

# Annex 2: Feasibility Study

Scaling up Resilience in Africa's Great Green Wall – SURAGGWA

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## LIST OF ACRONYMS

Acronym	Definition
CIMP6	Coupled Model Intercomparison Project Phase 6. An international collaboration of climate scientists who are working to evaluate the performance of climate models and improve our understanding of the Earth's climate system. CIMP6 is the latest phase of the Coupled Model Intercomparison Project (CIMP), which began in the 1990s.
CRU	Climate Research Unit of the university of East Anglia (United Kingdom).
CWB	Climatic Water Balance (see Climate Variables).
ETo	Reference Evapotranspiration (see Climate Variables).
HDays	Heat Days (see Climate Variables)
P	Annually accumulated Precipitation (see Climate Variables).
Pvar <sub>inter</sub>	Precipitation inter-annual variability (see Climate Variables).
Pvar <sub>intra</sub>	Precipitation intra-annual variability (see Climate Variables).
RCP 4.5	Representative Concentration Pathway 4.5. It is one of the four scenarios used by the Intergovernmental Panel on Climate Change (IPCC) to project future climate change. RCP4.5 is considered a stabilization scenario, as it assumes that greenhouse gas emissions will peak and then decline by the end of the century.
RCP 8.5	Representative Concentration Pathway 8.5. It is one of the four scenarios used by the Intergovernmental Panel on Climate Change (IPCC) to project future climate change. RCP8.5 is considered a business-as-usual scenario, as it assumes that greenhouse gas emissions will continue to increase throughout the 21st century.
SPEI	Standardized Precipitation Evapotranspiration Index (see Climate Variables).
TG	Average temperatures (see Climate Variables).
TN	Minimum Temperatures (see Climate Variables)
TNights	Tropical Nights (see Climate Variables)
TX	Maximum Temperatures (see Climate Variables)

## CHAPTER I – INTRODUCTION

The Scaling Up Resilience in the African Great Green Wall (SURAGGWA) project intends to support eight countries (Burkina Faso, Chad, Djibouti, Mali, Mauritania, Niger, Nigeria and Senegal) in implementing their climate change strategies and meeting their international climate change commitments, as expressed in the Nationally Determined Contributions (NDC) they submitted following the Paris agreement.<sup>1</sup> These eight countries are all members of the Great Green Wall initiative for the Sahara and the Sahel (henceforth Great Green Wall or GGW), which was founded in the early 2000's as a response against increasing desertification, as detailed in chapter VII.a. below.

While the eight SURAGGWA countries are very diverse, they have two key characteristics in common: all are **extremely exposed and vulnerable to climate change**, and their **greenhouse gas emissions originate mainly in the land use sector**. The countries' exposure and vulnerability to climate change is well documented (ND-GAIN reference). The high exposure derives from the expected climate change phenomena in the region: major temperature increases and reduced moisture availability (see chapter II). The extreme vulnerability is caused by the impacts of these expected climate change phenomena on a population that is still largely rural, lives off the land and has limited options for increasing the resilience of their livelihood strategies. This is even more true of the Great Green Wall zone of these countries, which tends to have annual rainfall of between 100 and 400 mm.<sup>2</sup> Therefore, the selection of project areas where land will be restored is mainly based on climate change adaptation considerations (see chapter III, and Table 1 below). The rural land use context in each of the eight countries as well as their particular vulnerabilities are detailed in Appendix 1 to this feasibility study.

According to the NDCs of the eight SURAGGWA countries (Burkina Faso, Chad, Djibouti, Mali, Mauritania, Niger, Nigeria and Senegal), GHG emissions from their Agriculture, Forestry and Land Use (AFOLU) sector account for the lion's share of their national emissions: between 63.8 and 91.1%. A large share of these AFOLU emissions derive from land use change and land degradation, so this is also where most of the GHG mitigation potential of these countries can be found. Through restoring 1.4 million ha of degraded land, the SURAGGWA aims to sequester 93 million tCO<sub>2</sub>e over the 20-year lifetime of the investment<sup>3</sup>.

Restoring degraded land provides these countries with a major opportunity not only to reduce their greenhouse gas emissions, but also to increase the resilience of the livelihoods of their rural populations. Under the EU-funded Action Against Desertification project (AAD),

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<sup>1</sup> The SURAGGWA project will also support three additional GGW countries to improve their land degradation and restoration monitoring systems (output 3.2): Eritrea, Ethiopia, and Sudan.

<sup>2</sup> While the annual rainfall may be somewhat higher in the GGW zone of some countries, e.g. Nigeria, it is highly variable in all countries, both inter-annually and intra-annually speaking (see details in chapter III), posing major challenges to farming, livestock raising and tree growing.

<sup>3</sup> The net result of the SURAGGWA project is slightly lower at 65.9 million tCO<sub>2</sub>e, as it takes into account a slight increase in livestock emissions due to the fodder production contribution of the restored land, see Annex 22, carbon impact potential assessment.

FAO helped six Sahelian countries to pilot a **novel approach to the restoration of highly degraded common lands**, based on a combination of mechanical land preparation to increase soil permeability and direct seeding of a variety of grass, shrub and tree species, selected by the local communities themselves. While the mechanical land preparation may seem (relatively) expensive, the increased water availability it affords the vegetation enhances the success of direct seeding – thus addressing the major climate change impact of reduced moisture availability (see chapter II) and reducing the need for establishing time-consuming and costly (water, inputs, labour) tree nurseries (see chapter IV).

There have also been major advances in the **restoration of moderately degraded farmlands** in the Great Green Wall countries, through a combination of agro-ecology and agro-forestry techniques, including joint seeding of trees and crops like sesame<sup>4</sup>, farmer-managed natural regeneration (FMNR)<sup>5</sup> and enrichment planting (see chapter IV). Simple techniques such as the addition of mulch to crop planting holes specially prepared to collect moisture (“zaï”) in combination with the increased soil fertility through nitrogen fixation and litter fall provided by native trees mixed with the crops has been reported to increase crop yields per hectare by a factor of 2-4. In some parts of the GGW zone, such as in Niger, the large-scale application of these techniques – in combination with a return of the rains after the devastating droughts in the 1970’s and 1980’s – has led to a net greening of the rural landscape, as documented by FAO’s Africa Open DEAL initiative<sup>6</sup> (see also Annex 22, carbon impact potential assessment). It is important to note, however, that even in GGW countries where there has been a net “greening” overall, such as Mali and Niger, land degradation continues to affect large areas, 2.95 and 3.46 million ha respectively over the 2000-2019 period.<sup>7</sup> Component 1 aims to restore 150,000 hectares (ha) of highly degraded common land and 1.3 million ha of moderately degraded farmland (see chapter IV).

The land restoration targets quoted for the African continent, and especially its dryland regions, have ballooned in recent years. The AFR100 (Africa Forest Landscape Restoration Initiative) 2030 targets for the eight SURAGGWA countries total 25.6 million ha, and this does not include Djibouti and Mauritania, which have not yet set AFR100 targets.<sup>8</sup> Practical progress with land restoration, however, has not kept up with these ever-increasing targets. One of the key problems is that land and ecosystem restoration are often framed as “environmental” activities with fairly abstract objectives, such as “combating desertification”, outside the economic mainstream. This framing is of course erroneous, as land restoration is essential for improving ecosystem services that African populations depend on, especially in the face of climate change, and land degradation generates major economic costs. A 2015 UNEP initiative, the Economics of Land Degradation in Africa, estimated that land degradation could lead to economic losses equivalent to 12% of GDP.<sup>9</sup> One way to reframe

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<sup>4</sup> An innovation by Sudanese farmers that is expanded under the GCF-funded Gums for Adaptation and Mitigation in Sudan project, see <https://www.greenclimate.fund/project/sap019>

<sup>5</sup> See e.g. <https://www.wvi.org/stories/niger/farmer-managed-natural-regeneration-one-solutions-rational-management-our-resources>

<sup>6</sup> The FAO Africa Open D.E.A.L (Data for Environment, Agriculture and Land) initiative has made Africa the first continent to complete the collection of accurate, comprehensive, and harmonized digital land use and land-use change data, see the 2022 assessment report for the 2000-2019 period at <https://www.fao.org/documents/card/fr/c/CC0725EN/>

<sup>7</sup> FAO Africa Open Deal 2022 op. cit. page 42, table 28.

<sup>8</sup> See Table 12 in full proposal document and <https://afr100.org/>

<sup>9</sup> ELD Initiative & UNEP (2015). The Economics of Land Degradation in Africa: Benefits of Action Outweigh the Costs. Available from [www.eld-initiative.org](http://www.eld-initiative.org)

restoration as both an economic and an environmental activity is to design land restoration programmes such that they generate more direct economic benefits to the local communities concerned. A **key pathway to create incentives for communities to manage restored lands sustainably is to ensure that produce from restored areas provides increased economic benefits to local communities**. This can be done by repositioning them in the value chains to obtain better prices for Non-Timber Forest Products (NTFP) produced on restored land, and by generating benefits more quickly – including through the seeding of fodder grasses that yield income in the first year of the intervention. The activities under component 2 (see chapter V below) aim to operationalize this pathway. As the yields of most NTFP are much less variable than annual crop yields, this helps rural smallholder producers to become more resilient in the face of climate change.

During SURAGGWA project preparation, extensive studies were carried out on the potential of NTFP and fodder value chain interventions to increase smallholder income and improve rural livelihood resilience (summarized in chapter V), in partnership with the African Forest Forum (AFF), the Arid and Rangelands Research Institute of the Kenya Agricultural and Livestock Research Organization (KALRO-ARLRI) and the Network on Gum Arabic in Africa (NGARA). These studies emphasized the importance of **improving the technical, organizational and commercial capacities of NTFP smallholder producer groups** to ensure that restored lands generate sufficiently attractive economic benefits. **Facilitation of equitable partnerships with private NTFP buyers** will also be essential. The project team also had extensive interactions with the World Economic Forum (WEF) and the World Business Council on Sustainable Development (WBCSD) to identify activities intended to enhance demand for NTFP from the GGW zone in international markets. The above-mentioned activities fall under outputs 2.1 and 2.2, and are described in detail in Chapter V below. Activities to improve the **access of NTFP smallholder collectors, processors, and sellers to financial services**, which fall under output 2.3, are described in Chapter VI. The latter activities generate important synergies with other IFI investments, including the GCF-funded IGREENFIN programme, implemented by IFAD.

The final piece of the puzzle is capacity development of the Great Green Wall institutions at national and regional level, which falls under component 3. **Land degradation and restoration monitoring capacities need to be strengthened** if the GGW countries want to be able to make a case for increased investment in restoration of degraded land. For many of the past restoration investments, geographic coordinates of areas restored are unavailable, which makes it extremely hard to demonstrate restoration impacts, and to justify increased funding demands. **Operational planning and programme monitoring capacities will be essential if land restoration is to be scaled up. Resource mobilization capacity development, including in the field of carbon finance, is high on the priority list** of both national and regional GGW institutions. Enhancing the capacity for knowledge management will also be tackled, in close coordination with IFAD's Great Green Wall Umbrella Program, which is also funded by the Green Climate Fund.

The climate change adaptation potential of the SURAGGWA project is summarized in Table 1 below.

**Table 1. SURAGGWA climate change impact potential for adaptation**

<b>Documented climate change effect</b>	<b>Impact on rural land users</b>	<b>Relevant programme output/activity</b>	<b>Risk reduction/impact mitigation</b>
		<b>Component 1 – Land restoration</b>	
Temperature increase	Reduced yields of annual crops due to overheating (see IFAD CARD <sup>10</sup> ) and lower moisture availability	Agroforestry/agro-ecology restoration of moderately degraded farmland, providing shade to crops and improving land productivity (through N fertilization, and increased soil organic carbon and nutrient inputs)	Increased vegetation cover provided by scattered trees in crop fields protects crops against overheating thereby reducing negative impact of rainwater runoff and increased temperatures on crop yields
Increase in frequency of extreme rainfall events	Increased run-off and reduced water infiltration reduces water availability for crops and pasture and causes water erosion damage downstream	Mechanized restoration of severely degraded sylvo-pastoral land including reseedling of trees, shrubs and grasses (i.e. replenishing soil seedbank and diversifying vegetation cover)	Reduces surface run-off and increases water infiltration, increasing water availability (including water table) for crops (food) and pasture (feed) and reducing damage to downstream fields and infrastructure. Contributes to smallholder incomes from fodder and NTFP production
Decrease in SPIE moisture index (due to increase in temperature combined with level precipitation)	Reduced crop yields due to lower water availability and lower productivity of lands	Agroforestry/agro-ecology restoration of moderately degraded farmland and planting fertilising species (see also under Component 2 below)	Increases water infiltration in the soil and water availability for crops, increases organic matters and diversifies production to include non-timber forest products (NTFP)
Increased windspeed, especially in JJAS	Increased desiccation of crops and depletion of soil nutrients	Agroforestry/agro-ecology restoration (e.g. live windbreaks and planted hedges) to reduce windspeed in crop fields	Reduces drying out of annual crops and limits depletion of soil nutrients
Increased windspeed, especially in JJAS	Increased soil erosion and reduced land productivity	Revegetation of denuded sand dunes around permanent & seasonal water bodies	Reduces siltation of water bodies and maintains their capacity to support human livelihoods (farming, livestock, fishing)
		<b>Component 2 – Smallholder value chain support and access to finance</b>	
Decrease in SPIE moisture index (see Chapter II)	Reduced yields of annual crops (see IFAD CARD)	Enabling smallholder producer groups to increase benefits from sustainable use and management of restoration-based non-timber forest products (NTFP)	Stabilises smallholder incomes, as NTFP yields are more resilient to climate change impact

<sup>10</sup> The IFAD CARD tool is available at <https://www.ifad.org/en/web/knowledge/-/publication/climate-adaptation-in-rural-development-card-assessment-tool>

Decrease in SPIE moisture index	Reduced yields of annual crops	Improved smallholder access to financial services will enable increased investment in agroforestry and other land restoration activities, as well as in NTFP processing	Stabilises smallholder incomes through livelihood diversification and risk reduction
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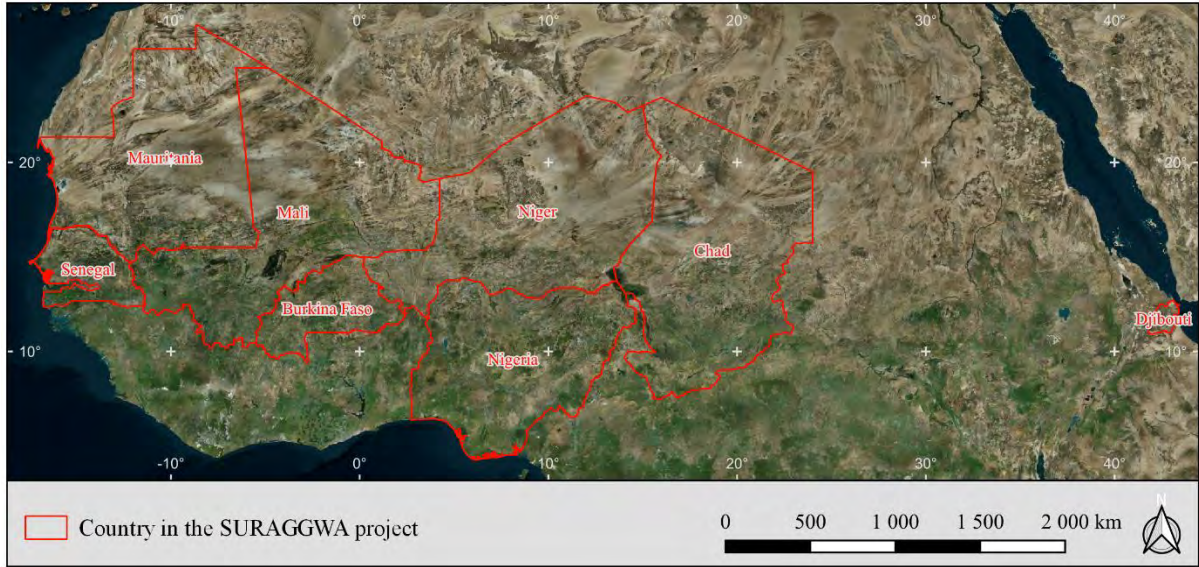
# Chapter II: CLIMATE ANALYSIS

## CURRENT CLIMATE

This section will outline the current climate in the 8 selected states in the SURAGGWA program.

### Summary

**Figure 1 – States participating in the SURAGGWA program**  
**Map background: Bing Maps**



The **average temperature** in six states (Chad, Djibouti, Mali, Mauritania, and Niger) exhibits a seasonal cycle characterized by two extreme points, with a **minimum observed in January and a maximum observed during the summer months** (April, May, June or July). The temperature pattern in Burkina Faso, Nigeria, and Senegal also exhibits a minimum in January and a maximum in April/May, but also presents **two local extremums**, a local maximum observed in October and a local minimum in August. This minor seasonal minimum is likely caused by the heavy rains that occur during this period. Across all states, monthly average temperatures range between 18°C and 34°C.

Across all states, the **peak in monthly accumulated precipitation occurs in August**, followed by a gradual decrease until it reaches minimal levels in October, November, or December. Djibouti, Mauritania, and Niger have the lowest peak monthly accumulated precipitation, which does not

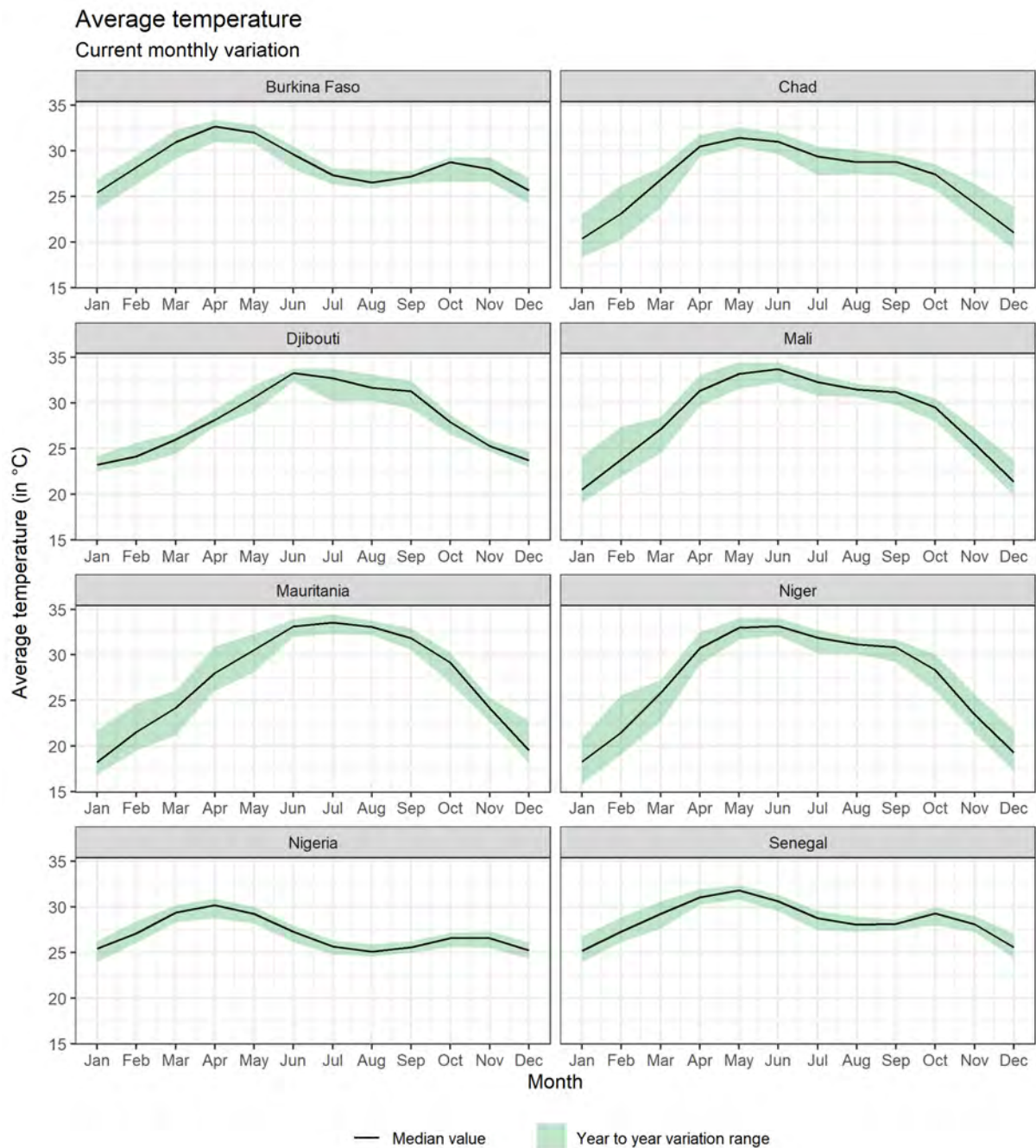
exceed 50 mm. Burkina Faso, Chad, Nigeria, and Senegal, on the other hand, experience a peak monthly accumulated precipitation that exceeds 100 mm. Mali falls somewhere in between, with a peak monthly accumulated precipitation of 78 mm in August.

## Average Temperature

The states participating in the SURAGGWA program exhibited a **monthly average temperature ranging from 18°C to 34°C**.

**Figure 2 – Current monthly average temperature**

Data aggregated over the 1991-2021 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020).



In five states (**Chad, Djibouti, Mali, Mauritania, and Niger**), the seasonal temperature cycle featured two distinct extreme values: **a minimum in January** and **a maximum in summer months**, either April, May, June, or July. The average temperature between these two periods exhibited a relatively consistent decrease or increase.

Conversely, **Burkina Faso, Nigeria, and Senegal** exhibit a seasonal temperature cycle with four distinct extreme values: **a minimum in January and a maximum in April or May**, similar to other states. However, they also feature two additional local extremums, a **local maximum in October** and a **local minimum in August**. This local minimum is likely a result of heavy rainfall during this period, as described in the [accumulated precipitation section](#). Notably, Nigeria experiences an inversion of the two minimums, with the major minimum in August and the minor minimum in January.

**Table 1 – Metadata on current monthly average temperature**

Data aggregated over the 1991-2021 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020).

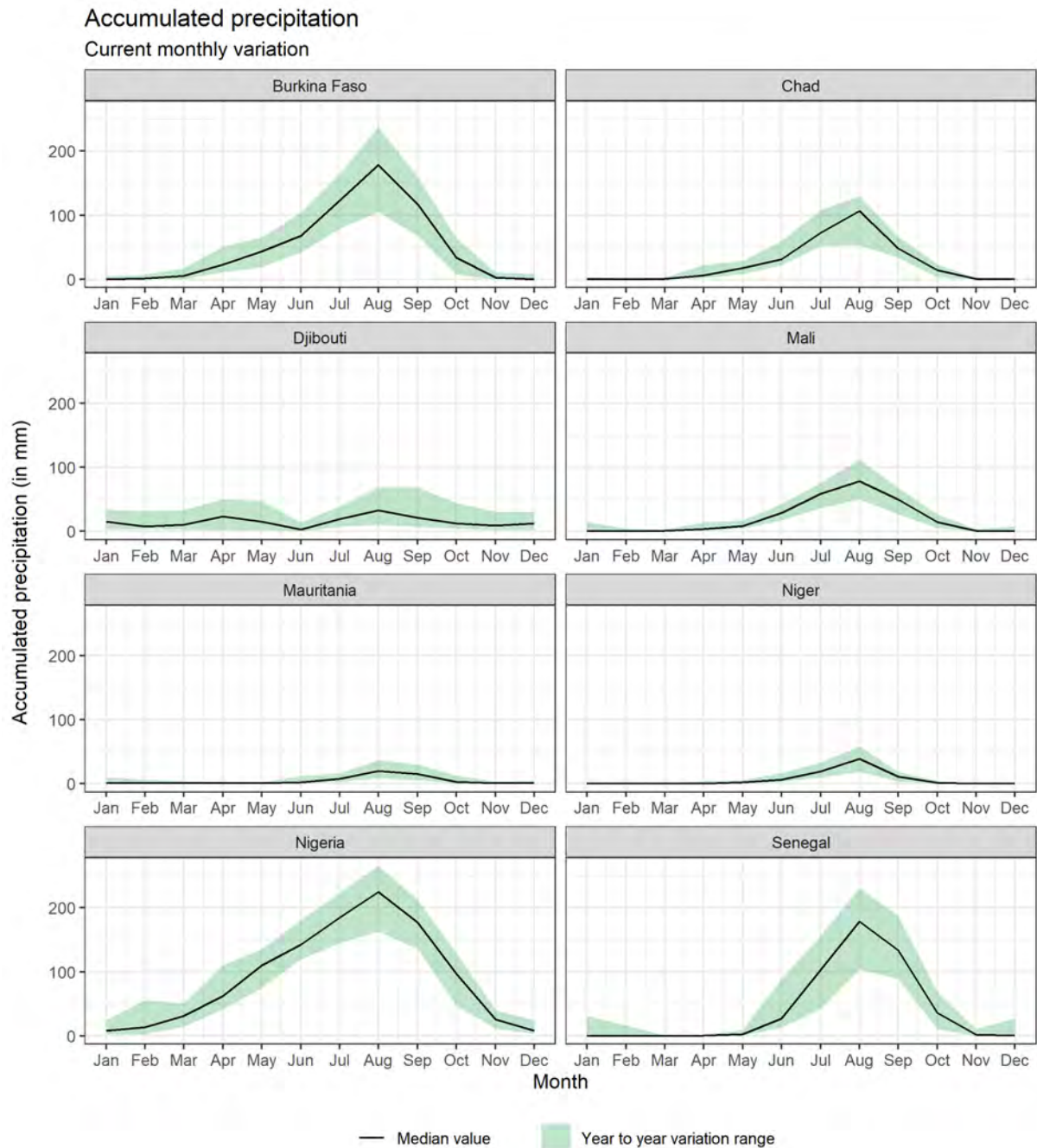
State	Maximum value month	Minimum value month
Burkina Faso	April (32.68°C)	January (25.45°C)
Chad	May (31.44°C)	January (20.37°C)
Djibouti	June (33.26°C)	January (23.24°C)
Mali	June (33.72°C)	January (20.52°C)
Mauritania	July (33.56°C)	January (18.24°C)
Niger	June (33.17°C)	January (18.30°C)
Nigeria	April (30.18°C)	August (25.10°C)
Senegal	May (31.82°C)	January (25.20°C)

## Accumulated precipitation

The Sahelian region is characterized by low to very low accumulated precipitation throughout most of the year.

**Figure 3 – Current monthly accumulated precipitation**

Data aggregated over the 1991-2021 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020).



There are, however, significant variations in precipitation patterns across the region:

- In **Djibouti**, **Mauritania**, and **Niger**, the highest monthly accumulated precipitation does not exceed 50 millimeters.
- Conversely in **Burkina Faso**, **Chad**, **Nigeria**, and **Senegal**, the monthly accumulated precipitation can exceed 100 millimeters at its peak.
- **Mali** falls in between of these two extremes, with the highest monthly accumulated precipitation reaching 78 millimeters in August.

All the selected states experience a peak in monthly accumulated precipitation during August, which is followed by a steady decline in precipitation levels until October, November, or December when precipitation becomes negligible. Then, from January to June, precipitation gradually increases until it reaches its peak again in August.

A notable exception to this precipitation pattern is **Djibouti**, located at the easternmost end of the Sahelian region, where a **bimodal precipitation pattern** can be observed. Indeed, in addition to a major rainy season in August, Djibouti experiences a minor rainy season in April, and minimal precipitation levels in June and November.

**Table 2 – Metadata on current monthly accumulated precipitation**

Data aggregated over the 1991-2021 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020).

State	Maximum value month	Minimum value month
Burkina Faso	August (178mm)	December (0mm)
Chad	August (106mm)	December (0mm)
Djibouti	August (33mm)	June (3mm)
Mali	August (78mm)	December (0mm)
Mauritania	August (20mm)	April (0mm)
Niger	August (39mm)	December (0mm)
Nigeria	August (225mm)	December (8mm)
Senegal	August (178mm)	January (0mm)

## WATER STRESS

This section will outline the past and expected future trends of water stress indices for the 8 selected states in the SURAGGWA program.

### Summary

It was difficult to discern a clear trend for historical and projected **accumulated precipitation**, as most states in the SURAGGWA program exhibit a lack of distinct patterns and/or statistical significance in their trends. Nevertheless, it is anticipated that annual accumulated **precipitation levels will remain stable in Mali and Mauritania**, while **Burkina Faso, Niger, and Nigeria are expected to experience an increase in precipitation levels under the business-as-usual scenario (RCP 8.5)**. **Senegal on the other hand, is projected to have an increase in annually accumulated precipitation levels under both RCP scenarios.**

Regarding precipitation intra-annual variability, with a few exceptions, the selected states displayed a **constant seasonal precipitation cycle, with a similar pattern to the current seasonal cycle, for historical and stabilization scenario (RCP 4.5)**. However, **if the current climate change mitigation policies are not successful**, within the next few decades, **the business-as-usual scenario (RCP 8.5) expects an increase in the intra-variability, increasing the range of extreme precipitation event in the participating countries**. The trends in inter-annual precipitation variability, on the other hand, are not as clear, as they either lack statistical significance or produce conflicting outcomes. However, the **annual largest precipitation accumulated over one and five day(s) (LP1 and LP5) are expected to increase under the business-as-usual scenario** for most of the selected countries, indicating an increased flood risks if the current climate change mitigation policies are not successful.

Regarding annually accumulated reference evapotranspiration, a significant increase was observed in most countries for historical and projected data, indicating a **consistent rise in water demand**. Additionally, persistent negative water balance values throughout the analysis period and a decreasing trend in historical and projected water balance indicate a **high and steadily increasing water deficit situation in the SURAGGWA countries**.

Finally, the analysis of the 3-, 9-, and 12-month SPEI, showed a consistent decline across the states, indicating an **ongoing increase in the frequency and intensity of hydrological, agricultural, and geological droughts**, together with an increase in the number of exceptionally dry months and a decrease in the number of exceptionally wet months.

In conclusion, the analysis of historical and projected data for precipitation, intra- and inter-annual precipitation variability, reference evapotranspiration, water balance and SPEI indicates a high and steadily increasing water deficit situation in the countries participating in the SURAGGWA program. While some states may experience stable or increased annual accumulated precipitation levels, projected trends expect an increase in intra-annual precipitation variability the annual largest precipitation accumulated over one and five day(s) in the participating countries if the current climate change mitigation policies are not successful,

which can lead to increased flood risks. Furthermore, there is a significant increase in water demand due to the high and increasing reference evapotranspiration, leading to consistently high and increase water deficit for historical and projected trends. The consistent decline in SPEI across states also points to an increase in the frequency and intensity of hydrological, agricultural, and geological droughts. **These findings highlight the urgent need for effective and sustainable land and water management strategies in the region to mitigate the effects of climate change on water availability.**

**Table 3 – Historic climate trends for water stress indices**

Time period: 1980-2020. Data sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020).

Historical trends								
Index	Burkina Faso	Chad	Djibouti	Mali	Mauritania	Niger	Nigeria	Senegal
<b>Accumulated precipitation</b>		 -16mm/dec.	 -21mm/dec.					
<b>Intra-annual standard deviation of accumulated precipitation</b>						 +1.26mm/dec.		
<b>Inter-annual standard deviation of accumulated precipitation</b>		 -7.85mm/dec.	 -7.39mm/dec.	 -1.63mm/dec.		 -2.18mm/dec.	 -13.67mm/dec.	 +3.10mm/dec.
<b>Largest precipitation accumulated over one day</b>	 +5.35 mm/dec			 +1.92 mm/dec		 +2.07 mm/dec	 +4.18 mm/dec	 +3.38 mm/dec
<b>Largest precipitation accumulated over five days</b>	 +7.30 mm/dec			 +2.25 mm/dec		 +2.68 mm/dec	 +4.77 mm/dec	 +6.02 mm/dec
<b>Accumulated reference evapotranspiration</b>		 +423mm/dec.	 +451mm/dec.	 +477mm/dec.	 +496mm/dec.	 +411mm/dec.		 +814mm/dec.
<b>Climatic water balance</b>		 -439mm/dec.	 -472mm/dec.	 -484mm/dec.	 -496mm/dec.	 -406mm/dec.		 -823mm/dec.
<b>3-month accumulated SPEI</b>		 -0.0005/dec.	 -0.0004/dec.	 -0.0005/dec.	 -0.0005/dec.	 -0.0004/dec.	 -0.0002/dec.	 -0.0007/dec.
<b>6-month accumulated SPEI</b>		 -0.0006/dec.	 -0.0005/dec.	 -0.0007/dec.	 -0.0007/dec.	 -0.0005/dec.	 -0.0002/dec.	 -0.0008/dec.
<b>12-month accumulated SPEI</b>		 -0.0009/dec.	 -0.0007/dec.	 -0.0009/dec.	 -0.0010/dec.	 -0.0008/dec.	 -0.0002/dec.	 -0.0010/dec.

**Table 4 – Projected climate trends under RCP 4.5 scenario for water stress indices**

Time period: 2020-2060. Data sources: World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

Projected trends under the RCP 4.5 scenario								
Index	Burkina Faso	Chad	Djibouti	Mali	Mauritania	Niger	Nigeria	Senegal
<b>Accumulated precipitation</b>				 -8mm/dec.				 -16mm/dec.
<b>Intra-annual standard deviation of accumulated precipitation</b>								 -1.66mm/dec.
<b>Inter-annual standard deviation of accumulated precipitation</b>		 +2.13mm/dec.	 +3.92mm/dec.		 -2.55mm/dec.	 -1.26mm/dec.	 +3.66mm/dec.	 -7.19mm/dec.

<b>Largest precipitation accumulated over one day</b>		+0.69 mm/dec.						
<b>Largest precipitation accumulated over five days</b>								
<b>Accumulated reference evapotranspiration</b>	+265mm/dec.	+380mm/dec.		+569mm/dec.	+607mm/dec.	+403mm/dec.	+289mm/dec.	+720mm/dec.
<b>Climatic water balance</b>		-369mm/dec.		-576mm/dec.	-602mm/dec.	-400mm/dec.	-268mm/dec.	-730mm/dec.
<b>3-month accumulated SPEI</b>	-0.0002/dec.	-0.0004/dec.	-0.0002/dec.	-0.0005/dec.	-0.0006/dec.	-0.0004/dec.	-0.0002/dec.	-0.0005/dec.
<b>6-month accumulated SPEI</b>	-0.0002/dec.	-0.0005/dec.	-0.0002/dec.	-0.0006/dec.	-0.0007/dec.	-0.0005/dec.	-0.0002/dec.	-0.0006/dec.
<b>12-month accumulated SPEI</b>	-0.0002/dec.	-0.0006/dec.	-0.0003/dec.	-0.0007/dec.	-0.0009/dec.	-0.0007/dec.	-0.0002/dec.	-0.0007/dec.

**Table 5 – Projected climate trends under RCP 8.5 scenario for water stress indices**

Time period: 2020-2060. Data sources: World Bank Climate Change Knowledge Portal (WBCKP)

<https://climateknowledgeportal.worldbank.org/>

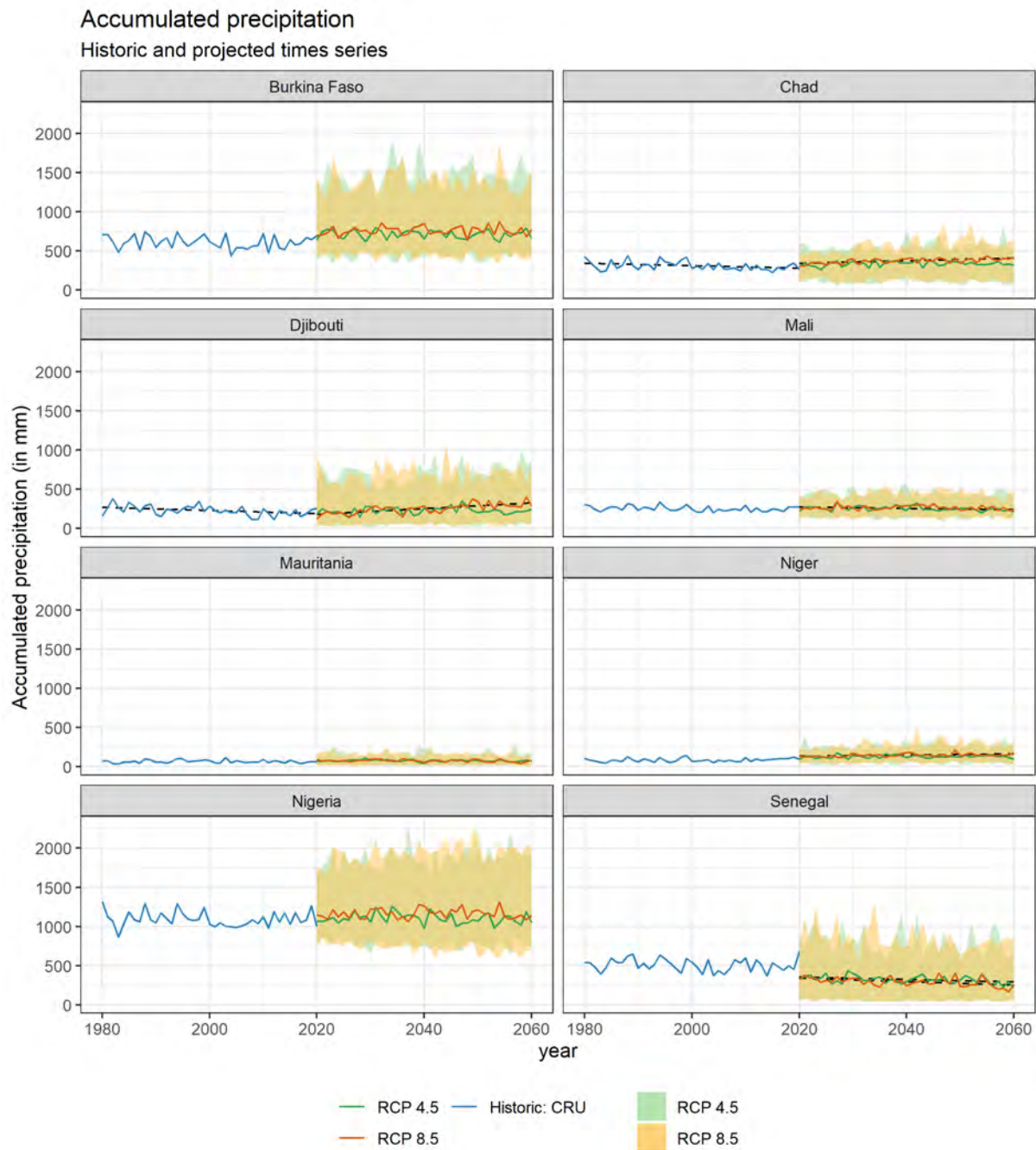
Projected trends under the RCP 8.5 scenario								
Index	Burkina Faso	Chad	Djibouti	Mali	Mauritania	Niger	Nigeria	Senegal
<b>Accumulated precipitation</b>		+17mm/dec.	+37mm/dec.			+7mm/dec.		-22mm/dec.
<b>Intra-annual standard deviation of accumulated precipitation</b>	+1.80mm/dec.	+2.08mm/dec.	+4.29mm/dec.			+0.82mm/dec.	+1.51mm/dec.	-2.48mm/dec.
<b>Inter-annual standard deviation of accumulated precipitation</b>	+5.06mm/dec.	+2.44mm/dec.	+14.13mm/dec.		+1.44mm/dec.			+2.98mm/dec.
<b>Largest precipitation accumulated over one day</b>	+3.49 mm/dec.	+1.23 mm/dec.	+1.61 mm/dec.	+1.78 mm/dec.		+1.28 mm/dec.	+2.22 mm/dec.	
<b>Largest precipitation accumulated over five days</b>	+3.89 mm/dec.	+3.36 mm/dec.	+3.82 mm/dec.	+2.19 mm/dec.		+1.50 mm/dec.	+2.70 mm/dec.	
<b>Accumulated reference evapotranspiration</b>		+395mm/dec.		+610mm/dec.	+691mm/dec.	+370mm/dec.	+351mm/dec.	+860mm/dec.
<b>Climatic water balance</b>		-363mm/dec.		-595mm/dec.	-686mm/dec.	-367mm/dec.	-309mm/dec.	-876mm/dec.
<b>3-month accumulated SPEI</b>	-0.0002/dec.	-0.0004/dec.	-0.0002/dec.	-0.0006/dec.	-0.0006/dec.	-0.0005/dec.	-0.0001/dec.	-0.0006/dec.
<b>6-month accumulated SPEI</b>	-0.0002/dec.	-0.0004/dec.	-0.0002/dec.	-0.0006/dec.	-0.0008/dec.	-0.0006/dec.		-0.0006/dec.
<b>12-month accumulated SPEI</b>	-0.0002/dec.	-0.0005/dec.	-0.0002/dec.	-0.0007/dec.	-0.0009/dec.	-0.0007/dec.		-0.0007/dec.

