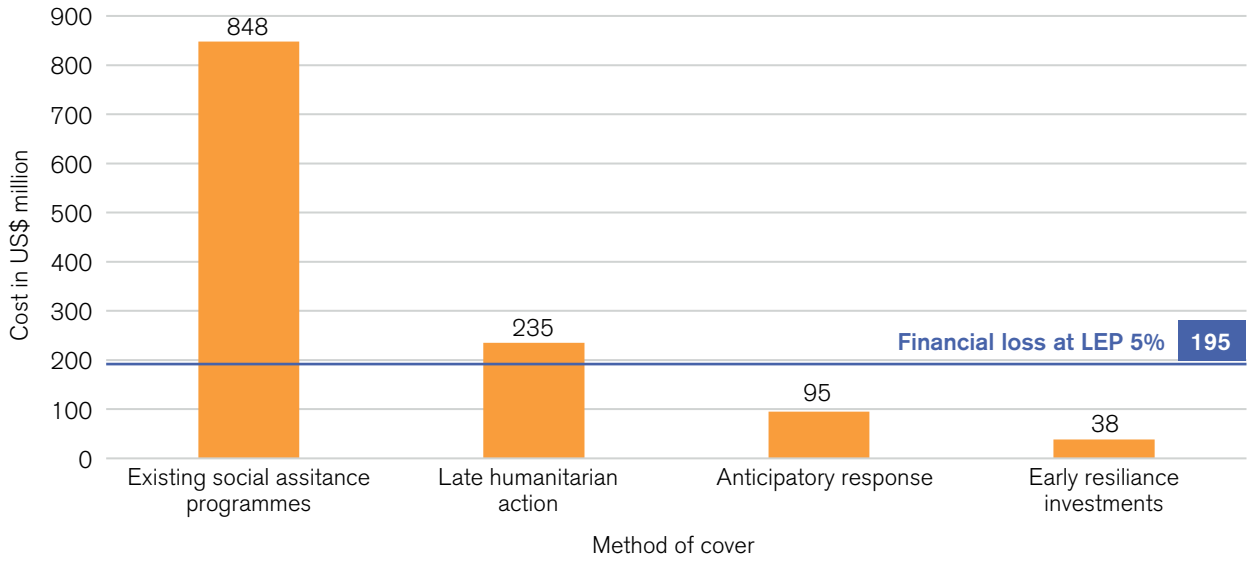


Source: Bharadwaj et al. (2023)

The economic case for changing this is strong. Household evidence from another research in flood- and drought-prone communes in the Sahel shows that when support comes through existing social assistance after a shock, households bear losses equal to 98% of their annual income. Late humanitarian response brings this down to 59%. Anticipatory support delivered before the shock brings it to 42%, and early investment in resilience to 27%. Across eight countries, every dollar invested in early resilience building returns US$5.17 in avoided losses and development gains, and every dollar in anticipatory support returns US$2.06. Late humanitarian response returns US$0.83 and existing social assistance US$0.23 (Bharadwaj et al., 2025).

For Senegal, a severe but plausible climate event of the kind expected once in 20 years would generate an estimated US$195 million in losses. Using existing social assistance to cover those losses after the event would cost around US$848 million, more than four times the loss and three times the country's annual social protection spending of about US$276 million. Anticipatory support before the event would cost around US$95 million and early resilience investment around US$38 million (Bharadwaj et al., 2025).

Figure 21. Cost to cover 100% financial losses caused at Loss Exceedance Probability (LEP) 5%



Source: Bharadwaj et al. (2025)

To make social protection work for the households in this study, the government of Senegal, with its development partners, should prioritise four actions:

- **Embed pre-agreed triggers in the major programmes:** the PNBSF, the CMU and Yokk Koom Koom should each have a written scalability provision: when a flood, storm surge or drought forecast crosses an agreed threshold, enrolled households in the affected zone should receive an additional transfer, a fee waiver or an in-kind package before the event. The drought trigger under development should be extended to floods and coastal hazards, which are the risks communities in Saint-Louis and Kafountine identified.
- **Add a climate layer to the RNU:** the recertification of PNBSF beneficiaries now under way is the moment to record each household's exposure to flooding, salinisation and erosion, so the register identifies who is at risk from which hazard, not only who is poor. Tenants, relocated households and island households, who are typically excluded from the register, should be captured explicitly.
- **Pre-arrange the finance:** attach a contingency budget to each trigger point, and design insurance-linked payouts that use the existing agricultural insurance provided by the Compagnie Nationale d'Assurance Agricole du Sénégal (CNAAS — National Agricultural Insurance Company of Senegal) and the Disaster Fund so that money is mobilised in advance and disbursed automatically. Section 4.5 sets out the sources.
- **Strengthen delivery at the last mile:** scale DigiPOS beyond Sédhiou, agree a contingency plan with clear roles across the six crisis response programmes, and give local governments, village assemblies and NGOs such as Enda Energie and the Centre Écologique Albert Schweitzer (CEAS — Albert Schweitzer Ecological Centre) a defined role in verifying and delivering support.

In Table 7, we have shown how the instruments Senegal already has could be used to reduce loss and damage at each stage of a shock.

