



Climate Security Pathway Analysis - Senegal

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1. Context

Climate exposure and vulnerability

Senegal has a Sudano-Sahelian climate characterised by the alternation of a dry session between November and May, and a rainy season from June to October. Precipitations in the country are distributed unevenly; the south receives the highest annual precipitation rates while these decrease towards the North. Climate trends show that precipitations have decreased and temperatures risen in the past few decades (Ministère de l'Environnement et du Développement Durable 2015b).

Senegal is part of the Sahel, one of the most climate-vulnerable regions in the world. Except for the greener south in the Casamance region, Senegal is located in an arid and drought-prone territory characterised by poor soil quality and adverse weather conditions as well as considerable exposure to climate change and variability. Senegal suffers from both slow and rapid onset events such as droughts, floods, coastal erosion and sea-level rise (The World Bank Group 2011). Current estimates show that the climate in Senegal will become more erratic. There will be an increase in average temperatures between 1.1 and 1.8°C by 2030 and, while there is an agreement that heavy rainfall events will increment, there is no consensus on whether annual rainfall will increase or decrease (Ministère de l'Environnement et du Développement Durable 2015ab; The World Bank Group 2011). As a consequence, extreme weather events such as droughts and floods may increase in frequency (The World Bank Group 2011). Sea levels are likely to continue rising by 1.4 mm per year, with some projections estimating a rise of up to one meter by 2100 (Ministère de l'Environnement et du Développement Durable 2015b).

Conflict and fragility

Senegal experiences far fewer conflicts than all other Sahelian countries and is considered one of the most stable countries in Africa. Since achieving its independence in 1960, Senegal has had relatively stable civilian governments with peaceful transitions of power (BBC 2018b; World Bank 2021; Elischer 2021). Nevertheless, the south of the country is the site of Africa's longest running armed conflict which, despite having evolved into a low-intensity war since the early 2000s, still presents a source of instability. Since 1982, the conflict in Casamance has pitted the Movement of Democratic Forces of Casamance (MFDC), which fights for the independence of the region, against the Senegalese government. The war has resulted

in 5,000 deaths and thousands of displaced people and, in the last two decades has been increasingly intertwined with criminal activities, notably timber and cannabis trafficking (Madurga López 2021; Foucher 2019).

Despite being one of the few countries where radical Islamic terrorism is not a salient issue and has never suffered a terrorist attack of that nature, there has been a recent incipient jihadist activity. The progress towards the west in neighbouring Mali of jihadist groups that are potentially seeking to enter Senegalese territory has raised concerns over the threat of radicalisation spread in the communities along the border (USAID 2017b; Pujol-Mazzini 2018; Counter Extremism Project 2020; Chair of the Security Council Committee 2021). Since the mid-2000s, drug trafficking has become an increasingly salient, stoking concerns that this illegal activity would enable the financing of terrorist groups (Sandor, 2016; Bird, 2021).

Socioeconomic

The Senegalese economy is strongly reliant on natural resources. The main exports include crude petroleum, minerals -mainly gold-, fisheries-related products and agricultural products such as groundnuts, cotton and tomatoes (OEC, 2020; CIAT and BFS/USAID 2016). Most of these sectors are highly vulnerable to climate variability and extreme weather events. Agriculture, livestock and fisheries employ more than 70% of the workforce and contribute to 13.6% of the GDP but they are also increasingly threatened by the climate crisis (Ministère de l'Environnement et du Développement Durable 2015a; 2015b; Jalloh et al. 2017). The absence of adequate infrastructure, the lack of access to quality seeds and fertilisers, the poor soil quality and the adverse weather conditions burden the agricultural sector, curtailing its potential and its ability to meet the food requirements of the country's growing population (CIAT and BFS/USAID 2016). This has entailed the strong dependence on food imports, including of some key staple crops such as rice since local rice production is only able to meet 35% of the national consumption (CIAT and BFS/USAID 2016).