## Accumulated precipitation

**Most of the historical and projected accumulated precipitation trends** in the states participating in the SURAGGWA program are **either insignificant or yield conflicting results**, making it difficult to predict future precipitation patterns with a high degree of insurance.

**Figure 4 – Historical and projected time series of annually accumulated precipitation**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>



- In **Mali** and **Mauritania**, no statistically significant variations in annually accumulated precipitation have been observed for either historical or projected data. As such, it can be assumed that **the accumulated precipitation for these states did (and will) remain stable**, at around 254 mm/year for Mali and 67 mm/year for Mauritania.

- Historical data for **Burkina Faso, Niger, and Nigeria** did not show any significant variation in annually accumulated precipitation. It can be assumed that **the annually accumulated precipitation has remained stable for the last 4 decades**, at around 615 mm/year in Burkina Faso, 85 mm in Niger, and 1093 mm in Nigeria. When considering projected trends, only the business-as-usual scenario (RCP 8.5) expected a significant trend, an increase ranging from 10 to 17 mm per decade.

**Table 6 – Metadata on historical and projected time series of annually accumulated precipitation**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

State	Data	Period	General Trend	Slope	Total variation during the period	Average value during the period	p-value	Adjusted R <sup>2</sup>
<b>Burkina Faso</b>	CRU	1980 - 2020	Not signif.	-	-	615mm	0.3411	0
	RCP 4.5	2014 - 2060	Not signif.	-	-	804mm	0.8036	-0.02
	RCP 8.5	2014 - 2060	+	+13mm/dec.	59mm	-	0.0334	0.08
<b>Chad</b>	CRU	1980 - 2020	-	-16mm/dec.	-63mm	-	0.0326	0.09
	RCP 4.5	2014 - 2060	+	+8mm/dec.	37mm	-	0.0174	0.1
	RCP 8.5	2014 - 2060	+	+18mm/dec.	84mm	-	less than 0.0001	0.49
<b>Djibouti</b>	CRU	1980 - 2020	-	-21mm/dec.	-83mm	-	0.0084	0.14
	RCP 4.5	2014 - 2060	Not signif.	-	-	261mm	0.0839	0.04
	RCP 8.5	2014 - 2060	+	+33mm/dec.	150mm	-	less than 0.0001	0.51
<b>Mali</b>	CRU	1980 - 2020	Not signif.	-	-	254mm	0.0984	0.04
	RCP 4.5	2014 - 2060	Not signif.	-	-	272mm	0.0632	0.05
	RCP 8.5	2014 - 2060	Not signif.	-	-	277mm	0.575	-0.02
<b>Mauritania</b>	CRU	1980 - 2020	Not signif.	-	-	67mm	0.8278	-0.02
	RCP 4.5	2014 - 2060	Not signif.	-	-	80mm	0.3654	0
	RCP 8.5	2014 - 2060	Not signif.	-	-	81mm	0.1462	0.03
<b>Niger</b>	CRU	1980 - 2020	Not signif.	-	-	85mm	0.1454	0.03
	RCP 4.5	2014 - 2060	Not signif.	-	-	140mm	0.3077	0
	RCP 8.5	2014 - 2060	+	+10mm/dec.	45mm	-	less than 0.0001	0.34
<b>Nigeria</b>	CRU	1980 - 2020	Not signif.	-	-	1093mm	0.4336	-0.01
	RCP 4.5	2014 - 2060	Not signif.	-	-	1212mm	0.9912	-0.02
	RCP 8.5	2014 - 2060	+	+17mm/dec.	77mm	-	0.0323	0.08
<b>Senegal</b>	CRU	1980 - 2020	Not signif.	-	-	511mm	0.4123	-0.01
	RCP 4.5	2014 - 2060	-	-12mm/dec.	-56mm	-	0.015	0.1
	RCP 8.5	2014 - 2060	-	-20mm/dec.	-93mm	-	5.00E-04	0.22

- Historical data for **Senegal** did not show any significant variation. Therefore, the **historical annually accumulated precipitation should be assumed constant, around 511 mm/year**. However, according to projected data, **under the stabilization scenario (RCP 4.5), a decrease of -12 mm per decade is expected**, while **under the business-as-usual scenario (RCP 8.5), the decrease could be as much as -20 mm per decade**.

- **Chad and Djibouti experience conflicting trends in their annually accumulated precipitation levels.** While historical data indicates a decline in the annual precipitation accumulation in both countries, projected data suggests an increase in the coming decades. This conflicting pattern makes it challenging to draw any definitive conclusions regarding annually accumulated precipitation levels. It is worth noting that over the past few decades, Mali has experienced an average accumulated precipitation of 254 mm, while Mauritania has received 67 mm on average.

## Precipitation variability

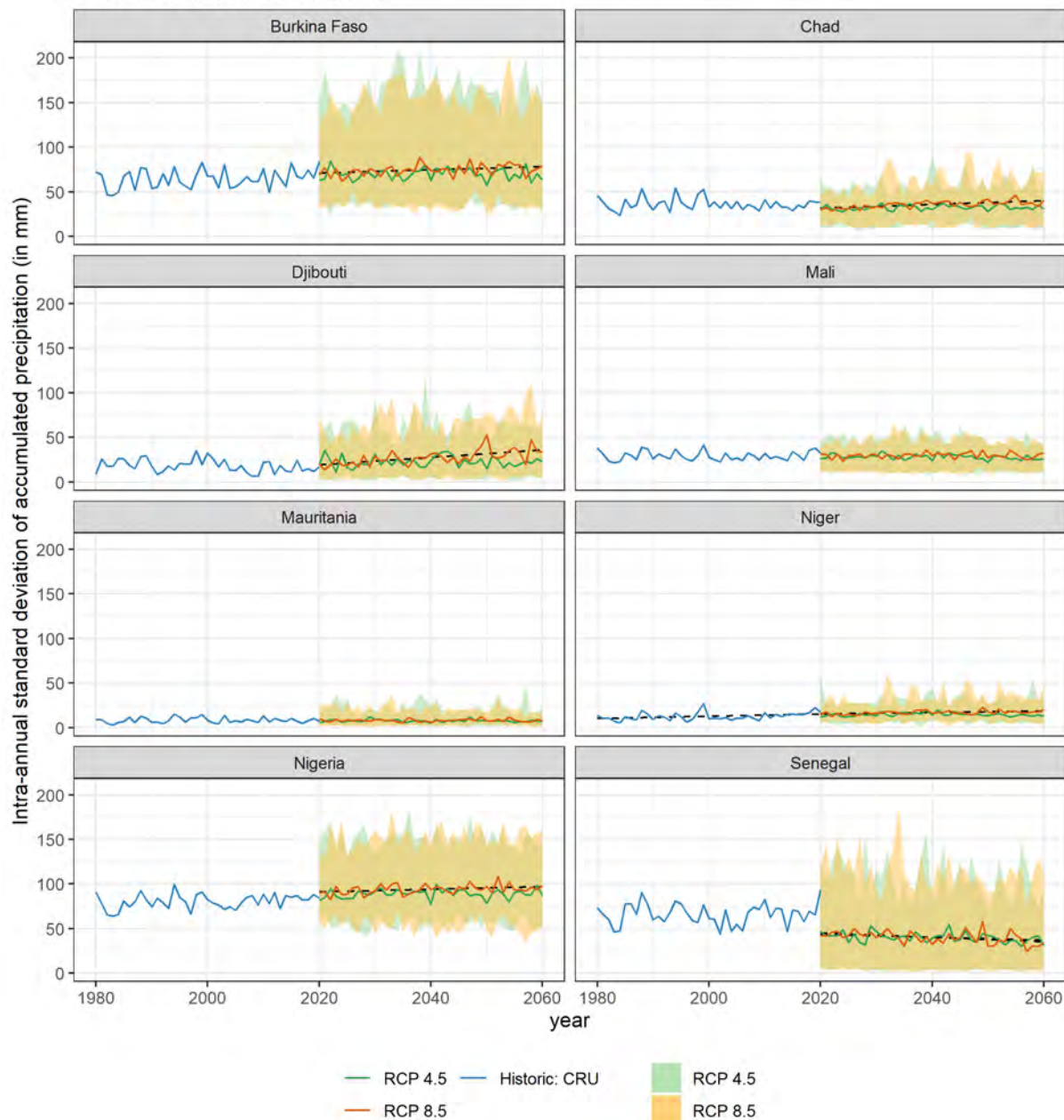
### *Intra-annual variability*

#### ***Figure 5 – Historical and projected time series of the annual standard deviation of monthly accumulated precipitation***

*Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WCKP)*  
<https://climateknowledgeportal.worldbank.org/>

## Intra-annual standard deviation of accumulated precipitation

Historic and projected times series



With a few exceptions, the states participating in the SURAGGWA program have exhibited **constant intra-annual variability for both historical and projected data under the stabilization scenario (RCP 4.5)**. However, **the business-as-usual scenario (RCP 8.5) is expected to lead to an increase in intra-annual variability for precipitation**. The exceptions are:

- In **Mali** and **Mauritania**, no significant variation in intra-annual variability was discernible for historical data nor for projected data, under either scenario.
- In **Niger**, a significant increase in intra-annual variability was discernible for historical data and projected data under the business-as-usual scenario (RCP 8.5). No significant variation was observed under the RCP 4.5 scenario.

- Historical data from **Senegal** shows no variation in intra-annual precipitation variability. However, projected data under both scenarios suggests that precipitation variability is likely to decrease.

**Table 7 – Metadata on historical and projected time series of the annual standard deviation of monthly accumulated precipitation**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

State	Data	Period	General Trend	Slope	Total variation during the period	Average value during the period	p-value	Adjusted R <sup>2</sup>
<b>Burkina Faso</b>	CRU	1980 - 2020	Not signif.	-	-	64.71mm	0.1175	0.04
	RCP45	2020 - 2060	Not signif.	-	-	80.93mm	0.9157	-0.03
	RCP85	2020 - 2060	+	+1.76mm/dec.	7.05mm	-	0.0278	0.1
<b>Chad</b>	CRU	1980 - 2020	Not signif.	-	-	36.33mm	0.5609	-0.02
	RCP45	2020 - 2060	Not signif.	-	-	32.70mm	0.323	0
	RCP85	2020 - 2060	+	+2.03mm/dec.	8.13mm	-	less than 0.0001	0.39
<b>Djibouti</b>	CRU	1980 - 2020	Not signif.	-	-	18.18mm	0.0759	0.05
	RCP45	2020 - 2060	Not signif.	-	-	26.39mm	0.921	-0.03
	RCP85	2020 - 2060	+	+4.20mm/dec.	16.78mm	-	less than 0.0001	0.36
<b>Mali</b>	CRU	1980 - 2020	Not signif.	-	-	29.41mm	0.9134	-0.03
	RCP45	2020 - 2060	Not signif.	-	-	28.80mm	0.0716	0.06
	RCP85	2020 - 2060	Not signif.	-	-	29.65mm	0.5094	-0.01
<b>Mauritania</b>	CRU	1980 - 2020	Not signif.	-	-	8.34mm	0.7675	-0.02
	RCP45	2020 - 2060	Not signif.	-	-	9.09mm	0.4458	-0.01
	RCP85	2020 - 2060	Not signif.	-	-	9.37mm	0.8196	-0.02
<b>Niger</b>	CRU	1980 - 2020	+	+1.26mm/dec.	5.05mm	-	0.0258	0.1
	RCP45	2020 - 2060	Not signif.	-	-	16.05mm	0.9196	-0.03
	RCP85	2020 - 2060	+	+0.80mm/dec.	3.21mm	-	0.0043	0.17
<b>Nigeria</b>	CRU	1980 - 2020	Not signif.	-	-	80.67mm	0.0909	0.05
	RCP45	2020 - 2060	Not signif.	-	-	96.49mm	0.4159	-0.01
	RCP85	2020 - 2060	+	+1.48mm/dec.	5.90mm	-	0.0324	0.09
<b>Senegal</b>	CRU	1980 - 2020	Not signif.	-	-	66.31mm	0.7457	-0.02
	RCP45	2020 - 2060	-	-1.62mm/dec.	-6.48mm	-	0.027	0.1
	RCP85	2020 - 2060	-	-2.43mm/dec.	-9.71mm	-	0.0064	0.15

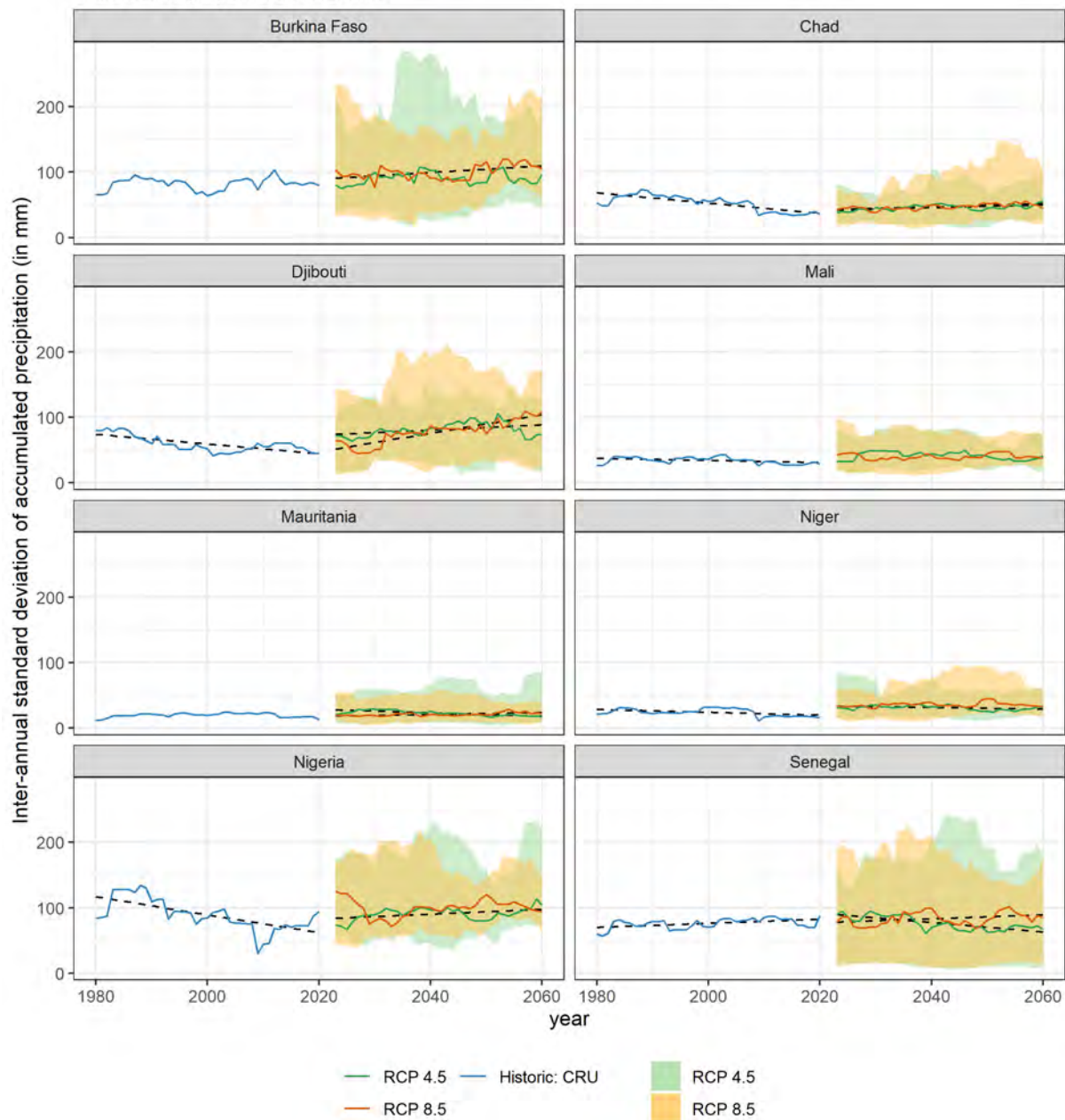
### Inter-annual variability

**Figure 6 – Historical and projected time series of the standard deviation of the annually accumulated precipitation of the last 10 years (rolling window)**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

## Inter-annual standard deviation of accumulated precipitation

Historic and projected times series



As for absolute value of the annually accumulated precipitation, **most of the historical and projected inter-annual variability trends** in the states participating in the SURAGGWA program are **either insignificant or yield conflicting results**, making it difficult to estimate future inter-annual variability patterns with a high degree of insurance.

- In **Burkina Faso**, while no significant variation in inter-annual variability was discernible for historical data nor for projected data under the RCP 4.5 scenario, the business-as-usual scenario (RCP 8.5) expect an increase in interannual variability.

- Although historical data from **Chad** and **Djibouti** indicated a decrease in inter-annual precipitation variability, the projected data presents conflicting results, with both scenarios showing an increase in inter-annual variability.
- Although historical data from **Mali** showed a decrease in inter-annual precipitation variability, the projected data expects the inter-annual variability to remain stable under both scenarios.
- In **Mauritania**, while no significant variation in inter-annual variability was discernible for historical data, the projected data under the stabilization scenario (RCP 4.5) expects the inter-annual variability to decrease, and the business-as-usual scenario (RCP 8.5) expects the inter-annual variability to increase.

**Table 8 – Metadata on historical and projected time series of the standard deviation of the annually accumulated precipitation of the last 10 years (rolling window)**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

State	Data	Period	General Trend	Slope	Total variation during the period	Average value during the period	p-value	Adjusted R <sup>2</sup>
<b>Burkina Faso</b>	CRU	1980 - 2020	Not signif.	-	-	82.08mm	0.3344	0
	RCP45	2023 - 2060	Not signif.	-	-	103.46mm	0.2927	0
	RCP85	2023 - 2060	+	+5.06mm/dec.	18.72mm	-	0.001	0.24
<b>Chad</b>	CRU	1980 - 2020	-	-7.85mm/dec.	-31.39mm	-	less than 0.0001	0.61
	RCP45	2023 - 2060	+	+2.13mm/dec.	7.89mm	-	2.00E-04	0.3
	RCP85	2023 - 2060	+	+2.44mm/dec.	9.03mm	-	less than 0.0001	0.41
<b>Djibouti</b>	CRU	1980 - 2020	-	-7.39mm/dec.	-29.56mm	-	less than 0.0001	0.5
	RCP45	2023 - 2060	+	+3.92mm/dec.	14.50mm	-	0.0098	0.15
	RCP85	2023 - 2060	+	+14.13mm/dec.	52.29mm	-	less than 0.0001	0.79
<b>Mali</b>	CRU	1980 - 2020	-	-1.63mm/dec.	-6.52mm	-	0.0094	0.14
	RCP45	2023 - 2060	Not signif.	-	-	44.61mm	0.0766	0.06
	RCP85	2023 - 2060	Not signif.	-	-	43.84mm	0.5861	-0.02
<b>Mauritania</b>	CRU	1980 - 2020	Not signif.	-	-	19.61mm	0.7134	-0.02
	RCP45	2023 - 2060	-	-2.55mm/dec.	-9.44mm	-	less than 0.0001	0.57
	RCP85	2023 - 2060	+	+1.44mm/dec.	5.32mm	-	less than 0.0001	0.39
<b>Niger</b>	CRU	1980 - 2020	-	-2.18mm/dec.	-8.72mm	-	0.0015	0.21
	RCP45	2023 - 2060	-	-1.26mm/dec.	-4.67mm	-	0.0089	0.15
	RCP85	2023 - 2060	Not signif.	-	-	38.24mm	0.1246	0.04
<b>Nigeria</b>	CRU	1980 - 2020	-	-13.67mm/dec.	-54.68mm	-	less than 0.0001	0.44
	RCP45	2023 - 2060	+	+3.66mm/dec.	13.52mm	-	0.0066	0.17
	RCP85	2023 - 2060	Not signif.	-	-	105.32mm	0.5148	-0.02
<b>Senegal</b>	CRU	1980 - 2020	+	+3.10mm/dec.	12.42mm	-	0.0018	0.2
	RCP45	2023 - 2060	-	-7.19mm/dec.	-26.62mm	-	less than 0.0001	0.57
	RCP85	2023 - 2060	+	+2.98mm/dec.	11.03mm	-	0.0365	0.09

- In **Niger**, the inter-annual variability was observed to decrease for both historical data and projected data under the RCP 4.5 scenario. Under the business-as-usual scenario, however (RCP 8.5) the inter-annual variability is expected to remain stable.
- In **Niger**, the inter-annual variability trends of historical data and projected data under the stabilization scenario (RCP 4.5) are conflicting: the historical inter-annual variability was observed to decrease, while the projected inter-annual variability under the RCP 4.5 scenario is expected to increase. Under the business-as-usual scenario, however (RCP 8.5) the inter-annual variability is expected to remain stable.
- In **Senegal**, while the inter-annual variability is increasing for historical data and for projected data under the RCP 8.5 scenario, the stabilization scenario (RCP 4.5) expects a decrease in interannual variability.

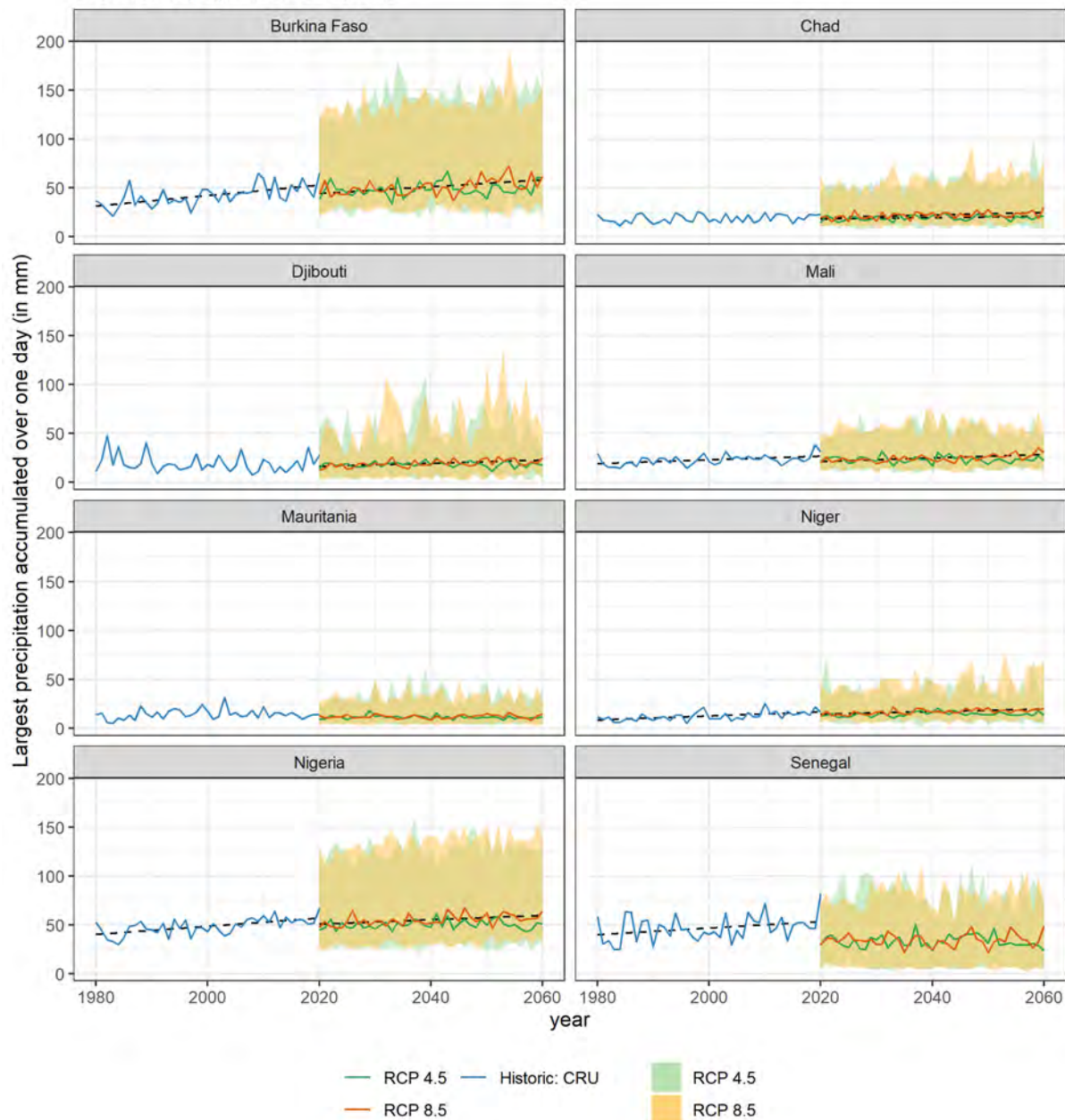
Largest precipitation accumulated over one day

***Figure 7 – Historical and projected time series of the annual largest precipitation accumulated over one day***

*Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WCKP)*  
<https://climateknowledgeportal.worldbank.org/>

## Largest precipitation accumulated over one day

Historic and projected times series



**Table 9 – Metadata on historical and projected time series the annual largest precipitation accumulated over one day**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

State	Data	Period	General Trend	Slope	Total variation during the period	Average value during the period	p-value	Adjusted R <sup>2</sup>
Burkina Faso	CRU	1980 - 2020	+	+5.35 mm/dec.	21.40 mm	-	less than 0.0001	0.34

	RCP 4.5	2014 - 2060	Not signif.	-	-	62.19 mm	0.2065	0.02
	RCP 8.5	2014 - 2060	+	+3.49 mm/dec.	13.95 mm	-	4.00E-04	0.26
Chad	CRU	1980 - 2020	Not signif.	-	-	18.71 mm	0.0909	0.05
	RCP 4.5	2014 - 2060	+	+0.69 mm/dec.	2.78 mm	-	0.0486	0.07
	RCP 8.5	2014 - 2060	+	+1.23 mm/dec.	4.92 mm	-	0.0068	0.15
Djibouti	CRU	1980 - 2020	Not signif.	-	-	19.28 mm	0.3385	0
	RCP 4.5	2014 - 2060	Not signif.	-	-	21.59 mm	0.9428	-0.03
	RCP 8.5	2014 - 2060	+	+1.61 mm/dec.	6.44 mm	-	4.00E-04	0.26
Mali	CRU	1980 - 2020	+	+1.92 mm/dec.	7.66 mm	-	0.0031	0.18
	RCP 4.5	2014 - 2060	Not signif.	-	-	26.53 mm	0.6749	-0.02
	RCP 8.5	2014 - 2060	+	+1.78 mm/dec.	7.13 mm	-	less than 0.0001	0.35
Mauritania	CRU	1980 - 2020	Not signif.	-	-	14.27 mm	0.373	0
	RCP 4.5	2014 - 2060	Not signif.	-	-	13.40 mm	0.5686	-0.02
	RCP 8.5	2014 - 2060	Not signif.	-	-	13.90 mm	0.3969	-0.01
Niger	CRU	1980 - 2020	+	+2.07 mm/dec.	8.29 mm	-	2.00E-04	0.29
	RCP 4.5	2014 - 2060	Not signif.	-	-	17.77 mm	0.1162	0.04
	RCP 8.5	2014 - 2060	+	+1.28 mm/dec.	5.11 mm	-	less than 0.0001	0.32
Nigeria	CRU	1980 - 2020	+	+4.18 mm/dec.	16.73 mm	-	less than 0.0001	0.34
	RCP 4.5	2014 - 2060	Not signif.	-	-	63.60 mm	0.3485	0
	RCP 8.5	2014 - 2060	+	+2.22 mm/dec.	8.87 mm	-	0.0013	0.22
Senegal	CRU	1980 - 2020	+	+3.38 mm/dec.	13.51 mm	-	0.0483	0.07
	RCP 4.5	2014 - 2060	Not signif.	-	-	36.94 mm	0.8132	-0.02
	RCP 8.5	2014 - 2060	Not signif.	-	-	37.74 mm	0.5142	-0.01

- Over the past 40 years, half of the countries in the SURAGGWA program (**Burkina Faso, Mali, Niger, and Nigeria**) have experienced rises in their annual largest precipitation accumulated over one day (LP1). While these countries do not anticipate further increases under the mitigation scenario (RCP4.5), they all expect further increases under the business-as-usual scenario (RCP8.5).
- For **Senegal**, there has been an increase in LP1 over the past 40 years, but the country does not expect any significant future variations.
- Conversely, **Chad and Djibouti** did not experience an increase in their LP1 over the last four decades. However, Chad and Djibouti both expect an increase in their LP1 levels in the next 40 years. Chad expects an increase under both scenarios, while Djibouti anticipates an increase only under the business-as-usual scenario (RCP8.5).
- Lastly, **Mauritania** has neither experienced nor expects any changes in its LP1 levels under either scenario.

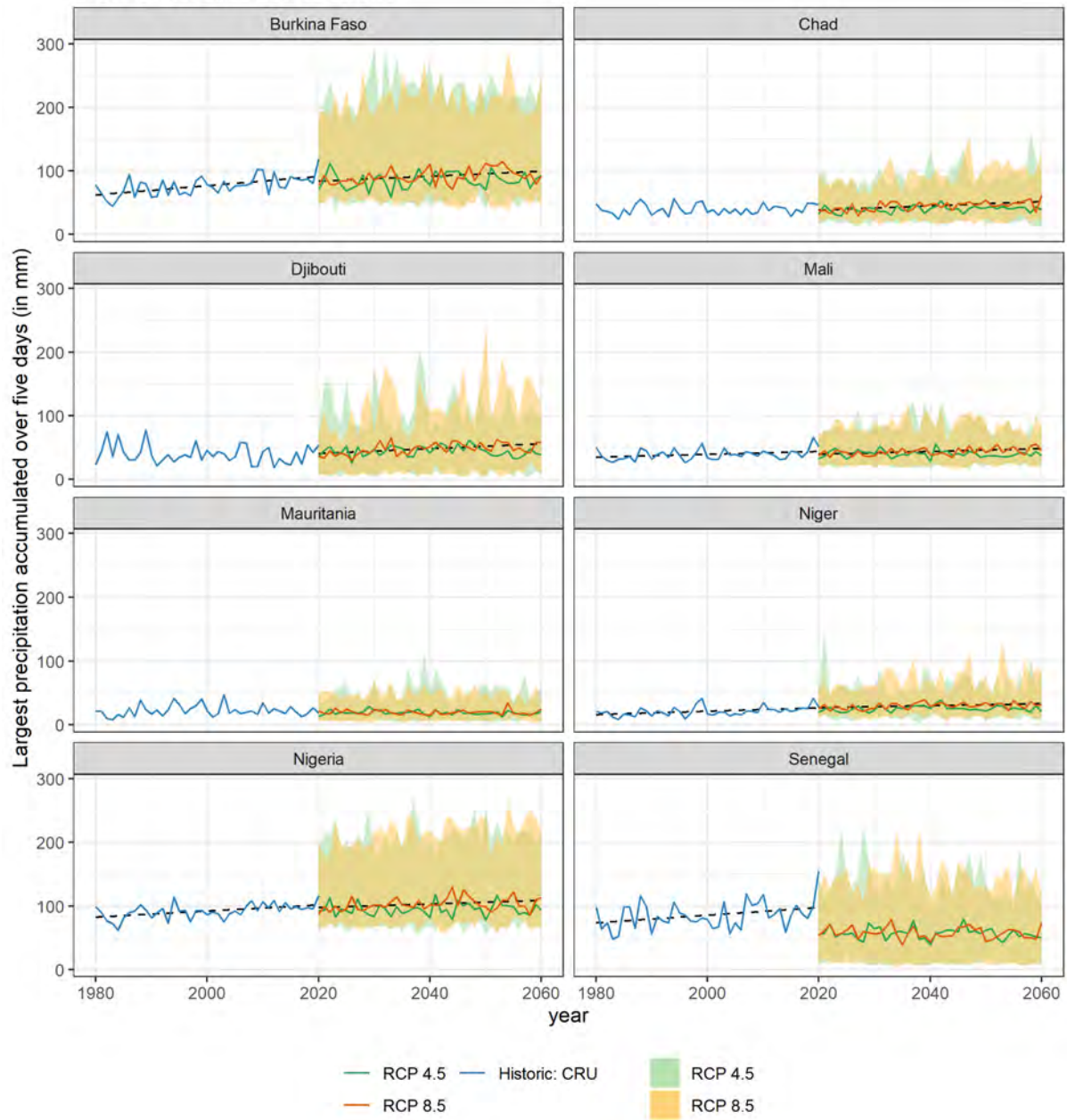
Largest precipitation accumulated over five days

**Figure 8 – Historical and projected time series of the annual largest precipitation accumulated over five days**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

## Largest precipitation accumulated over five days

Historic and projected times series



**Table 10 – Metadata on historical and projected time series the annual largest precipitation accumulated over five days**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

State	Data	Period	General Trend	Slope	Total variation during the period	Average value during the period	p-value	Adjusted R <sup>2</sup>
<b>Burkina Faso</b>	CRU	1980 - 2020	+	+7.30 mm/dec.	29.19 mm	-	less than 0.0001	0.31
	RCP 4.5	2014 - 2060	Not signif.	-	-	104.41 mm	0.41	-0.01
	RCP 8.5	2014 - 2060	+	+3.89 mm/dec.	15.55 mm	-	0.0074	0.15
<b>Chad</b>	CRU	1980 - 2020	Not signif.	-	-	39.71 mm	0.5437	-0.02
	RCP 4.5	2014 - 2060	Not signif.	-	-	45.34 mm	0.0713	0.06
	RCP 8.5	2014 - 2060	+	+3.36 mm/dec.	13.42 mm	-	1.00E-04	0.3
<b>Djibouti</b>	CRU	1980 - 2020	Not signif.	-	-	39.57 mm	0.3119	0
	RCP 4.5	2014 - 2060	Not signif.	-	-	47.82 mm	0.7662	-0.02
	RCP 8.5	2014 - 2060	+	+3.82 mm/dec.	15.27 mm	-	5.00E-04	0.25
<b>Mali</b>	CRU	1980 - 2020	+	+2.25 mm/dec.	8.99 mm	-	0.0437	0.08
	RCP 4.5	2014 - 2060	Not signif.	-	-	44.75 mm	0.4162	-0.01
	RCP 8.5	2014 - 2060	+	+2.19 mm/dec.	8.76 mm	-	0.0026	0.19
<b>Mauritania</b>	CRU	1980 - 2020	Not signif.	-	-	22.17 mm	0.6222	-0.02
	RCP 4.5	2014 - 2060	Not signif.	-	-	21.89 mm	0.2747	0.01
	RCP 8.5	2014 - 2060	Not signif.	-	-	22.59 mm	0.8282	-0.02
<b>Niger</b>	CRU	1980 - 2020	+	+2.68 mm/dec.	10.73 mm	-	0.0044	0.17
	RCP 4.5	2014 - 2060	Not signif.	-	-	29.75 mm	0.3986	-0.01
	RCP 8.5	2014 - 2060	+	+1.50 mm/dec.	5.99 mm	-	0.0158	0.12
<b>Nigeria</b>	CRU	1980 - 2020	+	+4.77 mm/dec.	19.08 mm	-	9.00E-04	0.23
	RCP 4.5	2014 - 2060	Not signif.	-	-	114.67 mm	0.6925	-0.02
	RCP 8.5	2014 - 2060	+	+2.70 mm/dec.	10.81 mm	-	0.0353	0.09
<b>Senegal</b>	CRU	1980 - 2020	+	+6.02 mm/dec.	24.06 mm	-	0.0331	0.09
	RCP 4.5	2014 - 2060	Not signif.	-	-	63.62 mm	0.5696	-0.02
	RCP 8.5	2014 - 2060	Not signif.	-	-	65.04 mm	0.5479	-0.02

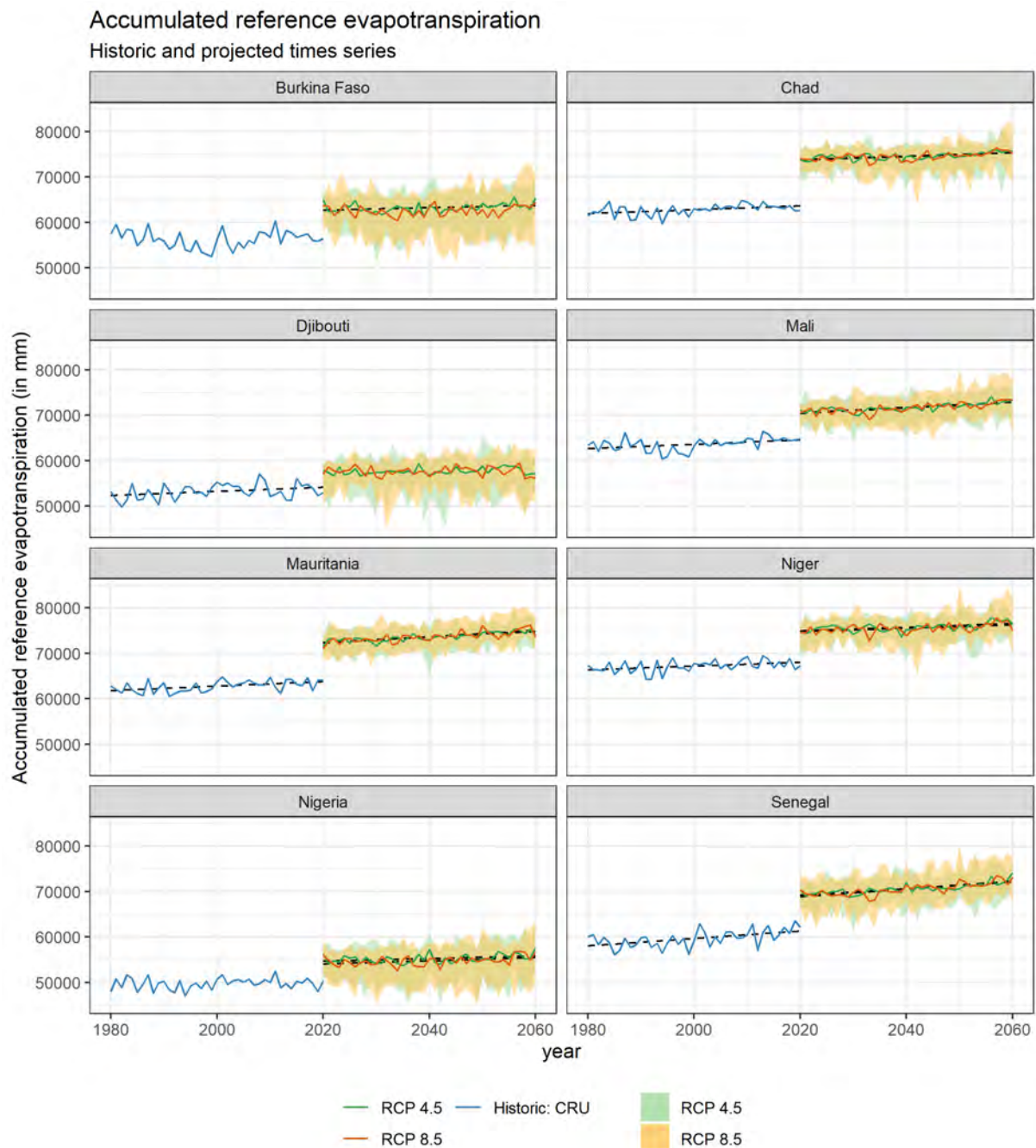
- **Burkina Faso, Mali, Niger, Nigeria, Senegal, and Djibouti** all exhibit a consistent pattern in their annual largest precipitation accumulated over five days (LP5) compared to their LP1.
- The LP5 trend in **Chad** deviates slightly from the LP1 trend. Although the country did not witness an increase in either LP5 and LP1 levels over the past four decades, the country expects a rise in LP5 levels within the next 40 years, but only under the business-as-usual scenario (RCP8.5).
- Lastly, **Mauritania**, has neither experienced nor expects any changes in its LP5 levels under either scenario.