Table 7. Anticipatory and shock-responsive social protection instruments for Senegal

Instrument and programme	Before the shock (anticipatory)	During and after (shock responsive)	Contribution to reducing loss and damage
Cash transfers (PNBSF)	Top-up transfer to enrolled households in the forecast zone when a flood or surge trigger is reached	Additional payment on verified damage Fast-track enrolment of newly affected households	Avoids distress borrowing, asset sales and school withdrawal Protects food consumption
Health coverage (CMU, Sesame Plan)	Pre-positioned drugs and mobile clinics in flood-prone quarters before the rains	Fee waiver for flood-related illnesses Psychosocial support for displaced households	Cuts out of pocket health costs Addresses mental health losses households reported
School feeding and education support	Advance planning of alternative classrooms and transport when schools are used as shelters	Continued meals and materials when schools flood Support for girls travelling to other schools	Prevents dropouts and learning losses
Public works (Yokk Koom Koom and municipal works)	Paid work on drain cleaning, dyke repair, mangrove planting and rainwater storage before the rainy season	Cash for work on clearance and reconstruction	Provides income in the lean season and builds the assets that reduce the next loss
Productive inclusion (Yokk Koom Koom)	Grants and training for salt-tolerant rice, processing units, fish and oyster farming	Livelihood recovery grants after asset loss	Supports the shift out of livelihoods that salinisation has made unviable
Agricultural and asset insurance (CNAAS, Disaster Fund)	Parametric cover for rice and fishing assets with pre-agreed triggers	Payout on trigger without claims process	Spreads the cost of catastrophic years Protects fishers and rice growers
Community safety nets	Support to women's cooperatives, savings groups and cereal banks	Solidarity funds for households excluded from formal relief	Reinforces the concession system and local solidarity that households rely on first

Source: adapted from Bharadwaj et al. (2025) for Senegal, drawing on community and national workshop inputs.

4.4 Address gaps in who gets reached: targeting, inclusion and coordination

How much a household in Pikine or Niomoune loses depends not only on the flood or the salination, but on whether the household is registered for the social protection support they are entitled to and whether the support reaches them. Both study sites showed gaps in who is covered and reached. In Saint-Louis, communities reported that relief censuses record one name for a whole concession (a family compound that often houses several households) so tenants and widow-headed households living within that concession are left off the lists. They also reported that lists are sometimes influenced by family or political connections, and that households relocated to Khar Yalla now live in a zone where building is prohibited, with no water, no electricity and no programme covering them. In Kafountine, communities reported that the family grants, grain and school materials they once received have stopped, that island villages cannot be reached by services or emergency vehicles, and that villages lose out on funding because they cannot prepare the project proposals required. In both sites, many households have a member who has migrated abroad. These households

cannot transfer any entitlement to the migrant or receive support on their behalf, because Senegal has not put in place portability arrangements, even though it is party to the Economic Community of West African States (ECOWAS) social security convention (Bharadwaj et al., 2023).

These are delivery failures — but they can be fixed without new programmes. We recommend the following:

- **Target by household, not by concession, and validate locally:** relief and programme registration should record every household within a concession, including tenants and women-headed sub-households, and lists should be validated through the same village and district assemblies that validate the RNU. A functioning grievance and appeal channel, which the social protection strategy already provides for, should be put in place at municipal level.
- **Cover displaced and mobile populations:** households relocated from Guet Ndar and other coastal quarters should be enrolled at their new location with services in place, and the abandonment of island villages in Kafountine should be treated as displacement, with the same rights to support provided by social protection programmes. Entitlements should follow people who move within Senegal, and the government should implement the ECOWAS convention so that emigrant remittance-sending households and returnees are not excluded.
- **Give the islands a specific plan:** accessibility, emergency response and service delivery on the islands of Lower Casamance need their own arrangements, as the national workshop asked, including pirogue-based emergency access and mobile health and registration services.
- **Coordinate across programmes and ministries:** participants at the national workshop asked for joint missions by the ministries concerned and a permanent consultation mechanism on loss and damage. At departmental level, a single social service window, also proposed at the workshop, would let a household in Pikine or Kafountine reach the PNBSF, the CMU, emergency relief and municipal services through one system. The Direction de la Protection Civile (DPC — Civil Protection Directorate) needs the capacity to lead this at local level.
- **Build local capacity to access finance:** communes and community organisations in Kafountine said they lose funding because they cannot prepare proposals. A small technical facility, hosted by Enda Energie or the departmental council, to support project preparation would unlock resources already available from NGOs, the Global Environment Facility's Small Grants Programme and municipal transfers.

4.5 Finance the response

None of the above will happen without money, and Senegal's fiscal space is already tight. Spending on social assistance is around 0.86% of GDP and there is no contingency allocation for anticipatory risk financing, and no use yet of private or insurance-linked finance for social protection (Bharadwaj et al., 2023). The World Bank estimates that Senegal needs around US$1.36 billion a year in climate action to 2030 (World Bank, 2024). Coastal protection alone, as the relocation programme in Saint-Louis shows, costs tens of millions of dollars per neighbourhood.

Three financing pathways should be pursued together.

- **Use international loss and damage finance to address the gaps in the existing system rather than to fund one-off projects:** Senegal is an LDC and therefore within the group for which half of the FRLD's initial resources are reserved. A request of the order of US$15 million under the FRLD's Barbados Implementation Modalities could finance the four aspects the social protection system currently lacks: early warning linked to triggers, the climate layer in the RNU, pre-arranged finance and last-mile delivery. That investment would let the country's existing social protection spending of around US$276 million a year also deliver early action, and it would create the delivery foundation that multilateral development banks (MDBs), the Global Shield Against Climate Risks and insurance actors need before they commit (Bharadwaj et al., 2025). The UNFCCC's Santiago Network can provide the technical assistance to design the triggers and the loss and damage register. The evidence in this report, and the indices in Appendix 2, give Senegal what a funding request needs, which is a documented, household-level account of economic and non-economic loss and damage in two priority sites.