Fishery is one of Senegal's main industries. The sector employs an estimated 17% of the workforce, and accounts for 1.8% of GDP and 3.2% of national exports. Fish also represents 62% of the protein intake of the local population (WorldFish Center 2005; USAID 2017a). Over the past two decades, however, the fishing industry has suffered an acute crisis in Senegal, witnessing a reduction in fish stocks along with a decline of the fishing sector's contribution to Senegal's GDP (Ministère de l'Environnement et du Développement Durable 2015b; USAID 2009). The reduction of fish stocks has been highly affected by the industrial fishing operations led by foreign vessels following the sale of fishing licences by the government in the 2000s (Faye 2011; Standing 2015; USAID 2009; 2017b). Illegal fishing has also contributed to overfishing in Senegal, leading to an annual loss of USD 272 million (Blédé, Diouf, and Compaoré 2015).

Despite having made notable development progress, Senegal still suffers from different socioeconomic vulnerabilities. There is a 43% and 58% poverty rate in urban and rural areas, respectively. Food insecurity rates show that a total of 8.6% of urban and 15.1% of the rural households are food insecure, of which 11.4% are moderately food insecure and 3.7% are severely food insecure in rural areas, while 6.6% are moderately food insecure and 2% severely food insecure in urban areas (WFP, 2011). Poverty and food insecurity rates illustrate strong rural-urban inequalities present in the country, which tend to spur migration towards the main urban centres. Levels of unemployment are at 2.9% while unemployment and underemployment together make up to 12.6% of the active workforce (ANSD and AFRISTAT, 2019).

2. Climate Security Pathways

Rising temperatures, increasing rainfall variability and ocean acidification are reducing crop yields, livestock productivity and fish stocks with detrimental effects over livelihoods and food security (as illustrated in the pathways) (ANACIM et al. 2013; CIAT and BFS/USAID 2016; Ministère de l'Environnement et du Développement Durable 2015b). The Sahelian drought of the 1970s and 1980s proved to have a devastating impact, particularly for rural communities who witnessed the loss of land, the reduced availability of water resources, crop losses, livestock death and an overall intensification of food insecurity. Many of these rural households were forced to migrate to the main urban centres (Gueye et al. 2015). At the present, worsening climate conditions and the increasing number of extreme weather events may, once again, have a strong detrimental impact on natural resources availability as well as on livelihoods by exacerbating existing risks and vulnerabilities. This impact can be categorised in two main pathways:

- Livelihood and food insecurity (**Pathway #1**).
- Resource availability and access (**Pathway #2**).

Pathway #1: Livelihood and food insecurity

Climate impacts may exacerbate existing socioeconomic vulnerabilities and contribute to livelihood and food insecurity which, in turn, might increase the likelihood of radicalisation and increase the prospects for the recruitment into armed groups. Simultaneously, climate impacts may exacerbate existing socioeconomic vulnerabilities and contribute to livelihood and food insecurity in Senegal, spurring migration towards urban centres both inside and outside of the country.

The predominance of rainfed agriculture -less than 5% of the cultivated land is irrigated- and the prevalence of smallholder farmers, most of whom cultivate rice, maize, millet and sorghum for subsistence, makes Senegalese agriculture particularly vulnerable to climate change and variability (CIAT and BFS/USAID 2016). The risk is considerable taking into account that agriculture, livestock, and fisheries employ more than 70% of the workforce and contribute to 13.6% of the GDP (Ministère de l'Environnement et du Développement Durable 2015a; 2015b; Jalloh et al. 2017). Rising temperatures, increasing rainfall variability and ocean acidification are reducing crop yields, livestock productivity and fish stocks with detrimental effects over livelihoods and food security (ANACIM et al. 2013; CIAT and BFS/USAID 2016; Ministère de l'Environnement et du Développement Durable 2015b; USAID 2017a).