## Evapotranspiration & Water Balance

### Reference Evapotranspiration

**Figure 9 – Historical and projected time series of the reference evapotranspiration**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>



The annually accumulated reference evapotranspiration was calculated at the monthly level, using the Hargreaves equation, modified by Droogers and Allen (Droogers and Allen 2002; Hargreaves 1994). This calculation required the following factors: monthly minimum and maximum temperatures, monthly accumulated precipitation, and the latitude of each state.

**Table 11 – Metadata on historical and projected time series of reference evapotranspiration**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

State	Data	Period	General Trend	Slope	Total variation during the period	Average value during the period	p-value	Adjusted R <sup>2</sup>
<b>Burkina Faso</b>	CRU	1980 - 2020	Not signif.	-	-	56307mm	0.9762	-0.03
	RCP45	2020 - 2060	+	+265mm/dec.	1062mm	-	0.0451	0.08
	RCP85	2020 - 2060	Not signif.	-	-	62302mm	0.2697	0.01
<b>Chad</b>	CRU	1980 - 2020	+	+423mm/dec.	1693mm	-	0.0062	0.16
	RCP45	2020 - 2060	+	+380mm/dec.	1520mm	-	less than 0.0001	0.36
	RCP85	2020 - 2060	+	+395mm/dec.	1579mm	-	0.0002	0.28
<b>Djibouti</b>	CRU	1980 - 2020	+	+451mm/dec.	1805mm	-	0.0356	0.09
	RCP45	2020 - 2060	Not signif.	-	-	57333mm	0.0651	0.06
	RCP85	2020 - 2060	Not signif.	-	-	57342mm	0.8329	-0.02
<b>Mali</b>	CRU	1980 - 2020	+	+477mm/dec.	1908mm	-	0.0115	0.13
	RCP45	2020 - 2060	+	+569mm/dec.	2275mm	-	less than 0.0001	0.55
	RCP85	2020 - 2060	+	+610mm/dec.	2438mm	-	less than 0.0001	0.49
<b>Mauritania</b>	CRU	1980 - 2020	+	+496mm/dec.	1983mm	-	0.0015	0.21
	RCP45	2020 - 2060	+	+607mm/dec.	2427mm	-	less than 0.0001	0.62
	RCP85	2020 - 2060	+	+691mm/dec.	2762mm	-	less than 0.0001	0.53
<b>Niger</b>	CRU	1980 - 2020	+	+411mm/dec.	1643mm	-	0.0152	0.12
	RCP45	2020 - 2060	+	+403mm/dec.	1613mm	-	0.0002	0.29
	RCP85	2020 - 2060	+	+370mm/dec.	1482mm	-	0.0028	0.19
<b>Nigeria</b>	CRU	1980 - 2020	Not signif.	-	-	49738mm	0.3758	0
	RCP45	2020 - 2060	+	+289mm/dec.	1155mm	-	0.0168	0.12
	RCP85	2020 - 2060	+	+351mm/dec.	1406mm	-	0.0103	0.14
<b>Senegal</b>	CRU	1980 - 2020	+	+814mm/dec.	3256mm	-	0.0004	0.26
	RCP45	2020 - 2060	+	+720mm/dec.	2881mm	-	less than 0.0001	0.58
	RCP85	2020 - 2060	+	+860mm/dec.	3441mm	-	less than 0.0001	0.6

**Most of the historical and projected annually accumulated reference evapotranspiration in the states participating in the SURAGGWA program presented a statistically significant increase.** There were however a couple of exceptions:

- In **Burkina Faso**, while a significant increase in annually accumulated reference evapotranspiration is expected under the RCP 4.5 scenario, no statistically significant variation was observed for historical data, or for projected data under the RCP 8.5 scenario.

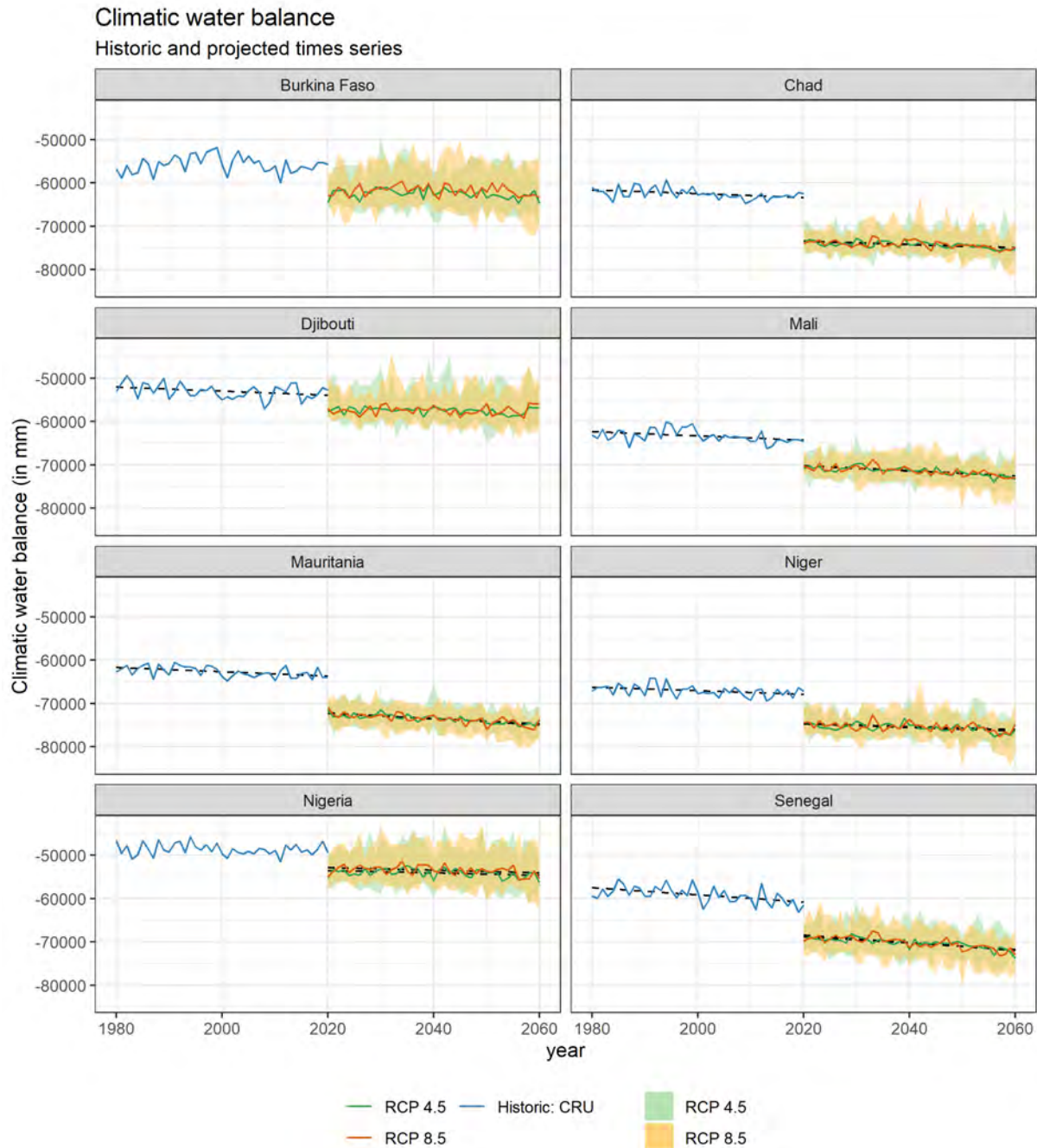
- In **Djibouti**, although historical data indicated an increase in annually accumulated reference evapotranspiration, the projected data presented no statistically significant variation under either scenario.
- Although historical data from **Nigeria** showed no significant variation in annually accumulated reference evapotranspiration, the projected data expects an increase for this variable under both scenarios.

### *Climatic Water Balance*

The climatic water balance was calculated by subtracting the monthly accumulated reference evapotranspiration to the monthly accumulated precipitation.

***Figure 10 – Historical and projected time series of the climatic water balance***

*Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP)*  
<https://climateknowledgeportal.worldbank.org/>





















Each state participating in the SURAGGWA program consistently demonstrated negative water balance values throughout the analysis period, highlighting a **persistent situation of water deficit**. Furthermore, in most cases, the historical and projected trends displayed a decrease, indicating a **steady rise in water deficit in these countries**. Three exceptions can be mentioned:

- In **Burkina Faso**, no significant variation in water balance was discernible for historical data nor for projected data under either scenario, indicating a constant water deficit level.
- Although historical data from **Djibouti** showed a decrease in water balance, the projected data expected this variable to remain stable under both scenarios, indicating a constant water deficit level in the near future.

- In **Senegal**, while no significant variation in water balance was discernible for historical data, the projected data expected a decrease in this variable, under both scenario, indicating a rise in water deficit level in the near future.

**Table 12 – Historical and projected time series of the climatic water balance**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

State	Data	Period	General Trend	Slope	Total variation during the period	Average value during the period	p-value	Adjusted R <sup>2</sup>
<b>Burkina Faso</b>	CRU	1980 - 2020	Not signif.	-	-	-55692mm	0.9449	-0.03
	RCP45	2020 - 2060	Not signif.	-	-	-62033mm	0.0791	0.05
	RCP85	2020 - 2060	Not signif.	-	-	-61443mm	0.3878	-0.01
<b>Chad</b>	CRU	1980 - 2020		-439mm/dec.	-1756mm	-	0.006	0.16
	RCP45	2020 - 2060		-369mm/dec.	-1475mm	-	less than 0.0001	0.33
	RCP85	2020 - 2060		-363mm/dec.	-1452mm	-	7.00E-04	0.24
<b>Djibouti</b>	CRU	1980 - 2020		-472mm/dec.	-1888mm	-	0.0318	0.09
	RCP45	2020 - 2060	Not signif.	-	-	-57071mm	0.0614	0.06
	RCP85	2020 - 2060	Not signif.	-	-	-57061mm	0.5797	-0.02
<b>Mali</b>	CRU	1980 - 2020		-484mm/dec.	-1938mm	-	0.0111	0.13
	RCP45	2020 - 2060		-576mm/dec.	-2304mm	-	less than 0.0001	0.55
	RCP85	2020 - 2060		-595mm/dec.	-2380mm	-	less than 0.0001	0.48
<b>Mauritania</b>	CRU	1980 - 2020		-496mm/dec.	-1985mm	-	0.0015	0.21
	RCP45	2020 - 2060		-602mm/dec.	-2410mm	-	less than 0.0001	0.61
	RCP85	2020 - 2060		-686mm/dec.	-2744mm	-	less than 0.0001	0.52
<b>Niger</b>	CRU	1980 - 2020		-406mm/dec.	-1625mm	-	0.0172	0.11
	RCP45	2020 - 2060		-400mm/dec.	-1601mm	-	2.00E-04	0.28
	RCP85	2020 - 2060		-367mm/dec.	-1466mm	-	0.004	0.17
<b>Nigeria</b>	CRU	1980 - 2020	Not signif.	-	-	-48645mm	0.3736	0
	RCP45	2020 - 2060		-268mm/dec.	-1072mm	-	0.0349	0.09
	RCP85	2020 - 2060		-309mm/dec.	-1234mm	-	0.0246	0.1
<b>Senegal</b>	CRU	1980 - 2020		-823mm/dec.	-3291mm	-	5.00E-04	0.25
	RCP45	2020 - 2060		-730mm/dec.	-2921mm	-	less than 0.0001	0.58
	RCP85	2020 - 2060		-876mm/dec.	-3503mm	-	less than 0.0001	0.6

## Standardized Precipitation-Evapotranspiration Index (SPEI)

The Standardized Precipitation-Evapotranspiration Index (SPEI) was computed on a monthly basis using the water balance level described in the previous section.

SPEI is a widely used tool for estimating droughts. It takes into account the current precipitation, temperature, and potential evapotranspiration data, as well as the same data accumulated over a certain number of previous months. The SPEI then compares this data to data from the same period in previous years, resulting in a value that fluctuates around 0. When the SPEI is below -1, it is generally considered a moderately dry period, while a value below -1.5 is typically considered as an exceptionally dry period. Conversely, When the SPEI is above 1, it is generally considered a moderately wet period, while a value above 1.5 is typically considered as an exceptionally wet period.

The SPEI is a highly flexible tool that can be adjusted to study different types of droughts<sup>11</sup>. By changing the period of accumulated months, the SPEI can be tailored to the specific characteristics of a given region or application. For example, meteorological droughts are typically studied using the 3-month accumulation SPEI, while agricultural droughts are often studied using the 6-month accumulation SPEI.

Over the past 40 years (468 months), the 3-month SPEI (meteorological droughts and wet periods) of the SURAGGWA countries presented a range of 35 to 21 exceptionally dry months and 32 to 44 exceptionally wet months. However, these numbers are projected to gradually change over the next 40 years, with exceptionally dry months expected to decrease to 34 to 47.5 months and exceptionally wet months expected to decrease to 5 to 18.5 months. The specific values depend on the country, model, and scenario. The values given above are median values for each combination.

Similarly, analyzing the 6-month SPEI (agricultural droughts and wet periods) over the same 40-year timeframe, the SURAGGWA countries encountered 18 to 40 exceptionally dry months and 33 to 47 exceptionally wet months. Looking ahead, these figures are anticipated to change gradually, with exceptionally dry months ranging from 36.5 to 50.5 months and exceptionally wet months ranging from 1 to 18 months. Again, the values vary depending on the country, model, and scenario.

Examining the 12-month SPEI (geological droughts and wet periods) for the past 40 years, the SURAGGWA countries faced 13 to 49 exceptionally dry months and 32 to 42 exceptionally wet

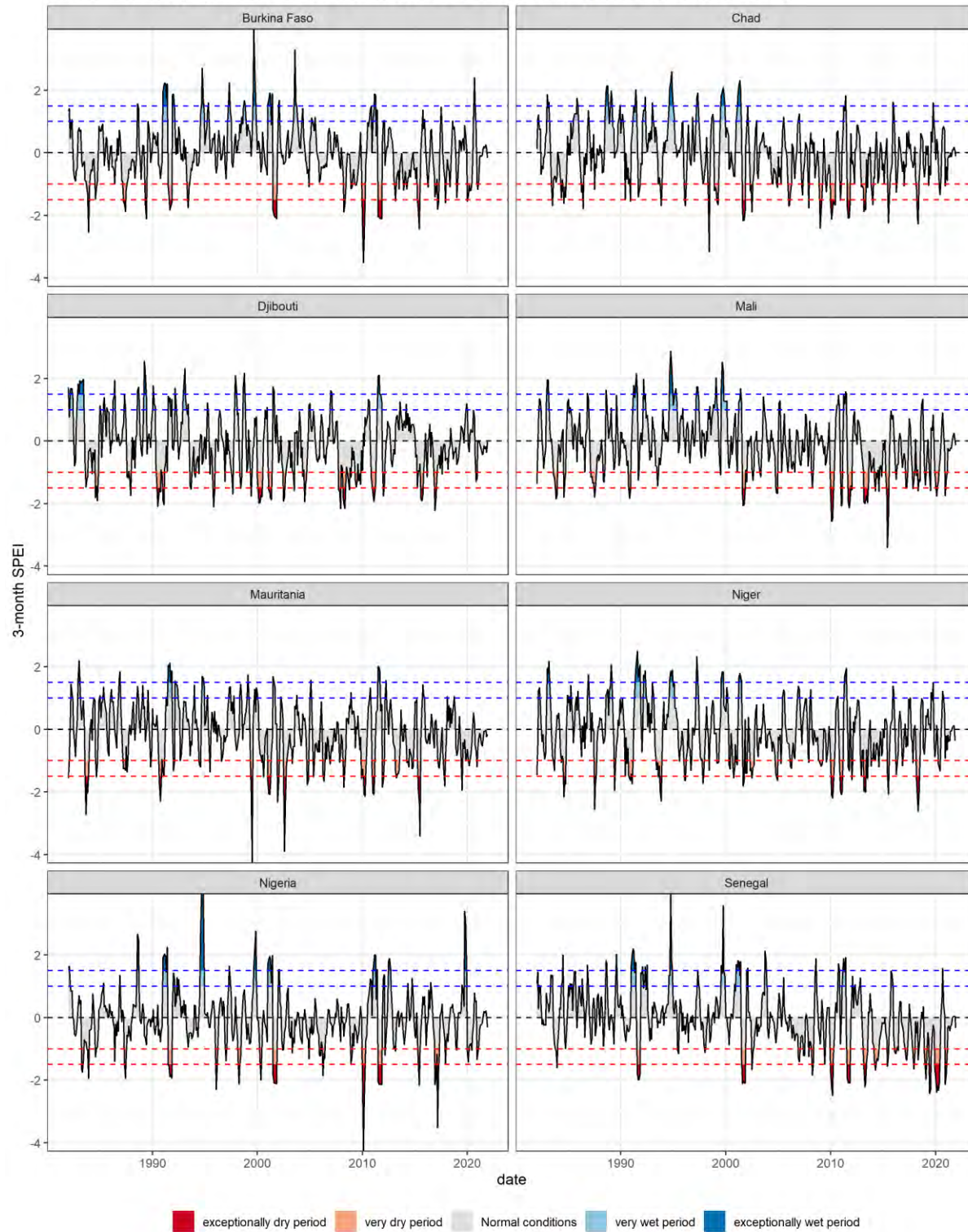
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<sup>11</sup> A Drought is an unexpected temporary phenomenon that occurs when the amount of rainfall falls below the average amount for a particular period, usually lasting for a month or more. There are multiple types of droughts, each characterized by different levels of severity and duration. Meteorological drought occurs when there is a prolonged period of below-normal precipitation, typically for a short period of time (usually 3 months). This type of drought impacts the availability of readily available water resources, including surface water and cisterns. Agricultural drought occurs when there is a prolonged period of below-normal precipitation, typically for a longer period of time (usually 6 months). Agricultural droughts have a significant impact on crop production, leading to reduced yields and economic losses. Finally, hydrological drought occurs when there is a prolonged period of below-normal precipitation, typically for a very long period of time (usually more than 9 months). This type of drought impacts watersheds, leading to reduced streamflow, depleted reservoirs, and dry wells. It often takes a long period of above-normal rainfall for the hydrological situation of the area to return to normal.

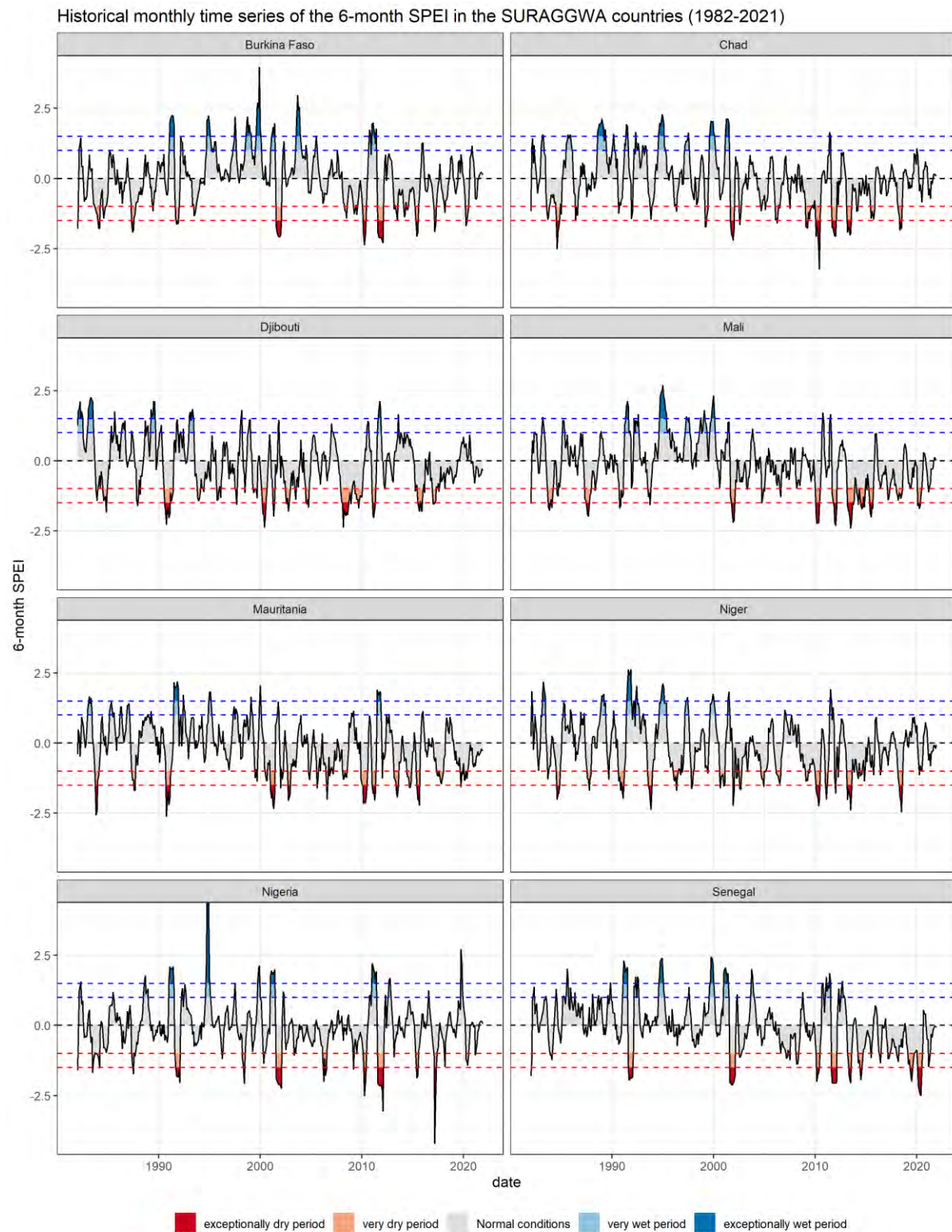
months. However, these numbers are projected to shift over the next 40 years, with exceptionally dry months expected to range from 37 to 57 months and exceptionally wet months from 0 to 16.5 months. As before, the values depend on the country, model, and scenario.

In summary, approximately 70 out of the last 468 months (15%) were classified as either exceptionally dry or exceptionally wet in the SURAGGWA countries. This ratio is expected to remain constant, but an increase in exceptionally dry months is anticipated, while fewer exceptionally wet events are expected.

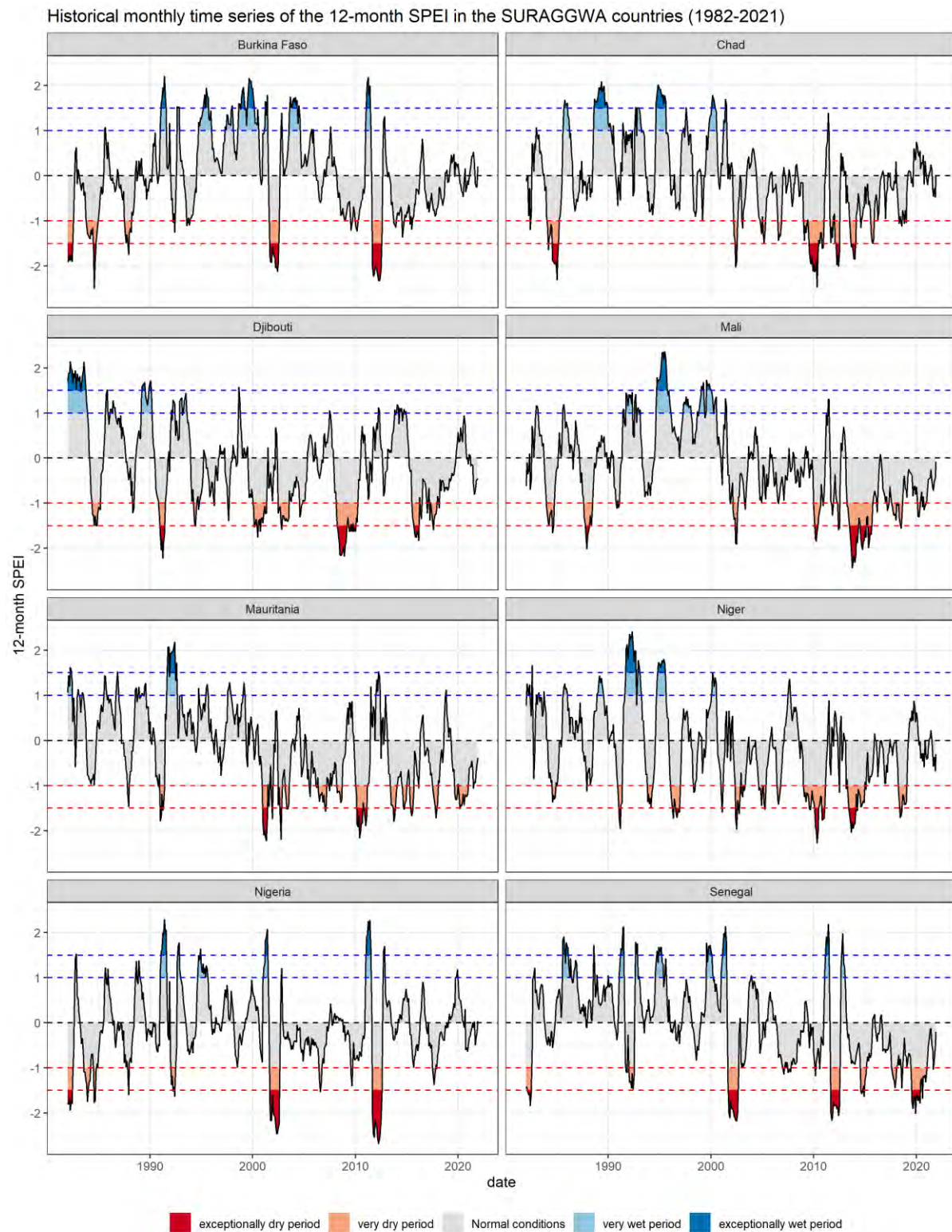
Historical monthly time series of the 3-month SPEI in the SURAGGWA countries (1982-2021)



**Figure 11 – Historical time series of the 6 months standardized Precipitation-Evapotranspiration Index**  
Time series over the 1982 to 2021 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020)



**Figure 12 – Historical time series of the 12 months standardized Precipitation-Evapotranspiration Index**  
Time series over the 1982 to 2021 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020)



**Table 13 – Number of the severely dry and wet month calculated based on the 3 months standardized Precipitation-Evapotranspiration Index**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

State	Data	Period	Median number of exceptionally dry month during the period	Median number of exceptionally wet month during the period
Burkina Faso	CRU	1982-2021	35	32
	RCP45	2020-2059	38 (range:52-25)	18 (range:38-7)
	RCP85	2020-2059	37.5 (range:53-0)	15 (range:50-1)
Chad	CRU	1982-2021	33	38
	RCP45	2020-2059	45.5 (range:56-26)	12.5 (range:32-0)
	RCP85	2020-2059	44.5 (range:58-18)	7.5 (range:29-0)
Djibouti	CRU	1982-2021	31	44
	RCP45	2020-2059	37 (range:56-19)	20 (range:31-9)
	RCP85	2020-2059	34 (range:52-16)	11.5 (range:32-3)
Mali	CRU	1982-2021	24	40
	RCP45	2020-2059	47.5 (range:63-25)	14.5 (range:27-3)
	RCP85	2020-2059	46.5 (range:60-20)	6 (range:28-1)
Mauritania	CRU	1982-2021	21	38
	RCP45	2020-2059	46 (range:58-32)	12 (range:26-4)
	RCP85	2020-2059	47 (range:70-22)	5 (range:32-0)
Niger	CRU	1982-2021	33	37
	RCP45	2020-2059	45 (range:59-31)	14 (range:26-4)
	RCP85	2020-2059	47 (range:58-20)	9 (range:30-1)
Nigeria	CRU	1982-2021	35	34
	RCP45	2020-2059	36 (range:52-22)	18.5 (range:38-10)
	RCP85	2020-2059	37 (range:52-9)	13.5 (range:47-6)
Senegal	CRU	1982-2021	34	36
	RCP45	2020-2059	45.5 (range:61-28)	13 (range:34-3)
	RCP85	2020-2059	47.5 (range:71-17)	6.5 (range:26-0)

**Table 14 – Number of the severely dry and wet month calculated based on the 6 months standardized Precipitation-Evapotranspiration Index**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

State	Data	Period	Median number of exceptionally dry month during the period	Median number of exceptionally wet month during the period
Burkina Faso	CRU	1982-2021	40	34
	RCP45	2020-2059	38 (range:53-17)	16 (range:43-9)
	RCP85	2020-2059	38 (range:60-0)	12.5 (range:51-0)
Chad	CRU	1982-2021	39	33
	RCP45	2020-2059	50 (range:62-29)	10 (range:27-0)
	RCP85	2020-2059	48 (range:63-15)	4 (range:35-0)
Djibouti	CRU	1982-2021	28	41
	RCP45	2020-2059	39.5 (range:52-19)	17.5 (range:36-1)
	RCP85	2020-2059	37 (range:58-9)	12 (range:36-0)
Mali	CRU	1982-2021	25	47
	RCP45	2020-2059	53 (range:68-30)	9 (range:34-1)
	RCP85	2020-2059	50.5 (range:64-15)	3 (range:37-0)
Mauritania	CRU	1982-2021	18	41
	RCP45	2020-2059	49 (range:67-35)	8 (range:20-2)
	RCP85	2020-2059	49 (range:67-22)	1 (range:21-0)
Niger	CRU	1982-2021	26	40
	RCP45	2020-2059	48 (range:61-24)	9 (range:24-2)
	RCP85	2020-2059	47 (range:58-16)	4 (range:38-0)
Nigeria	CRU	1982-2021	33	35
	RCP45	2020-2059	37 (range:56-9)	18 (range:35-10)
	RCP85	2020-2059	36.5 (range:49-4)	14 (range:47-4)
Senegal	CRU	1982-2021	35	38
	RCP45	2020-2059	47 (range:63-22)	12 (range:34-0)
	RCP85	2020-2059	47.5 (range:68-10)	5.5 (range:23-0)

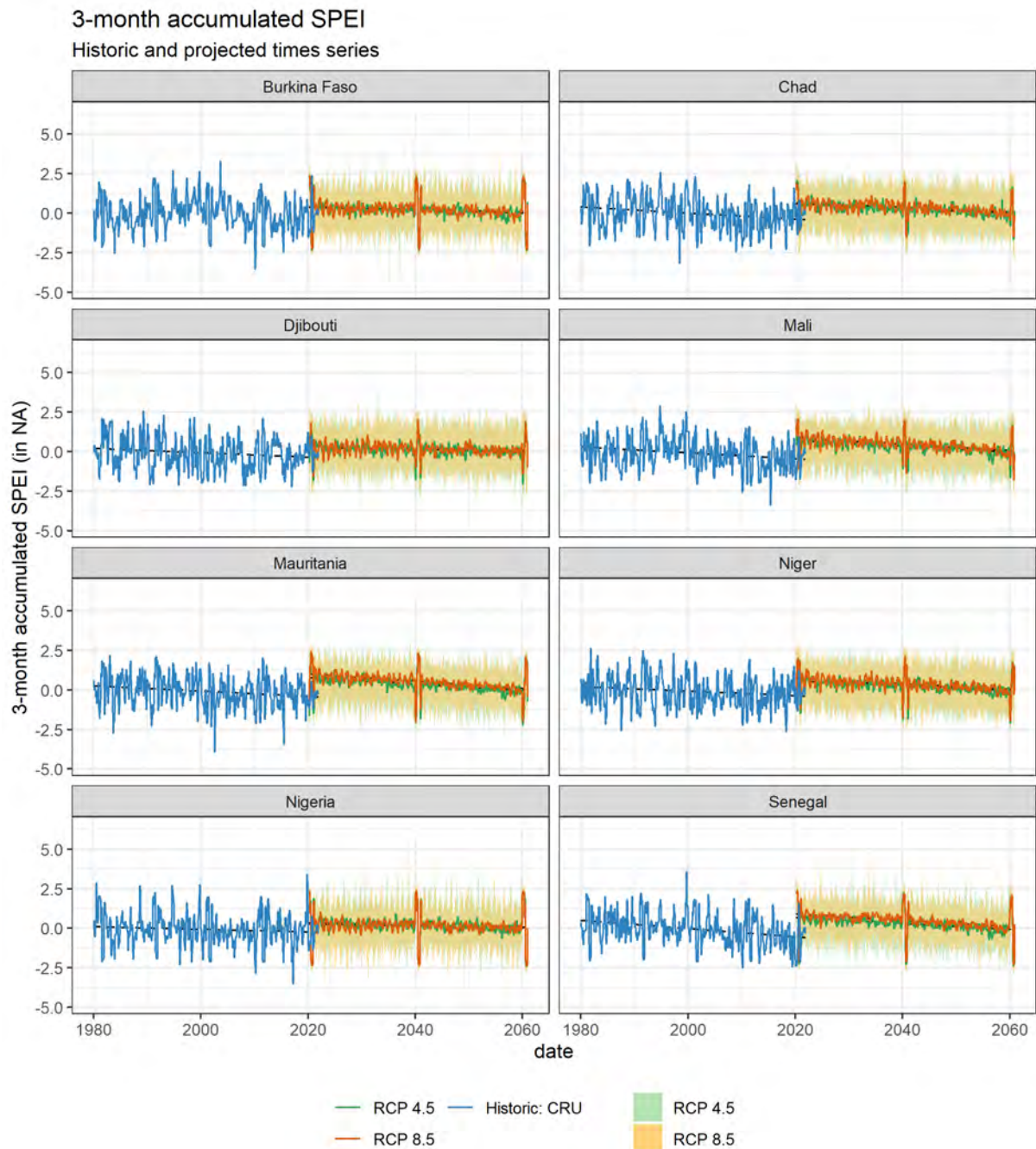
**Table 15 – Number of the severely dry and wet month calculated based on the 12 months standardized Precipitation-Evapotranspiration Index**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

State	Data	Period	Median number of exceptionally dry month during the period	Median number of exceptionally wet month during the period
<b>Burkina Faso</b>	CRU	1982-2021	49	33
	RCP45	2020-2059	43 (range:63-17)	13 (range:43-0)
	RCP85	2020-2059	43 (range:70-0)	8.5 (range:75-0)
<b>Chad</b>	CRU	1982-2021	42	32
	RCP45	2020-2059	53 (range:71-27)	6 (range:31-0)
	RCP85	2020-2059	50.5 (range:79-5)	0 (range:46-0)
<b>Djibouti</b>	CRU	1982-2021	30	39
	RCP45	2020-2059	42 (range:61-13)	16.5 (range:43-0)
	RCP85	2020-2059	44.5 (range:83-3)	9 (range:50-0)
<b>Mali</b>	CRU	1982-2021	22	37
	RCP45	2020-2059	57 (range:81-27)	5 (range:37-0)
	RCP85	2020-2059	56.5 (range:73-6)	0 (range:56-0)
<b>Mauritania</b>	CRU	1982-2021	13	35
	RCP45	2020-2059	53.5 (range:67-33)	4.5 (range:22-0)
	RCP85	2020-2059	49.5 (range:68-25)	0 (range:13-0)
<b>Niger</b>	CRU	1982-2021	25	36
	RCP45	2020-2059	54 (range:71-13)	4 (range:37-0)
	RCP85	2020-2059	52 (range:77-7)	0 (range:48-0)
<b>Nigeria</b>	CRU	1982-2021	22	37
	RCP45	2020-2059	38 (range:67-12)	15.5 (range:43-0)
	RCP85	2020-2059	37 (range:65-0)	12.5 (range:63-0)
<b>Senegal</b>	CRU	1982-2021	36	42
	RCP45	2020-2059	51 (range:73-27)	8 (range:33-0)
	RCP85	2020-2059	51 (range:77-6)	0 (range:38-0)

**Figure 13 – Historical and projected time series of the 3 months standardized Precipitation-Evapotranspiration Index**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>























Across nearly all states in the SURAGGWA program, historical and projected data consistently showed a decline in 3-, 9-, and 12-month SPEI, indicating an ongoing increase in the frequency and intensity of hydrological, agricultural, and geological droughts. The only 2 exceptions are:

- In **Burkina Faso**, no significant variation in 3-, 6-, and 12-months SPEI level was discernible for historical data, highlighting a constant drought cycle during the last 30 years.
- In **Nigeria** no significant variation in 6-, and 12-months SPEI level was discernible for projected data under the business-as-usual scenario (RCP 8.5), highlighting an expect constant drought cycle during the next 30 years under this scenario.