- **Layer the risk and response mechanism:** frequent, predictable losses such as annual flooding in Pikine should be financed from the national budget through contingency allocations and the National Solidarity Fund, because they will happen every year and insurance is an expensive way to pay for certainties. Rare, severe years should be covered by parametric insurance through CNAAS and regional risk pools such as the African Risk Capacity, with the Global Shield helping to bring premiums down. Slow-onset losses that cannot be insured, such as the permanent loss of rice land to salt, need grant finance for livelihood transition and, where necessary, for planned relocation.
- **Direct adaptation and development finance to the structural drivers of loss and damage identified in the findings:** AFD, the World Bank and the other partners already active in Saint-Louis and Casamance should align their coastal, sanitation, urban and agricultural investments with the priorities communities set out in Table 6, and route a defined share through municipal and community institutions so that adaptation is locally led. The national workshop's proposal for a national mechanism to monitor, geolocate and fund loss and damage should be taken up as the framework that ties these sources together.

Box 4. What the findings mean for Senegal and the FRLD

Even though the findings of this study are based on assessment of two locations, they are relevant for Senegal as a whole as well as the FRLD.

Relevance for Senegal

Three findings that will be useful to consider when formulating responses for addressing loss and damage at country level are:

- **Households that lose the most are those with the least assets to lose.** In both sites, the most vulnerable households reported almost no loss of crops or land, but they reported the highest levels of hunger, illness and children missing school. The regression analysis confirmed this pattern across all 424 households. This means that any assessment or targeting that is based on damage to assets will leave out these households, whether in Pikine, in Niomoune or in any other part of the country.
- **Slow onset-losses continue year after year and are mostly not recorded.** The median household in Kafountine has been losing income because of soil degradation for the last ten years. There is no single event that would lead to an assessment, and these losses do not appear in the national disaster record and do not qualify for relief. The same is likely to be the case in the Saloum delta and other estuaries where salt is moving inland.
- **The gap in delivery of social protection needs to be considered as a national issue.** The SPI scores of 11.7 and 5.8 at the two sites are consistent with what our readiness assessment found for the national system (Bharadwaj et al., 2023). The registry, programmes and payment systems are in place, but there are no triggers, no finance arranged in advance and weak delivery at the last mile.

Relevance for the FRLD

The immediate use of this evidence is to support Senegal's request for funding to the FRLD. However, the findings also have a bearing on how loss and damage finance is designed:

- **Slow-onset losses need to be counted in a way that does not depend on a disaster being declared.** Non-economic losses need to be assessed together with economic losses, because these are the losses that affect the poorest households the most, and the indices presented in Section 3.2 show that this can be done through a household survey.
- **If finance is allocated on the basis of the value of damaged assets, it will underestimate the needs of households that had little to lose but have the least capacity to recover.** The extent of loss therefore needs to be considered together with the vulnerability of the household.
- **Permanent losses, such as the islands abandoned in Kafountine, need a different kind of support,** because recovery to the earlier situation is no longer possible.

The household-level method used in this study is one way of meeting these needs, and it can be applied in other countries that face the same combination of rapid- and slow-onset impacts.

4.6 Recognise and respond to non-economic loss and damage

Communities in the study areas have lost more than what is typically recorded as loss. In Saint-Louis, floods have pushed families to carry funeral processions through the water and closed the Koranic school. In Kafountine, the sea has taken the sacred kapok tree at Abéné and the beaches where turtles nested, and salination has displaced villages that families had farmed for generations. Households in both places described mental stress, loss of dignity, and strain on the family and neighbourhood ties that are their first line of protection. The participants of the national workshop asked for these losses, and the psychological impacts of displaced households in particular, to be documented and addressed.

Responses to non-economic loss are possible, and low cost compared to what they protect. Psychosocial support can be delivered through the CMU and community health workers and included in the post-flood package. Cultural and religious sites at risk, mosques, cemeteries, sacred groves and heritage buildings, can be mapped and protected within municipal plans and coastal works, and their loss recorded in the national register. Traditional knowledge of mangrove management, rice varieties and fishing seasons can be documented and passed on through schools and cooperatives before it disappears with the people who hold it. Restoring mangroves and filao belts protects livelihoods and restores places that communities value in themselves. And where loss is permanent, as it is for the abandoned islands, recognition of the issue is important. The households that have lost their land and their village should be acknowledged, supported to settle and given a say in how what remains is managed.

5

Next steps

Our recommendations in Section 4 are built on programmes and systems that Senegal already has. The country already has a social registry, payment mechanisms, established social protection programmes and weather forecasting capacity. The immediate task is to connect these systems to climate risk and enable them to act before the next flood season and before salinisation further erodes livelihoods. The following steps set out where to begin and which institutions need to be involved.