Droughts have proven to have a strong detrimental effect on livelihood and food security, especially for rural communities who depend on climate-sensitive livelihoods. 50% of the variation in the total production of the main crops in the country (maize, millet, sorghum, rice and groundnut) is explained by interannual rainfall variability, illustrating the strong link between climate change and agricultural output (ANACIM et al. 2013). Meanwhile, there is also a strong correlation between production and food prices following harvests which suggests that rainfall variability could contribute to food insecurity by increasing food price volatility (ANACIM et al. 2013). Droughts also impact livestock productivity and mortality through heat stress, their effect on the availability of water resources and pastures as well as the production and quality of fodder which, in turn, burdens meat and milk production and reduces herders' income (Seck and Laubin, 2013; FAO, 2016; (Ministere de l'Environnement et de la Protection de la Nature 2006).

The Sahelian drought of the 1970s and 1980s led to the loss of land, the reduced availability of water resources, crop losses, livestock death and an overall intensification of food insecurity (Gueye et al. 2015).

The 2011/2012 drought, considered one of the worst on record, severely impacted more than 800,000 people in Senegal (ANACIM et al. 2013). In fact, the severe droughts episodes in 2002 and 2011/2012 were responsible for increasing food insecurity of more than 200,000 and 800,000 people, accordingly (Rigaud et al. 2021).

Between 1990 and the present, there has been a dramatic rise in the frequency of floods linked to intra-seasonal variability during the monsoon (ANACIM et al. 2013). Floods impact annually around 100,000 and 300,000 people (OCHA, 2013). Recent flood episodes in 2009 severely impacted the suburbs of Dakar, affecting 33.000 families (Gueye et al. 2015). Apart from the direct damage to the communities, people also stressed that the impact of floods had led to an increase in the disputes between neighbours around the measures that needed to be taken as well as a rise in criminal activity, rapes and assaults (Cissé and Sèye 2015). Besides, floods in some cases may also undermine food stability when the high dependency on food markets is coupled with the curtailed physical access to markets once the rainy season starts, especially when floods destroy infrastructure (ANACIM et al. 2013).

Climate impacts also contribute to the degradation of marine ecosystems and the overall decrease in fish stocks, exacerbating existing socio-economic vulnerabilities of people whose livelihood is connected to the fishing industry. Water temperatures have risen from 0.04 to 0.05° between 1980 and 2009, while Senegal's coastal water salinity has progressively increased (Ministère de l'Environnement et du Développement Durable 2015a). Increases in water temperatures affect ocean productivity, alter marine currents and change the distribution, reproduction and migration of the species, pushing fish to migrate northwards towards colder waters (Ministère de l'Environnement et de la Protection de la Nature 2010; Cheung et al. 2021; World Bank, 2013; Zickgraf, 2018; USAID, 2011, 2017b). Rises in water temperatures also contribute to the deterioration of mangroves and corals, which are home of many species (Dia Ibrahima, 2012; Zickgraf, 2018). Meanwhile, increasing water salinity boosts acidification which, in turn, may lead to the loss of species like molluscs that are particularly sensitive or not able to migrate (Zickgraf, 2018).

The intensification of existing climate trends, along with non-climatic factors, will continue to alter the environment of marine fauna, further reducing fish stocks and undermining the livelihoods of those that depend on it. In fact, around 50% of jobs related to the fishing industry will be lost by 2050 in West Africa due to climate change, impacting livelihoods, purchasing power and food and livelihood security of many people living in the coast (Belhabib et al. 2016).

