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Senegal's Climate Poverty and Migration: the Price of Inaction

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Climate change poses a significant threat to various regions in the developing world, including Africa (IPCC, 2022). The focus on Africa in addressing climate change is justified by the continent's heightened vulnerability to more severe and frequent climate-related impacts, necessitating targeted policy interventions.

Over the next few decades, millions of individuals across Africa might experience a decline in their quality of life due to the adverse impacts of climate change (Bari and Dessus, 2022). Extreme weather events such as droughts and floods have already caused substantial damages, resulting in the destruction of homes and livelihoods, alongside widespread suffering, displacement and conflicts (Cappelli et al., 2021). In recent decades, the exacerbation of issues such as inequality, poverty, conflicts and lack of economic opportunities has compounded the challenges, hindered growth and destabilised societies. Currently, there are concerns that the progress made in improving the quality of life through the implementation of the United Nations' Sustainable Development Goals could be reversed by upcoming climatic challenges.

The Sahel countries are at the forefront of this impending climate crisis, with multiple hazards not only diminishing the economic potential, but also destroying assets and hindering opportunities for a prosperous life (Rigaud et al., 2021). Understanding and addressing climate-induced migration in Africa is imperative for designing effective policies that mitigate humanitarian crises, social tensions and conflicts, while fostering sustainable development and international cooperation. In this policy brief, we shed light on the consequences of inaction, conducting a thorough assessment of the potential impact of climate change on the well-being and migration of the Senegalese population.

A Tool for Projecting the Consequences of Climate Change

We construct a spatial general equilibrium model of the world economy to project future scenarios of climate change and their impact on macroeconomic aggregates, demography, poverty, and migration movements of people. A feature that makes this model unique and perfectly suited for answering these types of questions

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is the detailed treatment of space, as the world is divided into 7.7 million of 5x5 km pixels (of which 2.4 million are habitable). These pixels represents local economies that interact through production, consumption, trade, and migration decisions of individuals (Burzynski et al., 2022). This enables us to model complex interdependencies between unequal spatial distributions of demographic, economic and climatic variables that generate the impact of climate change on key dimensions of living conditions all over the world.

Senegal, a country embedded in the global economic model, is the focus of this study, although the model computations are performed for all countries in the world. In this policy brief, we showcase the future climate scenario of RCP7.0 (+2 degrees Celsius worldwide on average at the end of the century relative to 2020, consistent with the status quo of climate policy and green technology), coupled with the SSP3 scenario (Regional rivalry, A Rocky Road) for 2030 and 2050.[1] All the results are computed relative to a scenario with no climate change (referred to here as RCP0.0, as if climate in the future was constant and equal to the observed state in 2010), under SSP3 conditions. Note that all the simulations disregard major adaptation policies and behavioural adjustments of individuals, therefore they can be used to identify regional vulnerabilities and the cost of inaction as if the 2010 status quo was persistent over time.

The country of Senegal, a medium-sized economy on the Atlantic coast, is a textbook example of how multidimensional climate damages are about to change the socio-economic landscape over the next decades. With a total population of 18 million people in 2023 (70 percent of whom live within commuting distance of the capital city, Dakar, see Figure 1a), and a gross domestic product per capita (GDPpc) of approximately $4,500 (see Figure 1b), this country is expected to be significantly affected by climate shocks. Below, we present a snapshot of the potential climatic damages under RCP7.0 in 2050, their economic consequences, and the migration responses of people in Senegal. We conclude this policy brief with an analysis of poverty and policy recommendations to mitigate the expected damages.