- **Establish a cross-government mechanism for anticipatory social protection:** responsibility is currently spread across the institutions responsible for climate policy, social protection, public finance and economic planning. METE should convene a small working group on climate-related loss and damage. It should include the DGPSN, the ministries responsible for finance, budgeting and planning, and the agencies responsible for forecasting, food security and disaster management. Its first task should be to agree who takes decisions, who releases funds and who delivers support when a warning threshold is reached.
- **Agree clear triggers for action:** METE should work with ANACIM and the relevant hydrological, coastal and agricultural agencies to define thresholds for floods, storm surges and salinity. Each threshold should be linked to a specific response, such as releasing cash, waiving healthcare fees or putting arrangements in place to keep schools operating. The drought-trigger mechanism being developed by the Food Security Commission offers a useful starting point, but separate triggers will be needed for these different hazards.
- **Include climate exposure in the RNU:** the current recertification of PNBSF beneficiaries provides an opportunity to record whether households are exposed to flooding, erosion or salinisation. The DGPSN should also ensure that each household living within a shared concession is registered separately. Without this distinction, several households affected by the same event may appear in the system as one and some may not receive support.
- **Test the approach before the next rainy season:** a pilot should be carried out in Pikine, Abéné and Niomoune. The PNBSF and the CMU could test the measures proposed in Section 4.3, including temporary cash top-ups, healthcare fee waivers and arrangements to prevent children from missing or delaying school. The pilot should be implemented with the municipalities, DPC and Enda Energie. Its success should be judged not only by how quickly support is delivered, but also by whether it reduces illness, food insecurity and disruption to education, the losses that Section 3 found to be most closely associated with vulnerability.
- **Use international climate finance to establish the system:** Senegal remains in the LDC category during its transition towards graduation in 2029. Subject to approval, Senegal's request under FRLD's first call could help finance the development of triggers, the addition of climate risk information to the RNU, pre-arranged finance and last-mile delivery. The evidence presented in this report, together with the indicators, can support this and future funding requests.
- **Use Senegal's direct access institutions for longer-term adaptation:** Senegal can access the Green Climate Fund through two national accredited entities: the Centre de Suivi Écologique (Ecological Monitoring Centre) and La Banque Agricole (Agricultural Bank). The adaptation investments proposed in Table 6 should be developed through these institutions where appropriate. This would allow national organisations to lead the design and management of investments rather than relying entirely on international intermediaries.

- **Provide domestic finance for recurrent losses:** international funding should complement, rather than replace, national responsibility. The ministry responsible for the budget should create a contingency allocation for predictable and recurring flood costs in Pikine. Insurance can be useful for less frequent and more severe events, but it is poorly suited to losses that occur almost every year. These require regular funding for prevention, preparedness and rapid response.
- **Create a national loss and damage register:** evidence of loss and damage is currently held across different institutions and collected using different methods. METE should establish a common register based on the indicators developed in this study, drawing on information from sectoral agencies, municipalities and affected communities. Senegal could request technical assistance from the Santiago Network to help design the methodology and reporting system. A consistent national record would make it easier to identify emerging needs, track economic and non-economic losses, and prepare future funding requests.
- **Assess the needs of island communities and improve relocation planning:** the vulnerability study of island communities proposed at the national workshop should be commissioned without delay. Any further relocation from the Langue de Barbarie must address livelihoods, services, drainage and tenure security from the outset. Moving people away from coastal risk will not reduce their losses if they are left without work, schools, healthcare or secure rights to their new homes. Future relocation should learn directly from the problems experienced at Khar Yalla.

Senegal already has most of the institutions and systems required. What is missing is a practical link between climate warnings, household information, agreed sources of finance and timely delivery. The coordination mechanism, trigger development and preparation of the pilot could begin within the next 12 months. The pilot would then provide the evidence needed to improve the approach before it is extended to other high-risk areas.

Appendices

Appendix 1. Study tools and sample

The evidence in this report comes from four sources, which include participatory community assessments, a household survey, FGDs and a national dialogue. Appendix 1 describes each of them and the households covered though the survey.

Participatory community assessments

Enda Energie carried out the participatory assessment in the Pikine quarter of Saint-Louis (Pikine Bas Sénégal, Fass Ngom and Sor Diagne) and in Abéné and Niomoune in Kafountine (Enda Energie, unpublished). It used transect walks, social mapping, mobility mapping, matrix ranking, historical mapping, risk and resource mapping, and perception mapping. The assessment identified the losses and the predisposing, precipitating and protective factors (3Ps) that shaped the household questionnaire and the indices. The issues explored during these exercises are summarised in Table A1a and Table A1b.

Saint-Louis







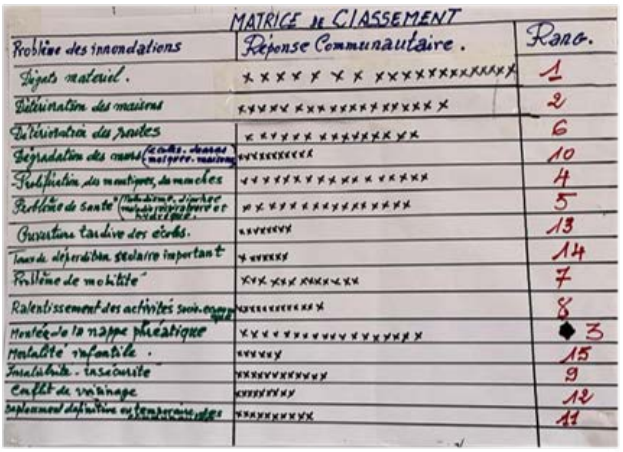






Table A1a. Saint-Louis: issues explored during participatory community assessments