**Table 16 – Metadata on the 3 months standardized Precipitation-Evapotranspiration Index**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

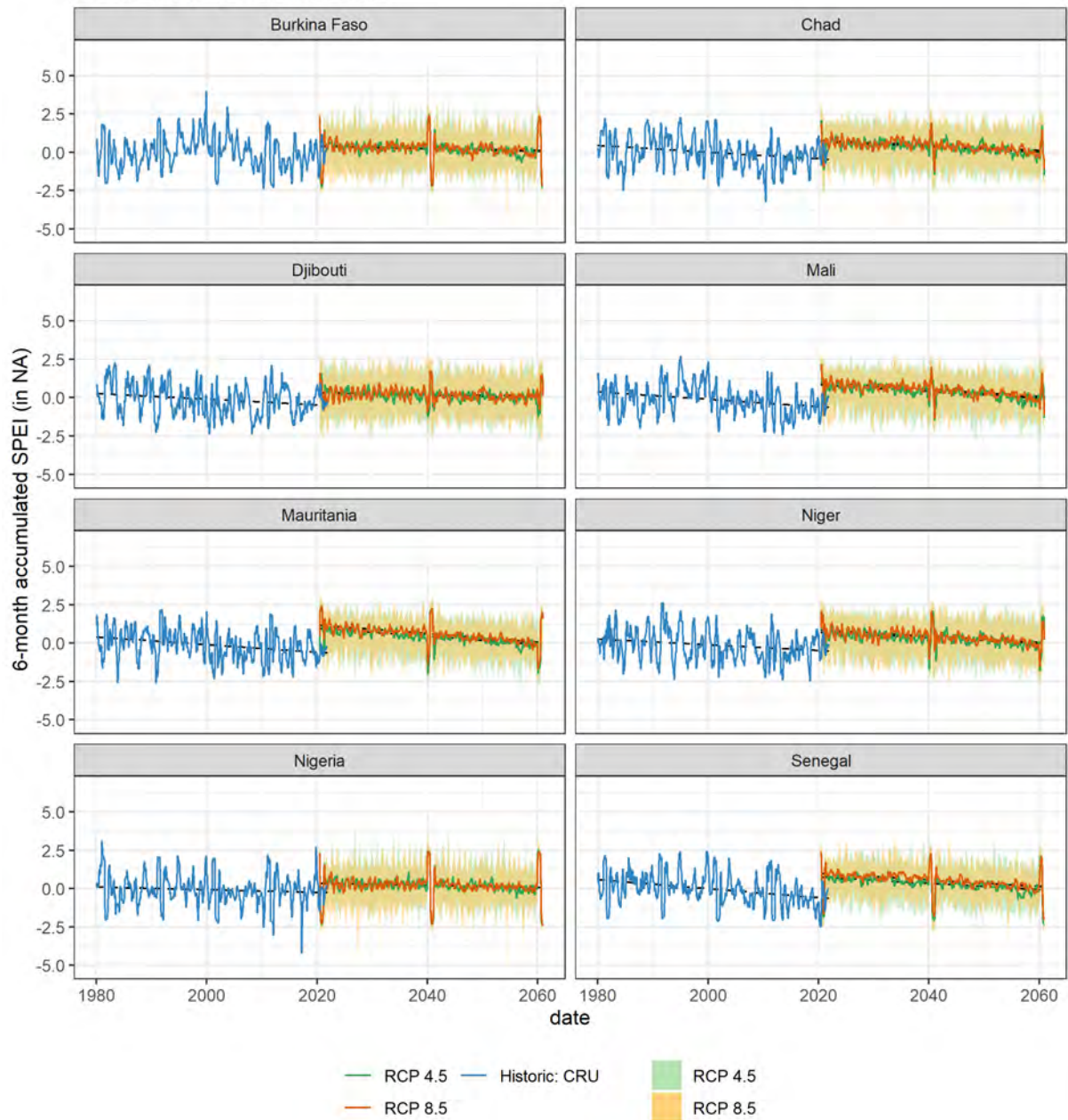
State	Data	Period	General Trend	Slope	Total variation during the period	Average value during the period	p-value	Adjusted R <sup>2</sup>
<b>Burkina Faso</b>	CRU	1980 - 2021	Not signif.	-	-	-0.0221	0.1536	0
	RCP45	2020 - 2060		-0.0002/dec.	-0.0010	-	less than 0.0001	0.03
	RCP85	2020 - 2060		-0.0002/dec.	-0.0009	-	3.00E-04	0.02
<b>Chad</b>	CRU	1980 - 2021		-0.0005/dec.	-0.0021	-	less than 0.0001	0.05
	RCP45	2020 - 2060		-0.0004/dec.	-0.0017	-	less than 0.0001	0.19
	RCP85	2020 - 2060		-0.0004/dec.	-0.0016	-	less than 0.0001	0.17
<b>Djibouti</b>	CRU	1980 - 2021		-0.0004/dec.	-0.0015	-	2.00E-04	0.03
	RCP45	2020 - 2060		-0.0002/dec.	-0.0008	-	less than 0.0001	0.04
	RCP85	2020 - 2060		-0.0002/dec.	-0.0007	-	less than 0.0001	0.03
<b>Mali</b>	CRU	1980 - 2021		-0.0005/dec.	-0.0021	-	less than 0.0001	0.05
	RCP45	2020 - 2060		-0.0005/dec.	-0.0020	-	less than 0.0001	0.25
	RCP85	2020 - 2060		-0.0006/dec.	-0.0022	-	less than 0.0001	0.28
<b>Mauritania</b>	CRU	1980 - 2021		-0.0005/dec.	-0.0019	-	less than 0.0001	0.04
	RCP45	2020 - 2060		-0.0006/dec.	-0.0023	-	less than 0.0001	0.2
	RCP85	2020 - 2060		-0.0006/dec.	-0.0025	-	less than 0.0001	0.26
<b>Niger</b>	CRU	1980 - 2021		-0.0004/dec.	-0.0016	-	less than 0.0001	0.03
	RCP45	2020 - 2060		-0.0004/dec.	-0.0016	-	less than 0.0001	0.14
	RCP85	2020 - 2060		-0.0005/dec.	-0.0019	-	less than 0.0001	0.21
<b>Nigeria</b>	CRU	1980 - 2021		-0.0002/dec.	-0.0009	-	0.0314	0.01
	RCP45	2020 - 2060		-0.0002/dec.	-0.0009	-	8.00E-04	0.02
	RCP85	2020 - 2060		-0.0001/dec.	-0.0005	-	0.0414	0.01
<b>Senegal</b>	CRU	1980 - 2021		-0.0007/dec.	-0.0029	-	less than 0.0001	0.1
	RCP45	2020 - 2060		-0.0005/dec.	-0.0021	-	less than 0.0001	0.15
	RCP85	2020 - 2060		-0.0006/dec.	-0.0022	-	less than 0.0001	0.18

**Figure 14 – Historical and projected time series of the 6 months standardized Precipitation-Evapotranspiration Index**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

# 6-month accumulated SPEI

Historic and projected times series



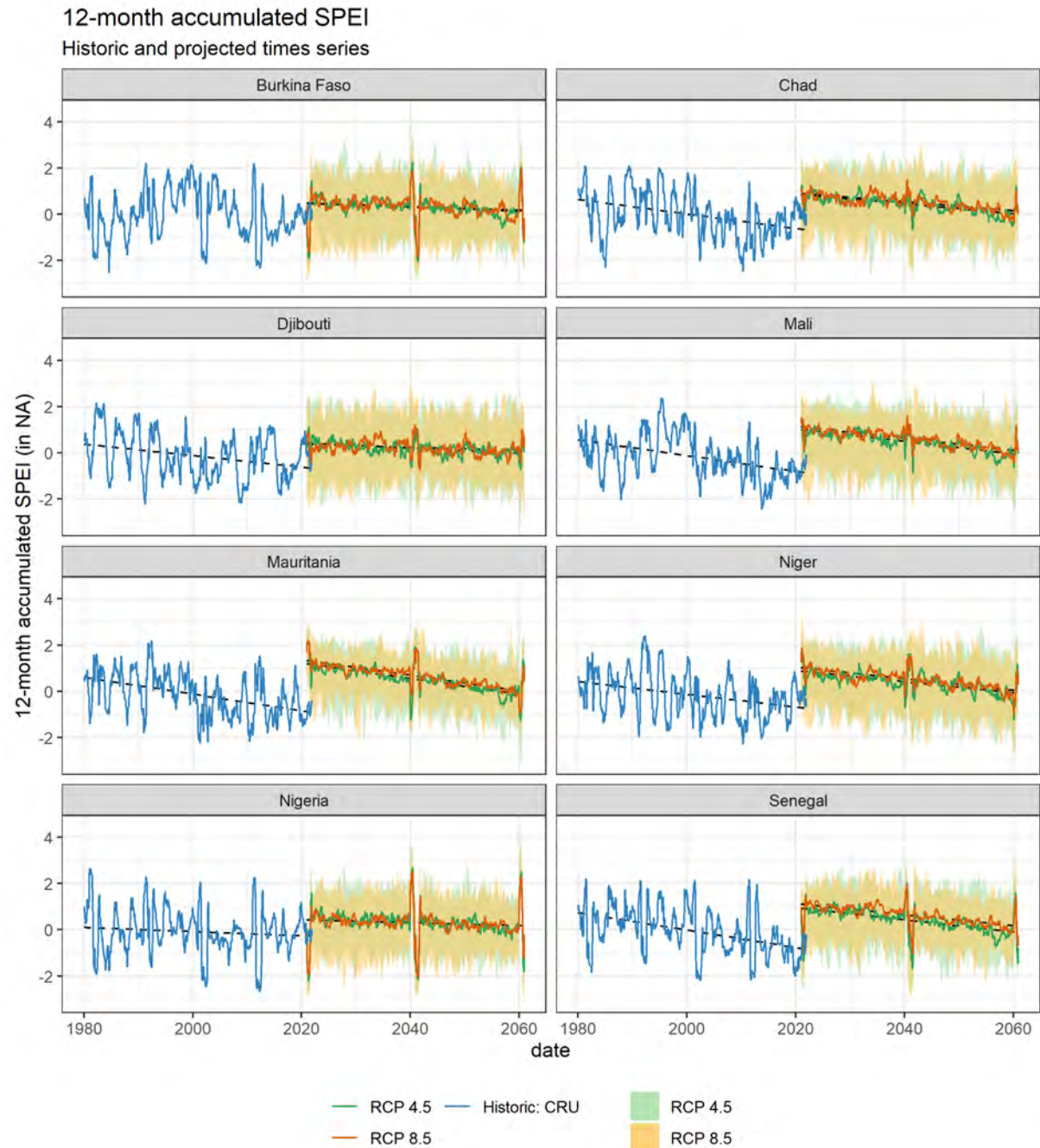
**Table 17 – Metadata on the 6 months standardized Precipitation-Evapotranspiration Index**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

State	Data	Period	General Trend	Slope	Total variation during the period	Average value during the period	p-value	Adjusted R <sup>2</sup>
<b>Burkina Faso</b>	CRU	1980 - 2021	Not signif.	-	-	0.0001	0.1904	0
	RCP45	2020 - 2060		-0.0002/dec.	-0.0009	-	4.00E-04	0.02
	RCP85	2020 - 2060		-0.0002/dec.	-0.0007	-	0.0027	0.02
<b>Chad</b>	CRU	1980 - 2021		-0.0006/dec.	-0.0024	-	less than 0.0001	0.07
	RCP45	2020 - 2060		-0.0005/dec.	-0.0019	-	less than 0.0001	0.27
	RCP85	2020 - 2060		-0.0004/dec.	-0.0018	-	less than 0.0001	0.26
<b>Djibouti</b>	CRU	1980 - 2021		-0.0005/dec.	-0.0021	-	less than 0.0001	0.05
	RCP45	2020 - 2060		-0.0002/dec.	-0.0009	-	less than 0.0001	0.07
	RCP85	2020 - 2060		-0.0002/dec.	-0.0006	-	less than 0.0001	0.03
<b>Mali</b>	CRU	1980 - 2021		-0.0007/dec.	-0.0027	-	less than 0.0001	0.09
	RCP45	2020 - 2060		-0.0006/dec.	-0.0024	-	less than 0.0001	0.37
	RCP85	2020 - 2060		-0.0006/dec.	-0.0025	-	less than 0.0001	0.42
<b>Mauritania</b>	CRU	1980 - 2021		-0.0007/dec.	-0.0028	-	less than 0.0001	0.1
	RCP45	2020 - 2060		-0.0007/dec.	-0.0029	-	less than 0.0001	0.3
	RCP85	2020 - 2060		-0.0008/dec.	-0.0031	-	less than 0.0001	0.39
<b>Niger</b>	CRU	1980 - 2021		-0.0005/dec.	-0.0021	-	less than 0.0001	0.05
	RCP45	2020 - 2060		-0.0005/dec.	-0.0019	-	less than 0.0001	0.21
	RCP85	2020 - 2060		-0.0006/dec.	-0.0022	-	less than 0.0001	0.32
<b>Nigeria</b>	CRU	1980 - 2021		-0.0002/dec.	-0.0010	-	0.0191	0.01
	RCP45	2020 - 2060		-0.0002/dec.	-0.0007	-	0.0068	0.01
	RCP85	2020 - 2060	Not signif.	-	-	0.1669	0.1779	0
<b>Senegal</b>	CRU	1980 - 2021		-0.0008/dec.	-0.0033	-	less than 0.0001	0.12
	RCP45	2020 - 2060		-0.0006/dec.	-0.0022	-	less than 0.0001	0.17
	RCP85	2020 - 2060		-0.0006/dec.	-0.0023	-	less than 0.0001	0.21






















**Figure 15 – Historical and projected time series of the 12 months standardized Precipitation-Evapotranspiration Index**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>



**Table 18 – Metadata on historical and projected time series of the 12 months standardized Precipitation-Evapotranspiration Index**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

State	Data	Period	General Trend	Slope	Total variation during the period	Average value during the period	p-value	Adjusted R <sup>2</sup>
<b>Burkina Faso</b>	CRU	1980 - 2021	Not signif.	-	-	-0.0089	0.2912	0
	RCP45	2020 - 2060		-0.0002/dec.	-0.0009	-	less than 0.0001	0.04
	RCP85	2020 - 2060		-0.0002/dec.	-0.0009	-	less than 0.0001	0.04
<b>Chad</b>	CRU	1980 - 2021		-0.0009/dec.	-0.0035	-	less than 0.0001	0.15
	RCP45	2020 - 2060		-0.0006/dec.	-0.0023	-	less than 0.0001	0.48
	RCP85	2020 - 2060		-0.0005/dec.	-0.0021	-	less than 0.0001	0.49
<b>Djibouti</b>	CRU	1980 - 2021		-0.0007/dec.	-0.0028	-	less than 0.0001	0.09
	RCP45	2020 - 2060		-0.0003/dec.	-0.0012	-	less than 0.0001	0.22
	RCP85	2020 - 2060		-0.0002/dec.	-0.0008	-	less than 0.0001	0.08
<b>Mali</b>	CRU	1980 - 2021		-0.0009/dec.	-0.0038	-	less than 0.0001	0.19
	RCP45	2020 - 2060		-0.0007/dec.	-0.0030	-	less than 0.0001	0.64
	RCP85	2020 - 2060		-0.0007/dec.	-0.0028	-	less than 0.0001	0.68
<b>Mauritania</b>	CRU	1980 - 2021		-0.0010/dec.	-0.0041	-	less than 0.0001	0.22
	RCP45	2020 - 2060		-0.0009/dec.	-0.0037	-	less than 0.0001	0.56
	RCP85	2020 - 2060		-0.0009/dec.	-0.0037	-	less than 0.0001	0.68
<b>Niger</b>	CRU	1980 - 2021		-0.0008/dec.	-0.0031	-	less than 0.0001	0.12
	RCP45	2020 - 2060		-0.0007/dec.	-0.0026	-	less than 0.0001	0.44
	RCP85	2020 - 2060		-0.0007/dec.	-0.0027	-	less than 0.0001	0.57
<b>Nigeria</b>	CRU	1980 - 2021		-0.0002/dec.	-0.0010	-	0.0093	0.01
	RCP45	2020 - 2060		-0.0002/dec.	-0.0007	-	0.0047	0.01
	RCP85	2020 - 2060	Not signif.	-	-	0.2185	0.1451	0
<b>Senegal</b>	CRU	1980 - 2021		-0.0010/dec.	-0.0042	-	less than 0.0001	0.21
	RCP45	2020 - 2060		-0.0007/dec.	-0.0029	-	less than 0.0001	0.36
	RCP85	2020 - 2060		-0.0007/dec.	-0.0026	-	less than 0.0001	0.44

## HEAT STRESS

This section will outline the past and expected future trends of heat stress indices for the 8 selected states in the SURAGGWA program.

### Summary

All participating states are experiencing heat stress, with annual average temperatures above 26°C and annual maximum temperatures above 33°C. Additionally, the number of tropical nights in the region is above 20 days per year, and amount of heat days exceeds 25.

This situation has been worsening over the past 40 years and is expected to continue to worsen, as evidenced by the widespread increase in average, minimum, and maximum temperatures, as well as the increase in tropical nights and heat days. This increase can be observed in both historical data and projected scenarios.

The only exceptions to this global trend were found in Djibouti, where no statistically significant trend was observed in minimum temperatures and tropical nights in historical data, and in Senegal, where no statistically significant trends were observed in historical data.

**Table 19 – Historic climate trends for heat stress indices**

Time period: 1980-2020. Data sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020).

Historical trends								
Index	Burkina Faso	Chad	Djibouti	Mali	Mauritania	Niger	Nigeria	Senegal
<b>Average temperature</b>	+0.21°C/dec.	+0.45°C/dec.	+0.14°C/dec.	+0.28°C/dec.	+0.25°C/dec.	+0.41°C/dec.	+0.20°C/dec.	+0.17°C/dec.
<b>Maximum temperature</b>	+0.19°C/dec.	+0.45°C/dec.	+0.15°C/dec.	+0.30°C/dec.	+0.27°C/dec.	+0.42°C/dec.	+0.21°C/dec.	+0.29°C/dec.
<b>Minimum temperature</b>	+0.24°C/dec.	+0.52°C/dec.		+0.26°C/dec.	+0.22°C/dec.	+0.45°C/dec.	+0.21°C/dec.	+0.14°C/dec.
<b>Accumulated tropical nights</b>	+4days/dec.	+9days/dec.		+3days/dec.	+4days/dec.	+7days/dec.	+4days/dec.	
<b>Accumulated heat days</b>	+6days/dec.	+2days/dec.	+3days/dec.	+7days/dec.	+6days/dec.	+3days/dec.	+3days/dec.	+9days/dec.

**Table 20 – Projected climate trends under RCP 4.5 scenario for heat stress indices**

Time period: 2020-2060. Data sources: World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

Projected trends under the RCP 4.5 scenario								
Index	Burkina Faso	Chad	Djibouti	Mali	Mauritania	Niger	Nigeria	Senegal
<b>Average temperature</b>	+0.29°C/dec.	+0.31°C/dec.	+0.27°C/dec.	+0.35°C/dec.	+0.31°C/dec.	+0.33°C/dec.	+0.29°C/dec.	+0.33°C/dec.
<b>Maximum temperature</b>	+0.29°C/dec.	+0.30°C/dec.	+0.26°C/dec.	+0.36°C/dec.	+0.34°C/dec.	+0.32°C/dec.	+0.27°C/dec.	+0.35°C/dec.
<b>Minimum temperature</b>	+0.33°C/dec.	+0.32°C/dec.	+0.31°C/dec.	+0.37°C/dec.	+0.33°C/dec.	+0.36°C/dec.	+0.30°C/dec.	+0.31°C/dec.

Accumulated tropical nights	 +5days/dec.	 +5days/dec.	 +11days/dec.	 +5days/dec.	 +5days/dec.	 +4days/dec.	 +5days/dec.	 +8days/dec.
Accumulated heat days	 +15days/dec.	 +10days/dec.	 +12days/dec.	 +10days/dec.	 +7days/dec.	 +10days/dec.	 +13days/dec.	 +15days/dec.

**Table 21 – Projected climate trends under RCP 8.5 scenario for heat stress indices**

Time period: 2020-2060. Data sources: World Bank Climate Change Knowledge Portal (WBCKP)  
<https://climateknowledgeportal.worldbank.org/>

Projected trends under the RCP 8.5 scenario								
Index	Burkina Faso	Chad	Djibouti	Mali	Mauritania	Niger	Nigeria	Senegal
<b>Average temperature</b>	+0.52°C/dec.	+0.49°C/dec.	+0.45°C/dec.	+0.58°C/dec.	+0.56°C/dec.	+0.56°C/dec.	+0.48°C/dec.	+0.49°C/dec.
<b>Maximum temperature</b>	+0.47°C/dec.	+0.47°C/dec.	+0.42°C/dec.	+0.56°C/dec.	+0.55°C/dec.	+0.53°C/dec.	+0.46°C/dec.	+0.51°C/dec.
<b>Minimum temperature</b>	+0.55°C/dec.	+0.58°C/dec.	+0.51°C/dec.	+0.62°C/dec.	+0.62°C/dec.	+0.62°C/dec.	+0.50°C/dec.	+0.51°C/dec.
<b>Accumulated tropical nights</b>	+8days/dec.	+8days/dec.	+14days/dec.	+9days/dec.	+10days/dec.	+7days/dec.	+9days/dec.	+14days/dec.
<b>Accumulated heat days</b>	+21days/dec.	+16days/dec.	+18days/dec.	+15days/dec.	+10days/dec.	+14days/dec.	+21days/dec.	+21days/dec.

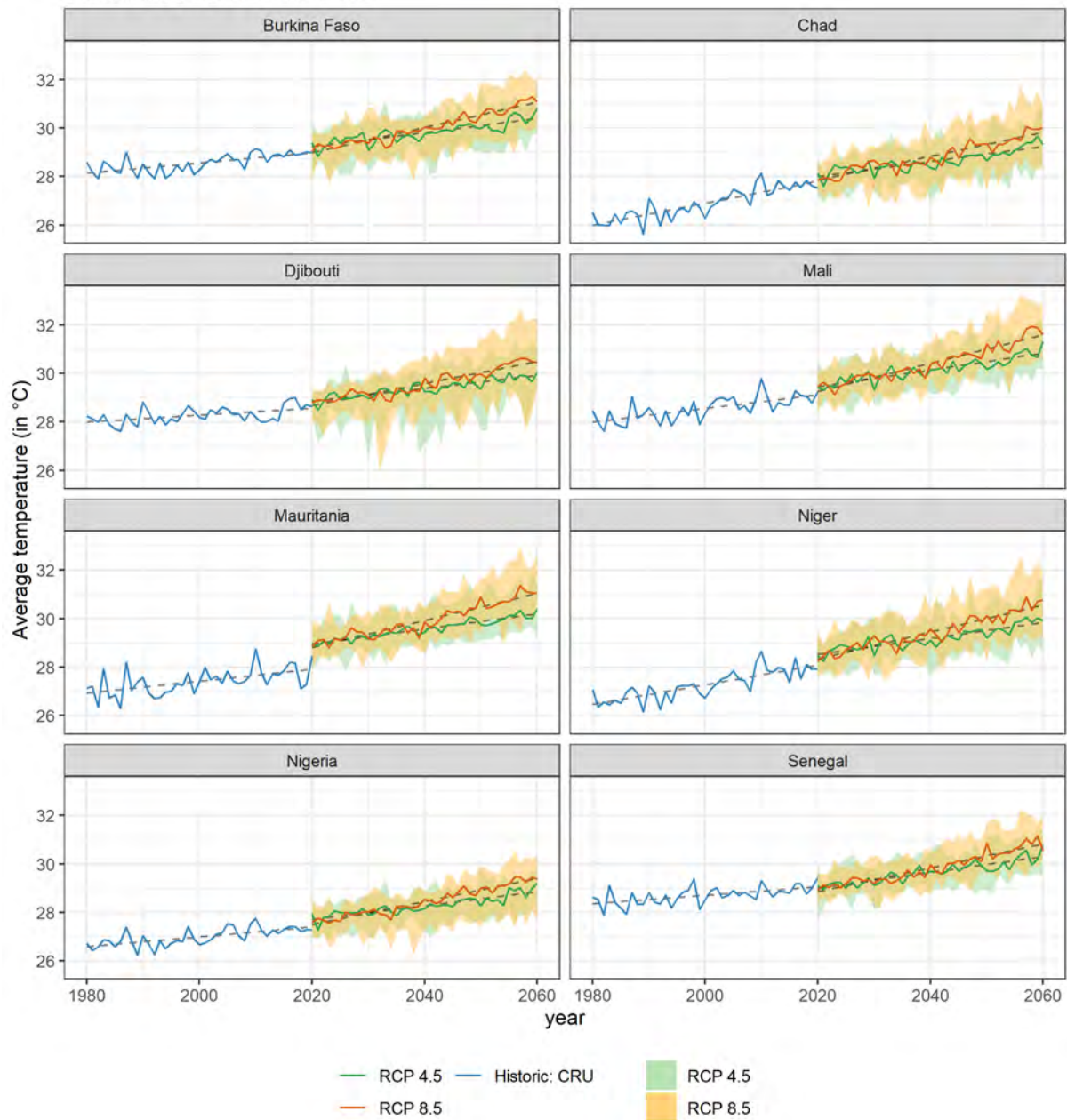
## Temperatures

In this section we will present the historic and projected trends of average, maximum and minimum temperatures within the states participating in the SURAGGWA program.

**Figure 16 – Historical and projected time series of average temperatures**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP)  
<https://climateknowledgeportal.worldbank.org/>

### Average temperature Historic and projected times series



Across almost all states participating in the SURAGGWA program, both historical and projected data consistently showed an upward trend in average, minimum, and maximum temperatures. The only exception was found in Djibouti, where no trend was observed in historical minimum temperatures. The degree of increase varied depending on the scenario and the variable, but ranged as follows:

- Based on historical data, the increase in **average temperatures** ranged from +0.14°C per decade in Djibouti to +0.45°C per decade in Chad. The stabilization scenario (RCP 4.5) predicts an increase in average temperatures ranging from +0.27°C per decade in Djibouti to +0.35°C per decade in

Mali. For its part, the business-as-usual scenario (RCP 8.5) anticipates an increase ranging from +0.45°C per decade in Djibouti to +0.58°C per decade in Mali.

- According to historical data, **maximum temperatures** increased from +0.15°C per decade in Djibouti to +0.45°C per decade in Chad. Under the stabilization scenario (RCP 4.5), maximum temperatures are expected to increase by a range of +0.26°C per decade in Djibouti to +0.36°C per decade in Mali. The business-as-usual scenario (RCP 8.5) predicts an increase ranging from +0.42°C per decade in Djibouti to +0.56°C per decade in Mali.

**Table 22 – Metadata on historical and projected time series of average temperatures**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

State	Data	Period	General Trend	Slope	Total variation during the period	Average value during the period	p-value	Adjusted R <sup>2</sup>
Burkina Faso	CRU	1980 - 2020	+	+0.21°C/dec.	0.84°C	-	less than 0.0001	0.45
	RCP45	2020 - 2060	+	+0.29°C/dec.	1.17°C	-	less than 0.0001	0.7
	RCP85	2020 - 2060	+	+0.52°C/dec.	2.08°C	-	less than 0.0001	0.92
Chad	CRU	1980 - 2020	+	+0.45°C/dec.	1.81°C	-	less than 0.0001	0.72
	RCP45	2020 - 2060	+	+0.31°C/dec.	1.24°C	-	less than 0.0001	0.74
	RCP85	2020 - 2060	+	+0.49°C/dec.	1.97°C	-	less than 0.0001	0.87
Djibouti	CRU	1980 - 2020	+	+0.14°C/dec.	0.57°C	-	6.00E-04	0.24
	RCP45	2020 - 2060	+	+0.27°C/dec.	1.07°C	-	less than 0.0001	0.78
	RCP85	2020 - 2060	+	+0.45°C/dec.	1.81°C	-	less than 0.0001	0.88
Mali	CRU	1980 - 2020	+	+0.28°C/dec.	1.12°C	-	less than 0.0001	0.46
	RCP45	2020 - 2060	+	+0.35°C/dec.	1.38°C	-	less than 0.0001	0.79
	RCP85	2020 - 2060	+	+0.58°C/dec.	2.33°C	-	less than 0.0001	0.9
Mauritania	CRU	1980 - 2020	+	+0.25°C/dec.	0.98°C	-	2.00E-04	0.28
	RCP45	2020 - 2060	+	+0.31°C/dec.	1.25°C	-	less than 0.0001	0.9
	RCP85	2020 - 2060	+	+0.56°C/dec.	2.24°C	-	less than 0.0001	0.9
Niger	CRU	1980 - 2020	+	+0.41°C/dec.	1.62°C	-	less than 0.0001	0.64
	RCP45	2020 - 2060	+	+0.33°C/dec.	1.31°C	-	less than 0.0001	0.78
	RCP85	2020 - 2060	+	+0.56°C/dec.	2.23°C	-	less than 0.0001	0.89
Nigeria	CRU	1980 - 2020	+	+0.20°C/dec.	0.81°C	-	less than 0.0001	0.43
	RCP45	2020 - 2060	+	+0.29°C/dec.	1.14°C	-	less than 0.0001	0.77
	RCP85	2020 - 2060	+	+0.48°C/dec.	1.91°C	-	less than 0.0001	0.93
Senegal	CRU	1980 - 2020	+	+0.17°C/dec.	0.70°C	-	less than 0.0001	0.31
	RCP45	2020 - 2060	+	+0.33°C/dec.	1.30°C	-	less than 0.0001	0.8
	RCP85	2020 - 2060	+	+0.49°C/dec.	1.97°C	-	less than 0.0001	0.9

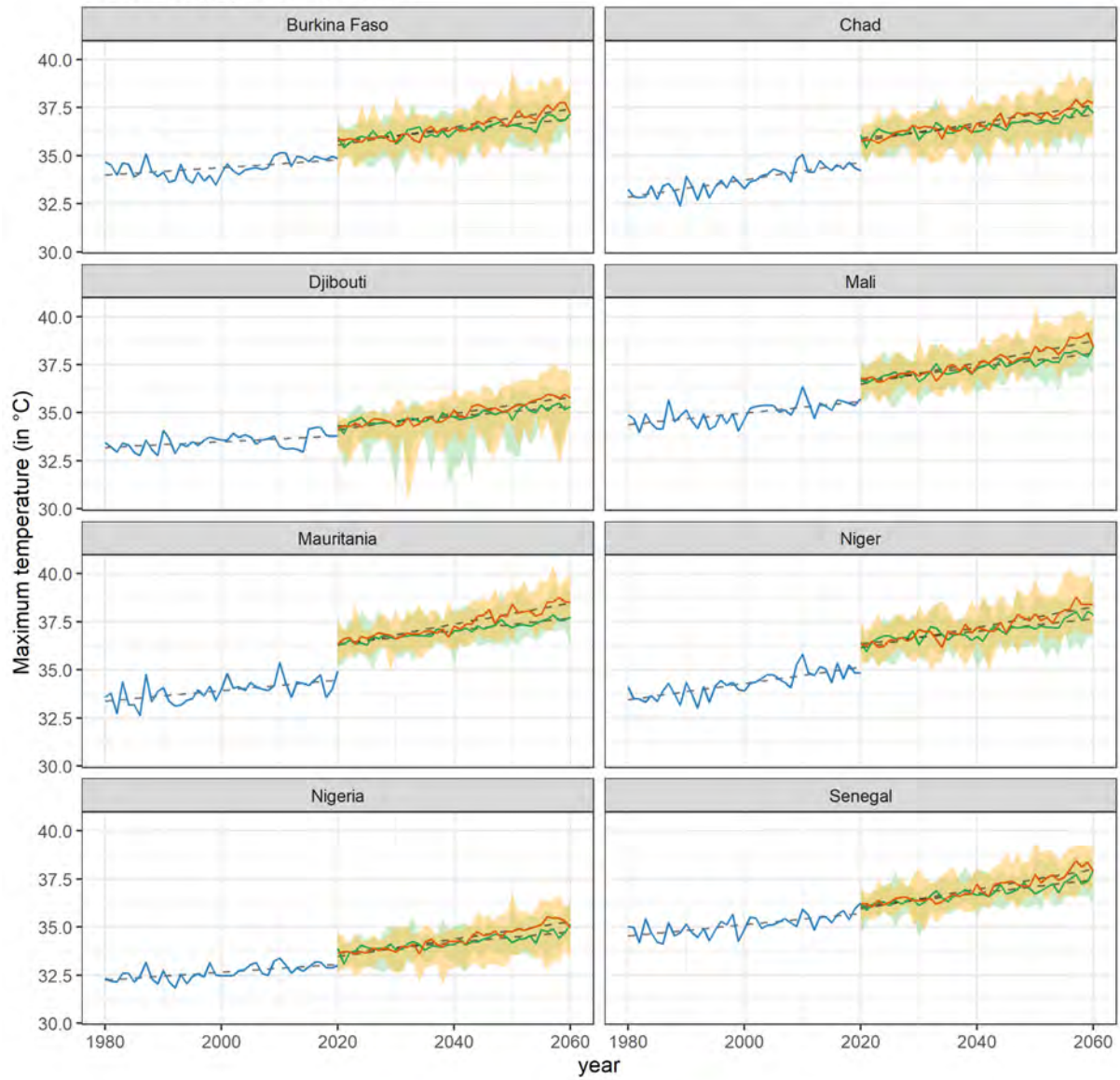
- **Minimum temperatures** showed an increase ranging from +0.14°C per decade in Senegal to +0.52°C per decade in Chad, according to historical data. Under the stabilization scenario (RCP 4.5), minimum temperatures are projected to increase within a range of +0.30°C per decade in Nigeria to +0.37°C per decade in Mali. In contrast, the business-as-usual scenario (RCP 8.5) predicts an increase ranging from +0.50°C per decade in Nigeria to +0.62°C per decade in Mali, Mauritania, and Niger.