The overall detrimental impact of climate change on livelihood and food security may indirectly contribute to increases in radicalisation and recruitment by armed groups. Although the common practice of Islam in Senegal, strongly influenced by Sufi brotherhoods, is considered inherently peaceful and widely regarded as the bulwark against radicalisation, there has been an expansion of radical discourses in the past decades (Sambe and Ba, 2013; Volk 2017). This minority discourse is mainly present in the suburbs of the main urban centres and in the bordering regions with Mali, especially among the younger generations, precisely those considered highly vulnerable to climate impacts (Sambe and Ba, 2013). Several studies conducted by the Timbuktu Institute have shown that socioeconomic factors are the most important drivers of radicalisation in Senegal. In particular, poverty, unemployment and the lack of viable livelihoods and income-generating activities have been identified as the main motives for joining jihadist armed groups (Sambe et al. 2021a, 2021b; Sambe et al. 2016; Sambe et al. 2018). Rather than a strong adherence to radical Islam, socioeconomic frustrations and the expected economic benefits to

compensate worsening livelihood security may play a stronger role in the recruitment of radical Islamist groups (Toupane et al. 2021; Sambe et al. 2021). Livelihood insecurity can also increase the likelihood of people, especially the youth, to engage in criminal and illicit activities such as banditry, robbery, illegal logging, illicit crops and different kinds of trafficking, undermining state capacity and increasing fragility insecurity (USAID 2017b; Toupane et al. 2021).

Through its detrimental impact on livelihood and food security, climate impacts are also pushing people to migrate and seek for alternative income-generating activities in the cities (Rigaud et al. 2021). Migration has always been a way of coping with various hardships in West Africa and elsewhere, including those related to economic shocks, security issues as well as environmental factors (Adepoju, 2003; Rigaud et al. 2021; Diallo, 2019). Recently, rural-urban migration has intensified across West African countries as farmers found it increasingly hard to sustain their livelihoods and were forced to seek for alternative income-generating activities in the cities (Adepoju, 2003). Although Senegal has been considered for many years an attractive destination for migrants in the region, it has also experienced economic and political crises that have also spurred out-migration of Senegalese nationals (Adepoju, 2003). Between 2002 and 2011, internal migration flows in Senegal increased by 23.86% (Rigaud et al. 2021).

Climate-related factors such as drought, desertification, flooding and coastal erosion have influenced and accelerated pre-existing migration patterns in different regions of Senegal (Zickgraf, 2018). For instance, the strong Sahelian drought that occurred during the 1970s was a crucial factor in spurring rural-urban migration in the region, including Senegal (Grechi and Agustoni 2017). Hence, migration is usually an adaptation strategy to cope with climate-related risks, particularly used by the most vulnerable segments of the population (Liehr et al. 2016; Rigaud et al. 2021; Liehr et al. 2016).

These trends are likely to increase in the following decades. Water stress and losses in crop productivity will be particularly relevant in determining migration in the following decades (Rigaud et al. 2021). Some studies stress that, by 2050, internal climate migration in Senegal could rise up to 1 million, encompassing 3.33% of the population. By this year, climate-induced internal migrants could exceed those who migrate because of development reasons (Rigaud et al. 2021). A recent study from the World Bank highlights that the main coastal urban centres such as Dakar, Thiès and Saint-Louis as the most important hotspots of climate-induced outmigration while the interior regions around Matam, Ziguinchor, Diourbel and Kaffrine are considered the main hotspots of climate-induced in-migration (Rigaud et al. 2021). When lacking local, national and regional level planning, climate-induced migration can exacerbate existing vulnerabilities in receiving areas and aggravate ongoing social tensions and increase conflicts (Rigaud et al. 2021).

Livelihood and food insecurity in **Matam** and **Tambacouda**

Matam and Tambacounda are among the most vulnerable provinces of Senegal with most of its population relying on climate-sensitive livelihoods such as agriculture, fishing, and mining. While agriculture provides 70% of the employment and contributes to 40% of the regional GDP in Matam, it is still mostly rainfed and based on traditional farming methods, making it highly vulnerable to changes in climate (FAO, 2016). Annual mean temperatures in Matam and Tambacounda are projected to see an increase of 2°C by 2050, while average precipitation will decrease between 9.2% and 10%, leading to more severe droughts (CIAT and BFS/USAID 2016; ANACIM et al. 2013). Recent climate trends in Senegal show that climate conditions particularly exacerbate food insecurity in northern Tambacounda and southern Matam (ANACIM et al. 2013). For instance, rainfall variability and long dry spells can affect crop

production, while climate-related shocks can impact livestock productivity and mortality through their effect on the availability of water resources and pastures, increasing food and livelihood insecurity (Seck and Laubin, 2013; FAO, 2016).