Topics	Issues
Water and environment	Frequent flooding of roads, homes, schools and public spaces due to a lack of effective rainwater drainage systems.
	Blocked river drainage channels, particularly in Fass Ngom, result in water stagnation and an increased risk of disease.
	Rise in waterborne and vector-borne diseases such as malaria, diarrhoea, scabies and respiratory infections.
	In flooded areas, households often manage with makeshift adaptations, such as diverting water into alleys and using sandbags to block off areas.
	Mangrove loss and salinisation near coastal and riverine zones reduce ecosystem stability and local resilience.
	Makeshift boats are sometimes the only way to move around flooded neighbourhoods (for example, Fass Ngom).
Livelihoods and economic activities	Key activities include fishing, market gardening, livestock rearing, transport, small-scale trade and repair services.
	Floods disrupt local economies, causing slowdowns in transportation, trade, craft work and market gardening.
	Mechanic garages and informal traders lose income during floods due to inaccessible roads.
	Historical loss of farming activities due to urbanisation and land conversion.
	Sea and river fishing is declining, especially in Pikine and Sor Diagne, due to overexploitation and environmental changes.
	Youth migration is driven by climate stress and lack of employment opportunities; remittances help families cope.
Civic and social issues	Displacement and resettlement of communities from coastal areas (for example, Guet Ndar to Pikine).
	Widow-headed households and tenants are particularly vulnerable and often excluded from aid.
	Poor sanitation and overcrowding during flood emergencies contribute to unsanitary living conditions and mental stress.
	Lack of solidarity in some concessions due to resource constraints; one person usually represents a whole household during censuses.
	Delays and bias in census and distribution processes lead to the exclusion of vulnerable people from relief efforts.
	Cultural practices such as burials are affected: the deceased are transported by wheelbarrow or carried on backs due to inaccessible roads.

Topics	Issues
Infrastructure	Severe damage to homes, schools, mosques, garages and roads during floods.
	Many homes are made from zinc, cement or fibre cement, with poor resilience to water damage.
	Schools are frequently flooded, causing delayed starts, dropouts and overcrowding (for example, 110 pupils per class in Pikine Bas).
	Health centres are limited or absent (for example, none in Fass Ngom), with reduced access during rainy seasons.
	Mobility is severely affected: taxis refuse to enter flooded areas; people rely on carts, wheelbarrows or carry patients on foot.
	Drainage infrastructure is inadequate, particularly in areas such as Fass Ngom and lower Pikine.
Social protection	Support mechanisms include motor pumps, ORSEC emergency plan, cash transfers, sand trucks and food aid.
	Social assistance, including family grants and the Sesame Plan health insurance scheme, is suspended or inconsistently applied.
	Census processes are politicised or poorly managed, affecting fair aid distribution.
	Aid is often delayed, limited to pumping water from homes (not alleys), and lacks long-term impact.
	Communities express partial satisfaction with relief responses but call for systemic and timely interventions.
	The informal sector's dominance in Pikine and Sor areas makes residents more dependent on external assistance.
Community adaptation	Temporary coping measures include pumping water from houses, stacking bricks for cooking, and relocating to schools or relatives' homes.
	Communities maintain socioeconomic activities despite adversity.
	Local mobility during floods relies on carts, motorbikes or walking through water.
	Concession-based census often misrepresents household realities.
	Community volunteers, local authorities, and NGOs coordinate some aid, but coordination is weak.
	Calls for more sustainable solutions include protective dykes, improved drainage infrastructure and resilient social support.

Kafountine









Matrice de classement

Erosion / Destruction de la biodiversité

Problèmes	Décision des communautés	Rang
Destruction de la Biodiversité	XX	3
Disparition d'espèces médicinales		6
Baisse des Revenus		4
(perte d'espace) Dévalorisation de la plage		1
Diminution des Tortues marines		9
Disparition d'espèces Animales		5
Perturbation des Activités socio-économiques		2
Absence de protection des bâtiments contre la brise marine		8
Migration des oiseaux		7
Pertes d'Emploi		3

Table A1b. Kafountine: issues explored during participatory community assessments

Topics	Issues
Water and environment	Soil and water salinisation is widespread, due to seawater intrusion, irregular rainfall and degraded dykes.
	Loss of arable land and declining yields of rice and vegetables pose a threat to food security.
	Coastal erosion is shrinking fishing areas and tourist sites (for example, sacred cheese tree).
	Deforestation and drying of backwaters (for example, Bitini) are reducing biodiversity and grazing land.
	Wells are drying up or becoming brackish.
	Water shortages affect households, agriculture and livestock.
	Rainwater is stored temporarily; reliance on expensive boreholes is common.
Livelihoods and economic activities	Fishing and fish processing are key livelihoods, but they are threatened by a lack of infrastructure (for example, no cold storage, poor landing sites).
	Agriculture (rice and market gardening) is declining due to salinisation, pests, and stray animals.
	Tourism has potential (sacred trees, wildlife), but coastal degradation and plastic waste are deterrents.
	NTFPs provide food, shade, medicinal plants and firewood.
	Communities are increasingly shifting to non-agricultural work, such as trade, mechanics and masonry.
Civic and social issues	School dropouts are often attributed to high education costs and inadequate family income.
	Women and youth face the brunt of food insecurity and employment challenges.
	Migration is both voluntary and forced; youth leave due to declining land productivity and economic opportunities.
	Some families lose land and depend on others for temporary access.
	Health issues (for example, diabetes, tooth decay) are rising without clear awareness of causes.
Infrastructure	Houses use a mix of mud bricks, zinc, straw and cement, showing varying resilience to floods and heat.
	Health and education services are present but under-resourced.
	Road access is poor, particularly during the rainy season, and mobility is constrained, which increases costs and isolation.
	Traditional and manual dykes have been built, but are poorly maintained and easily destroyed.
Social protection	Family grants and government aid (including grain distribution and school materials) were previously active but are now suspended.
	Communities often lack the skills necessary to write effective project proposals that secure funding opportunities.
	Infrastructure investments (for example, fishing quays, roads) are often inadequate or poorly managed.
	NGOs (for example, Enda Energie, CEAS) provide support: food processing units, awareness sessions, reforestation and health services.
	Local solidarity remains key: land lending among families, shared wells and mutual labour.
Community adaptation	Dyke construction to prevent salt intrusion (though often damaged).
	Rainwater harvesting, reforestation, creation of nurseries and community forests.
	Women's cooperatives operate processing and storage units; market gardening contributes to the education of children.
	Social cohesion facilitates adaptive resource sharing and plot use.
	Mobility solutions in The Gambia include walking, bicycles, motorbikes, unlicensed taxis and pirogues.