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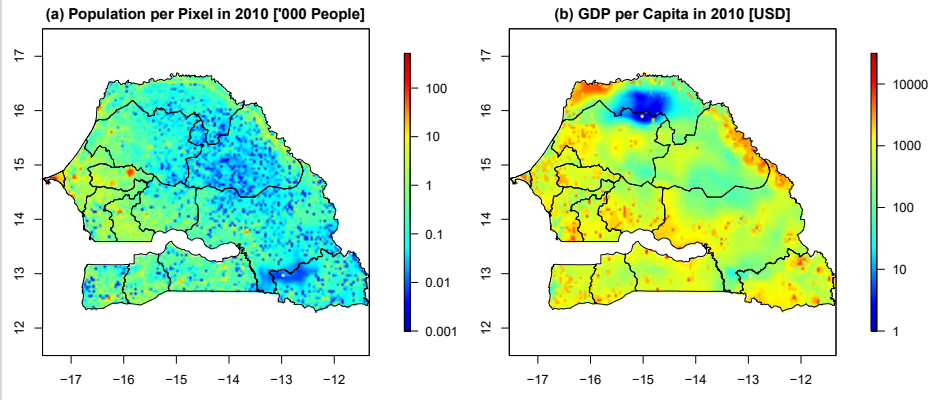

Figure 1: Distribution of Population (a) and Gross Domestic Product per Capita (b) in Senegal in 2010

[1] *Representative Concentration Pathways (RCPs) are greenhouse gas concentration (not emissions) trajectories, while Shared Socioeconomic Pathways (SSPs) consider climate change scenarios of projected socio-economic changes. The Intergovernmental Panel on Climate Change (IPCC) has defined both collections of scenarios in the Sixth Assessment Report (2021).*

Mechanisms and Regional Vulnerabilities

Our spatial macroeconomic model includes four types of climate damages. First, we consider the impact of temperatures on labour productivity, noting that shifts in annual temperature distributions cause substantial losses in workers' efficiency – with different effects across various job types, calibrated using the ILO damage functions estimated by Kjellstrom et al. (2018). Figure 2a illustrates the projected losses in labour productivity in Senegal in 2050 RCP7.0, relative to 2050 RCP0.0. The central and eastern parts of the country (where agriculture dominates) experience the largest losses, ranging from 60 to 75 percent of workers' productivity. In the more urbanised western and coastal parts of the country, these impacts are significantly milder, including losses of up to 10 percent in the Dakar Region. We observe this pattern not only because the climate is more bearable in the coastal area (thus the future increase in temperature is lower than on the continent), but also because of job types dominating in this area: industrial and service jobs that are less affected by extreme heat than agricultural jobs.

Second, land productivity will change over the next decades, as illustrated in Figure 2b. While only the northern and southern extremes of Senegal will experience a decline in agricultural yields, the central part of the country is expected to become more productive. This outcome arises from the mix of higher precipitation in the rainy season and the assumption of using land irrigation, which improves agricultural yields, especially near river basins.

Third, our model recognises that some parts of the land will be permanently flooded by the sea, as depicted in Figure 2c. Sea level rise in Senegal will cause most damage to the southern coast, which is already sparsely populated. Thus, the increase in the sea level results in limited losses in GDP and small numbers of displaced people.

Finally, Figure 2d summarises expected losses from disasters and extreme weather events. Here, our model includes droughts, floods, cyclones and heatwaves. The central and southern parts of the country are subject to high magnitudes of hazards, with droughts dominating in the north and floods in the centre and south. Heat is the key factor in the north-east, while cyclones bring relatively small effects in selected coastal areas. Due to its geography, the diversified climatic exposures and hazards pose different threats to people living in different parts of the country. The next part of the policy brief shows the consequences of these shocks, with a key focus on the economy and migration.