***Figure 17 – Historical and projected time series of maximum temperatures***

*Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP)*  
<https://climateknowledgeportal.worldbank.org/>

# Maximum temperature

## Historic and projected times series



— RCP 4.5 — Historic: CRU — RCP 4.5  
 — RCP 8.5 — RCP 8.5

**Table 23 – Metadata on historical and projected time series of maximum temperatures**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

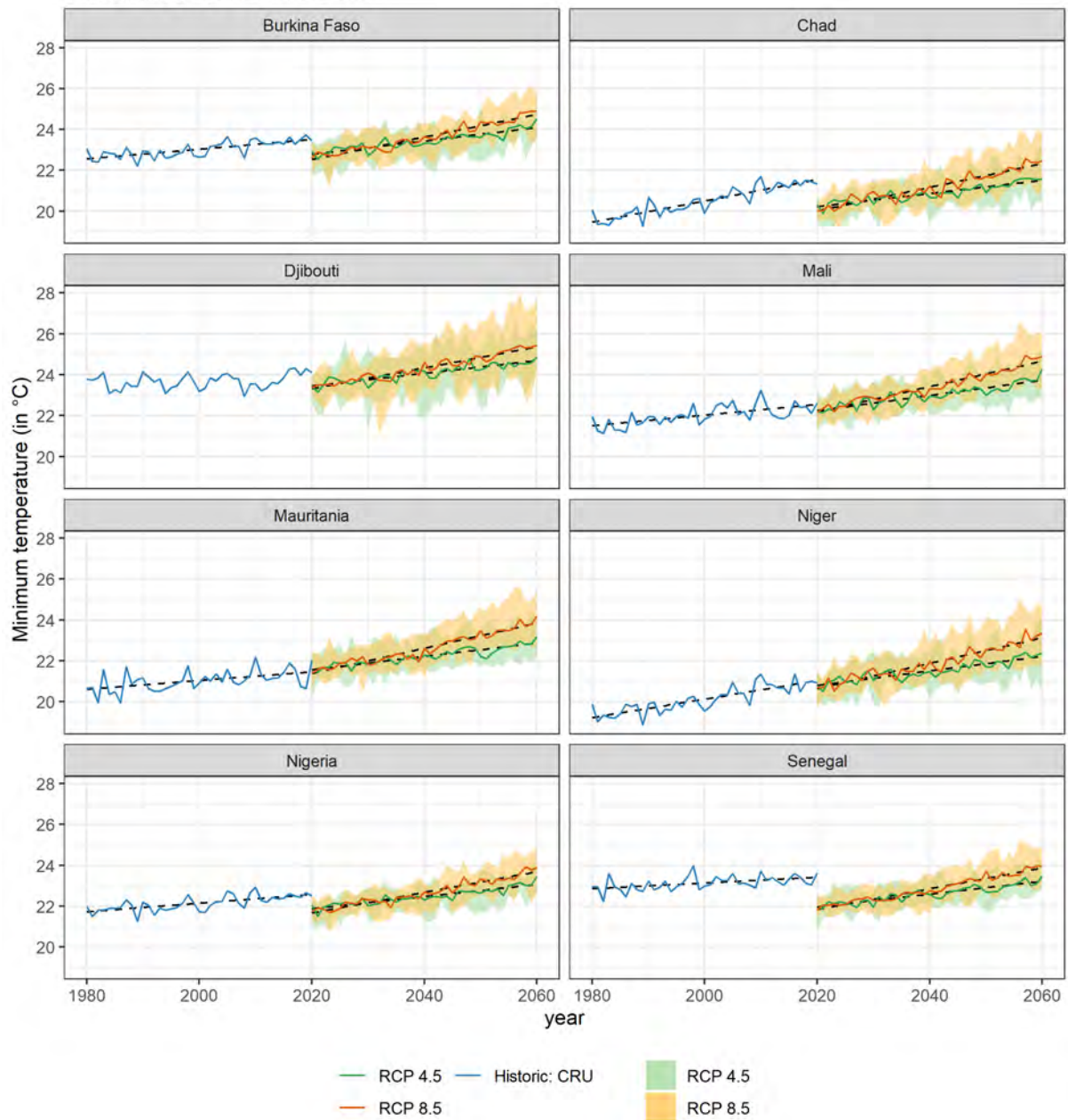
State	Data	Period	General Trend	Slope	Total variation during the period	Average value during the period	p-value	Adjusted R <sup>2</sup>
<b>Burkina Faso</b>	CRU	1980 - 2020	+	+0.19°C/dec.	0.78°C	-	0.0011	0.22
	RCP45	2020 - 2060	+	+0.29°C/dec.	1.15°C	-	less than 0.0001	0.7
	RCP85	2020 - 2060	+	+0.47°C/dec.	1.89°C	-	less than 0.0001	0.86
<b>Chad</b>	CRU	1980 - 2020	+	+0.45°C/dec.	1.80°C	-	less than 0.0001	0.68
	RCP45	2020 - 2060	+	+0.30°C/dec.	1.20°C	-	less than 0.0001	0.71
	RCP85	2020 - 2060	+	+0.47°C/dec.	1.87°C	-	less than 0.0001	0.85
<b>Djibouti</b>	CRU	1980 - 2020	+	+0.15°C/dec.	0.60°C	-	0.0023	0.19
	RCP45	2020 - 2060	+	+0.26°C/dec.	1.03°C	-	less than 0.0001	0.75
	RCP85	2020 - 2060	+	+0.42°C/dec.	1.69°C	-	less than 0.0001	0.86
<b>Mali</b>	CRU	1980 - 2020	+	+0.30°C/dec.	1.20°C	-	less than 0.0001	0.41
	RCP45	2020 - 2060	+	+0.36°C/dec.	1.43°C	-	less than 0.0001	0.82
	RCP85	2020 - 2060	+	+0.56°C/dec.	2.25°C	-	less than 0.0001	0.88
<b>Mauritania</b>	CRU	1980 - 2020	+	+0.27°C/dec.	1.10°C	-	2.00E-04	0.29
	RCP45	2020 - 2060	+	+0.34°C/dec.	1.34°C	-	less than 0.0001	0.9
	RCP85	2020 - 2060	+	+0.55°C/dec.	2.19°C	-	less than 0.0001	0.88
<b>Niger</b>	CRU	1980 - 2020	+	+0.42°C/dec.	1.69°C	-	less than 0.0001	0.6
	RCP45	2020 - 2060	+	+0.32°C/dec.	1.30°C	-	less than 0.0001	0.68
	RCP85	2020 - 2060	+	+0.53°C/dec.	2.13°C	-	less than 0.0001	0.85
<b>Nigeria</b>	CRU	1980 - 2020	+	+0.21°C/dec.	0.82°C	-	less than 0.0001	0.4
	RCP45	2020 - 2060	+	+0.27°C/dec.	1.10°C	-	less than 0.0001	0.72
	RCP85	2020 - 2060	+	+0.46°C/dec.	1.83°C	-	less than 0.0001	0.89
<b>Senegal</b>	CRU	1980 - 2020	+	+0.29°C/dec.	1.17°C	-	less than 0.0001	0.44
	RCP45	2020 - 2060	+	+0.35°C/dec.	1.39°C	-	less than 0.0001	0.79
	RCP85	2020 - 2060	+	+0.51°C/dec.	2.05°C	-	less than 0.0001	0.87

**Figure 18 – Historical and projected time series of minimum temperatures**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

# Minimum temperature

## Historic and projected times series



**Table 24 – Metadata on historical and projected time series of minimum temperatures**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

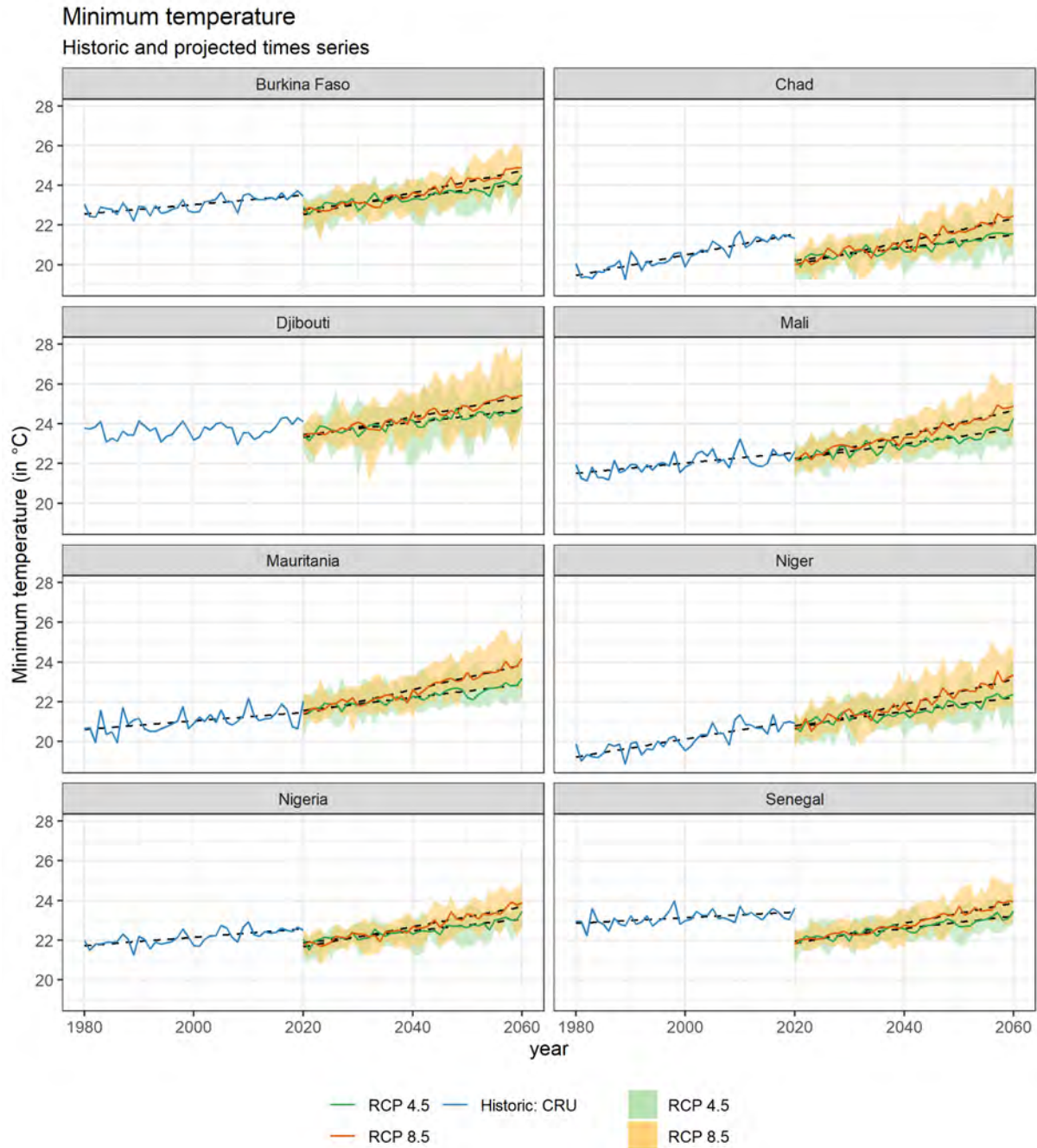
State	Data	Period	General Trend	Slope	Total variation during the period	Average value during the period	p-value	Adjusted R <sup>2</sup>
Burkina Faso	CRU	1980 - 2020	+	+0.24°C/dec.	0.96°C	-	less than 0.0001	0.53
	RCP45	2020 - 2060	+	+0.33°C/dec.	1.31°C	-	less than 0.0001	0.8
	RCP85	2020 - 2060	+	+0.55°C/dec.	2.21°C	-	less than 0.0001	0.93
Chad	CRU	1980 - 2020	+	+0.52°C/dec.	2.09°C	-	less than 0.0001	0.8
	RCP45	2020 - 2060	+	+0.32°C/dec.	1.30°C	-	less than 0.0001	0.84
	RCP85	2020 - 2060	+	+0.58°C/dec.	2.31°C	-	less than 0.0001	0.89
Djibouti	CRU	1980 - 2020	Not signif.	-	-	23.68°C	0.073	0.06
	RCP45	2020 - 2060	+	+0.31°C/dec.	1.24°C	-	less than 0.0001	0.79
	RCP85	2020 - 2060	+	+0.51°C/dec.	2.04°C	-	less than 0.0001	0.93
Mali	CRU	1980 - 2020	+	+0.26°C/dec.	1.04°C	-	less than 0.0001	0.41
	RCP45	2020 - 2060	+	+0.37°C/dec.	1.49°C	-	less than 0.0001	0.8
	RCP85	2020 - 2060	+	+0.62°C/dec.	2.49°C	-	less than 0.0001	0.94
Mauritania	CRU	1980 - 2020	+	+0.22°C/dec.	0.86°C	-	6.00E-04	0.24
	RCP45	2020 - 2060	+	+0.33°C/dec.	1.30°C	-	less than 0.0001	0.85
	RCP85	2020 - 2060	+	+0.62°C/dec.	2.46°C	-	less than 0.0001	0.93
Niger	CRU	1980 - 2020	+	+0.45°C/dec.	1.81°C	-	less than 0.0001	0.7
	RCP45	2020 - 2060	+	+0.36°C/dec.	1.43°C	-	less than 0.0001	0.81
	RCP85	2020 - 2060	+	+0.62°C/dec.	2.49°C	-	less than 0.0001	0.9
Nigeria	CRU	1980 - 2020	+	+0.21°C/dec.	0.85°C	-	less than 0.0001	0.46
	RCP45	2020 - 2060	+	+0.30°C/dec.	1.19°C	-	less than 0.0001	0.83
	RCP85	2020 - 2060	+	+0.50°C/dec.	2.02°C	-	less than 0.0001	0.93
Senegal	CRU	1980 - 2020	+	+0.14°C/dec.	0.56°C	-	0.0012	0.22
	RCP45	2020 - 2060	+	+0.31°C/dec.	1.25°C	-	less than 0.0001	0.83
	RCP85	2020 - 2060	+	+0.51°C/dec.	2.03°C	-	less than 0.0001	0.95

## Tropical Nights

Tropical nights are defined in this report as the **number of days with a minimum temperature above 20°C**.

**Figure 19 – Historical and projected time series of tropical nights**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>



Across most of the states in the SURAGGWA program, historical and projected data consistently showed an increase in the number of tropical nights. The only exceptions were observed in Djibouti and Senegal, where no statistically significant trends were observed in historical data.

The range of increase in the number of tropical nights for historical data was between +3 days per decade in Mali and +9 days per decade in Chad. Under the stabilization scenario (RCP 4.5), the number of tropical nights is expected to increase within a range of +4 days per decade in Nigeria to +11 days per decade in

Djibouti. finally, under the business-as-usual scenario (RCP 8.5), an increase ranging from +7 days per decade in Niger to +14 days per decade in Djibouti and Senegal is expected.

**Table 25 – Metadata on historical and projected time series of tropical nights**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

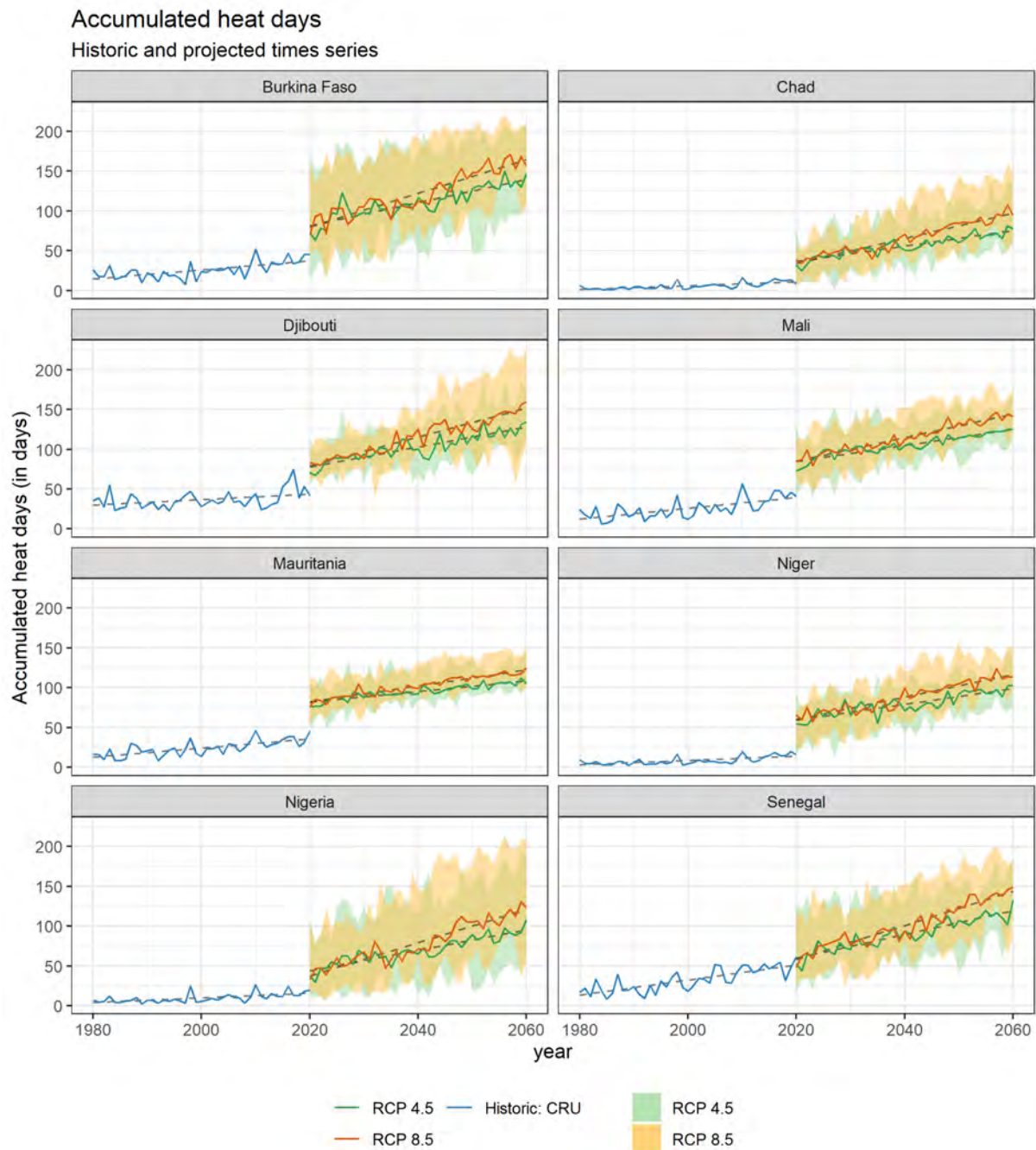
State	Data	Period	General Trend	Slope	Total variation during the period	Average value during the period	p-value	Adjusted R <sup>2</sup>
Burkina Faso	CRU	1980 - 2020	+	+4 days/dec.	17days	-	9.00E-04	0.23
	RCP45	2020 - 2060	+	+5 days/dec.	21days	-	less than 0.0001	0.66
	RCP85	2020 - 2060	+	+8 days/dec.	33days	-	less than 0.0001	0.81
Chad	CRU	1980 - 2020	+	+9 days/dec.	37days	-	less than 0.0001	0.69
	RCP45	2020 - 2060	+	+5 days/dec.	21days	-	less than 0.0001	0.75
	RCP85	2020 - 2060	+	+8 days/dec.	32days	-	less than 0.0001	0.85
Djibouti	CRU	1980 - 2020	Not signif.	-	-	286 days	0.5053	-0.01
	RCP45	2020 - 2060	+	+11 days/dec.	43days	-	less than 0.0001	0.71
	RCP85	2020 - 2060	+	+14 days/dec.	54days	-	less than 0.0001	0.83
Mali	CRU	1980 - 2020	+	+3 days/dec.	14days	-	6.00E-04	0.24
	RCP45	2020 - 2060	+	+5 days/dec.	19days	-	less than 0.0001	0.71
	RCP85	2020 - 2060	+	+9 days/dec.	34days	-	less than 0.0001	0.92
Mauritania	CRU	1980 - 2020	+	+4 days/dec.	17days	-	0.0023	0.19
	RCP45	2020 - 2060	+	+5 days/dec.	20days	-	less than 0.0001	0.68
	RCP85	2020 - 2060	+	+10 days/dec.	39days	-	less than 0.0001	0.91
Niger	CRU	1980 - 2020	+	+7 days/dec.	29days	-	less than 0.0001	0.53
	RCP45	2020 - 2060	+	+4 days/dec.	17days	-	less than 0.0001	0.73
	RCP85	2020 - 2060	+	+7 days/dec.	27days	-	less than 0.0001	0.8
Nigeria	CRU	1980 - 2020	+	+4 days/dec.	16days	-	0.0007	0.24
	RCP45	2020 - 2060	+	+5 days/dec.	21days	-	less than 0.0001	0.65
	RCP85	2020 - 2060	+	+9 days/dec.	35days	-	less than 0.0001	0.82
Senegal	CRU	1980 - 2020	Not signif.	-	-	294 days	0.2124	0.01
	RCP45	2020 - 2060	+	+8 days/dec.	30days	-	less than 0.0001	0.75
	RCP85	2020 - 2060	+	+14 days/dec.	58days	-	less than 0.0001	0.89

## Heat Days

In this report, heat days refer to the **number of days when the heat index exceeds 35°C**. The heat index is an index that reflects the perceived temperature by taking into account both the actual temperature and atmospheric moisture. The heat index increases as the temperature and/or atmospheric moisture increase.

**Figure 20 – Historical and projected time series of heat days**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>



Across all states in the SURAGGWA program, historical and projected data consistently showed an increase in the number of heat days.

The historical data indicated an increase ranging from +2 days per decade in Chad to +9 days per decade in Senegal. Under the stabilization scenario (RCP 4.5), the number of heat days is expected to increase

within a range of +7 days per decade in Mauritania to +15 days per decade in Burkina Faso and Senegal. Meanwhile, the business-as-usual scenario (RCP 8.5) expects an increase ranging from +10 days per decade in Mauritania to +21 days in Burkina Faso, Nigeria, and Senegal.

**Table 26 – Metadata on historical and projected time series heat days**

Time series over the 1980 to 2060 period. Data Sources: Climate Research Unit (CRU) of the University of East Anglia (Harris et al. 2020) and World Bank Climate Change Knowledge Portal (WBCKP) <https://climateknowledgeportal.worldbank.org/>

State	Data	Period	General Trend	Slope	Total variation during the period	Average value during the period	p-value	Adjusted R <sup>2</sup>
<b>Burkina Faso</b>	CRU	1980 - 2020	+	+6 days/dec.	23days	-	less than 0.0001	0.4
	RCP45	2020 - 2060	+	+15 days/dec.	58days	-	less than 0.0001	0.74
	RCP85	2020 - 2060	+	+21 days/dec.	85days	-	less than 0.0001	0.85
<b>Chad</b>	CRU	1980 - 2020	+	+2 days/dec.	10days	-	less than 0.0001	0.45
	RCP45	2020 - 2060	+	+10 days/dec.	39days	-	less than 0.0001	0.82
	RCP85	2020 - 2060	+	+16 days/dec.	63days	-	less than 0.0001	0.92
<b>Djibouti</b>	CRU	1980 - 2020	+	+3 days/dec.	14days	-	0.0149	0.12
	RCP45	2020 - 2060	+	+12 days/dec.	50days	-	less than 0.0001	0.78
	RCP85	2020 - 2060	+	+18 days/dec.	73days	-	less than 0.0001	0.9
<b>Mali</b>	CRU	1980 - 2020	+	+7 days/dec.	27days	-	less than 0.0001	0.42
	RCP45	2020 - 2060	+	+10 days/dec.	40days	-	less than 0.0001	0.85
	RCP85	2020 - 2060	+	+15 days/dec.	59days	-	less than 0.0001	0.92
<b>Mauritania</b>	CRU	1980 - 2020	+	+6 days/dec.	23days	-	less than 0.0001	0.49
	RCP45	2020 - 2060	+	+7 days/dec.	27days	-	less than 0.0001	0.81
	RCP85	2020 - 2060	+	+10 days/dec.	40days	-	less than 0.0001	0.91
<b>Niger</b>	CRU	1980 - 2020	+	+3 days/dec.	11days	-	less than 0.0001	0.42
	RCP45	2020 - 2060	+	+10 days/dec.	39days	-	less than 0.0001	0.73
	RCP85	2020 - 2060	+	+14 days/dec.	57days	-	less than 0.0001	0.88
<b>Nigeria</b>	CRU	1980 - 2020	+	+3 days/dec.	12days	-	less than 0.0001	0.33
	RCP45	2020 - 2060	+	+13 days/dec.	51days	-	less than 0.0001	0.81
	RCP85	2020 - 2060	+	+21 days/dec.	84days	-	less than 0.0001	0.88
<b>Senegal</b>	CRU	1980 - 2020	+	+9 days/dec.	38days	-	less than 0.0001	0.6
	RCP45	2020 - 2060	+	+15 days/dec.	60days	-	less than 0.0001	0.84
	RCP85	2020 - 2060	+	+21 days/dec.	85days	-	less than 0.0001	0.91

## Climate Variable, Data Sources & Analytical Framework

### Climate Variables

A comprehensive list of the variables presented in this brief, along with their corresponding acronyms and definitions, can be found in Table 27.

**Table 27 – Variables considered, and corresponding acronyms and definitions**

VARIABLE	ACRONYM	DEFINITION
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Annually accumulated Precipitation	P	Accumulated sum of the daily precipitation over a given period (month or year).
Average Temperature	TG	Average temperature over a given period (month or year).
Climatic Water Balance	CWB	Balance between ETo and P; it is calculated by subtracting the monthly value of ETo to the monthly value of P. A negative value represent water deficit, while a positive value represents water excess.
Heat Days	HDays	number of days when the heat index exceeds 35°C. The heat index is an index that reflects the perceived temperature by taking into account both the actual temperature and atmospheric moisture. The heat index increases as the temperature and/or atmospheric moisture increase.
Maximum Temperature	TX	Average of the daily maximum temperature over a given period (month or year).
Minimum Temperature	TN	Average of the daily minimum temperature over a given period (month or year).
Precipitation inter-annual variability	Pvar <sub>inter</sub>	Standard deviation of the annually accumulated precipitation of the last 10 years
Precipitation intra-annual variability	Pvar <sub>intra</sub>	Standard deviation of monthly accumulated precipitation of each year
Reference Evapotranspiration	ETo	Amount of water loss by evapotranspiration from a hypothetical grass surface, known as a reference crop, under standardized environmental and management conditions. In this brief, ETo is calculated using the Hargreaves equation, modified by Droogers and Allen (Droogers and Allen 2002; Hargreaves 1994).
Standardized Precipitation Evapotranspiration Index	SPEI	Drought index that combines precipitation and evapotranspiration data to quantify drought severity and duration. It represents the difference between the observed precipitation and the ETo, both standardized by their respective means and standard deviations over a given period. In this brief we used 3 different periods: 3 months SPEI (representing meteorological droughts), 9 months SPEI (representing agricultural droughts) and 12 months SPEI representing geological droughts.
Tropical Nights	TNights	the number of days with a minimum temperature above 20°C.

## Data Sources

This brief used 2 data sources. These sources are presented in Table 28.

**Table 28 – Data sources**

DATA SOURCE	TYPE	DEFINITION
CRU	Historical	Data provided by the Climate Research Unit of the University of East Anglia (Harris et al. 2020). These data will be used to assess the current and historical state of the climate in each state of the Program. Data sourced from the Climate Knowledge Portal of the World Bank.
CIMP6	Projected	Data provided by the Coupled Model Intercomparison Project Phase 6. These data will be used to assess the future state of the climate in each state of the Program. The models included in the ensemble used includes cams-csm1-0, canesm5, cnrm-esm2-1, ec-earth3-veg, fgoals-g3, gfdl-esm4, ipsl-cm6a-lr, miroc-es2l, miroc6, mri-esm2-0 and ukesm1-0-ll. Data sourced from the Climate Knowledge Portal of the World Bank.

### Analytical Framework

The analytical framework outlined in the following section was applied to each state participating in the SURAGGWA Program.

#### Current Climate

The analysis of the current climate for the states participating in the SURAGGWA program was conducted by examining the fluctuations of monthly accumulated precipitation and monthly average temperature over the past 30 years. The data was aggregated by month and, to present the data, we created charts displaying the monthly median values of the variables over the past 30 years (represented by the black line) and the range between the 10th and 90th quantile values of the same monthly data (represented by the green shade).

To provide more information, a table was included in addition to the chart, which shows the months when the maximum and minimum values occurred, along with their corresponding actual values.

#### Water Stress

Each selected variable representing the water stress situation in the SURAGGWA program was analyzed using the same analytical framework. For each variable, an annual time series of both historical and projected data was presented in a single chart. The chart consists of the following elements:

- The **blue line** represents the country's historical time series of the annually aggregated variable, as provided by the CRU.
- The **green line** represents the country's median value of the projected time series of the annually aggregated variable of each projected CIMP6 model used in this analysis under the RCP 4.5 scenario.
- The **red line** represents the country's median value of the projected time series of the annually aggregated variable of each projected CIMP6 model used in this analysis under the RCP 8.5 scenario.
- The **green shade** represents the range between the maximum and minimum values of the projected time series of the annually aggregated variable of each projected CIMP6 model used in this analysis under the RCP 4.5 scenario.
- The **orange shade** represents the range between the maximum and minimum values of the projected time series of the annually aggregated variable of each projected CIMP6 model used in this analysis under the RCP 8.5 scenario.

To supplement the chart, a table is provided that displays the metrics of the variations of the variable, for historical data and projected data (under both scenarios).

**Trends Statistical Significance:** In this report, trends were calculated using linear regression on the time series, and the p-value of the F-Statistics corresponding to the regression was determined. If the p-value was less than an alpha of 0.05, the regression was considered statistically significant, and a dashed black regression line was added to the chart to indicate the trend. If the p-value was higher than 0.05, the trends were considered not statistically significant, and no variation of the variable was reported.

**Projected data validation:** Due to a lack of sufficient data overlap, a validation analysis could not be conducted. The monthly historical data spanned from 1971 to 2020, while the projected data covered the range from 2020 to 2100, resulting in no overlapping data. At the yearly level, historical data was available from 1950 to 2020, and projected data from 2015 to 2100, which provided only a five-year overlap, which is not sufficient for conducting a thorough validation of the projected data.

## CHAPTER III – PROJECT AREA SELECTION

### BACKGROUND ON PROJECT OBJECTIVES

SURAGGWA proposes to implement three key interventions that are designed to address the technical, organizational, and financial barriers to alleviate climate change impacts and heighten resilience of local communities through the following:

- develop a programme to scale-up successful restoration practices, promote biodiversity, regenerate native species, and sequester carbon.
- support the development of climate-resilient, low emission non-timber forest product value chains benefiting vulnerable communities' livelihoods, as well as food and nutrition security.
- strengthen the Great Green Wall (GGW)'s regional and national institutions to secure the sustainability of interventions and scale up successful practices.

### CLIMATE CHANGE ADAPTATION AND RESTORATION IN GGW

**The Sahel is one of the most sensitive ecosystems to climate change and climate variability.**

Historical data shows a succession of severe drought periods which, in combination with unsustainable land use practices, have led to the degradation of natural resources and ecosystems with negative impacts on the development of affected countries.

**Climate change is likely to further aggravate land degradation and desertification in the region, posing a serious threat to agriculture and livestock-dependent communities.**

In addition, climate change is expected to have a significant influence on the ecology and distribution of tropical ecosystems – though, the magnitude, rate, and direction of these changes are uncertain. With rising temperatures and increased frequency and intensity of droughts, wetlands and riverine systems – which are essential for rural livelihoods in the GGW zone – are increasingly at risk of being disrupted and altered. In addition to these climate drivers, low agricultural productivity and population growth could continue to drive unsustainable agricultural practices, resulting in increased deforestation, fires, and land degradation.

**In the absence of proposed interventions, the vulnerability of the area to climate risks will continue to grow, especially rainfed agriculture.** Repeated cycles of droughts and floods make it increasingly harder for the local population to sustain agricultural practices. Extreme weather events can lead to increased land degradation as a result of wind and water erosion and surface run-off, resulting in widespread crop failure and a reliance on food assistance programs. Additionally, the impact of climate change is straining the relationships among farmers and herders (including transhumant pastoralists) and thus also ethnic relations. For centuries, pastoralists have crossed the Sahel following seasonal patterns, which allowed them to feed and water their herds and adapt to climate variation. The scarcity of water, pasture, and fertile soil

force people to migrate. Such displacement can lead to conflicts over land and resources between herders and farmers, which in turn further fuel displacement dynamics.

## SELECTING PROJECT AREAS (BASED ON EXPOSURE AND VULNERABILITY)

It is well-known that the predominant livelihoods in the Sahel are subsistence agriculture and pastoralism, combined with forestry and fishing activities depending on the location<sup>12,13</sup>. Studies<sup>14</sup> have also suggested a strong link between environmental conditions and rural livelihoods in the Sahel, where cultural heritage could contribute to the adaptive capacity.

In the last 40 years, the Sahel has already experienced significant increases in temperature, changes in precipitation patterns, and declines in vegetation, emphasizing its vulnerability to climate change and the need for restoration efforts. The total area of land suitable for farming and grazing diminished, leading to decreased crop production and increased food insecurity (OECD, 2022), and subsequently conflict risks (Benjaminsen, 2012; SEI, 2022; Schwarz et al., 2022).

In the 2022 technical report on the impacts of climate change on agriculture and vegetation in Africa, Sacande et al. noted that heat stress days (HSD) > 32°C increased by one day on average, whereas HSD > 40°C increased by 12 days on average in the Sahel. The region has also lost forests (2.61%) and grasslands (1.01%), while witnessing 2.08% of its land being degraded into a drier aridity category. In addition, Nkoya et al. (2015) already estimated the annual economic impacts of land degradation in the Sub-Saharan Africa at roughly 7-percent of the countries' GDP, with half of the costs attributed to loss of ecosystem services such as carbon sequestration.

Under a changing climate, these already extreme baseline conditions would make similar future trends to profoundly impact the region. This is concerning as climate change projections (Annex 2 on Climate brief; IPCC, 2021; UK Met Office, 2020) warn of more common droughts and extreme heat, causing further risks to staple crops and livestock production, exacerbating existing challenges. Farming practices relying on favorable environmental conditions and landscape features will be most affected by these risks. For instance, rainfed agriculture, which constitutes 95% of the Sahel's food production, would be highly vulnerable (OECD, 2022).

Hence, to select ideal project locations, data on climate variability, farming, forest areas, and restoration suitability in the Sahel were combined to calculate climate risk and exposure in the GGW areas. The goal was to overlay the locations of current economic activities to the locations of future climate risks. Information on the potential for forest restoration and promotion of Non-Timber Forest Products (NTFP) value chains were also incorporated as they are pertinent to

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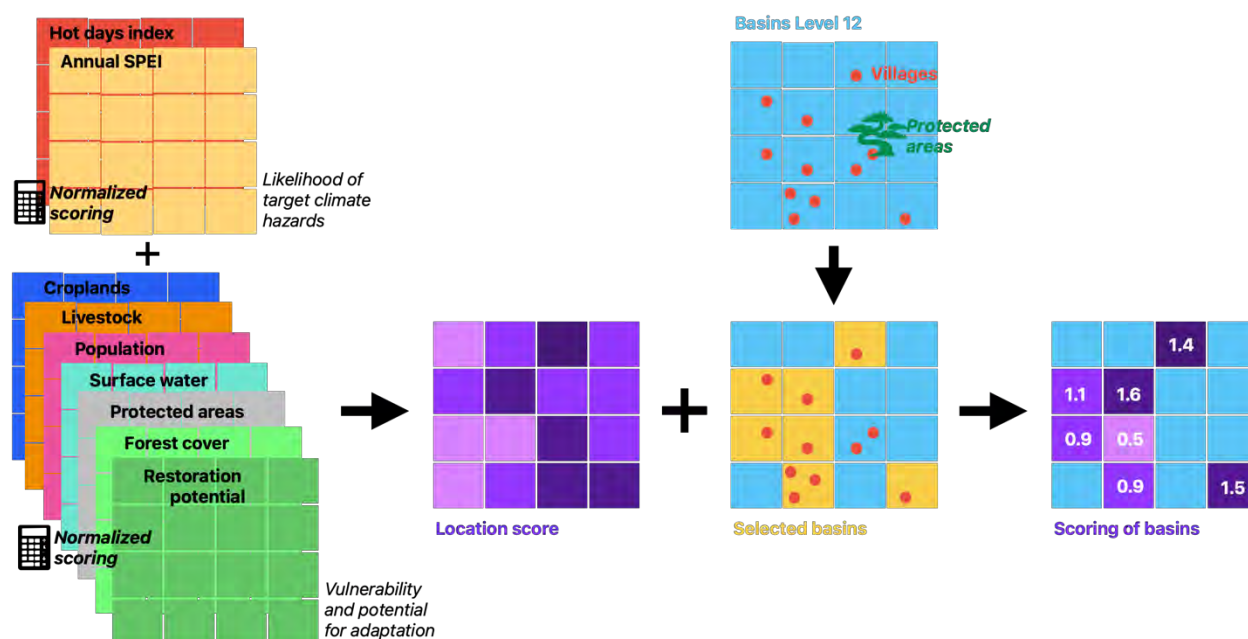
<sup>12</sup> <https://fews.net/topics/livelihoods>

<sup>13</sup> <https://www.oecd.org/swac/topics/siccs.htm>

<sup>14</sup> <https://www.unep.org/resources/report/ecosystem-services-and-rural-livelihoods-sahel-environmental-accounting-and-wealth>

project activities. Then, a geospatial analysis was conducted to calculate the score of several locations within the GGW areas to determine their suitability as project sites.

In this analysis, areas with high score are the locations where the project would be effective in maintaining the resilience of current farming and rural livelihood activities, while increasing tree, shrub and grass cover through seeding and planting, and promoting other, more resilient income-generating value chains. Since the final site selection would depend on baseline survey and security situation in the area at the start of the project, the suggested locations in the full proposal document and Annex 16 are by the first level administrative units within each country, but the site-level locations are shown in this analysis.



**Figure 21: Approach to select project locations**

**Step 1.** Several layers linked to future climate variability, farming, and restoration suitability were combined to determine the exposure to changes in climate variables. Per Annex 2 on climate brief, increase in temperature would be the main climate change threats, whereas precipitation trends would vary by country. Hence, the use of hot days index and annual SPEI as proxy variables for climate hazards. Since temperature increase will lead to increased moisture stress at any locations in the countries, the location of agriculture and livestock areas within the Great Green Wall zone in each country was also considered. In addition, layers that suggests ideal location for restoration activities and where Non-Timber Forest Products value chains could be promoted was also included in the scoring. Table 1 summarizes the layers normalized and combined to get a score of climate hazard exposure and project suitability. The score layer was obtained via the following formula.

[Eq. 1]

$$\text{Climate\_risk\_score} = (w1 * \text{Annual\_SPEI} + w2 * \text{Anomaly\_Heat\_index\_35}) / 2$$

[Eq. 2]

$$\text{Exposure\_score} = (w3 * \text{Cropland\_location} + w4 * \text{Livestock\_count} + w5 * \text{Population\_count} + w6 * \text{Surface\_water\_occurrence} + w7 * \text{Proximity\_to\_protected\_areas} + w8 * \text{Forest\_cover} + w9 * \text{Tree\_restoration\_potential}) / 7$$

[Eq. 3]

$$\text{Location\_score} = \text{Climate\_risk\_score} + \text{Exposure\_score}$$

*For all the scoring, each layer was scaled from 0 to 1 using the min-max approach and taking into account only the variations within each country. All layers were given the same weight of  $w\# = 1$ .*

*The climate\_risk\_score is calculated as the arithmetic mean of two (02) layers: Annual Standardized Precipitation Evapotranspiration Index (SPEI) and anomalies in days with heat index > 35C. The combination of both layers is used as proxy for future drought risks, human, forestry, and farming stress that may affect productivity.*

*The exposure\_score is calculated as the arithmetic mean of seven (07) layers. The first four (04) layers indicate the location of the people, assets, and economic activities exposed to the climate risks. The last three (03) indicate the areas suitable to the project objectives.*

**Step 2.** Using OpenStreetMap data, all “villages” within the GGW areas were extracted. Villages were selected because population within villages have lower adaptive capacity than in those in “cities”. And villages are smaller settlements and less likely to have local governments when compared to “town”. All of this adds some elements of vulnerability to current and future climate hazards on the villages. Then, each level 12 basin (or smallest catchment) containing these villages were extracted from the HydroSHEDS datasets. The rationale for selecting the basin as the unit of the analysis lies in the facility to contain adaptation measures within the basin. Each basin can have its own water budget, slope, shape, and ideal measures for dune stabilization.

**Step 3.** Finally, the average score of the selected basins is estimated using the location score layer. The zonal statistics tool from ArcGIS will be used for this calculation. Each basin then be ranked within each country.

**Step 4.** Data from Integrated Food Security Phase Classification (IPC) were used to characterize the selected regions and identify where the projects would contribute to both land restoration and adaptive capacity of the beneficiary communities. Data were obtained for the periods of Oct-Dec 2020, 2021, and 2022. IPC data indicate what action is needed: build resilience, protect livelihoods, or urgent/emergency actions. Here, the assumption is that the project would improve the overall food security of the region because of improved land productivity and economic opportunities that address disaster risks and build resilience.