Household survey

The survey was carried out between 25 October and 12 November 2025. It covered 424 households: 209 in Saint-Louis and 215 in Kafountine. Table A1c shows surveyed households by site and village.

Table A1c. Surveyed households by site and village

Saint-Louis (Pikine quarter)	Households	Kafountine commune	Households
Khar Yalla (resettlement site)	46	**Abéné**	30
Cité Niakh	20	**Hillol**	28
Diaminar	20	**Diogué**	26
Pikine Eaux Claires	20	**Haer**	26
Médina Course	19	**Hitou**	25
Sor Daga	19	**Niomoune**	25
Fass Ngom	16	**Kouba**	24
Pikine Bas Sénégal	15	**Kassel**	16
Tableau Walo	11	**Mantate**	6
Sor Diagne	7	**Elou**	5
Pikine, neighbourhood not recorded	16	**Other or not recorded**	4
Total	209	**Total**	215

Table A1d describes the households covered under the survey.

Table A1d. Characteristics of the surveyed households

Household type	Saint-Louis	Kafountine	All
Households surveyed	209	215	424
Non-migrant households	159	212	371
Displaced households	48	0	48
Migrant households	2	3	5
Respondents who are women	146 (69.9%)	62 (28.8%)	208 (49.1%)
Households headed by a woman	42.6%	14.4%	28.3%
Mean household size (members)	11.1	8.4	9.7
Median household size	10	8	9
Mean age of household head (years)	57.4	54.6	56.0
Mean age of respondent (years)	50.4	50.9	50.7

Focus group discussions

Six FGDs were held after the survey, four in Saint-Louis (Pikine Eaux Claires, Khar Yalla, Sor Daga and Sor Diagne) and two in Kafountine (Kouba and Niomoune). Each followed the checklist, covering climate change and its impacts, fishing, farming and livestock, water, food, health, education, living conditions, migration, social protection, culture and identity, and the concession system. The FGDs were used to explain the survey findings.

National dialogue

The findings were presented to national stakeholders at a dialogue in Dakar on 10 July 2026, attended by government departments, AFD and civil society.

Appendix 2. Methodology and index structure

C-CIQ approach

The study follows the Comprehensive Climate Impact Quantification (C-CIQ) toolkit (Bharadwaj et al., 2024a), which we have applied in Mali and India (Bharadwaj et al., 2024a, 2025). It follows five steps:

- First, inclusive and participatory community assessments identify the losses people experience and who bears them.
- Second, the information is organised using the 3P framework into predisposing factors (the conditions that make some households more susceptible to loss before a hazard strikes), precipitating factors (the hazards that turn vulnerability into loss) and protective factors (the support and practices that reduce loss or help recovery).
- Third, the losses are classified across four domains: tangible and intangible, functional and intrinsic, with attention to when and where they occur.
- Fourth, the losses are quantified through a household survey, FGDs and secondary data, using indices for non-economic losses and monetary valuation for economic ones.
- Fifth, responses are co-developed with communities and government.

Household questionnaire

The questionnaire had 35 modules. Modules 1 to 12 recorded the household: sampling type, respondent, concession, members, household head, housing, land, boats and fishing equipment, livestock, income (by sector and by individual earner), and access to government and NGO support. Modules 13 to 17 recorded migration and displacement: who had moved, where, why, at what cost and with what remittances, and the factors behind permanent displacement. Modules 18 to 35 recorded losses: livelihood impacts of flooding, of rainfall deficit, irregular rainfall and salinisation, water supply, food security, food consumption by food group, health during floods, biodiversity loss, soil degradation, living conditions, security, indebtedness, cultural heritage and traditions, loss of organs and health, loss of desired social practices, education, loss of life, and mental wellbeing. For each loss module, displaced and migrant households were asked the questions twice, once for their village of origin and once for where they live now.

Three indices of the 3P framework

Structural Household Vulnerability Index (SHVI)

The SHVI measured the predisposing factors. It combined household characteristics that shape the ability to withstand a shock: household composition (size, dependants, sex of the household head), education of the household head, land ownership and area, ownership of boats and livestock, household income, type of house, tenure and sanitation. Each variable was scored so that a higher value means greater vulnerability; the scores were combined with equal weights and the index was scaled from 0 to 100.

Climate Risk Index (CRI)

The CRI measured the precipitating factors as the losses each household has actually experienced covering crop loss from climate, livestock losses, employment loss, housing damage, loss of equipment and tools, health spending caused by water hardship, and the need to fetch or buy drinking water during drought. The index was scaled from 0 to 100.

Social Protection Index (SPI)

The SPI measured the protective factors as access to formal support in the past year. It was built from eight indicators: food assistance, cash transfers, school feeding, school supplies, agricultural extension, veterinary or fisheries extension, financial aid for economic activity, and health coverage. The index was scaled from 0 to 100.