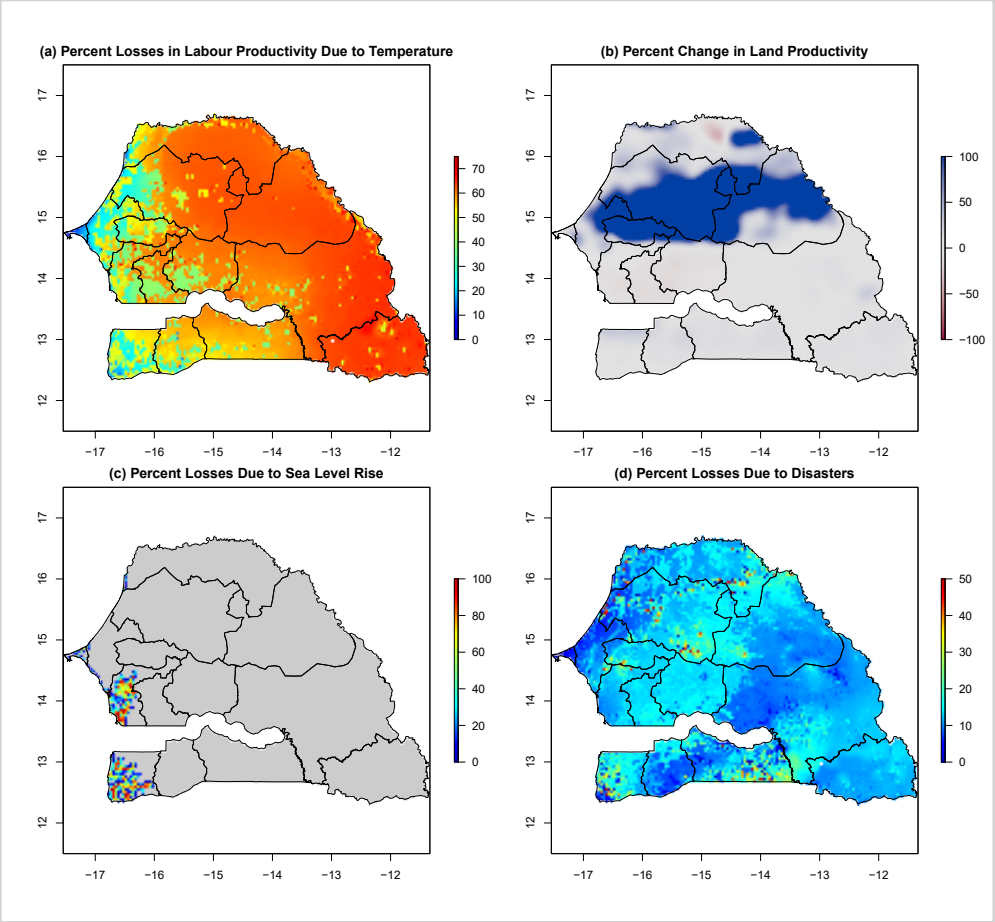

Figure 2 : The Impact of Climate Change on Labour Productivity (a), Land Productivity (b), Sea Level Rise (c), and Damages by Extreme Weather (d) in 2050 under the RCP7.0 Scenario

Assessing the Cost of Inaction

According to Figure 3a, extensive area of Senegal will suffer huge income losses, ranging from 50 to 70 percent. Only the central part of the country is projected to benefit from climate change. A combination of more favourable rain conditions during the rainy season and higher land productivity will lead to significant gains in the agricultural, poorest, and least populated part of Senegal. The regions of Dakar and Thies are projected to lose less than 5 percent of average income, although this result can be attributed to the changed composition of the workforce caused by migration. Figure 3b reports net inflows of Senegalese to all the regions characterised by rising GDPpc and those with high levels of urbanisation. In contrast, the northern, eastern and southern regions not only experience severe economic losses, but also important outflows of inhabitants who try to escape climate damage. The spatial pattern of people allocation is clear, with accelerated urbanisation and concentration in the west, and continued depopulation of the poorest parts of the country. These processes deepen already high inequalities across regions and preclude income convergence within Senegal. Only a handful of regions attract newcomers, while a dozen of the least developed administrative units suffer economic and demographic crises induced by climate damage in 2050 RCP7.0.