Through its impact on Land, Water and Food (LWF) systems, climate change may exacerbate food and livelihood insecurity in Matam and Tambacounda, which are already stressed by non-climatic factors and influenced by the historical marginalisation by both colonial and post-colonial governments (Ninot 2003; Grechi and Agustoni 2019; Sakho 2005). Poverty rates -among the highest in the country- are higher than 50% and food insecurity rates between 10 and 21% (ANACIM et al. 2013; WFP, 2011). Natural resources are already afflicted by poor management practices, increasing competition over resources, and the politicization of land allocation (Seck and Laubin, 2013; USAID 2017b). There is also a lack of access to markets and natural resources, rising disputes between farmers and herders as well as youth unemployment and disaffection (USAID 2017b; ANACIM et al. 2013). Simultaneously, the progress towards the west in neighbouring Mali of jihadist groups that are potentially seeking to enter Senegalese territory has raised concerns over the risk that Matam and Tambacounda could see the threat of radicalisation spread in their communities (USAID 2017b; Pujol-Mazzini 2018; Counter Extremism Project 2020; Chair of the Security Council Committee 2021).

Livelihood insecurity can, in turn, contribute to feelings of resentment by local communities for the government's reduced attention and uneven distribution of resources to Matam and Tambacounda (USAID 2017b). A visible outcome of climate-influenced livelihood insecurity may be a growing number of people -especially the youth- engaging in illegal activities such as poaching, trafficking, and banditry as they search for alternative sources of livelihood (USAID 2017b). Radical Islamist groups could benefit from or even partner with existing illicit economies and groups engaged in criminal activities, undermining state capacity and contributing to aggravating the security situation (Toupane et al. 2021).

The youth in Matam and Tamacounda is extremely vulnerable, especially considering that, with the highest rates in the country, 63,4 and 55,8% of the young people between 15 and 35 years of age are not in the education system nor employed (ANSD and AFRISTAT. 2019). If the region's youth seize on these feelings of resentment influenced by climate-induced livelihood insecurity, they risk becoming more vulnerable to anti-government narratives, including those advanced by Sahelian jihadi groups like JNIM (Sambe et al. 2021; Toupane et al. 2021; USAID 2017b). A recent study developed by the Timbuktu Institute in Matam and Tambacounda showed that socioeconomic factors are the most important drivers of radicalisation in the region. In particular, poverty, unemployment and the lack of viable livelihoods and income-generating activities were identified as the main motives for joining a jihadist armed groups (Sambe et al. 2021).

Livelihood and food insecurity in **Dakar**

Climate impacts on fish stocks as well as the devastating effect of floods may exacerbate existing socioeconomic vulnerabilities (unemployment, poverty and food insecurity) and contribute to the livelihood insecurity of people living in the suburbs of Dakar, especially affecting the youth, who may become more vulnerable to radicalisation and increase the prospects for the recruitment of extremist armed groups. A joint report conducted by ECOWAS and the ISS found that it was precisely in the most impoverished neighbourhoods of Dakar that interviewees showed more positive attitudes towards

radical Islam, including the narrative that portrays Western countries as antimuslim (Sambe and Ba, 2013). The lack of economic opportunities has been identified as a main driver in the radicalisation and recruitment of young Senegalese into extremist armed groups. A study from the Timbuktu Institute in the suburbs of Dakar found that the lack of employment opportunities and poverty are considered the two main drivers of the enlistment of the Senegalese youth in radical Islamist groups (Sambe et al. 2016).