Loss and damage index structure

Table A2a details the index structure developed for Senegal from the participatory assessment. Under each of the four C-CIQ domains, we have listed the indices, sub-indices and indicators. The variables that measure each indicator were built into the household questionnaire and the FGD checklist. Not every indicator could be measured at household level, especially those that require administrative data (for example cost of repair per kilometre of road, or malaria cases per health post), which were included so that the structure can be used for a national loss and damage register.

Table A2a. Loss and damage indices, sub-indices and indicators for Senegal

Tangible–functional loss and damage

Index	Sub-index	Indicators
Loss of livelihoods and income	Loss of production and productivity in farming	Rainfall variability; yield loss per hectare; income loss per hectare
	Reduction in fish catch	Change in number of active fishers and pirogues; change in fishing income per household; change in breeding season; access to cold chain and markets; move from artisanal to mechanised fishing; move from fishing to other livelihoods
	Loss of pasture land	Area of pasture lost; conversion of pasture to farming
	Loss of livestock	Livestock mortality; loss of milk and meat yield; distress sale of livestock
	Loss of labour in farming, fishing and associated work	Working days lost; time needed to resume work after the event; income lost; labour mobility between farming and fishing; change in women's labour participation
	Loss of tourism activity	Change in tourist arrivals; loss of tourism revenue; damage to beaches, heritage sites, mangroves and biodiversity
Damage to pasture and arable land	Loss of arable land and pasture	Share of arable land lost; increase in fallow land; decrease in livestock population
	Soil degradation	Crop-yield loss from land degradation; deforestation; salinisation of lowlands; coastal erosion; waterlogging
Loss of houses and infrastructure	Loss or damage to houses	Partial or complete collapse or inundation; economic loss; cost of repair or reconstruction; exposure to erosion and sea-level rise; housing type and materials
	Loss or damage to roads and water and sanitation facilities	Cost of repair per kilometre of road; cost of repair per metre of drainage
	Loss or damage to farm and fishing equipment	Type of loss; value of equipment lost; cost of repair or replacement; income lost
Loss of education of children	Damage to school infrastructure	Number of flood events; damage by type and location of school; accessibility during and after floods; cost of repair
	Learning loss	Days of closure; school days lost; instruction hours lost per pupil; distance to school; crowded classrooms
	Financial incapacity to access schooling	Share of income spent on education; children withdrawn from school; school-age children in fishing, farming or herding; borrowing for school expenses
Increased indebtedness	Forced borrowing to offset loss	Average loan per household; loans by purpose, source, size and interest rate; share of loans for repairs, relocation, healthcare, migration, consumption and repayment of earlier loans
	Reduction in food consumption	Reliance on cereal aid; households reducing meal frequency; change in share of income spent on food
	Distress sale of assets	Type of asset sold; purpose and timing of sale; price realised against market price; opportunity cost

Index	Sub-index	Indicators
Drudgery during and after disasters	Lack of transport for the sick	Sick persons delayed by lack of transport; households without transport in floods; cases treated on site; travel time to health facilities; avoidable deaths from delay
	Additional burden on women	Time fetching water, firewood and food; distance to clean water; cooking conditions; care of children, older and sick members; cleaning and repairing the house
Loss of biodiversity	Loss of medicinal plants	Access to plant remedies; loss of trees with cultural uses; overharvesting; loss of knowledge; decline in traditional healers
	Loss of coastal and marine biodiversity	Fish species diversity; turtle populations; shelter belt (*Casuarina equisetifolia*) area; mangrove cover
	Exploitation of forest resources	Species lost to salinisation and deforestation; charcoal kilns; forest fires

Intangible–functional loss and damage

Index	Sub-index	Indicators
Distress migration and displacement	Living in temporary shelters	Type and duration of shelter; water, sanitation and hygiene; communicable disease; livelihood loss from relocation; school attendance; exposure to violence or insecurity; burden on host families
	Fishers forced to move to other waters	Change in catch, income and cost per trip; share of fishers who migrated; distance from home village; assets lost in storms; trawler encroachment; competition with mechanised fishing; type of migration; cross-border tensions
	Youth in cross-border international migration	Share of youth (15 to 35) who have migrated; households with a youth abroad; jobs at destination; change in youth population; destination countries; accidents on the journey; disruption of family life; burden on women and elders; returnees; share of remittances in family income
	Pastoralists and farmers moving to coastal towns	Types and reasons for migration; reduction in pasture and water points; soil degradation and yields; urban job opportunities; migrant networks; jobs at destination
Poor living conditions	Precarious living conditions in settlements	Time in queues at water points; shared toilets; open defecation; migrant households without safe water; waterborne illness; time to fetch water
	Dysfunctional community infrastructure	Schools and health centres without basic water and sanitation; drainage and sewage; overcrowding in houses, schools, mosques and shelters; lack of mobility in floods; waste and pollution of water sources
Loss of cultural identity	Skill and knowledge erosion among artisanal fishers	Use of traditional gear; competition with trawlers; youth losing connection with fishing; knowledge of seasonal patterns; fishing songs, stories and rituals
	Farmers losing traditional farming knowledge	Traditional seed varieties; reliance on purchased inputs; traditional rice and agroforestry systems; sacred forests and shifting cultivation; move to monoculture
	Stress on the concession system and social capital	Trust, reciprocity and mutual support within concessions; capacity for mutual support; shared resources; kinship rituals; youth migration; conflicts over land, remittances and inheritance; shared meals and rituals