In rural areas, income is projected to drop by up to 70% by 2050 under RCP7.0

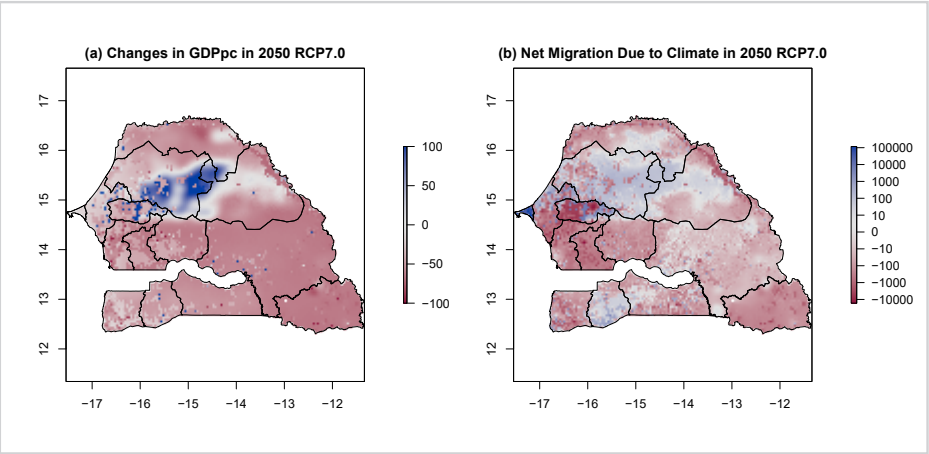

Figure 3 : Deviations in GDP per Capita (a) and Net Migration (b) Caused by Climate Change in 2050 (RCP7.0 vs RCP0.0)

By aggregating these local effects of climate damage, we discover the magnitude of the economic tragedy in Senegal caused by climate change in 2050, as shown in Table 1. Our model projects that the overall value of GDP will plummet by 40% because of climate shocks in the RCP7.0 scenario. The effects differ across sectors, with industry experiencing the most significant loss (55%), followed by agriculture (45%) and services (36%). The income per worker drops by 41%, as the model projects a slight increase in Senegal's population, while the educational composition of the workforce shifts towards less educated individuals, mainly due to international outmigration. Climate change affects spatial distribution of workers and their allocation across sectors. By supporting concentration and agglomeration, employment in agriculture reduces slightly (5%), while it increases in industry (20%) and services (1%). On top of income losses, climate change in Senegal will lead to a substantial increase in price levels, with agricultural goods being more expensive by 57%, industrial goods by 97%, and services by 34%. This means that the purchasing power of Senegalese incomes reduce by more than 50% by mid-century. Due to higher demand for more advanced goods and services, a well-documented fact as countries grow over time, the availability of basic products will be a less pressing problem than access to industrial goods.

In 2050, Senegal's GDP is projected to drop by 40% due to climate shocks under RCP7.0

	All Sectors		
Working age pop.	0.88%		
GDP per worker	-40.63%		
GDP	-40.11%		
Share of tertiary	-3.66%		
	AGRI	**INDU**	**SERV**
GDP	-45.14%	-55.17%	-36.15%
Employment	-5.40%	19.74%	0.77%
Price level	56.76%	97.08%	34.01%
Average wage	-42.01%	-62.56%	-36.64%

Table 1 : Aggregated Macroeconomic Effects of Climate Change in 2050 (Relative Change Between RCP7.0 vs RCP0.0)

Our results confirm that the common fears related to the expected implications of climate change could very soon materialise. Sub-Saharan countries are particularly exposed to economic losses from climate-related damage, given that their economies depend on less advanced sectors, and their production is dominated by agriculture and low-productivity services. Moreover, Senegal has relatively weak trade links with other countries, which cannot mitigate the effects of local price increases, especially for industrial goods. By influencing the demographic structure of the population, climate change reduces the country's ability to absorb and develop new technologies.

At Stable Costs, Migration Responses to Climate Change are Limited

These gloomy macroeconomic projections have crucial consequences for the migration patterns generated by climate change. Regarding aggregated immigration to Senegal (the left column of Table 2), one can observe a substantial increase in movements from Mauritania (MRT). Simultaneously, migration to Senegal from Guinea (GIN), Mali (MLI), Gambia (GMB), France (FRA) and Sierra Leone (SLE) decreases, indicating that Senegal is more affected by climate change than these countries. When it comes to emigration from Senegal (right column of Table 2), tens of thousands of Senegalese are projected to seek better perspectives in Italy (ITA), Spain (ESP), France (FRA) and North America (USA, CAN). At the same time, emigration towards many Sub-Saharan and Sahel countries plummets, indicating a general trend induced by climate change in developing world: people tend to substitute short- and medium-distance movements for long-distance migration. Overall, Senegal will see an increase in immigration of 11,223 people (1.2% of total migration inflows) and a reduction in emigration of 18,831 (-0.8% of total migration outflows) due to climate change over the period 2010-2050. We thus conclude that climate has little effect on the size of the flows but fundamentally changes the direction of international migration, with people moving to the rich global North instead of remaining in the poor and damaged South.