**Step 5.** An additional analysis of adaptation- and restoration-related projects was conducted to understand what has been done recently regarding climate vulnerability. It provides an

approximate location and directions of ongoing interventions<sup>15</sup> in each country. Specific focus was given to Green Climate Fund (GCF), Global Environment Facility (GEF), and Adaptation Fund (AF) projects which are the main sources of funding for CC projects.

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<sup>15</sup> All relevant projects that are ongoing or approved after 2017 (5 years ago)

**Table 29: Layers used to identify exposure to climate hazards and project suitability**

Layers and Data source	Description
<u>Annual SPEI</u> Multi-model ensemble mean from WB CC Knowledge portal  <u>Days with heat &gt;35C</u> Multi-model ensemble anomaly from WB CC Knowledge portal  <i>[proxy for climate risks]</i>	Both layers were available at 1 degree tile which was resampled to 30 arcsecond (1km) using bilinear approach. With this resampling, the layers are matched with the other layers while the relative spatial variation is maintained. RCP8.5 data for the reference period 2040-2059 was chosen, taking into account the capitalization phase of SURAGGWA.  <i>NB: Annex 2 provides details on the climate trends and extent of climate change impacts in each country.</i>
<u>Croplands</u> Global Food Security-support Analysis Data (GFSAD30) at 30m resolution for the year 2015 <i>[proxy for exposure of farming]</i>	The GFSAD30 provides high-resolution global cropland extent. All cropland areas were given the value of 1 and the rest of the pixel were reclassified as zero.
<u>Livestock</u> Gridded Livestock of the World - (GLW 4) at 10km resolution <i>[proxy for exposure of livestock]</i>	The GLW 4 contains peer-reviewed spatial dataset on livestock distribution for the year 2015. Dasytic animal count for the following species (which are rangeland species) were collected: cattle, sheep, and goats. The animal number were aggregated to cattle-equivalent by multiplying sheep and goat numbers by 0.2. This value (0.1 TLU <sup>16</sup> x 2) accounts for resilience, higher productivity, and high reproductive rate of small ruminants in the Sahel. Then the resulting layer was normalized from 0 to 1 using min-max scaling.
<u>Population</u> WorldPop 2020 data at 1km resolution <i>[proxy for exposure of population]</i>	The estimated number of people per grid cell in 2020. The layer was also normalized from 0 to 1 using min-max scaling.
<u>Surface water</u> Global surface water extent (GSWE) at 30m resolution <i>[proxy for drought-sensitivity]</i>	Data on the occurrence of permanent and temporary surface water was collected for the year 2020, with information on location and temporal distribution. The layer was also normalized from 0 to 1 using min-max scaling.
<u>Protected areas (PA)</u> World database of protected areas (WDPA) <i>[proxy for restoration suitability and opportunity to promote NTFP]</i>	WDPA has up-to-date information on conservation areas in the project countries. Data from 08 February 2023 was collected for the analysis. Euclidean distance from protected areas was calculated for every location in the countries. Then a min-max normalization of the distances was applied, with those closest to PA given the value of 1, because of the restoration objectives and NTFP promotion in the project. However, areas within the PA themselves will not be considered as project areas.
<u>Forest cover</u> Hansen tree cover at 30m resolution <i>[proxy for restoration suitability and opportunity to promote NTFP]</i>	This is the tree canopy cover for the year 2000, defined as canopy closure for all vegetation taller than 5m in height, and encoded as a percentage per grid cell. This layer was rescaled from 0 to 1, with 1 being the areas with highest cover. The location of forests is relevant for this exercise because of the focus on restoration and the promotion of NTFP value chains as part of the project. The reference year of 2000 also adds elements of biodiversity and tree potential to the location.
<u>Restoration potential</u> Tree restoration potential from Bastin et al. (2019) <i>[proxy for restoration suitability]</i>	The tree restoration potential layer indicates suitable locations for tree plantation. It is important that this layer does not include cropland by default (not suitable) but have grazing areas. The layer was rescaled from 0 to 1, with 1 being the areas with highest potential.

## Suggested project locations

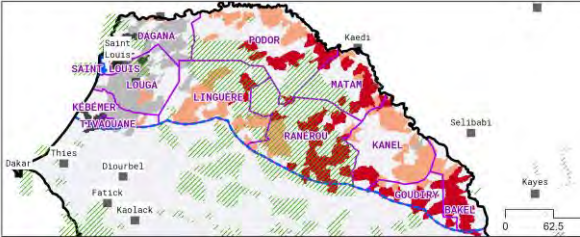
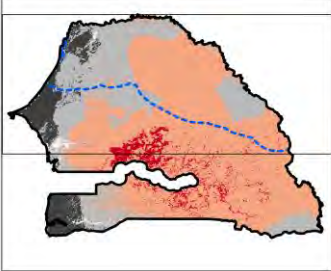
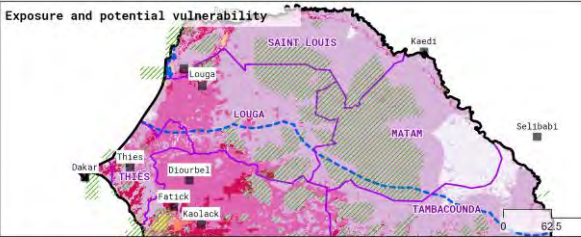
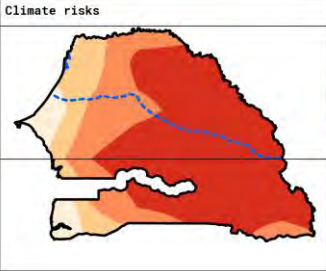
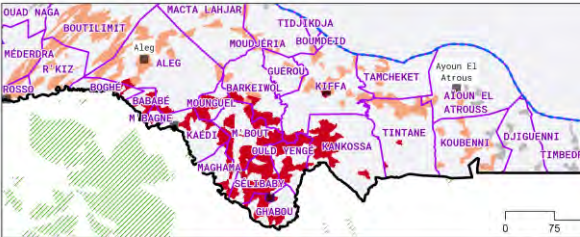
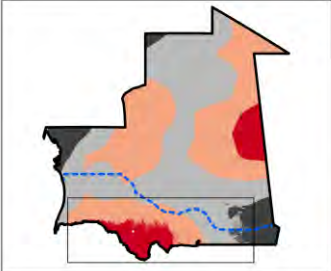

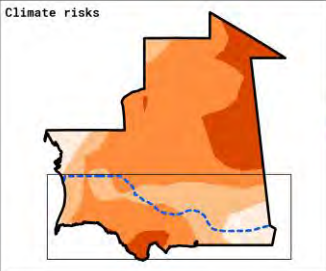
Areas outside of the GGW are considered as out-of-scope for the project but can be pertinent in terms of restoration. The final selection would depend on baseline survey and security situation in the area at the start of the project.

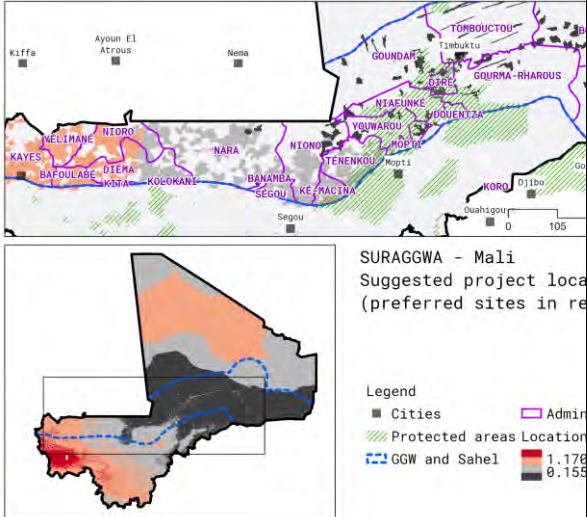
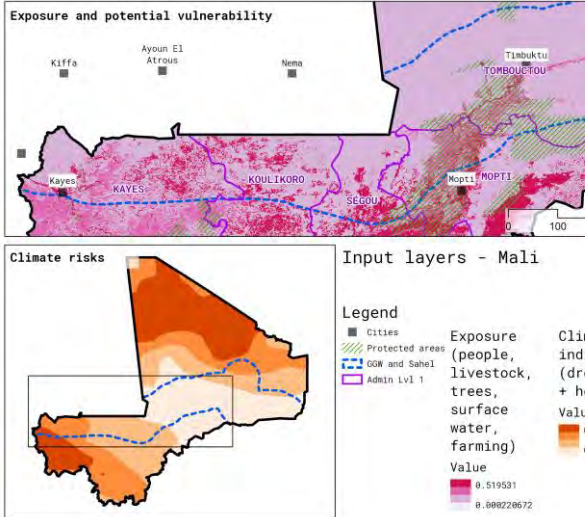
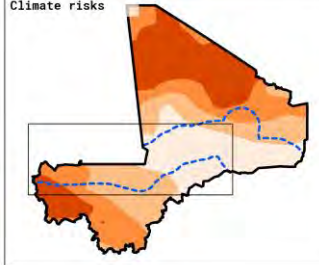
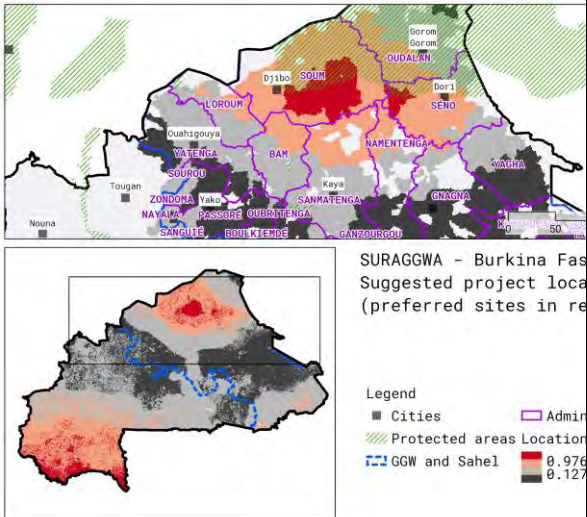
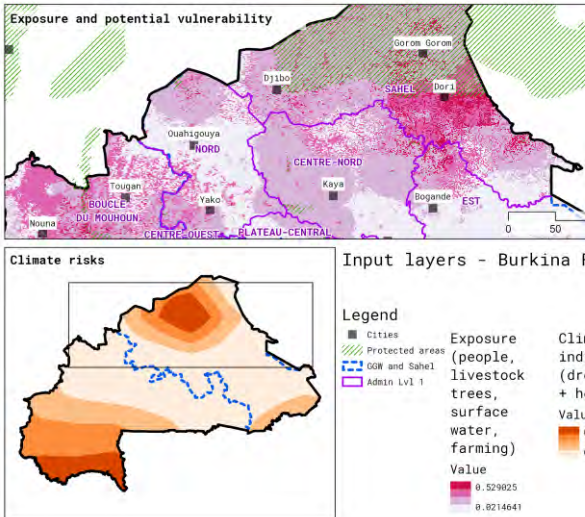
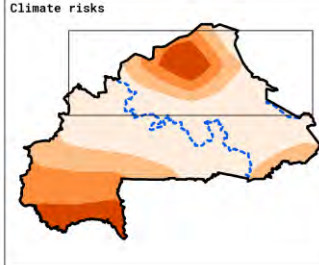
The extent of the climate-related damages is detailed in Annex 2.

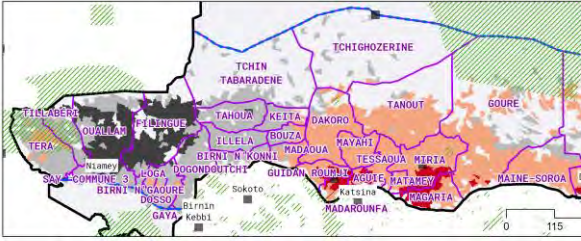
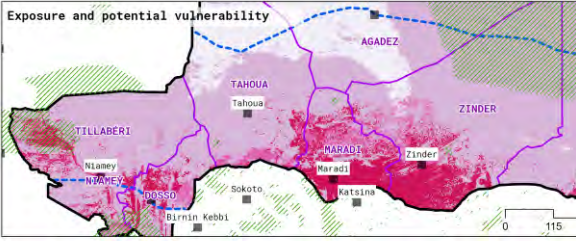
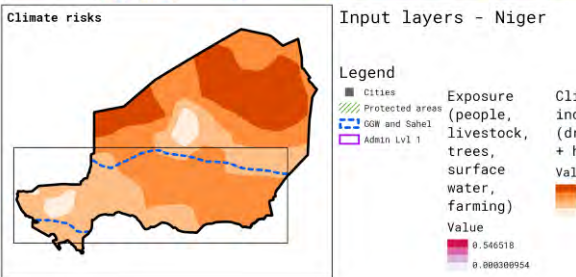
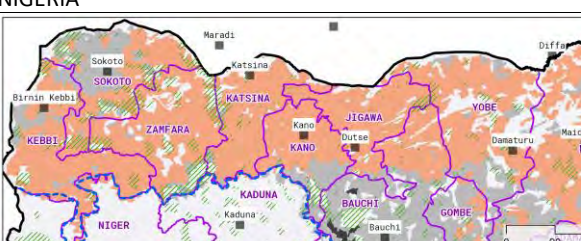
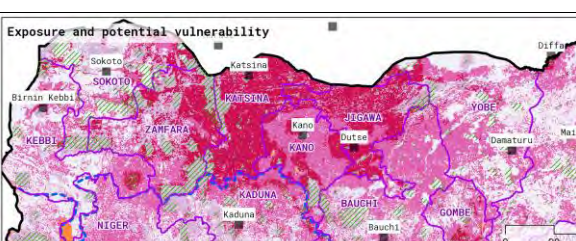
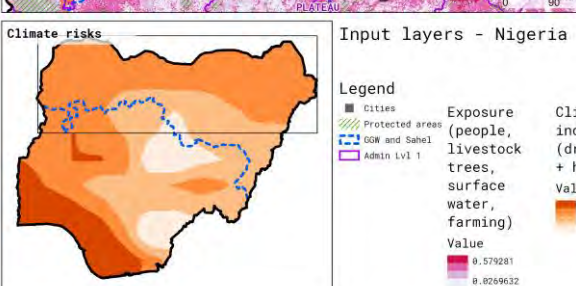
<sup>16</sup> Tropical Livestock Unit per Jahnke et al (1988): <https://www.fao.org/3/x5443E/x5443e04.htm>.

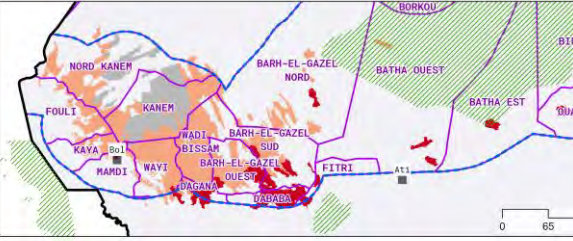
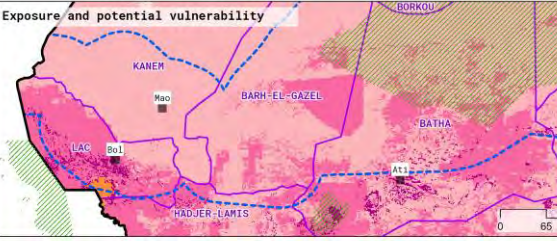
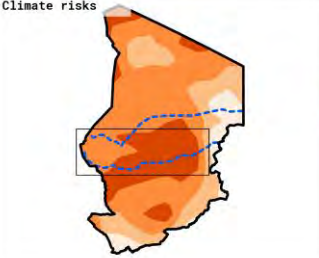
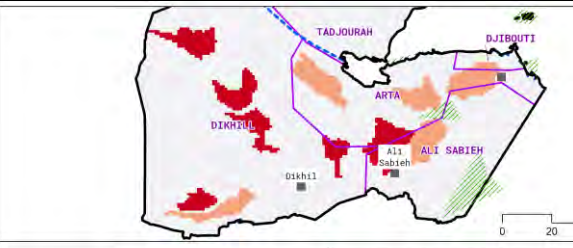
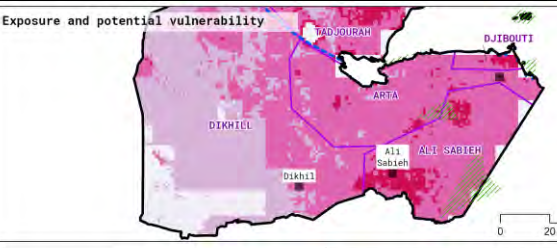
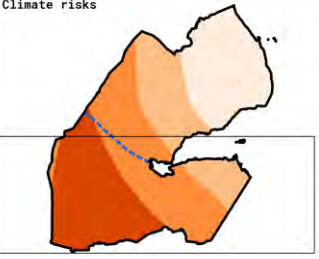
**Table 30: Results of the project area selection based on scoring**

**Note:** The table below illustrates the suggested locations by country. Maps on the left show the final score layer. Areas in red are the ideal locations. Top map displays the scores by basins within the GGW, and bottom map is by pixel for the whole country. Maps on the right show the input layers used to get the final score. Top map displays the exposure and potential vulnerability, and bottom map is proxy for the future likelihood of climate hazards.

SENEGAL	
  <p><b>SURAGGWA - Senegal</b> Suggested project location (preferred sites in red)</p> <p>Legend</p> <ul style="list-style-type: none"> <li>Cities</li> <li>Protected areas</li> <li>GGW and Sahel</li> <li>Admin Lvl 1</li> </ul> <p>Value: 1.263 to 0.247</p>	  <p><b>Input layers - Senegal</b></p> <p>Legend</p> <ul style="list-style-type: none"> <li>Cities</li> <li>Protected areas</li> <li>GGW and Sahel</li> <li>Admin Lvl 1</li> </ul> <p>Exposure (people, livestock, trees, surface water, farming)</p> <p>Value: 0.571453 to 0.0134835</p>
<p>Areas with relatively high exposure and vulnerability: <b>Northeast Tambacounda, Matam, East Louga, and East St. Louis.</b></p> <p>IPC data shows that these areas gradually overlap with regions where risk reduction is needed to address food security. The main priority regions are Tambacounda, Matam, and Louga.</p>	<p>Future climate variability will affect mostly the <b>Eastern</b> part of the country's GGW. Exposure and potential vulnerability mostly in <b>Matam and Northeast Tambacounda</b>. As of February 2022, there are 05 climate change related project ongoing in the country's GGW areas (Table 3).</p>
MAURITANIA	
  <p><b>SURAGGWA - Mauritania</b> Suggested project location (preferred sites in red)</p> <p>Legend</p> <ul style="list-style-type: none"> <li>Cities</li> <li>Protected areas</li> <li>GGW and Sahel</li> <li>Admin Lvl 1</li> </ul> <p>Value: 1.223 to 0.485</p>	  <p><b>Input layers - Mauritania</b></p> <p>Legend</p> <ul style="list-style-type: none"> <li>Cities</li> <li>Protected areas</li> <li>GGW and Sahel</li> <li>Admin Lvl 1</li> </ul> <p>Exposure (people, livestock, trees, surface water, farming)</p> <p>Value: 0.488589 to 0.47211e-07</p>
<p>Areas with relatively high exposure and vulnerability: Mostly in <b>Gorgol, Guidimagha, Southern Assaba</b>. Some areas in <b>Brakna, Trarza, and Hodh El Gharbi</b>.</p> <p>IPC data shows that these areas overlap with regions where risk reduction is needed to address food security. But the main priority regions are Gorgol and Guidimagha, where sometimes urgent actions are also needed.</p>	<p>Future climate variability will affect mostly the <b>Southern</b> part of the country's GGW. Exposure and potential vulnerability mostly in <b>Gorgol and Guidimagha</b>. As of February 2022, there are 07 climate change related project ongoing in the country's GGW areas (Table 3).</p>
MALI	

 <p><b>SURAGGWA - Mali</b> Suggested project locations (preferred sites in red)</p> <p>Legend</p> <ul style="list-style-type: none"> <li>Cities</li> <li>Protected areas</li> <li>GW and Sahel</li> <li>Admin Lvl 1</li> </ul> <p>Value: 1.178, 0.155</p>	<p><b>Exposure and potential vulnerability</b></p>  <p><b>Climate risks</b></p>  <p><b>Input layers - Mali</b></p> <p>Legend</p> <ul style="list-style-type: none"> <li>Cities</li> <li>Protected areas</li> <li>GW and Sahel</li> <li>Admin Lvl 1</li> </ul> <p>Exposure (people, livestock, trees, surface water, farming) Value: 0.519531, 0.898228672</p>
<p>Areas with relatively high exposure and vulnerability: Mostly in <b>Kayes</b>. Some areas in <b>Ségou</b> and <b>Koulikoro</b>. IPC data shows that there is minimal food insecurity threats in the selected regions, except for Diema (Kayes) and Niouro (Kayes). Areas with most concerns are Gao and Tombouctou but they are not ideal project locations based on scores.</p>	<p>Future climate variability will affect mostly the <b>Southwestern</b> part of the country's GW. Exposure and potential vulnerability mostly in <b>Segou</b> and <b>Mopti</b>. As of February 2022, there are 08 climate change related project ongoing in the country's GW areas (Table 3).</p>
<p><b>BURKINA FASO</b></p>	
 <p><b>SURAGGWA - Burkina Faso</b> Suggested project locations (preferred sites in red)</p> <p>Legend</p> <ul style="list-style-type: none"> <li>Cities</li> <li>Protected areas</li> <li>GW and Sahel</li> <li>Admin Lvl 1</li> </ul> <p>Value: 0.976, 0.127</p>	<p><b>Exposure and potential vulnerability</b></p>  <p><b>Climate risks</b></p>  <p><b>Input layers - Burkina Faso</b></p> <p>Legend</p> <ul style="list-style-type: none"> <li>Cities</li> <li>Protected areas</li> <li>GW and Sahel</li> <li>Admin Lvl 1</li> </ul> <p>Exposure (people, livestock, trees, surface water, farming) Value: 0.529825, 0.8214641</p>
<p>Areas with relatively high exposure and vulnerability: Mostly in <b>Sahel</b>. Some areas in <b>Centre-Nord</b>, <b>Nord</b>, and <b>Est</b>. IPC data shows that these areas overlap with regions where urgent actions are always needed to address food security. The main priority regions are: Sahel (all), Namentenga, Sanmatenga, Komandjari, and Loroum.</p>	<p>Future climate variability will affect mostly the <b>Northern</b> part of the country's GW. Exposure and potential vulnerability mostly in <b>East Sahel</b>. As of February 2022, there are 09 climate change related project ongoing in the country's GW areas (Table 3).</p>
<p><b>NIGER</b></p>	

 <p><b>SURAGGWA - Niger</b> Suggested project locations (preferred sites in red)</p> <p>Legend</p> <ul style="list-style-type: none"> <li>Cities</li> <li>Protected areas</li> <li>GGW and Sahel</li> <li>Admin Lvl 1</li> </ul> <p>Value: 0.932, 0.239</p>	<p><b>Exposure and potential vulnerability</b></p>  <p><b>Climate risks</b></p>  <p><b>Input layers - Niger</b></p> <p>Legend</p> <ul style="list-style-type: none"> <li>Cities</li> <li>Protected areas</li> <li>GGW and Sahel</li> <li>Admin Lvl 1</li> </ul> <p>Exposure (people, livestock, trees, surface water, farming) Value: 0.546518, 0.880309954</p>
<p>Areas with relatively high exposure and vulnerability: Mostly in <b>southern Maradi</b> and <b>Zinder</b>. Some areas in <b>southern Diffa, Dosso, Tilaberi, and Tahoua</b>. IPC data shows that these areas overlap with regions where risk reduction is needed to address food security. Tilaberi (Ouallam) and Diffa are amongst the most at risk.</p>	<p>Future climate variability will affect mostly the <b>Eastern</b> part of the country's GGW. Exposure and potential vulnerability mostly in <b>Maradi</b> and <b>Zinder</b>. As of February 2022, there are 06 climate change related project ongoing in the country's GGW areas (Table 3).</p>
<p><b>NIGERIA</b></p>	
 <p><b>SURAGGWA - Nigeria</b> Suggested project locations (preferred sites in red)</p> <p>Legend</p> <ul style="list-style-type: none"> <li>Cities</li> <li>Protected areas</li> <li>GGW and Sahel</li> <li>Admin Lvl 1</li> </ul> <p>Value: 1.464, 0.375</p>	<p><b>Exposure and potential vulnerability</b></p>  <p><b>Climate risks</b></p>  <p><b>Input layers - Nigeria</b></p> <p>Legend</p> <ul style="list-style-type: none"> <li>Cities</li> <li>Protected areas</li> <li>GGW and Sahel</li> <li>Admin Lvl 1</li> </ul> <p>Exposure (people, livestock, trees, surface water, farming) Value: 0.579281, 0.8269632</p>
<p>Areas with relatively high exposure and vulnerability: <b>Kebbi, Sokoto, Zamfara, Katsina, Kano, Jigawa, Bauchi, Yobe, and Borno</b>. Almost everywhere in the GGW because of high vulnerability and opportunity for restoration. IPC data shows that these areas overlap with regions where urgent actions are always needed to address food security. The main priority regions are Borno, Sokoto, Zamfara, and Yobe.</p>	<p>Future climate variability will affect mostly the <b>Northern</b> part of the country's GGW. Exposure and potential vulnerability mostly in <b>Katsina, Jigawa, and Zamfara</b>. As of February 2022, there are 03 climate change related project ongoing in the country's GGW areas (Table 3).</p>
<p><b>CHAD</b></p>	<p><b>CHAD</b></p>

 <p><b>SURAGGWA - Chad</b> Suggested project locations (preferred sites in red)</p> <p>Legend</p> <ul style="list-style-type: none"> <li>Cities</li> <li>Protected areas</li> <li>GGW and Sahel</li> <li>Admin Lvl 1</li> <li>Location</li> </ul> <p>Value: 1.058, 0.248</p>	<p><b>Exposure and potential vulnerability</b></p>  <p><b>Climate risks</b></p>  <p><b>Input layers - Chad</b></p> <p>Legend</p> <ul style="list-style-type: none"> <li>Cities</li> <li>Protected areas</li> <li>GGW and Sahel</li> <li>Admin Lvl 1</li> <li>Exposure (people, livestock, trees, surface water, farming)</li> <li>Climate indices (drought, heat)</li> </ul> <p>Value: 0.535625, 0.896765622</p>
<p>Areas with relatively high exposure and vulnerability: Mostly in <b>southern Bahr-el-Gazel, northern Hadjer-Lamis, Kanem, and Lac</b>. Some areas <b>Batha, Ouaddai, and Wadi Fira</b>. IPC data shows that these areas overlap with regions where risk reduction is needed to address food security. However, the affected population seems to be decreasing already. The main priority regions are Kanem and Lac.</p>	<p>Future climate variability will affect mostly the <b>Central</b> part of the country's GGW. Exposure and potential vulnerability mostly in <b>Lac, Batha, Bahr-el-Gazel</b>, and some locations <b>Ouaddai</b>. As of February 2022, there are 05 climate change related project ongoing in the country's GGW areas (Table 3).</p>
<p><b>DJIBOUTI</b></p>  <p><b>SURAGGWA - Djibouti</b> Suggested project locations (preferred sites in red)</p> <p>Legend</p> <ul style="list-style-type: none"> <li>Cities</li> <li>Protected areas</li> <li>GGW and Sahel</li> <li>Admin Lvl 1</li> <li>Location</li> </ul> <p>Value: 1.367, 0.749</p>	<p><b>Exposure and potential vulnerability</b></p>  <p><b>Climate risks</b></p>  <p><b>Input layers - Djibouti</b></p> <p>Legend</p> <ul style="list-style-type: none"> <li>Cities</li> <li>Protected areas</li> <li>GGW and Sahel</li> <li>Admin Lvl 1</li> <li>Exposure (people, livestock, trees, surface water, farming)</li> <li>Climate indices (drought, heat)</li> </ul> <p>Value: 0.576899, 0.172942</p>
<p>Areas with relatively high exposure and vulnerability: <b>Dikhil, Arta, and Ali Sabieh</b>. There is no IPC data for Djibouti.</p>	<p>Climate risk is overall uniform in Djibouti (at least based on the data used). But the impacts will likely be more significant in southern <b>Ali Sabieh</b>. As of February 2022, there are 05 climate change related project ongoing in the country's GGW areas (Table 3).</p>

List of projects with potential synergies in suggested locations

**Table 31: List of projects with potential synergies in suggested locations**

Selected GGW Countries	Implement ing partners	Senegal	Mauritan ia	Mali	Burki na Faso	Niger	Nigeria	Chad	Djibout i
<i>Locations severely affected by food insecurity between Oct 2020 and Dec 2022. Emergency support likely occurred or occurring. And actions to reduce disaster risk and protect livelihoods would also be pertinent.</i>	<i>n/a</i>	<i>Louga. Matam. Tambacou nda.</i>	<i>Gorgol. Guidimag ha. Hodh El Gharbi.</i>	<i>Gao. Mopti. Ségou.</i>	<i>Centre -Nord. Est. Nord. Sahel.</i>	<i>Diffa. Tahou a. Tillabé ri.</i>	<i>Adama wa. Borno. Jigawa. Sokoto. Yobe. Zamfar a.</i>	<i>Ennedi Ouest. Kanem .</i>	<i>n/a</i>
<i>Locations with food security stress between Oct 2020 and Dec 2022. Actions to reduce disaster risk and protect livelihoods would be pertinent.</i>	<i>n/a</i>	<i>Saint Louis. Thiès.</i>	<i>Assaba. Brakna. Hodh Charghi. Inchiri. Tagant. Trarza.</i>	<i>Kayes. Tombouct ou.</i>	<i>Platea u- Centr al.</i>	<i>Dosso. Marad i. Zinder .</i>	<i>Bauchi. Gombe. Kano. Katsina. Kebbi.</i>	<i>Barh- El- Gazel. Batha. Borkou . Ennedi Est. Hadjer -Lamis. Lac. Ouadd ai. Wadi Fira.</i>	<i>n/a</i>
Programme for Integrated Development and Adaptation to Climate Change in the Niger Basin (PIDACC/NB)	GCF / AfDB			Gao, Koulikoro, Mopti, Ségou, Tombouct ou	Centr e- Nord, Est, Platea u- Centr al, Sahel	Dosso, Tahou a, Tillabé ri	Kebbi, Sokoto, Zamfara		
The Africa Integrated Climate Risk Managemen t Programme: Building the resilience of smallholder farmers to climate change impacts in 7 Sahelian	GCF / IFAD	Louga, Thiès	Brakna, Hodh El Gharbi	Kayes, Koulikoro, Ségou		Dosso, Marad i, Tahou a, Zinder		Hadjer -Lamis	

Selected GGW Countries	Implement ing partners	Senegal	Mauritan ia	Mali	Burki na Faso	Niger	Nigeria	Chad	Djibout i
Countries of the Great Green Wall (GGW)									
Inclusive Green Financing Initiative (IGREENFIN I): Greening Agricultural Banks & the Financial Sector to Foster Climate Resilient, Low Emission Smallholder Agriculture in the Great Green Wall (GGW) countries [Component 1 and 2]	GCF / IFAD	Louga, Thiès		Kayes, Koulikoro, Ségou					
Inclusive Green Financing Initiative (IGREENFIN I): Greening Agricultural Banks & the Financial Sector to Foster Climate Resilient, Low Emission Smallholder Agriculture in the Great Green Wall (GGW) countries [Component 3]	GCF / IFAD	Louga, Matam, Saint Louis, Tambacou nda, Thiès	Assaba, Brakna, Gorgol, Guidimag ha, Hodh Charghi, Hodh El Gharbi, Tagant, Trarza	Gao, Kayes, Kidal, Koulikoro, Mopti, Ségou, Tombouct ou	Centr e- Nord, Est, Nord, Platea u- Centr al, Sahel	Diffa, Dosso, Marad i, Tahou a, Tillabé ri, Zinder	Adama wa, Bauchi, Borno, Gombe, Jigawa, Kano, Katsina, Kebbi, Sokoto, Taraba, Yobe, Zamfara	Barh- El- Gazel, Batha, Borko u, Ennedi Est, Ennedi Ouest, Hadjer -Lamis, Kanem , Lac, Ouadd aï, Wadi Fira	Ali Sabieh, Arta, Dikhill, Djibouti , Tadjour ah
Sustainable management of dryland landscapes in Burkina Faso	GEF / IUCN				Nord				

<b>Selected GGW Countries</b>	<b>Implement ing partners</b>	<b>Senegal</b>	<b>Mauritan ia</b>	<b>Mali</b>	<b>Burki na Faso</b>	<b>Niger</b>	<b>Nigeria</b>	<b>Chad</b>	<b>Djibout i</b>
Climate Resilience in the Nakambe Basin	GEF / UNDP				Centr e- Nord, Nord				
GEF-IAP: Participatory Natural Resource Management and Rural Development Project in the North, Centre-North and East Regions (Neer Tamba project)	GEF / IFAD				Nord				
Integrated Development for Increased Rural Climate Resilience in the Niger Basin	GEF / AfDB			Gao, Kidal, Koulikoro, Mopti, Ségou, Tombouct ou	Centr e- Nord, Est, Platea u- Centr al	, Dosso, Marad i, Tahou a, Tillabé ri	, Katsina, Kebbi, Sokoto, Zamfara		
Integration of climate change adaptation measures in the concerted management of the WAP transboundary complex: ADAPT-WAP (Benin, Burkina Faso, Niger)	Adaptation Fund / SSO				Est				
Promoting Climate-Smart Agriculture in West Africa (Benin, Burkina Faso, Ghana, Niger, Togo)	Adaptation Fund / BOAD				Est	Dosso, Tillabé ri			

Selected GGW Countries	Implement ing partners	Senegal	Mauritan ia	Mali	Burki na Faso	Niger	Nigeria	Chad	Djibout i
Regional Sahel Pastoralism Support Project (PRAPS)	World Bank	Louga, Matam, Saint Louis, Tambacou nda	Assaba, Brakna, Gorgol, Guidimag ha, Hodh Charghi, Hodh El Gharbi, Tagant, Trarza	Gao, Kayes, Kidal, Koulikoro, Mopti, Ségou, Tombouct ou	Est, Nord, Sahel	Diffa, Dosso, Marad i, Tahou a, Tillabé ri, Zinder		Barh- El- Gazel, Batha, Borko u, Ennedi Est, Ennedi Ouest, Hadjer -Lamis, Kanem , Lac, Ouadd āi, Wadi Fira	
Enhancing the resilience of agriculture and livestock producers through improved watershed management and development of environmen tally-positive value chains in South East Mauritania	GEF / FAO		Assaba, Guidimag ha, Hodh El Gharbi						
Climate change adaptation and livelihoods in three arid regions of Mauritania	GEF / UNEP		Trarza						
Integrated ecosystem management project for the sustainable human development in Mauritania	GEF / FAO		Assaba, Brakna, Gorgol, Guidimag ha						
PSG- Sustainable Landscape Managemen t Project	GEF / World Bank		Brakna, Gorgol, Trarza						

<b>Selected GGW Countries</b>	<b>Implement ing partners</b>	<b>Senegal</b>	<b>Mauritan ia</b>	<b>Mali</b>	<b>Burki na Faso</b>	<b>Niger</b>	<b>Nigeria</b>	<b>Chad</b>	<b>Djibout i</b>
under SAWAP									
Climate security and sustainable management of natural resources in the central regions of Mali for peacebuildin g	GEF / UNDP			Mopti					
Scaling up and Replicating Successful Sustainable Land Managemen t (SLM) and Agroforestry Practices in the Koulikoro Region of Mali	GEF / UNEP			Koulikoro					
Building Resilience For Food Security and Nutrition in Chad's Rural Communities	GEF / AfDB							Barh- El- Gazel, Kanem	
Enhancing the Resilience of the Agricultural Ecosystems	GEF / IFAD							Batha, Hadjer -Lamis	
Ecosystem- based Adaptation (EbA) for resilient natural resources and agro- pastoral communities in the Ferlo Biosphere Reserve and Plateau of Thies	GEF / UNDP, IUCN	Matam							

<b>Selected GGW Countries</b>	<b>Implement ing partners</b>	<b>Senegal</b>	<b>Mauritan ia</b>	<b>Mali</b>	<b>Burki na Faso</b>	<b>Niger</b>	<b>Nigeria</b>	<b>Chad</b>	<b>Djibout i</b>
Planning and implementin g Ecosystem based Adaptation (EbA) in Djibouti's Dikhil and Tadjourah regions	GEF / UNEP								Dikhil, Tadjour ah
Sustainable Managemen t of Water Resources, Rangelands and Agro- pastoral Perimeters in the Cheikhetti Wadi watershed of Djibouti	GEF / UNDP								Dikhil
Integrated Water and Soil Resources Managemen t Project (Projet de gestion intégrée des ressources en eau et des sols PROGIRES)	Adaptation Fund / IFAD								Ali Sabieh, Arta, Dikhil, Tadjour ah
Strengthenin g Drought Resilience for Small Holder Farmers and Pastoralists in the IGAD Region	Adaptation Fund / SSO								Ali Sabieh, Dikhil

## Chapter IV: COMPONENT 1 LAND RESTORATION

### RURAL LAND USE CONTEXT IN THE GGW ZONE

#### The Agricultural production systems in the region

The agricultural sector in the Sahelian countries is still marked by a high vulnerability. Besides the structural issues associated to subsistence farming, the performance of the agricultural sector is highly subject to a number of risks, such as : (i) high dependence on rainwater, which is the sole water source for a large majority of small farms and falls during only a few months of the year in many countries; (ii) recurrence of natural disasters and extreme weather events, locust outbreaks, animal and vegetable diseases, which reduce productivity levels; (iii) changes and variations in climate conditions from one year to another; (iv) fluctuations in the agricultural market for both inputs and outputs; (v) limited disaster management policies in support to agriculture, and (vi) the failure to adopt a land reform law, which has impacts on investment security.