Index	Sub-index	Indicators
Loss of heritage sites	Damage to mosques	Mosques damaged; disruption of prayer; closures; time and cost of repair; use of mosques as shelters and distribution points
	Damage to heritage buildings	Buildings damaged; severity; cost of restoration; heritage tourism before and after
	Loss of beaches	Events causing beach loss; jobs and income lost in beach tourism; natural buffers (mangroves, dunes); damage to beachside infrastructure; loss of ceremonies and gatherings on the beach

Tangible–intrinsic loss and damage

Index	Sub-index	Indicators
Loss of lives	Loss of lives and death of breadwinners	Deaths directly due to flooding or drought; indirect deaths (waterborne disease, heat, hunger); cause of death; time between event and death; mortality per 1,000 affected; insurance or compensation
Loss of organs	Loss of organs from floods and related accidents	Permanent disability from flood accidents; availability of emergency care; injuries with organ damage; jobs and income lost after organ loss
Malnutrition in children	Lack of access to nutritious food	Spending on nutritious food; disruption of feeding and breastfeeding in displacement; infections from contaminated water; stunting and wasting
Food insecurity	Crop loss and depleted food stocks	Household food availability; meal frequency and quality; borrowing for food; loss of seed reserves
	Lack of mobility to buy staples during floods	Days transport shut down; days markets inaccessible; increase in transport costs; reduction in food vendors
	Lack of access to cereal aid and family grants	Affected households receiving cereal aid; households without identity documents or registration; awareness of entitlements; flooded roads to distribution points; diversion or delay of aid; days between disaster and receipt of aid

Intangible–intrinsic loss and damage

Index	Sub-index	Indicators
Physical health	Loss of access to health centres	Health centres closed by flooding; days without access to the nearest health post; mothers unable to access prenatal or delivery care; children missing vaccinations; emergency transport; untreated illness during floods; displaced households without health services
	Increase in vector-borne disease (malaria)	Malaria cases after the flood season; malaria deaths; stagnant water near homes; use of treated nets
	Increase in waterborne disease (diarrhoea)	Diarrhoea cases before and after floods; children under five with diarrhoea; diarrhoea deaths; use of contaminated water; water treatment; damaged latrines
	Increase in healthcare expenses	Monthly healthcare spending before and after the disaster; transport cost to reach care; paid and free treatment; cost of medicines; workdays lost to illness; debt for healthcare
	Health issues of women	Menstrual hygiene in flooded or crowded conditions; exhaustion from carrying loads and walking; risk of violence in shelters or displacement
Mental health	Anxiety and stress during displacement	Symptoms of depression or anxiety; sleep disorders; self-reported wellbeing; awareness of mental health services; traditional and formal care; suicide risk among displaced fishers, farmers and youth; substance abuse

Source: study design (Bharadwaj et al., 2024a, adapted for Senegal from the participatory assessment).

Regression analysis

For Section 3.4, a binomial logistic regression was estimated for each of 23 types of loss, with the household's SHVI (in units of 10 points) as the only explanatory variable, as set out in Box 3. Full outputs, including the number of households and events in each model, odds ratios, 95% confidence intervals and p-values, are given in Table A2b.

Table A2b. Logistic regression results: odds of each loss for a 10-point rise in the SHVI

Type of loss	Households in model	Households reporting the loss	Odds ratio	95% confidence interval	p-value
Crop or yield loss	424	75	0.605	0.501 to 0.730	<0.001
Food scarcity	424	159	1.443	1.250 to 1.665	<0.001
Illness during floods	424	103	2.045	1.687 to 2.479	<0.001
Land abandonment (farming households)	212	95	0.699	0.557 to 0.878	0.002
Decline in fish catch	424	73	0.590	0.516 to 0.673	<0.001
Infrastructure damage	424	148	1.329	1.155 to 1.530	<0.001
Equipment and tool loss	424	34	1.120	0.883 to 1.420	0.351
Livestock deaths	424	62	0.737	0.613 to 0.886	0.001
Employment loss	424	17	1.187	0.850 to 1.658	0.315
Soil-related income loss	259	104	0.577	0.471 to 0.705	<0.001
Serious injury due to disaster	424	4	2.537	1.013 to 6.050	0.047
Death due to disaster	424	0	Not estimable		
Biodiversity loss (index above zero)	424	416	1.450	0.902 to 2.330	0.125
Cultural erosion (index above zero)	424	424	Not estimable		
Mental distress (index above zero)	424	402	0.653	0.474 to 0.899	0.009
Land and soil degradation (index above zero)	424	253	0.581	0.498 to 0.678	<0.001
Food insecurity (index above zero)	424	187	1.701	1.462 to 1.979	<0.001
Indebtedness (index above zero)	424	113	1.301	1.118 to 1.514	<0.001
Loss of health and organs (index above zero)	424	103	2.045	1.684 to 2.482	<0.001
Loss of life (index above zero)	424	0	Not estimable		
Loss of education (index above zero)	424	61	2.017	1.598 to 2.545	<0.001

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Knowledge Products

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Floods in Saint-Louis and salinity in Kafountine are already costing coastal households in Senegal a large share of their annual income, and most of this loss is not recorded anywhere. In both places, the households that lose most are the poorest. Their losses are in food, health, schooling and debt. Some of this loss can still be prevented, some can be reduced if support reaches households before the hazard rather than after, and some is now permanent and needs a different kind of response. Senegal has the registry, programmes and payment systems that could deliver all three, but not the climate finance to make them work. This report provides the evidence of who is losing what, which a request for that finance needs.

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International Institute for Environment and Development
44 Southampton Buildings, London WC2A 1AP, UK

Tel: +44 (0)20 3463 7399
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