Immigration to Senegal

Country	People	Share of RCP0.0
MRT	67,934	36.0%
CIV	857	6.2%
GNB	506	0.4%
TGO	265	5.3%
ITA	0	0.0%
...		
SLE	-4,440	-8.1%
FRA	-5,332	-27.8%
GMB	-9,194	-13.8%
MLI	-13,772	-8.8%
GIN	-14,948	-7.2%
TOTAL	**11,223**	**1.2%**

Emigration from Senegal

Country	People	Share of RCP0.0
ITA	63,323	24.6%
ESP	58,112	23.4%
FRA	40,274	17.9%
USA	17,494	16.2%
CAN	5,907	22.3%
...		
BFA	-7,839	-23.6%
CIV	-11,591	-6.9%
MLI	-15,365	-20.1%
GMB	-75,741	-15.7%
MRT	-109,230	-34.8%
TOTAL	**-18,831**	**-0.8%**

Table 2 : Top/Bottom Five Countries of Immigration to and Emigration from Senegal in RCP7.0 relative to RCP0.0 by Country of Origin/ Destination over 2010-2050

International migration is a very costly strategy and might not be accessible to every citizen of Senegal. Instead, people tend to flee climate damage through internal migration movements. Table 3 confirms our findings from Figure 3b, determining the scale of human mobility across and within regions of Senegal. Nearly 250,000 people are pushed by climate change to migrate to the Dakar region, while regions of Thies, Sedhiou and Louga experiencing inflows under 20,000. The remaining regions experience population decline, confirming that Senegalese are fleeing areas of their country in which climate damaged reduces agricultural yields and puts huge pressures on working conditions and wages. Over the period 2010-2050, Dakar also reports the highest number of people discouraged from leaving the region, which in total results in an increase in net internal migration by 410,000 people due to climate change. At the country level, net migration across Senegal regions increases by 13,000 people due to climatic factors, which is again a drop in the ocean, considering that the total population in Senegal will exceed 30 million by 2050. Climate change significantly discourages migration within Senegalese regions, as movements over short distances provide little chance of escaping climate damages. At the country level, 75,000 fewer people decide to move locally.

By 2050, almost 250,000 people in Senegal will decide to migrate to the Dakar region due to climate change

Region	Regional in migration	Regional out migration	Local migration	Net internal immigration
Dakar	245,241	-164,471	-63,447	409,711
Ziguinchor	-9,372	28,178	3,744	-37,550
Diourbel	-28,077	41,552	-4,403	-69,629
Saint Louis	-26,322	16,081	-387	-42,403
Tambacounda	-25,815	-13,563	-2,998	-12,252
Kaolack	-31,967	42,226	-2,429	-74,192
Thies	19,893	-348	13,946	20,241
Louga	4,734	-16,660	1,603	21,394
Fatick	-17,030	53,877	4,457	-70,907
Kolda	-11,844	5,359	-244	-17,204
Matam	-48,685	4,041	-13,408	-52,725
Kaffrine	-23,510	10,989	-2,642	-34,499
Kedougou	-43,046	6,827	-11,867	-49,873
Sedhiou	8,732	-1,156	2,760	9,888
TOTAL	**12,932**	**12,932**	**-75,314**	**0**

Table 3 : Aggregated Internal Migration by Regions in Senegal in RCP7.0 relative to RCP0.0 over 2010-2050

Migration remains an important strategy for coping with climate shocks but is not a game-changing phenomenon in Senegal. This fact confirms findings of recent studies, saying that climate migration brings little relief, as people most threatened by climate hazards are oftentimes unable to move. The causes of this well-known fact are multiple (Rikani et al., 2023; Benveniste et al., 2022). Climate immobility arises among populations that suffer from poverty, rely on agriculture and lack proper education. Attachment to local communities and to the land, even when it is degraded by climate damage and extreme weather, is more of a rule than an exception. Moreover, low cultural proximity, language barriers, travel costs and insufficient education that strongly restrict the pool of available jobs imply low numbers of international and internal climate migrants in Senegal.