Livelihood and food insecurity in Casamance

Climate change is exacerbating food and livelihood insecurity in Casamance which may push more young unemployed people to resort to alternative livelihoods linked to illicit economies -especially illegal logging- to complement or substitute agricultural activities, contributing to the degradation of natural resources and accentuating instability and tensions in some local communities.

With comparatively more favourable climatic conditions compared to the north, the Casamance region is known for its biodiversity, land fertility and vast -although rapidly declining- forest cover. Casamance has been historically considered Senegal's "breadbasket" since it is responsible for a considerable part of Senegal's agricultural production. It is the region with the largest production of cashew nut and the second biggest production of rice and cotton (ANACIM et al. 2013; Marut, 2015). However, the prevalence of climate-sensitive livelihoods in Casamance makes it particularly vulnerable to changes in temperature and rainfall patterns (Bacci and Diop, 2015). Temperatures have been increasing in the past decades and recent studies project that the annual mean temperature will increase by 1.6 °C in Ziguinchor and 1.9 °C in Kolda by 2050, while total precipitation will decrease by 7% in Ziguinchor and 10% in Kolda by the same year (CIAT and BFS/USAID 2016; Sané et al. 2010). Increases in salinization due to droughts and sea-level rise will continue increasing due to climate change which may augment erosion and the soil degradation near the coast and the Casamance River, reducing farmland and agricultural production (ANAMIC et al. 2013; Ministère de l'Environnement et du Développement Durable, 2015; USAID 2017a).

Casamance's northern agricultural systems are affected by wind and water-driven erosion, land degradation, deforestation, reduced rainfall and bush fires; while in the southern ones salinisation of rice fields, acidification of lowland soils, wind and water erosion, reduced rainfall and degradation of vegetation cover are strongly observed. The cultivation of rice, a popular staple crop in Casamance - especially in subsistence farming-, has already been impacted by declines in precipitations and increasing levels of land and water salinity that have reduced farmland and decreased yields in the regions of Ziguinchor et Kolda, and will be further affected under current climate change projections (Ministère de l' Environnement et du Développement Durable, 2015; Manzelli et al. 2015; Ruë and Descroix, 2015).

Through its impact on LWF systems, climate change is exacerbating food and livelihood insecurity in Casamance, which are already stressed by non-climatic factors mainly related to the ongoing armed conflict between the Movement of Democratic Forces of Casamance (MFDC) and the Senegalese government that has resulted in 5,000 deaths and thousands of displaced people and, in the last two decades has been increasingly intertwined with illicit economies, notably timber and cannabis trafficking

(Madurga López 2021; Foucher 2019). Casamance suffers from the highest food insecurity rates in the country, mostly ranging between 20% and 60% (WFP, 2011), while the percentage of young people between 15 and 35 years of age that are not in the education system nor employed reaches 32,4% in Ziguinchor, 55.6% in Kolda and 53.8 in Sédihou (ANSD and AFRISTAT. 2019). Precisely, a study developed in the city of Vélingara, in Casamance, by the Timbuktu Institute found that lack of employment opportunities and poverty were clearly the two main factors driving the youth to engage in criminal activities and banditry as well as radicalisation (Sambe et al. 2018).

However, illegal logging can be regarded as a maladaptation strategy against climate change that provides an alternative source of income for some people in the short term but contributes to the unsustainable plunder of natural resources in the medium and long term (Jones Sanchez, 2020; Marut, 2015). Apart from its socio-economic impact and environmental impact (Evans, 2022; Marut, 2015; EIA, 2020), illegal logging has created tensions -sometimes reaching violent altercations- among communities in Casamance, which have sometimes been exacerbated by unsuccessful environmental peacebuilding projects (Jones Sanchez, 2020). These inter-communal disputes have usually confronted the younger generations, who are the ones that mostly benefit from illegal logging, and the older generations, who usually profit less from this activity (Jones Sanchez, 2020). While illegal logging has often been tolerated and even considered a legitimate activity by a considerable part of rural communities, more recently, discourses that strongly criminalise fellers have gained preponderance (Evans, 2022; Jones Sanchez, 2020).