According to a recent analysis published by FAO (2016), agriculture, forestry and other land uses is the key sector proposed to achieve the NDCs targets submitted to the UNFCCC by most African countries. Indeed, Sahel's forests, woodlands, wetlands, and grasslands are important ecosystems that host vast biodiversity of plant and animal species which help sustain livelihoods and their resilience. They provide a range of ecological and socio-economic services including important NTFP commodities that generate additional sources of income in poor agricultural years and enhance resilience to climate variability and climate change; they often provide the extra income necessary, a safety-net to sustain livelihoods (FAO, 2018). These ecosystems play a key role in adaptation when they are properly managed, restored and excess pressure is reduced on vulnerable natural resources (water, soils, wood and non-wood products, fodder and pastoral land). These restorative activities increase soil fertility, preserve water quality and water cycles, reduce run-off, protect land and agricultural production from increasingly intense floods and droughts, increase percolation of rainwater, regenerate grasses for livestock. In fact, restoration of ecosystems' natural capital from barren lands to robust and adapted dryland ecosystems has large mitigation benefits from increased soil organic matter, as well as from below and above ground biomass

#### Pastoralist livestock production systems in the Sahel

Referring to recent literature and studies, we can define pastoralism as a set of food production systems based on livestock. Although these systems are very diverse, they all aim to improve the animals' diet and maintain animal welfare through the planned management of grazing routes throughout the year. This management of grazing routes makes the best possible use of the natural resources available throughout the seasons<sup>17</sup>, while also helping to maintain or improve biodiversity in the different agro-ecological zones. Over the years, the continuous adaptation to strong environmental variability<sup>18</sup> shows that pastoralism is a sustainable approach to increase animal production, but also essential to adapt agricultural systems to the effects of climate change (IPCC,2019). Pastoralism is therefore more than a defined production system or a subset of a given production system. It is in some ways an alternative approach to food production with livestock, in which animal production is focused on emancipation from the natural environment (Krätli, 2008). According to Krätli and al. 2019: *Most Sahelian pastoralists, including some of the most specialized and mobile groups in the world*<sup>19</sup>, have always spent the dry season in agricultural areas, where

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<sup>17</sup> The pasture production in the Sahelian countries "follows" the rainfall as it moves North from the beginning of the rainy season. Thus, pastoralists move South before the onset of the rainy season and Move northward as the rains progress.

<sup>18</sup> Changing rainy seasons, reduced water availability, scarcity of fodder resources, increasing temperatures, etc.

<sup>19</sup> The example of the Wodaabe Fulani community is considered one of the most special and mobile groups in the world.

*livestock feed on crop residues for up to six months of the year. This would place Sahelian pastoralism in the category of "mixed farming" defined as "livestock systems in which more than 10% of the dry matter fed to animals is derived from crop by-products, stubble, or more than 10% of the total value of production is derived from non-livestock activities.* Pastoralism represents a promising prospect for achieving the Sustainable Development Goals (SDGs), particularly with regard to strengthening food and nutritional security in Sahelian countries (FAO, 2011), reducing zoonoses by preserving more resistant local breeds (Ancey and Monas, 2005) and preserving the land and its functionality, especially in terms of carbon sequestration (Silva et al., 2019).

### Management of conflicts related to pastoralism in the face of climatic and security crises

Conflict management is a central concern when it comes to pastoralism. It is indeed the cornerstone for ensuring inter- and intra-community social cohesion. In addition, the inability of public authorities to ensure equitable access to resources and infrastructure fractures social ties and leads to community retreat and conflict. Even today, most conflicts are resolved through traditional conflict resolution mechanisms that allow different communities to find common ground. However, a recent observation shows that, given the increasing complexity of relations between communities and the security crises in the Sahel, these traditional mechanisms are not very well adapted (FAO, 2020).

Since 2012, Sahelian pastoralism has been seriously affected by the security crisis and conflicts generated by armed groups<sup>20</sup> that take advantage of the "distance of the populations from the Government" whose role is perceived to be insufficient at the local level to provide services to weakened communities and to set up rules of access to natural resources that are more favorable to the disadvantaged social strata (transhumant pastoralists, individuals belonging to the so-called lower castes). From an agrarian perspective, the diversification of production systems has (i) reduced the interdependence between agricultural and livestock systems; (ii) increased competition for access to space and the use of its natural resources. Traditional pastoralists have diversified their sources of income by becoming more involved in agriculture, while farmers have increasingly invested in livestock. The integration of agriculture and livestock has thus created new forms of tension and competition between agro-pastoralists who now share limited spaces. The phenomenon is all the more important as the pressure on resources increases from year to year with climate change. In addition to the evolution of the agrarian landscape in favor of agricultural expansion, irregularities in access to pastoral resources, due in particular to extreme climatic events, lead transhumant herders to concentrate on increasingly saturated areas.

Details on the agricultural and livestock production systems in each of the eight countries are provided in Appendix 1 to this feasibility study.

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<sup>20</sup> Presence of the Islamic State in the Greater Sahara (ISGS) which integrates the Islamic State in West Africa. Presence also of the group of support to Islam and the Muslim JNIM, which brings together various groups of Al Qaeda in the Islamic Maghreb (AQIM). These are mainly Ansar Dine and its "katiba Macina, the Al-Furqan katiba and Al-Mourabitoun

## LAND USE RELATED GHG EMISSIONS AND NDC COMMITMENTS IN SURAGGWA COUNTRIES

While the eight SURAGGWA countries are very diverse, they have two key characteristics in common: all are **extremely exposed and vulnerable to climate change**, and their **greenhouse gas emissions originate mainly in the land use sector**.

According to the NDCs of the eight SURAGGWA countries (Burkina Faso, Chad, Djibouti, Mali, Mauritania, Niger, Nigeria and Senegal), **GHG emissions from their Agriculture, Forestry and Land Use (AFOLU) sector account for the lion's share of their national emissions: between 63.8 and 91.1%**. A large share of these AFOLU emissions derive from land use change and land degradation, so this is also where most of the GHG mitigation potential of these countries can be found.

The table below details the land use sector commitments that the eight SURAGGWA countries made in the Nationally Determined Contributions (NDCs) that they submitted to UNFCCC. These commitments, and the activities they entail, are closely aligned with the proposed SURAGGWA investments.

Table 4: Countries NDC and Climate Change targets relevant to SURAGGWA

	Mitigation	Land use sector adaptation/mitigation priorities
Burkina Faso (2021-25)	Reduce GHG emissions by 31,682.3 Gg CO <sub>2</sub> eq by 2030, i.e. 29.42% compared to the Business as Usual scenario.	Agriculture, water management, and land use: <ul style="list-style-type: none"> <li>• Restore and maintain land fertility of 1.575 million ha of cropland;</li> <li>• Restore 1.125 million ha of degraded land for pasture and forest;</li> <li>• 10,000 tons of fodder collected and stored each year;</li> <li>• 30,000 ha of stream banks protected;</li> <li>• Compost from biodigesters fertilizes 750,000 ha.</li> </ul>
Chad October 2021	Cumulative reduction of GHG emissions by 2030 to 88,350 kt CO <sub>2</sub> eq (unconditional and conditional measures) with an overall mitigation target of 19.3% compared to the baseline scenario.	Agriculture, livestock and fisheries: <ul style="list-style-type: none"> <li>• Develop intensive and diverse cultivation;</li> <li>• Use improved inputs, (organic fertilizers including composts, adapted plant varieties);</li> <li>• Agroforestry;</li> <li>• Land and water conservation;</li> <li>• Common grazing zones, creating and popularizing fodder banks, crossbreeding of animal species;</li> <li>• Development of enclosed fish farming areas.</li> </ul>
Djibouti 2015	The Republic of Djibouti is committed to reducing its GHG emissions by 2030 by 40%, i.e. nearly 2Mt CO <sub>2</sub> e.	Six priority areas: <ul style="list-style-type: none"> <li>• Ensuring water access;</li> <li>• Promotion of best practices in the agriculture, forestry, fishery and tourism sectors;</li> <li>• Reduce vulnerability to the effects of climate change for the most exposed social, economic or geographic sectors;</li> <li>• Protect and enhance ecosystems and maintain the services they provide</li> <li>• Ensure the development of sustainable and resilient cities; and</li> <li>• Ensure resilience and sustainability of the country's key infrastructure.</li> </ul>
Mali (29/9/15)	Commits to reducing emissions by 29% for agriculture, 31% for energy and 21% for forests and land use, each by 2030, and in comparison, to a BAU scenario. This is an average reduction of 27%. This is conditional upon international support, although around 40% of this can be met unconditionally. Includes a section on adaptation, though only for the period 2015-2020.	Agriculture: <ul style="list-style-type: none"> <li>• 92,000 ha under climate smart agriculture and sustainable land management;</li> <li>• Improve livestock rotation over grazelands to reduce farmer-livestock conflict over 400,000 ha;</li> <li>• Improved crop and livestock varieties;</li> <li>• Small scale agricultural development, including fruit trees for reforestation, and vegetation cover and erosion prevention (post 2020);</li> </ul> Land use and forestry: <ul style="list-style-type: none"> <li>• Anti-desertification and protection of 9 million ha;</li> <li>• Reforestation of 325,000 ha.</li> </ul> Water and water supply: <ul style="list-style-type: none"> <li>• Rainwater harvesting and storage to ensure universal potable water access;</li> <li>• 75,000 rural households have</li> </ul>

		drinking water from drinking water systems and water collection structures; • Watershed management (post-2020) • Wastewater treatment (post-2020)
Mauritania (2021-2030)	Committed to reducing approximately 33.56 million tonnes Eq-CO <sub>2</sub> , i.e. 22.3% during the period 2020-2030.	Agriculture and land management: • Aerial seeding of degraded land (10,000 ha per year) to promote regeneration of the natural environment; • Restoration of natural pastures (deferred grazing and rangeland management); • Exploration of aquifers (drilling) Fisheries and aquaculture: • Promotion of fish-farming and responsible fishing on Lake Fouta Djall; Water and water management: • Rehabilitation and integrated management of sustainable wetlands against the effects of climate change; • Drinking water supply systems in rural areas equipped with solar energy; Climate risk management: • Protecting cities of Nouakchott and Nouadhibou against risks marine emersion and silting;
Senegal 2020	<p>Senegal has revised its targets and is now committing to a relative reduction in greenhouse gas emissions by 5% unconditional by 2025 and 7% by 2030, compared to the BUA. This reduction may be increased to 23% and 29% respectively, to horizons 2025 and 2030, if Senegal benefits from the support of the international community.</p> <p>Overall emissions projections until 2025 : 32 648 Gg CO<sub>2</sub> 2030 : 37 761 Gg CO<sub>2</sub></p> <p>NDC (Unconditional objective of achieving GHG emission reductions with national capacity) 2025 : - 1 632.4 Gg CO<sub>2</sub> equivalent 2030 : - 2 643.27 Gg CO<sub>2</sub> equivalent</p> <p>NDC + (Conditional objective of achieving GHG emission reduction the support of the international community) 2025 : - 7 509.04 Gg CO<sub>2</sub> equivalent 2030 : - 10 950.69 Gg CO<sub>2</sub> equivalent</p>	<p>Agriculture (through PRACAS2 2019-2023) : NDC :</p> <ul style="list-style-type: none"> <li>• 99,621 ha of agricultural land under assisted natural regeneration (ANR)</li> <li>• 4,500 ha under compost, by 2030</li> <li>• Make available organic manure and improved compost with biogas production</li> <li>• NDC + :</li> <li>• 28,500 ha of irrigated rice to an Intensive Rice Cultivation System (IRCS) reducing both water use and methane emissions.</li> <li>• 498,105 ha for ANR and 14,400 ha for compost.</li> </ul> <p>Forestry (through "Lettre de Politique de l'environnement") NDC :</p> <ul style="list-style-type: none"> <li>• Increase annually the reforested/restored areas by about 1,297 ha of mangrove and 21,000 ha of various plantations;</li> <li>• Reduce the burned areas due to late fires by 5% and those due to controlled fires by 10% compared to 2015.</li> </ul> <p>NDC+ :</p> <ul style="list-style-type: none"> <li>• Secure 500,000 ha of forests,</li> <li>• Reforest and restore 4,000 ha/year of mangroves,</li> <li>• Carry out 500,000 ha of various plantations</li> <li>• Reduce the area burned by bushfires by 90% by the fifth year of implementation of the management plans.</li> </ul> <p>NB: These efforts will reduce the deforestation rate by 25%, from 40,000 ha/year in 2010 to 30,000 ha/year in 2030.</p>
Niger 2021	<p>the AFAT sector: Unconditional Reductions: 4.50% (BAU 2025) and 12.57% (BAU 2030) and Conditional Reductions: 14.60% (BAU-2025) and 22.75% (BAU 2030)</p> <p>- the Energy sector: Unconditional Reductions: 11.20% (BAU-2025) and 10.60% (BAU2030) and Conditional Reductions: 48% (BAU-2025) and 45% (BAU-2030).</p>	Agriculture and sustainable land management: • Restoration of agricultural/forestry/pastoral lands: 1,030 000 ha.; • Assisted natural regeneration: 1,100,000 ha.; • Fixation of dunes: 550,000 ha.; • Management of natural forests: 2,220,000 ha.; • Hedgerows: 145,000 km.; • Planting of multiuse species: 750,000 ha.; • Planting of Moringa oleifera: 125 000 ha.; • Seeding of roadways: 304,500 ha.; • Private forestry: 75,000 ha.
Nigeria 2021	20% below BAU by 2030 and 47% conditional on international support. Or 100MTCO <sub>2</sub> e below 2018 levels	Agriculture: • Adopt improved agricultural systems for both crops and livestock (e.g. diversify livestock and improve range management); • Increase access to drought resistant crops and livestock feeds; • adopt better soil management practices; • provide early warning/meteorological forecasts and related information); • Implement strategies for improved

		resource management (e.g., water efficiency of irrigation systems; increase rainwater & sustainable ground water harvesting); • Increase planting of native vegetation cover & promotion of re-greening efforts; • Focus on agricultural impacts in the savanna zones, particularly the Sahel, the areas that are likely to be most affected by the impacts of climate change.
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## RESTORATION OF HIGHLY DEGRADED COMMON LAND AND MODERATELY DEGRADED FARMLAND

As highlighted above, land restoration is an important element of the NDC commitments of the eight SURAGGWA countries, for both adaptation and mitigation purposes. SURAGGWA will engage in the restoration of two main types of land: highly degraded common land and moderately degraded farmland. SURAGGWA

### Restoration of highly degraded common land

While natural regeneration of vegetation cover tends to work well on moderately degraded lands, it tends to be ineffective in severely degraded landscapes, where the soil has become impermeable and most rainfall runs off the land or evaporates, rather than infiltrating in the soil. For restoring highly degraded land, the SURAGGWA programme uses an innovative approach that combines direct seeding (sometimes combined with enrichment planting) of native woody and grass species with large-scale land preparation for rainwater harvesting and soil permeability. This innovative approach has been tested in the field with good results through different Great Green Wall (GGW) projects including FAO's EU-funded Action Against Desertification project (AAD), which operated in four SURAGGWA countries: Burkina Faso, Mali, Niger and Senegal. The key elements<sup>21</sup> are:

- the use of a participatory approach based on community needs and preferences for species and restoration objectives
- the use of mechanized land preparation techniques in order to reach the targeted scale and the desired water harvesting result;
- the use of high-quality restoration seeds and propagation material of well-adapted native species;
- the use of direct seeding as much as possible, to minimize cost and demands on community time and obviate the need for developing large tree nurseries and additional water supplies;
- the use of a mixture of grasses and woody species to maximize land cover and generate early returns for communities from the production of fodder;

The cost-effectiveness of this approach is further detailed in Annex 3, which contains a cost-benefit analysis of the restoration of highly degraded common land using this approach in each of the eight SURAGGWA countries.

<sup>21</sup> Sacande M., Parfondry M. & Cicatiello C. 2020. *Restoration in Action Against Desertification. A manual for large-scale restoration to support rural communities' resilience in Africa's Great Green Wall*. Rome, FAO. <https://doi.org/10.4060/ca6932en>

## Restoration of moderately degraded farmland

The restoration of moderately degraded farmland can often be done without major external inputs, using approaches such as agroecology and agroforestry, building on the valuable traditional ecological knowledge and land management skills of dryland communities. The technical characteristics of these approaches are described in more detail below. The cost-effectiveness of these approaches is further detailed in Annex 3, which contains a cost-benefit analysis of the restoration of moderately degraded farmland using this approach in each of the eight SURAGGWA countries.

### Agroecology

Agroecology is internationally recognized as a powerful lever for making agriculture and food production more sustainable (FAO, 2018a; IPES-Food, 2018; De Schutter, 2011) and involves drawing inspiration from the functioning of ecosystems in order to optimize the interactions between plants, animals, humans, and the environment. Agroecology emerged in the scientific literature as early as the 1920s and has found expression in the practices of family farmers around the world. The approach aims to reconcile agricultural development with the protection of resources, the environment and wild and domestic biodiversity. Agroecology aims to transform agriculture and food systems to address the root causes of hunger, poverty, inequality and environmental problems. It aims to jointly improve the health of humans, animals, plants, the environment, and territories.

According to FAO (2018a), agroecology is fundamentally different from any other approach to sustainable development. Based on bottom-up and territorial processes, it helps solve local problems through context-specific solutions. Agroecological innovations are based on the joint production of knowledge, combining science with the traditional, concrete and local knowledge of producers. By strengthening their autonomy and their capacity to adapt, agroecology empowers producers and populations to be key actors of change. Agroecology has been translated into public policy by countries such as France (Projet Agroécologique pour la France, 2012) and has entered the vocabulary of international organizations and United Nations agencies.

In sub-Saharan Africa, numerous case studies prove that agroecology can contribute to food and nutrition security while restoring resources, ecosystem services, and biodiversity (Oakland Institute, 2020; AFSA, 2019; FAO, 2020). These studies also show that agroecology can play an important role in social cohesion, resilience building, and climate change adaptation. According to FAO (2017), agroecology enables the harnessing of Africa's social, natural, and economic assets, as it enhances local biodiversity and natural resource conservation. Agroecology opens up new opportunities for rural youth and can help stem the current rural exodus in sub-Saharan Africa. A recent study conducted in Senegal, Burkina Faso and Togo (Levard & Mathieu, 2018) demonstrated that the use of organic manure had a positive effect on farmers' income. The study also showed that income gains are strongest for farmers who integrate several agroecological practices. In some situations, agroecology allows families to generate income per family asset that is two to four times higher than other families, for an equivalent level of land.

The integration of the AgroEcological (AE) movement in West Africa is well underway. Several regional organizations such as ECOWAS and ROPPA and institutional donors such as the EU, AFD, and USAID have committed to collaborate in support of AE and have invested large amounts of resources to stimulate a paradigm shift from industrial domination of food production to strengthening short circuits, local food systems, restoration and conservation agriculture, agroforestry, ecological and

organic agriculture, and more recently, agroecology itself, with three major regional initiatives: PATAE (ECOWAS and AFD), PAIAD (ECOWAS and EU), and TAPE and the present program (FAO).

From an institutional point of view, the agroecology framework is aligned with the objectives of the international agreements of the 2030 Agenda of the SDGs, the Land Degradation Neutrality of the UNCCD, the Paris Agreements and the Convention for Biological Diversity. OECD<sup>22</sup> in an analysis of the role of food systems, recognizes the need for sustainability in the context of SDG commitments in the face of rapidly changing demographics and consumption patterns. The African Union's strategy on agriculture<sup>23</sup>, part of Agenda 2069, highlights ecological organic agriculture. In 2015, ECOWAS created the Framework for the Development of Smart Agriculture (ECOWAP/CAADP)), implemented through 8 major regional projects. The Framework also calls on member states to integrate climate smart agriculture into national policies. The West African Family Farmers' Association (ROPPA) also recognizes the paramount importance of AE in a 2018 policy paper<sup>24</sup> and a ROPPA representative sits on the Alliance for AE in West Africa (3AO) board.

**Senegal and Burkina Faso** belong to the **group 1** where agroecology is by far the most advanced in the region. They are characterized by institutional frameworks that recognize agroecology, training systems at all levels, a large and well-organized producer base, funding from large donor projects, and an active private sector with a wide range of offerings (FAO, 2022).

These countries are best positioned to make an agro-ecological transition in the Sahelian region and could provide a favorable public policy environment for (i) fostering the certification of organic inputs and increasing their subsidization, (ii) strengthening support to grassroots producer organizations and cooperatives, and (iii) promoting social safety nets for transitioning producers. National and small-scale projects in this group can be implemented by several actors already well involved and with proven expertise (local and national NGOs, farmers' associations, local authorities).

In the **group 2**, which includes **Mali, Niger, Nigeria and Chad**, agroecology is not recognized but producers are numerous. Their institutional framework is neutral towards agroecology but supportive of sustainable practices. Many producers and NGOs adopt and promote various "traditional" and sustainable practices, but they are not organized in a structured chain with a common strategy and advocacy around agroecology. Most of the funding comes from projects and institutional donors and there are few or no training opportunities in the agroecological approach. There is a need to consolidate the production base and economic stability of the agroecology sector by supporting farmers through increased access to mechanization, organic inputs, and social protection. Need to provide technical support to structure the sector, create or strengthen national umbrella organizations. Subsidies to develop urban markets, create cooperatives, strengthen training structures by improving infrastructure and providing subsidies, support private operators developing promising services such as farmer advice, mechanization, production and marketing of seeds and organic inputs, marketing and commercialization of products (FAO, 2022).

For the promotion of agroecology, there are commonalities across countries that can be addressed at the sub-regional level: (i) The AE sector is dominated by smallholders, small local non-profit organizations, international NGOs and research institutes, and bilateral donors. The private sector, political institutions, banks, multilateral donors, research and educational institutions in West and Central Africa have room for growth; (ii) Barriers to transition due to competition from highly subsidized conventional agriculture.; (iii) Difficulties in accessing capital, loans, secure land, organic inputs, water, access to markets, training.; (iv) Very few or no data to measure the extent of progress;

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<sup>22</sup><https://sahelcenter.org/2021/06/02/food-system-transformations-in-the-sahel-and-west-africa-implications-for-people-and-policies-oecd/>

<sup>23</sup><https://au.int/en/directorates/agriculture-and-food-security>

<sup>24</sup>[https://www.roppa-afrique.org/IMG/pdf/note\\_de\\_position\\_vsf\\_1\\_.pdf](https://www.roppa-afrique.org/IMG/pdf/note_de_position_vsf_1_.pdf)

(v) Insufficient penetration of knowledge and understanding in the political, financial and rural spheres.

**Table 32. Agroecological SWOT of the Sahel, FAO 2022**

<p><b>Strength</b></p> <ul style="list-style-type: none"> <li>- Commitments of Regional Organizations and some countries to the environment and to a transition towards sustainable food systems</li> <li>- Already a large community producer, market and developer community, with several countries already preparing for a partial transition</li> <li>- Wide range of target markets, from local villages to the urban middle class and export outside of Africa (the latter being at odds with the circular economy principles but not necessarily at odds with any of the 13 principles)</li> <li>- Strong social networking and extensive use of Facebook for communication and knowledge co-creation</li> <li>- Cross-sectoral: AE is known to be aligned with: (i) Environment/Climate Change, (ii) Nutrition/Health/Food Security, (iii) Food Security, (iv) Agricultural Markets (Import/Export), (v) Gender, (vi) Youth Employment and (vii) National Agricultural Priorities and Access to National Subsidies</li> <li>- The shortcomings of the current agricultural system have been widely described and acknowledged, including soil degradation, erosion of biodiversity and water supplies, increasing social inequality and hunger. The current system is "not feeding people" despite being subsidized at about 15%.</li> </ul>	<p><b>Weakness</b></p> <ul style="list-style-type: none"> <li>- Weak workforce because agriculture does not attract young people due to the gold rush</li> <li>- High level of technical knowledge required for successful transition</li> <li>- Lack of access to capital and social protection</li> <li>- Community services are not developed. The region suffers from a low level of mechanization and access to maintenance services</li> <li>- Extreme vulnerability of populations, which exacerbates the risks and costs of transition, and favors short-term individual strategies</li> <li>- Need for organic inputs that are not available, due to the need for labor and long-term investment to produce in-house or because it is not profitable to produce as a business</li> <li>- Low level of bio-input certification (and access to subsidies)</li> </ul>
<p><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>- AE offers a refuge from the sub-region's high vulnerability to speculation and competition for agricultural products in international markets</li> <li>- AE is aligned with international priorities, SDGs, GEF, etc. and is poised to increase countries' contributions to key international agreements for sustainability, equity and youth employment</li> <li>- Aid funds from bilateral and multilateral donor strategies and priorities are consistent with AE (EU Green Deal, France's 4/1000 initiative, France-Germany alliance for AE, etc.)</li> <li>- States are committed; they support platforms and offer grants</li> <li>- Low cost of labor, usually in Africa</li> <li>- Several states are already committed to developing AE (Senegal and Burkina Faso)</li> <li>- Training and knowledge is widely available and disseminated: Lots of training materials on YouTube and free on the internet, most countries have training centers, pilot farms, some even have university programs</li> <li>- Most countries are engaged in policies and reforms to promote sustainability in natural resource management, which is consistent with AE: Several countries are exploring land reforms and considering land use plans. The region is engaged in broad strategies for soil restoration, agroforestry, sustainable land management, climate smart agriculture development, ecological and organic agriculture (EOA or AB), invasive species management</li> <li>- Rural entrepreneurship and youth: AE services, management and machinery rental</li> <li>- Private sector to some services, such as organic fertilizers, technologies and some mechanization to AE producers =&gt; Youth employment, access to larger markets,</li> <li>- High inflation in international food and chemical fertilizer markets due to rising Russian gas prices.</li> <li>- Pastoralism (manure), high crop losses (30-40%) and urban waste can be processed to produce organic inputs.</li> <li>- Traditional practices are widespread and consistent with AE. They can be capitalized on through "inventories of AE practices" at the national level.</li> <li>- Availability of several potassium mines</li> <li>- The recent inflation and Ukraine crises have highlighted the societal dangers of excessive speculation in the agricultural sector, low efficiency of agricultural subsidies and dependence on wheat and fertilizer imports.</li> </ul>	<p><b>Threats</b></p> <ul style="list-style-type: none"> <li>- Incentives for states to export agricultural products, concentrates national economies on exports. Threatens to restrict subsidies to promote export products</li> <li>- AE commercial enterprises are not very likely to succeed and survive long enough to be profitable</li> <li>- Land tenure insecurity, exacerbating the risk of investing in AE transition</li> <li>- Low labor force for agriculture in general: after the rapid urbanization of the population over the past few decades and despite the increase in unemployment and poverty, people are unlikely to return to agriculture / AE</li> <li>- In some areas: Low availability of nitrogenous waste to produce manure and organic inputs</li> <li>- Low or no access to financial services for AE transition</li> </ul>

## Agroforestry

In the Great Green Wall zone of the Sahel, where opportunities for promoting irrigation are often limited, one of the key climate change adaptation options for agriculture that is accessible to smallholder farmers, in addition to agroecology (see previous section) is the promotion of agroforestry, as foreseen by the eight countries' NDCs. Under agroforestry<sup>25</sup> systems, trees are mixed into the crop fields in order to protect crops from moisture stress, which is projected to increase significantly under future climate change scenarios (see chapter II). It is now generally accepted that tree-based production systems such as agroforestry have enormous potential to reduce vulnerability to climate change and increase the resilience of households living in dryland regions of Sub-Saharan Africa, including the Great Green Wall zone. The World Bank's 2022 Climate Change and Development Report for the G-5 Sahel region (Burkina Faso, Chad, Mali, Mauritania and Niger), includes "Develop

<sup>25</sup> For a formal definition and a more extensive discussion of the concept of agroforestry, see the section Definitions and Key Concepts, above.

and strengthen agroforestry value chains to enable farmers to benefit from crop and tree products and to reap other benefits from re-greening” among its 2030 policy recommendations.<sup>26</sup>

Trees provide food, fodder (especially during the dry season, when there is no grass), fuel and fibre, soil enhancement (through litter fall and nitrogen fixation) and with their deep rooting systems, offer some level of production even in drier years – unlike most annual crops. They are therefore a good buffer against climatic risk and a critical element in rural livelihood diversification strategies. Production of the most important dryland crops is typically associated with dispersed trees in the farm fields, a form of land use often referred to as “agroforestry parklands”.<sup>27</sup>

Trees on farms will become even more important in the future, as they mitigate the impact of increased moisture stress, through promoting greater water infiltration, reducing temperature (through shade) and wind speed, and thereby reducing evaporation. They also contribute to increased resilience indirectly, through their impact on reducing soil erosion, trapping of wind-blown dust, increasing soil fertility, and therefore to improved soil moisture holding capacity.<sup>28</sup> Although trees provide valuable environmental services, these functions are not generally the primary reason why farmers plant, manage and retain them. Rather, the impetus for tree cultivation is the value of the other products trees can provide, such as timber, woodfuels and other non-timber forest products (food, medicines etc.), with immediate and clear benefits to farmers’ livelihoods.<sup>29</sup>

Hundreds of non-timber forest products (NTFP) are regularly harvested and used in the Great Green Wall zone. Some NTFPs are regularly exported: gum arabic (*Acacia senegal* and *Acacia seyal*)<sup>30</sup>, frankincense (*Boswellia papyrifera*), as well as tamarind fruit (*Tamarindus indica*), baobab fruit (*Adansonia digitata*), among others (see details in chapter V). Most NTFP, however, play an important role in rural smallholders’ livelihoods not through export trade but through direct household consumption as well as sale in local markets – and are therefore consistently undervalued in national economic statistics in the GGW zone.<sup>31</sup> A major FAO study on NTFP in Sudan (Mahmoud, 2016) provided strong evidence of the significant contribution NTFPs make to local communities, including food, fodder, medicinal materials, and other uses. The use of NTFPs as fodder – obtained from many different species – ranked first (45 percent), followed by food (29 percent), medicinal materials (21 percent) and other uses (5 percent).<sup>32</sup>

Several NTFP producing species that were prioritized by stakeholders in the eight SURAGGWA countries (see chapter V, pp 91-92) are reviewed for their suitability for use in dryland agroforestry systems in Table 2 below. The two gum arabic species<sup>33</sup>, *Acacia senegal* and *Acacia seyal*, appear to be the most suitable tree species for integration in agroforestry systems in the GGW zone overall. This is not only because of their large and growing export market potential for gum arabic (see Box 1 below), but also because of their nitrogen fixation capabilities, fodder production and their suitability for being grown in a mix with annual crops, providing them with protection against heat and drying winds but not unduly competing with them.

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<sup>26</sup> See page xv, <https://openknowledge.worldbank.org/entities/publication/50936c70-3771-5618-8b3e-52e7c01be5f8>

<sup>27</sup> World Bank. 2016. Tree-Based Production Systems for Africa’s Drylands. <http://dx.doi.org/10>

<sup>28</sup> Ong, C.K., Black, C.R. and Wilson, J., eds. 2015. Tree-Crop Interactions, 2nd edition: Agroforestry in a Changing Climate. Wallingford and Boston: CAB International.

<sup>29</sup> van Noordwijk, M., Hoang, M. H., Neufeldt, H., Oborn, I., and Yatchi, T, eds. 2011. How trees and people can co-adapt to climate change: reducing vulnerability in multifunctional landscapes. Nairobi: World Agroforestry Centre (ICRAF).

<sup>30</sup> Other *Acacia* gums, such as the gums of *Acacia papyriphera* and *A. polyacantha*, are also exported in smaller quantities (10s to 100s of tonnes rather than over 60,000 tonnes such as GA) from Sudan, however their growing areas are restricted to Blue Nile, Sennar and South Darfur States.

<sup>31</sup> See African Forest Forum project preparation studies summarized in chapter V.

<sup>32</sup> Mahmoud, T.E. 2016. Potentials of non-wood forest products (NWFP) for value chain development, value addition and development of NWFP-based rural microenterprises in Sudan. Consultancy report, Khartoum: FAO.

<sup>33</sup> Taxonomists have recently changed the name of the species *Acacia senegal* to *Senegalia senegal* and the name of *Acacia seyal* to *Vachellia seyal* (Kull and Rangan 2015, Kyalangaliwa et al 2013), but since these new names are not generally accepted in the agroforestry literature or in the eight SURAGGWA countries, they are not used in this project document.

**Table 2.** Comparison of selected NTFP species for suitability in agroforestry systems in the GGW<sup>34</sup>

Latin name	Common name	Market potential	Suitability for agroforestry	Fodder quality	Observations
<i>Acacia senegal</i>	(hard) gum arabic	+++	+++	+++	Produces “hard” variety of gum arabic. Nitrogen fixer. Grows best on sandy soils but also found on clay soils.
<i>Acacia seyal</i>	(friable) gum arabic	+++	+++	+++	Produces “friable” variety of gum arabic. Nitrogen fixer. Grows only on clay soils, fodder quality marginally better than <i>A. senegal</i> .
<i>Adansonia digitata</i>	baobab	+(+)	+	++	Fruit rich in vitamin C, used in food. Tree too large for easy integration in agroforestry, but highly valued by farmers and with increasing (export) market potential.
<i>Balanites aegyptiaca</i>	desert date	+(+)	+	+	Fruit can be processed into high-quality oil for food and personal care. Casts dense shade so less suitable for agroforestry. Increasing (export) market potential.
<i>Boswellia papyrifera</i>	frankincense	+(+)	++	+	Tree yields high-value gum-resin. Suitable for mixing with crops but not a nitrogen fixer. Considerable market potential.
<i>Tamarindus indica</i>	Tamarind	+(+)	+	++	Fruit used for seasoning food. Nitrogen fixer, but large spreading crown less suitable for agroforestry. Mainly local market potential.
<i>Ziziphus mauritiana</i>		+	++	++	Small tree suitable for mixing with crops,

<sup>34</sup> Based on discussions held with local stakeholders during project preparation and the agroforestry literature cited above.

					not a nitrogen fixer. Fruit is made into flour, mainly local market potential.
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Legend: + = low; ++ = medium; +++ = high

### Box 1. Gum Arabic – a unique product, a tree like no other

Gum arabic is the most commercially important plant-based gum worldwide, recognized as a food additive by the Codex Alimentarius.<sup>35</sup> It is a complex branched polysaccharide composed of galactopyranose units and small quantities of glycoprotein, which give it its emulsifying properties. Plants (either wild or domesticated) are the only sources of gum arabic, which has never been synthesized successfully because of its complex composition and multiple biochemical properties.<sup>36</sup> Gum arabic is in high demand in international markets for use as an emulsifier in a variety of foods and beverages and as a neutral carrier in the pharmaceutical and cosmetics industry, among others. Gum arabic has recently been recognized as a probiotic by the US Food and Drug Administration, which should further increase export market demand.

The value of raw gum exports from producer countries averaged USD 148,479,000 annually in 2014-2016, with Sudan accounting for over two thirds of this value, or USD 105,993,000. Gum prices have remained remarkably strong, despite a steady increase in worldwide gum supply from just over 30,000 tons in 1992 to 110,000 tons in 2016.<sup>37</sup>

Gum arabic is produced by two *Acacia* tree species, *Acacia senegal*, which grows on mainly on sandy soils and produces hard gum, and *Acacia seyal*, which grows exclusively on clay soils and produces brittle gum. Both species occur not only in wild stands but also as scattered trees on farms, forming the so-called “agroforestry parklands”. The trees start to produce gum 5 to 7 years after their establishment for an average period of 20 years. Gum tapping and harvesting is done in the dry season, thus avoiding conflicts with the agricultural calendar.

The reason why *Acacia senegal* is especially suitable for increasing the resilience of smallholder farming systems and livelihood strategies in the GGW zone is its extreme tolerance to dry conditions.<sup>38</sup> The species’ range extends to the very North of the Great Green Wall zone, where the annual rainfall is only 100-150 mm, whereas most of the restoration sites have considerably higher rainfall.

In conclusion, gum arabic agroforestry is a robust and low-risk climate change adaptation option, especially for the rural smallholder farmers and livestock producers in the Great Green Wall zone, who are considered to be particularly vulnerable to climate change impacts (see chapter III above).

<sup>35</sup> <https://www.fao.org/gsfaonline/additives/details.html?id=63&d-3586470-s=2&d-3586470-o=2&print=true>

<sup>36</sup> Sacande, M. & Parfondry, M., 2018. Non-timber forest products: from restoration to income generation. Rome, FAO. <https://www.fao.org/documents/card/en/c/CA2428EN>

<sup>37</sup> UNCTAD (United Nations Conference on Trade and Development). 2018. Commodities at a Glance: Special issue on Gum Arabic. Geneva: UNCTAD.

<sup>38</sup> According to Ong et al. op. cit. 2015, *Acacia senegal* has a documented root depth of 32 m, about 4-5 times the tree height!



## CHAPTER V – COMPONENT 2 SMALLHOLDER NTFP VALUE CHAIN SUPPORT

Non-timber forest products and fodder as an incentive for community engagement in land restoration in the Sahel

FAO (2009) defines a NTFP as "any good of biological origin other than wood, including plants and fungi, animals, derived from forests, other wooded land and trees outside forests, in particular spontaneous, domesticated plants and those intended for reforestation".

### THE SOCIOECONOMIC IMPORTANCE OF NTFP AND FODDER IN RURAL LIVELIHOODS IN THE SAHEL

Non-timber forest products (NTFPs) are wild plant and animal products harvested from forests, such as wild fruits, vegetables, nuts, edible roots, honey, palm leaves, medicinal plants, poisons and bush meat. Millions of people – especially those living in rural areas in developing countries – collect these products daily, and many regard selling them as a means of earning a living<sup>39</sup>. They are important sources of livelihood and income for millions of people worldwide, especially for those living in or near forested areas such as the Great Green wall zone. NTFP are also harvested from trees outside forests, including trees that are grown on farmland, in so-called agroforestry systems.

Non-Timber Forest Products (NTFPs) have been used by human beings since time immemorial (Panayotou and Ashton, 1993; Sonowal, 2007) for a variety of purposes like food, fodder, fiber traditional medicine, agricultural amenities, domestic materials, construction materials, and many of them are associated with cultures (Gauraha, 1992; Chopra, 1993; Malik, 2000). Examples of non-timber forest products include: (i) Medicinal plants: Many forests are rich in medicinal plants that are used for traditional medicines; (ii) Fruits and nuts: Forests are home to a wide variety of edible fruits and nuts, such as berries, mangoes, and cashews; (iii) Gum and resins: Gum and Resins are substances that are secreted by some trees, such as frankincense tree (*Boswellia spp*) for resins and *Acacia spp* for gum, and are used in the manufacture of various products, such as adhesives and varnishes; (iv) Fibers : Forests are a source of natural fibers such as rattan, bamboo, and wild for different usage including for c; (v) Essential oils: Essential oils are distilled from the leaves, bark, and flowers of many forest plants and are used in aromatherapy, perfumes, and cosmetics; (vi) Game animals: Forests are home to many species of game animals, including deer, wild boar, and various birds; (vii) Fish: Forests that are near rivers or lakes are a source of fish, which are an important source of protein for many people; (viii) fodder: fodder a very important element (animal feeds) and is produced in all the GGW zones, where livestock grazing is of great economic importance for the communities and the country.