Inaction Leads to Severe Escalations in Extreme Poverty

Consequently, the vast majority of people in Senegal remain in their areas of birth and fully suffer the climate shocks, seeing their disposable income and purchasing power decline sharply. According to Figure 4, the distribution of incomes in Senegal experiences a huge leftward shift because of climate change in 2050. Even though everyone loses, losses for the poorest are severe, pushing millions of Senegalese into extreme poverty (indicated to the left of the grey vertical line). In 2050, without climate change, our model projects 5% of Senegalese in extreme poverty (living on less than $2.15, adjusted to 2050 purchasing power). Under RCP7.0 scenario, 11.5% of the Senegalese population will be in extreme poverty by mid-century.

Climate change alone increases the share of extremely poor people by a factor of 2.3. This result can be compared to wiping out decades of efforts, progress, and international support that resulted in successfully implementing UN Sustainable Development Goals in Senegal until today.

> By 2050, 11% of Senegalese is projected to face extreme poverty (increase by a factor of 2.3 vs. no climate change)

Climate change poses a significant threat to economic prosperity, social cohesion and human living conditions in Senegal (Rigaud et al., 2022). Due to peoples' limited mobility capabilities, the severe shocks expected over the next decades bring insurmountable losses and drain the country from its growth potential. Everyone in Senegal will see their incomes fall, while millions of individuals slide below the extreme poverty line. These facts are devastating from the policy perspective, as losses of such magnitudes are hard to circumvent in the course of 20-30 years. Apart from strengthening the call at the international forums for reducing global emissions, national authorities in Senegal have few action points that could improve these pessimistic prospects. One of them could be reducing climate losses through accelerated structural change of the economy (probably fuelled by global development funds). Converting rural areas into industrial and service-based centres is a tough task, as human resources and direct investments are scarce, but brings immediate and efficient relief to higher temperatures while generating growth. Second, developing trade links with partner countries could diversify the risk of price increases, boosting imports of industrial goods, and favouring exports of services. Third, unlocking the potential of secondary cities (mainly those with population below 200,000) by increasing their attractiveness for internal migrants with secure jobs, public infrastructure, and sustainable housing. Fourth, raising social awareness of likely future scenarios could incentivise people to start planning for future migration (internal or international) by accumulating education, financial resources, or knowledge needed to undertake a medium- or long-distance move. Finally, a necessary intervention would be to investigate the impacts of climate change on health outcomes. With the increased availability of relevant data, this topic emerges as an important future model extension aimed at enhancing our understanding of the underlying complexities.

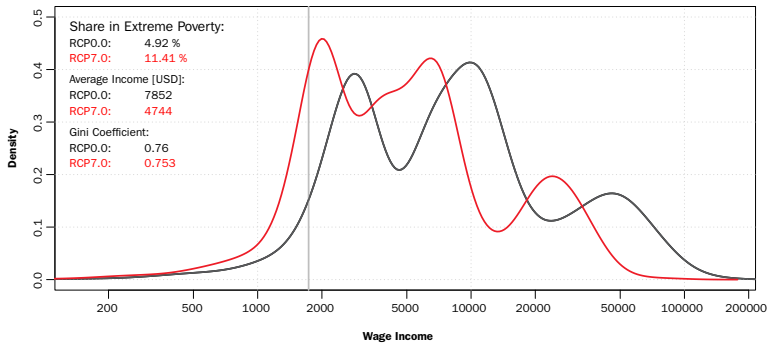

Figure 4 : Distribution of Income in Senegal 2050 RCP7.0 (red) and 2050 RCP0.0 (black)

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