Participating in illegal logging and timber trafficking is also a risk in itself since it usually entails engaging with the rebels, who largely control the business and have been reported to issue “permits” to allow the transport of timber to the Gambia and even worked in escorting the transportation via the MFDC-controlled territory, helping smugglers to avoid land mines (EIA, 2020). Tensions and conflicts between young fellers and MFDC rebels have been reported on several occasions (Jones Sanchez, 2020; Liffraan, 2018). The unsuccessful cooperation with the rebels can directly risk the lives of the fellers, as it allegedly happened to 13 boys in 2018 (Liffraan, 2018). Similar conflicts have also been reported between rebels and communities, who are impeded from accessing and using forest resources for sustainable livelihoods (TRIAL International, 2020). Ultimately, illegal logging is partly responsible for the depletion and degradation of natural resources, curtails development, perpetuates instability and contributes to accentuating tensions and insecurity in some communities of Casamance.

Pathway #2: Resource availability and access pathway

The impact of climate change on land, water and food systems in Senegal may undermine the availability of certain key resources which, apart from increasing livelihood insecurity, can impact the availability of natural resources and increase competition over their access and use.

Rainfall variability, dry spells and droughts reduce the availability of water resources and affect crop production. Meanwhile, these phenomena also impact pasture and water resources that are needed by the herds, reducing livestock productivity and mortality (Seck and Laubin, 2013; FAO, 2016). As seen in the Ferlo region, located in northern Senegal, rainfall variability has tended to curtail livestock weight

gain, leading to lower incomes and worse nutrition intake of some pastoralists because of the fewer meat and milk production, and the increase in local food security (Rigaud et al. 2021).

Farmers cope with increasing water scarcity by expanding their fields, often encroaching transhumance corridors and land that is devoted to pastoralism. Land encroachment by farmers obstruct the mobility of herders and curtails the access to water and pasture, creating tensions between both groups (Rigaud et al. 2021; World Bank, 2020; Kitchell et al. 2014). At the same time, herders, which are among the most vulnerable groups to climate-induced food insecurity, are coping with the reduced availability of water by changing the timing of their mobility. Changes in these patterns brings them in closer proximity to farmer communities before the end of the harvest season, leading sometimes to the destruction of crops (Rigaud et al. 2021; World Bank, 2020). In fact, recent findings of the Pastoral Early Warning System (PEWS) show that since 2010 there have been records in the mobility of pastoralists due to worsening environmental conditions and that the southwards migration of herds towards greener pastures and water resources is taking place earlier than usual (Rigaud et al. 2021). Overall, these issues can aggravate existing tensions and conflicts between both livelihood groups, such as those seen in Matam and Kolda, which are often intertwined with ethnic rivalries (Rigaud et al. 2021; USAID, 2017b)

Climate impacts also contribute to the degradation of marine ecosystems and the overall decrease in fish stocks, exacerbating existing socio-economic vulnerabilities of people whose livelihood is connected to the fishing industry. Water temperatures have risen from 0.04 to 0.05° between 1980 and 2009, while Senegal's coastal water salinity has progressively increased (Ministère de l'Environnement et du Développement Durable 2015a). Increases in water temperatures affect ocean productivity, alter marine currents and change the distribution, reproduction and migration of the species, pushing fish to migrate northwards towards colder waters (Ministère de l'Environnement et de la Protection de la Nature 2010; Cheung et al. 2021; World Bank, 2013; Zickgraf, 2018; USAID, 2011, 2017b). Rises in water temperatures also contribute to the deterioration of mangroves and corals, which are home of many species (Dia Ibrahima, 2012; Zickgraf, 2018). Meanwhile, increasing water salinity boosts acidification which, in turn, may lead to the loss of species like molluscs that are particularly sensitive or not able to migrate (Zickgraf, 2018).

Climate impacts can further impact the availability of fish stocks and exacerbate existing conflicts and tensions over the access and use of resources between and among different users such gold miners and fishers seen in Tambacounda and Kédougou as well as between artisanal and industrial fishermen (Mbaye et al. 2022). The conflicts between artisanal fishermen and industrial fishing companies are posing an important threat to human security and sustainability while being characterised by a strong imbalance of power because of the different existing relationships with the government (DuBois and Zografos, 2012). There are also several conflicts between different fishing communities who practice artisanal fishing such as those that occurred in Mbao and Ngaparou as well as the Saint-Louis and Yarakh within Senegal, between migrants and local fishers, and, finally, between Senegalese fishermen from St. Louis and Mauritanian coastguards (DuBois and Zografos, 2012; Beatley and Edwards, 2018; Failler and Binet, 2010).

Resource availability and access in **Saint Louis**

The described effects of climate on fish stocks may exacerbate existing socioeconomic vulnerabilities and contribute to livelihood insecurity of fishing communities in Saint Louis, pushing people to continue

engaging in illegal fishing in Mauritanian waters and, consequently, putting their safety at risk while also potentially contributing to the conflict escalation between the Senegalese and the Mauritanian communities living on each side of the border (USAID, 2017b).

Although the relationship between Mauritania and Senegal has improved in the last three decades, tensions between both countries escalated in 1989, forcing people to migrate and leading to retaliations and killings on both sides of the borders. Senegalese residents in Mauritania, such as those living in Nuakchot, suffered attacks while Mauritanian traders in Dakar and Saint Louis were heavily targeted by local Senegalese who also targeted the property of Mauritians (SWAC, 2010; Magistro, 1993). The outcome were hundreds of deaths, thousands of refugees and displaced people and almost the start of an intrastate war between both countries (SWAC, 2010; Magistro 1993).

The Senegal River Delta, where the city of Saint Louis is located, is subject to different climate impacts, including droughts, floods, sea level rise and coastal erosion (Sambou et al. 2020). UN-Habitat described Saint-Louis as the most threatened city by sea level rise in the whole African continent (BBC 2008). Some recent studies show that in Saint Louis fishing is the economic activity that has been most impacted by climate change and that fishermen are the most climate-vulnerable occupation (Sambou et al. 2020).

The reduced availability of resources in northern Senegalese waters, influenced by climate change, has pushed some fishermen to cope with the hardship by moving northwards and fishing in Mauritanian waters (Belhabiba et al. 2014; Deme and Ndiaye 2022; Zickgraf, 2018). However, in the last decade Mauritania has adopted a stricter policy and it is now less tolerant with these practices which, apart from becoming increasingly dangerous, have also created source of conflicts and disputes, mainly between Senegalese fishermen and Mauritanian authorities (Deme and Ndiaye 2022; Hallaire 2015). Mauritanian authorities have responded with numerous fines, arrests, beatings and even gunshots to Senegalese fishermen (Hallaire 2015; Zickgraf, 2018). The lack of access to Mauritanian waters has led to increasing frustration of Senegalese fishermen in Saint Louis who feel abandoned by the government (USAID 2017b).

Still, most fishermen take the risk, crossing the maritime border during night time with their lights off hoping to avoid the coastguards which sometimes leads to boat collisions and various accidents, further increasing the insecurity of the fishermen (Hallaire 2015; Deme and Ndiaye 2022; Daïm, 2012). The continuation of this trend, exacerbated by climate impacts, will increase livelihood insecurity of Senegalese fishermen living in Saint Louis and continue to push them towards Mauritanian waters which, in turn, may boost the grievances of Senegalese fishermen and become a source of violent tensions between both communities. In fact, the killing of a Senegalese fisherman by a Mauritanian coastguard in 2019 ignited attacks to Mauritanian-owned businesses in the border city of Saint Louis, reminding of the tragic events of 1989 (Alonso Cabré 2019; BBC 2018).

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