The sustainable management and use of NTFPs can provide economic benefits to local communities while also promoting the conservation of forests and biodiversity. However, the

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<sup>39</sup> [\\*untitled \(doc-developpement-durable.org\)](#); Agrodok 39, 2006

extraction and trade of some NTFPs can also have negative impacts on forests and the people who depend on them, and it is important to ensure that their use is sustainable and responsible.

NTFPs play an important part in the resilience strategy of rural communities in the drylands, both seasonally and in times of crisis. Gum arabic and many other NTFP are harvested during the dry season, when there are fewer agricultural activities. NTFP are also important as they can provide considerable cash income and items for direct consumption in times of crisis, like during periods of drought and floods – the frequency of which is expected to increase due to climate change. Finally, the yields of many NTFP are more resilient in the face of climate anomalies than annual crops, and some of them, like gum trees, tend to yield more in drier years. Studies have shown that in West Africa, economic contribution of NTFPs to total rural household income varies from 12% in South-west Burkina Faso to 35% and 39% in Southern Ghana and Northern Benin respectively, and 45% in the Sudanian Savanna of Burkina Faso (Leßmeister et al., 2018). In Great Green Wall countries of this study, they contribute between 15 and 25% of the average annual income in households, alongside other traditional production systems. This contribution is within the average income share of 21.4 % obtained from a global comparative analysis of NTFP income contribution in Africa by Angelsen et al. (2014). A large part of the diet in rural areas that is provided by NTFPs includes fruits, seeds, leaves, sap, edible fungi, edible insects (caterpillars and termites), honey, medicinal plants and fodder. Eaten raw or cooked, some NTFPs replace cereal crops during times of crisis or are used as nutritional supplements in the daily diet<sup>40</sup>.

With increasing urbanization, the demand for NTFPs, especially as a source of food and medicine, is also growing rapidly in urban centers. Long neglected, the development and sustainable management of natural resources for NTFPs, have become a national and sub-regional priority because of their importance and potential contribution to national economies and to the food security of the populations who depend on them (Maisharou and Larwanou, 2015). As many of these NTFP are directly consumed by the people that collect them, or traded informally, they tend to be undervalued in national economic statistics. In addition, while household surveys in many countries do include self-consumption of crops and livestock products, they do not cover self-consumption of NTFP (Shepherd et al. 2011). Therefore, NTFP economic potential is not always sufficiently highlighted. The exploitation and marketing of NTFPs contributes approximately 5% to Gross Domestic Product (GDP) in Mali, according to statistics from the National Directorate of Tax Investigations of Mali (Direction Nationale des Eaux et Forêts –DNEF-) (National Strategy for the Promotion and Valorization of NTFPs, 2016). In Burkina Faso, this contribution is approximately 4%, with total marketed added value of 271.85 billion FCFA (Ministry of Environment-DGEEVCC, 2018).

At regional level, NTFPs are highly traded between countries. For example, Burkina Faso is reported to export 20% of its production of shea nuts to Ghana and 94.6% of tamarind products to Senegal. Conversely, the country imported Néré seeds from Ghana and Benin to produce “soubala”, a condiment made from fermented processed seeds that is sold in national markets as well as exported to neighbouring countries such as Niger and Côte d’Ivoire (Koboret et al., 2018) and progressively at international level. Based on the stakeholders’ main reasons for engaging in the NTFPs sector and according to the typology of NTFP livelihood strategies (Adam et al., 2013), the development of the selected NTFPs value chains could be considered mainly as subsistence and adaptative strategies for the majority of actors, as they

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<sup>40</sup> World Economic Forum, 2022

are used either to spread risks through diversification or as coping or survival mechanisms by fulfilling their basic needs. However, the NTFPs contribution is already evolving toward an accumulative livelihood strategy, by increasing income flow and asset stocks.

The selected value chains under SURAGGWA programme support local food security, income generation and employment especially for women and youth, with baobab, Shea, Néré, moringa, jujube, Balanites and gum arabic, showing the greatest potential.

NTFPs offer great promise for all gender groups in the Great Green Wall countries, but more specifically to women, owed to the significant role women play in providing family needs in terms of food and medicine, their knowledge of traditional/artisanal processing methods and their limited access to other livelihood opportunities (Pouliot, 2012; Suleiman et al., 2017). Activities such as NTFPs' collection, processing and trade are gender-differentiated.

#### Properties of prioritized tree crop value chains

Tree	Value chain	Sector	Properties
Acacias	Gum arabica	Superfood Food (gum); Fodder (leaves)	Commonly used in some food and pharmaceutical industries as an emulsifier, thickener and stabilizer, recognized as a probiotic in the USA
Balanites	Oil	Superfood Food, Personal care	Known for its emollient, regenerating and nourishing properties Rich in antioxidants Maintains skin hydration
Baobab	Oil and powder	Superfood Food	Antioxidant, anti-inflammatory, rich in fibre, moisturizing; promotes wound-healing and rejuvenates skin cells; promotes digestive health, balances blood sugar levels
Kinkeliba <sup>41</sup>	Leaves	Superfood Food	Antioxidant, anti-inflammatory, diuretic, digestive aid
Locust beans	Seeds	Superfood Food	Nutritionally useful ingredient
Moringa	Oil, leaf, powder, dried leaves	Personal care Superfood	Antioxidant, anti-inflammatory Moisturizer that can be used as a cleansing agent Antioxidant, anti-inflammatory, highly nutritious May lower blood glucose levels
Shea	Butter	Personal care, Food	Antioxidant, anti-inflammatory, antifungal Treats acne, psoriasis, eczema and other skin disorders Boosts collagen production, promotes cell regeneration and lessens sun damage
Tallow Tree	Juice	Food	Local drink highly popular for its taste and vitamin C content

Source: Derived from literature review, and consultations with stakeholders

## COMPLEMENTARITY OF NTFP AND FODDER PRODUCTION WITH OTHER RURAL INCOME-GENERATING ACTIVITIES

- i. Diversification of income: Rural households often rely on a single source of income, such as agriculture (with limited period of activity given the agro ecological conditions of the

<sup>41</sup> The local name for the tree species *Combretum micranthum*.

areas/environment) or livestock rearing. NTFPs and fodder production can provide an additional source of income, which can help reduce dependence on a single source of income and increase resilience to shocks;

- ii. Seasonal income: NTFPs and fodder production can provide income during the off-season or during lean periods when other income sources may not be available. The agro-climatic conditions of GGW zones do not offer much options and possibilities in terms of agricultural/crops production.
- iii. Low investment and high return: NTFPs and fodder production require low investment and can provide relatively high returns, making them attractive income-generating activities for smallholders. With the fast population growth and rapid urbanization of the GGW countries, many people are showing more interest in animal rearing in urban areas and contributing to a growing demand for fodder. Youth are investing in the production and marketing of fodder in sub-urban areas in Burkina Faso, Niger, Senegal, Mali and Chad as observed during the field visits.
- iv. Sustainable use of natural resources: NTFPs and fodder production can be sustainable activities that promote the conservation of natural resources. For example, sustainable harvesting of NTFPs can help protect forests and other ecosystems, while fodder production can help reduce pressure on grazing lands; Beekeeping can contribute to a sustainable management of the natural resources and improve the biodiversity.
- v. Value addition: NTFPs and fodder can be processed into value-added products, such as handicrafts, herbal medicines, and animal feed, which can increase their market value and provide additional income opportunities;
- vi. Synergy with other activities: NTFPs and fodder production can complement other income-generating activities, such as agroforestry, beekeeping, and livestock rearing. For example, NTFPs can be harvested from agroforestry systems, while fodder production can provide feed for livestock rearing especially during the first years of land restoration;

Overall, NTFP and fodder production can be valuable components of a diversified rural livelihood portfolio, providing income, promoting sustainable use of natural resources, and complementing other income-generating activities.

#### THE INCREASING MARKET POTENTIAL OF MANY NTFP (GROWING URBAN MARKETS IN-COUNTRY, GROWING INTEREST FOR SUPERFOODS AND OTHER NATURAL PRODUCTS IN EXPORT MARKETS WORLDWIDE)

The Sahel provides local and international market-relevant products. However, despite a strong global personal care market estimated at \$240 billion per year, the Sahel is estimated to capture only \$5 billion in value (across all products) and, with the exception of shea, GGW oils currently have limited competitiveness in the natural cosmetic oil market due to quality and processing challenges and limited market demand/exposure/information. In the \$150 billion superfoods market, however, the selected GGW value chain products are already relatively competitive<sup>42</sup>, although with comparatively higher production costs and low product awareness<sup>43</sup>.

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<sup>42</sup> Given their specific functionalities, baobab, balanites and moringa oils from GGW can compete on the cosmetic oil market. GGW dried products, such as kinkeliba leaves, baobab fruit powder and moringa leaves, show exciting potential for competitiveness in a high value-added global market.

<sup>43</sup> World Economic Forum, 2022, P14

One of the key drivers of the growing market potential for NTFPs is the increasing demand for natural and organic products, in addition to the urbanization and the population growth, consumers are becoming more aware of the impact that their purchasing decisions have on the environment, and are looking for products that are sustainably sourced and produced. NTFPs, which are often harvested in a way that is less harmful to the environment than other forms of resource extraction, are becoming an increasingly popular choice for consumers looking for eco-friendly alternatives.

Only Balanites and shea are relatively competitive. However, balanites oil is mainly sold in domestic and traditional markets with limited quality standards. Its limited productivity, and the need for SMEs to industrialize the transformation process, have so far prevented Balanites oil from entering international markets. Nevertheless, its high-end properties, especially its light texture, mean that it has potential in the

According to the findings from a study conducted by WEF in 2022, another factor contributing to the market potential of NTFPs is their value as ingredients in various industries. Many NTFPs are used in the production of cosmetics, pharmaceuticals, and other consumer goods, which means that there is a steady demand for these resources from these industries. According to the World Economic Forum, 2022, as an example, the sub-Saharan cosmetic market is estimated at approximately \$10–20 billion (excluding South Africa, which accounts for approximately 3% of the global market), of which the Sahel is worth as much as \$5 billion (\$1 billion in Senegal alone), with significant growth estimated at 8–10% per year. Additionally, increasing consumer demand for cosmetics and toiletries that avoid chemicals is expected to fuel market growth and provide opportunities for suppliers in GGW countries. In addition, wider awareness of NTFPs' benefits is required to increase demand<sup>44</sup>. Additionally, the growing interest in traditional medicine and natural remedies has also led to an increased demand for NTFPs. Many NTFPs have been used in traditional medicine for centuries, and as interest in these practices grows, so too does the demand for these resources.

Unfortunately, a lack of robust baseline data on the number of trees, production levels and export volumes and values from GGW countries makes it difficult to accurately quantify the market potential of the prioritized value chains especially in the in the Great Green Wall zones. Except for shea and gum arabica, few market studies/investigations have been conducted at the regional level<sup>45</sup>. However, functionalities and pricing trends in leading markets allow some conclusions to be drawn on the value chains with the greatest potential. Based on the medicinal and nutritional properties of the prioritized tree crop value chains, the personal care and superfood markets are of most interest.

It should be noted that, the increasing market potential of many NTFPs is not only limited to local or regional markets, but also at the national level. In fact, the market potential of NTFPs at the national level is driven by various factors that create demand for these resources, as well as opportunities for entrepreneurs and communities to benefit from their sustainable

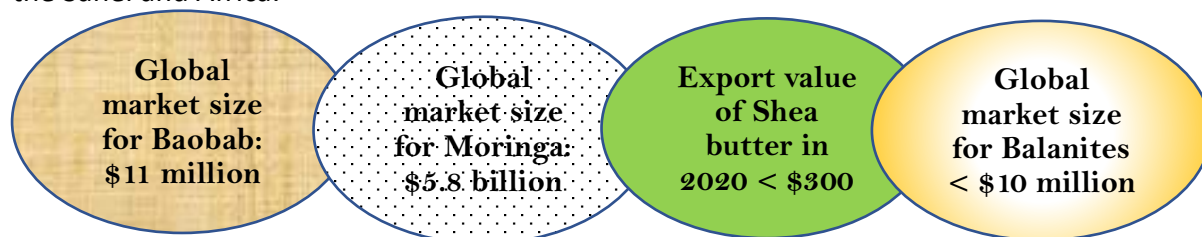
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<sup>44</sup> A 2018 survey of UK consumers showed that only 23% had heard of baobab, and only 6% had tasted it.<sup>35</sup> Although a growing number of brands and ingredient companies are incorporating baobab into their products, the number doing so remains small. From 2013 to 2017, there was 53% annual growth in new food and beverage products containing baobab, with Europe accounting for 52% of new product launches and the US for 35%.<sup>36</sup> As a notable growth driver, some brands built entirely around baobab have emerged (such as Aduna in the UK, Baobab Foods in the US, Matahi in France and Baola in Germany): [Baobab: the next superfood? | Analysis & Features | The Grocer](#)

<sup>45</sup> Nevertheless, the majority of tree crops (apart from moringa) lack scientific evidence demonstrating their beneficial properties, which would support their high-end cost positioning and ability to differentiate from competing superfood powders.

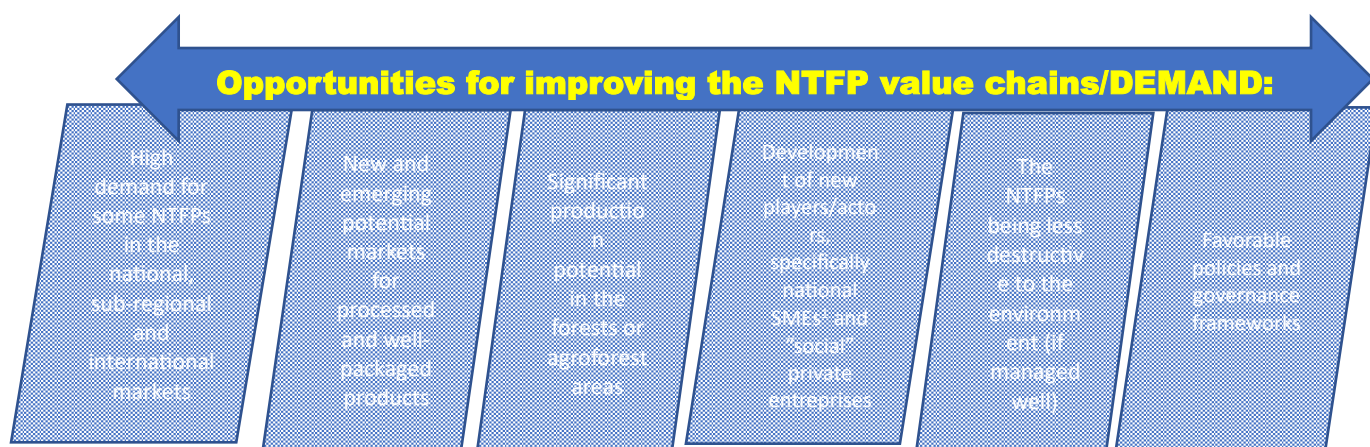
production and trade. One key factor driving the market potential of NTFPs at the national level is the growing interest in sustainable and organic products. As mentioned above, consumers are becoming more aware of the environmental and social impacts of their purchasing decisions, and are increasingly seeking out products that are sustainably sourced and produced. This has led to increased demand for NTFPs, which are often harvested using sustainable methods that support the conservation of forest ecosystems. Furthermore, the increasing recognition of the importance of indigenous knowledge and practices in natural resource management has led to greater attention being paid to NTFPs and their role in sustaining forest ecosystems and supporting the livelihoods of forest-dependent communities. This has resulted in the development of policies and programs aimed at promoting the sustainable management and trade of NTFPs, which can create new opportunities for businesses and communities to benefit from these resources. The majority of the SURAGGWA beneficiary countries have developed sectorial strategy for the promotion of the NTFPs as well as dedicated agencies/institutions/directorates within the ministry of environment.

With the exception of shea, GGW oils currently have limited competitiveness in the natural cosmetic oil market due to higher prices coupled with low productivity (inefficiency), quality and processing challenges, and limited market exposure and demand. Nonetheless, the international context of price inflation and potential supply disruption of more traditional oils could favour the emergence of new, locally produced cooking oils to replace imported oils in the Sahel and Africa.



Overall, the increasing market potential for many NTFPs presents an opportunity for communities that rely on these resources for their livelihoods. By developing sustainable harvesting practices and building networks to connect with buyers, these communities can potentially benefit from the growing demand for these valuable resources.

With the right support and investment, the prioritized/selected tree crops offer significant potential to capitalize on regional and international markets and deliver environmental and social impacts on the ground. Multistakeholder engagement and partnerships could accelerate and scale up the multiple social and ecological impact benefits of these restoration-focused value chains and unlock development finance and carbon finance for restoration and value chain development. These partnerships would build on the existing network of innovative local SMEs and emerging sector-wide support organizations that are already driving change within their respective value chains.



Source: Adapted from the World Economic Forum study, 2022

#### Competitiveness gap for identified GGW oils/butter (international markets)

	Competitiveness with competing products	Competitiveness with other regions producing same product	Market potential	Differentiation
<b>Baobab oil</b>	Can be competitive	Prices in GGW 40% higher vs. SADC oil	++	Need for scientific evidence of properties (emollient, softening, regenerating and nourishing)
<b>Balanites oil</b>	Needs to be improved	Competitive	++	Need for scientific evidence of properties (light texture, regenerating, antioxidant, nourishing, haircare)
<b>Moringa oil</b>	Needs to be improved	Prices in GGW 45% higher vs. Indian oil	+++	Organic, lack of contamination
<b>Shea butter</b>	Competitive	Competitive	+++	Properties (skin moisturiser, haircare, anti-inflammatory, antioxidants, anti-ageing)

Source: Derived from literature review, and consultations with stakeholders (WEF, 2022, P15)

#### FODDER PRODUCTION AS A WAY TO GENERATE QUICK RETURNS FROM RESTORATION

Fodder crops are crops that are cultivated primarily for animal feed. By extension, natural grasslands and pastures are included, whether they are cultivated or not. Fodder comprises grasses, crop residues and parts of trees and shrubs such as leaves, flowers and fruit that are harvested and used as feed for livestock and other domesticated animals. In drylands such as in GGW zones, natural vegetation is the main source of fodder, and tree fodder is essential as there is no grass during a significant part of the year.

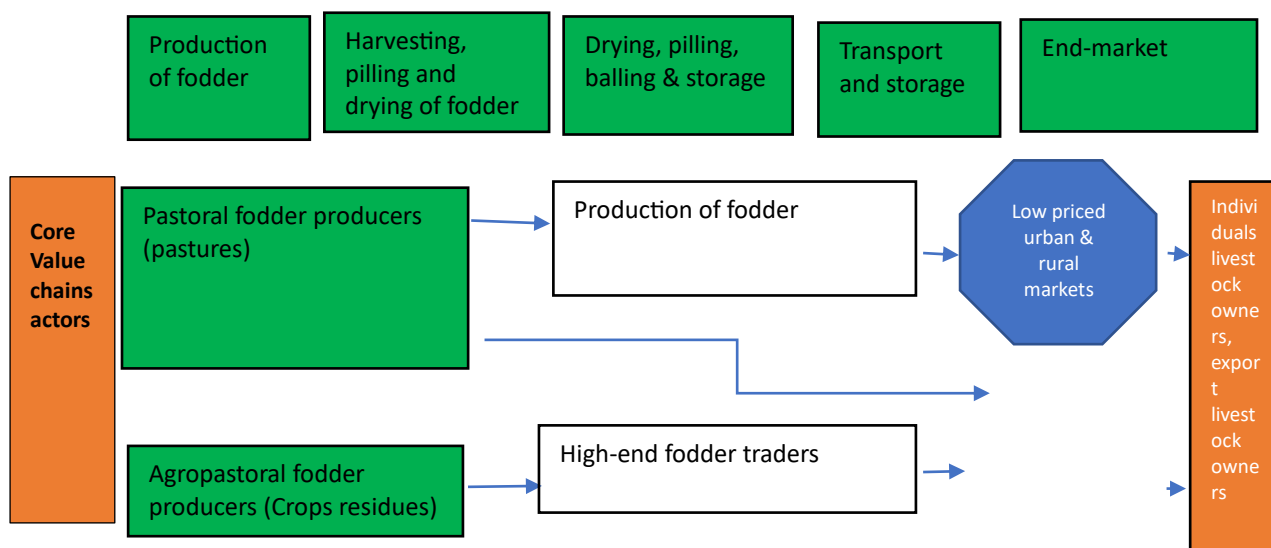
Demand for fodder is very high throughout the GGW core area, putting pressure on natural vegetation and agricultural land. This pressure, combined with poor management practices, has caused the degradation and decline of large areas of natural pastures. Conflicts are common between pastoralists and crop farmers, especially during seasonal and annual transhumance (that is, the movement of livestock from one grazing area to another), when livestock may trespass on farms in search of food and cause damages. It has been estimated that, should the degradation of pastures and the decline of fodder availability continue, by 2030, the availability of feed and other necessary resources will be insufficient to maintain most pastoralists and agropastoralists in sub-Saharan dryland countries, even at 50 percent of the poverty line (WEF, 2020). Solutions to this looming disaster may be found in restoring and enriching degraded pastoral landscapes with native fodder species. In terms of lessons learned, the AAD restoration model combines the planting of herbaceous and woody fodder species, particularly in the GGW core area in Burkina Faso, Mali, Niger, Nigeria and Senegal, where communities have shown a very high preference for fodder species. Restoration with grass fodder species can require 5–10 kg of seeds sowed per hectare (Sacande and Berrahmouni, 2016)<sup>46</sup>. It is important, therefore, to ensure that farmers have access to sufficient numbers of well-adapted, high-quality seeds and knowledge of how best to sow them. The inclusion of high-quality herbaceous fodder species, combined with woody species, is a key innovation brought by AAD to large-scale restoration in the GGW core area.

Key plant species supporting fodder production include: in the group of Poaceae: *Andropogon ganyanus*, *Schoenefeldia gracilis*, *Panicum laetum*; in the group of Fabaceae/Leguminosae: *Alysicarpus ovalifolius*, *Piliostigma reticulatum*, *Faidherbia albida*, *Azalia africana*; in the group of Meliaceae: *Khaya senegalensis*;

Fodder production/business can be a way to generate quick returns from restoration efforts for several reasons: (i) Fast- growing species: Fodder crops, such as grasses and legumes, can grow quickly and provide a yield within a short time frame, often within a few months; (ii) Low-cost production: Fodder crops can be grown using low-cost production methods, such as broadcast seeding or intercropping with other crops, which can minimize the initial investment required; (iii) Immediate demand: Fodder is in high demand in many rural areas, where it is used as feed for livestock. This means that there is an immediate market for fodder production, providing an opportunity for quick returns on investment; (iv) Improved soil health: Fodder production can improve soil health by increasing soil organic matter and nutrient levels. This can enhance the productivity of the land in the long term, leading to increased yields and higher returns on investment over time; (v) Restoration benefits: Fodder production can be used as a tool for ecological restoration by improving biodiversity, increasing biodiversity, and enhancing ecosystem services. This can lead to additional benefits such as improved water quality, carbon sequestration, and increased wildlife habitat; (vi) Multiple uses: Fodder crops can have multiple uses, such as providing food for humans, fuel, and medicine, which can increase their value and potential for generating income.

A schematic representation of the fodder value chain, its actors and linkages.





Source: Adapted from the literature review<sup>47</sup>

Overall, fodder production can provide a way to generate quick returns from restoration efforts, while also promoting sustainable land use practices and providing multiple benefits to local communities. In the case of SURAGGWA, fodder production is an integrated part of the land restoration for ecosystem restoration. This fodder production with the support of the SURAGGWA programme will capitalize on the lessons learned from Action against Desertification project as well as other initiatives. As an example, community members received training in seeds collection and conservation, fodder production and processing under the AAD project.

## SELECTION OF PRIORITIZED NTFPS BY THE DIFFERENT SURAGGWA COUNTRIES AND CRITERIA USED

The selection of the priority NTFPs for SURAGGWA has been done based on principles, criteria and methodology described below, building on the results of the NTFP studies that were carried out during the concept note phase.<sup>48</sup>

In terms of principles, the selection of the NTFPs for SURAGGWA programme is aligned with the preliminary list contained in the concept note that has been approved by GCF. It should be noted that the process for the identification and prioritization of the NTFPs has been participatory and inclusive, with the contributions of all the relevant stakeholders in the sector<sup>49</sup>; As mentioned in the concept note, restoration interventions must be linked with socio-economic improvements through promotion of non-timber forest product value chains

<sup>47</sup> FNS-REPRO Somaliland - Key Findings from literature review, rapid fodder value chain assessment and stories of change

<sup>48</sup> INSERT FULL REFERENCES TO AFF ETC STUDIES HERE

<sup>49</sup> With the supporting partner institutions, promising co-funding, synergies and partnerships with NGOs, micro-credit institutions and the private sector, seven innovative major value chains have already been identified to be developed further. They include (i) Mechanized ploughing for large-scale land preparation and restoration; (ii) Restoration seeds and seedlings; (iii) Gum Arabic and resins; (iv) Balanites oil; (v) Honey production and beekeeping; (vi) Herbaceous fodder as feed for livestock; (vii) forest and tree foods – nuts, fruits, seeds.

through sustainably used species preferred by local communities, for improvement in livelihoods, food security & nutrition and well-being. Therefore, the final selection of restoration species, including grasses, shrubs and trees, will be made by the local communities during project implementation. Multiple useful species for restoration not only increase adaptation and resilience capacity of production landscapes, but also diversify and improve livelihoods. Native species should always be given preference, as they are well adapted to local ecological conditions and therefore more suitable for the natural re-establishment of the native flora and fauna species and enhance ecosystem resilience when it comes to land restoration.

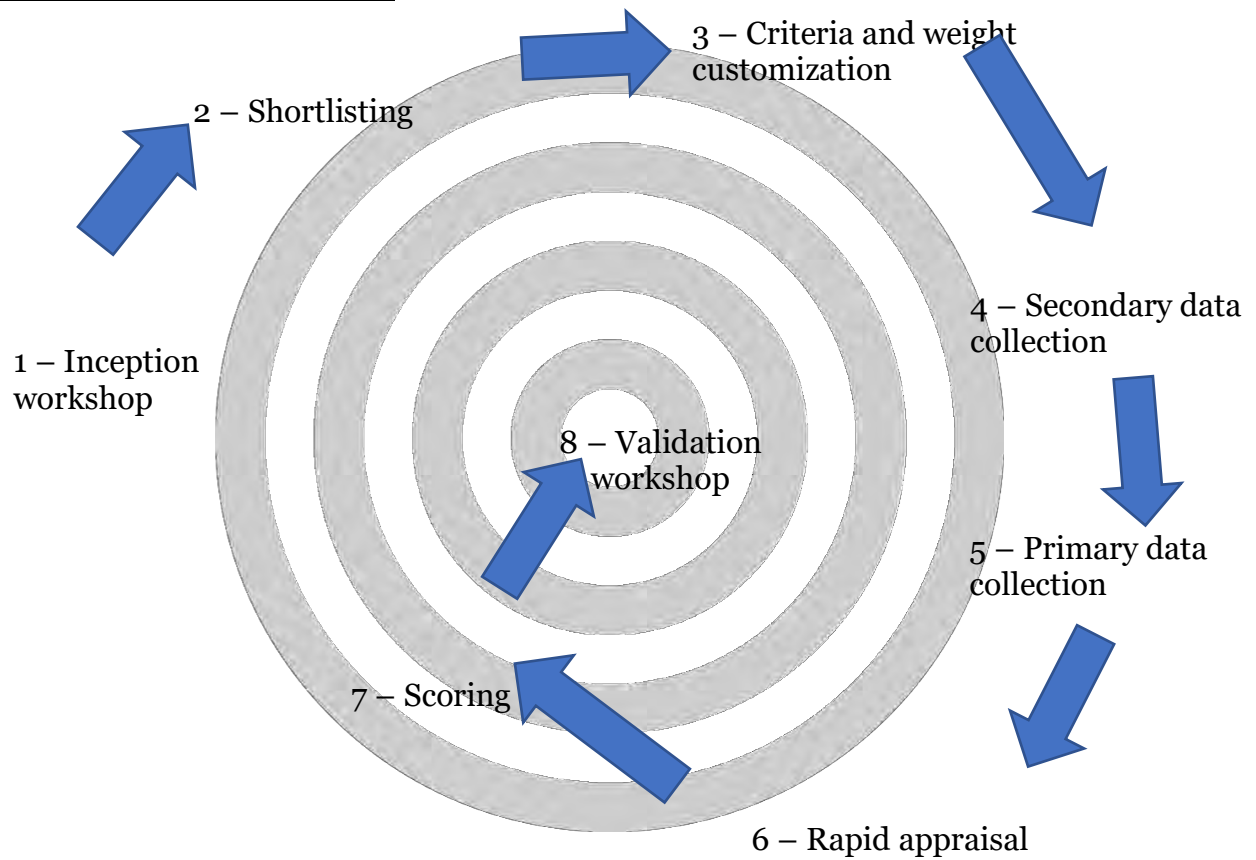
In terms of criteria, the following was considered: (i) tree (crop value chains with the highest potential to provide landscape and soil restoration benefits through market-based incentives in the Sahel; (ii) tree crop value chains that present business case for multistakeholder partnerships (including SMEs and the private sector) to accelerate socially and ecologically responsible restoration efforts in the Sahel as part of value chain development and enhancement; (iii) tree crops and associated value chains with the highest potential across the following areas: international market potential, regional/national market potential, environmental potential and socioeconomic impact potential; In terms of approaches, during the full proposal design phase, the selection process of the NTFP value chains has been very participatory and inclusive at different levels. It has used secondary as well as primary data, including consultations (remote and in-person) with the main stakeholders from the beneficiary countries.

Primary data sources included extensive data collection through consultations and interviews across the value chains (from producers/collectors, processors, traders/distributors from the visited/beneficiary countries to international off-takers and international organizations), as well as interviews with environmental experts and other key stakeholders. This was complemented through desk research and secondary data sources. With regard to the secondary data, the programme formulation team exploits data and information from the approved concept note, reports and documents from studies on NTFP value chains from various partners and institutions, reports and documents from the AAD projects, research on internet, etc. Concerning the primary data, the team gathered data during the field missions where consultations took place with the main stakeholders through the organization of workshops, bilateral meetings with the participation of different value chain actors, institutions and partners; visits and direct observations with different value chain actors in the NTFP sector, etc (Honey/beekeeping and moringa processors in in Niger, showcase/shops in Burkina, Senegal, etc.).

For the final selection of the prioritized NTFP value chain for component 2, a value chain selection's tool adapted from the food system approach developed by FAO has been applied during the consultations in the visited/participating countries. Given the limit of time, a simplified version of this tool has been utilized during the consultation workshops. The entire process is supposed to be implemented in 8 steps, as follows: *Inception workshop – Shortlisting – Criteria and weight – Secondary data collection – Primary data collection – Rapid Appraisal- Scoring- and Validation workshop*. All these steps have been conducted in approximatively three steps: inception workshops during the formulation of the concept note, the shortlist of NTFPs value chains and the final selection during the full proposal

formulation phase with the application of criteria and weight. The process has been supported by the exploitation of secondary data and information available for the sector.

Value chains selection process:



Key criteria	Weight of criteria	Value chain 1			Value chain 2		
		Score	Weighted score	Underlying data for scoring	Score	Weighted score	Underlying data for scoring
<b>I FEASIBILITY</b>							
<b>A Economic feasibility</b>							
1 Market demand							
2 Competitive advantage							
3 Support services							
4 Coordination							
<b>B Societal feasibility</b>							
5 Government support							
6 Donor and partner support							
7 Private sector support							
8 Socio-cultural norms							
<b>C Environmental feasibility</b>							
9 Natural resource endowment							
10 Weather-related and environmental risks							
<b>II IMPACTS</b>							
<b>A Economic impacts</b>							
11 Salaries and jobs							
12 Profits							
13 Tax revenue							
14 Consumer benefits							
<b>B Social impacts</b>							
15 Added value distribution							
16 Nutrition and health							
17 Workers' rights and safety							
18 Social institutions							
19 Animal welfare							
<b>C Environmental impacts</b>							
20 Carbon footprint							
21 Water footprint							
22 Soil use							
23 Biodiversity							
24 Animal and plant health							

This is a ranking matrix to compare several VCs (adapted from GIZ). It is composed of 24 criteria divided in two main categories. Each criterion in the matrix is weighted to adapt to the context and project goals:

- Feasibility:** Is it feasible to facilitate change considering the social, environmental and economic perspectives? (Economic feasibility, environmental feasibility and social feasibility);
- Impact:** Will the change have impact? To what extent will upgrading this value chain generate **economic, social and environmental benefits** for the value chain stakeholders (e.g. SMEs, workers, government, consumers)?

Source: Extracted from FAO training course on food system approach: Sustainable food systems: concept and framework<sup>50</sup>

The consultation workshops organized in the countries visited during the full proposal design brought together actors and stakeholders including producers/collectors, processors, traders/distributors, exporters, financial institutions, civil society organizations, government institutions, development partners, projects and programmes in the NTFP sector, etc. The FAO programme design team in collaboration with the national partners (GGW agencies and NDA, among others) facilitated these consultations in an inclusive and participatory manner. Based on the above, the below final list of prioritized NTFPs has been produced. It should be noted that this list takes into consideration not only the tree species that will be used for the land restoration but also the NTFPs that are available and actually collected, processed and marketed by the actors, which will benefit from the component 2 interventions at the start-up of project implementation. The selection/list of these NTFPs confirmed also the findings

<sup>50</sup> [Sustainable food systems: concept and framework \(fao.org\)](https://www.fao.org/publications/defaultcard.do?lang=en&info=65939)

and conclusions<sup>51</sup> of various studies and analysis conducted in the in the Sahel and in the Great Green Wall zones<sup>52</sup>.

Each beneficiary country of the programme should observe a certain flexibility in the support of NTFP value chains during the implementation as further and more detailed data and information will be collected and analysed in order to better guide the interventions of the this component. As mentioned above, two criteria (feasibility and impact) have been used for the selection of the priority NTFP. The below table summarizes the list of prioritized NTFP per beneficiary country.

*List of the prioritized/selected NTFP value chains for the eight (8) beneficiary countries;*

<b>Burkina Faso</b>	<b>Chad</b>	<b>Djibouti</b>	<b>Mali</b>
<b>Balanites</b> ( <i>Balanites aegyptiaca</i> ), <b>Baobab</b> ( <i>Adansonia digitata</i> ), <b>Gum arabic</b> ( <i>Acacia</i> spp), African locust bean ( <i>Parkia biglobosa</i> ), Jujube ( <i>Ziziphus mauritiana</i> ) Tamarind ( <i>Tamarindus indica</i> ), Shea ( <i>Vitellaria paradoxa</i> ), Neem ( <i>Azadirachta indica</i> ), <b>Fodder,</b> <b>Honey,</b> Moringa ( <i>Moringa oleifera</i> )	<b>Balanites</b> ( <i>Balanites aegyptiaca</i> ), <b>Gum arabic</b> ( <i>Acacia</i> spp), Jujube ( <i>Ziziphus mauritiana</i> ) <b>Fodder,</b> <b>Honey,</b> Moringa ( <i>Moringa oleifera</i> )	Gum arabic ( <i>Acacia</i> spp), Jujube ( <i>Ziziphus mauritiana</i> ), Frankincense ( <i>Boswellia</i> spp), Date palm ( <i>Phoenix dactylifera</i> ), <b>Fodder,</b> <b>Honey,</b> Moringa ( <i>Moringa oleifera</i> )	<b>Balanites</b> ( <i>Balanites aegyptiaca</i> ), <b>Baobab</b> ( <i>Adansonia digitata</i> ), <b>Gum arabic</b> ( <i>Acacia</i> spp), Ronier ( <i>Borassus aethiopum</i> ), <b>Fodder,</b> <b>Honey</b>
<b>Mauritania</b>	<b>Niger</b>	<b>Nigeria</b>	<b>Senegal</b>

<sup>51</sup> From AFF study: The prioritized NTFPs within the study region include honey, pulp and seed from *Parkia biglobosa* (Nere), fruits and oil from *Balanites aegyptiaca* (Balanite) seeds, leaves and pulp from *Adansonia digitata* (Baobab) fruit, oil from *Azadirachta indica* (Neem) seeds and leaves from *Piliostigma reticulatum*, fruits from *Ziziphus mauritiana* (Jujube fruit) and *Phoenix dactylifera* (Date palm).

<sup>52</sup> List of NTFP recommended by the WEF, 2022: African locust beans (*Parkia biglobosa*), African baobab (*Adansonia digitata*), balanites (*Balanites aegyptiaca*), the gum arabicas (*Acacia senegal* [Senegalia senegal] and *Acacia seyal* [Vachellia seyal]), kinkeliba (*Combretum micranthum*), moringa (*Moringa oleifera*), shea (*Vitellaria paradoxa*) and tallow tree (*Detarium senegalense*).

<b>Balanites</b> ( <i>Balanites aegyptiaca</i> ), <b>Baobab</b> ( <i>Adansonia digitata</i> ), <b>Gum arabic</b> ( <i>Acacia</i> spp.) Jujube ( <i>Ziziphus mauritiana</i> ) Doum palm ( <i>Hyphaene thebaica</i> ), <i>Neocarya macrophylla</i> <b>Fodder,</b> <b>Honey,</b> Moringa ( <i>Moringa oleifera</i> )	<b>Balanites</b> ( <i>Balanites aegyptiaca</i> ), <b>Baobab</b> ( <i>Adansonia digitata</i> ), <b>Gum arabic</b> ( <i>Acacia</i> spp.) Jujube ( <i>Ziziphus mauritiana</i> ) Doum palm ( <i>Hyphaene thebaica</i> ) <i>Nymphaea lotus</i> <i>Sporobolus robustus</i> , <b>Fodder</b> <b>Honey,</b> Moringa ( <i>Moringa oleifera</i> )	<b>Balanites</b> ( <i>Balanites aegyptiaca</i> ), <b>Baobab</b> ( <i>Adansonia digitata</i> ), <b>Gum arabic</b> ( <i>Acacia</i> spp.), Neem ( <i>Azadirachta indica</i> ), <b>Fodder,</b> <b>Honey,</b>	<b>Balanites</b> ( <i>Balanites aegyptiaca</i> ), <b>Baobab</b> ( <i>Adansonia digitata</i> ), Jujube ( <i>Ziziphus mauritiana</i> ) <b>Gum arabic</b> ( <i>Acacia</i> spp.), <b>Fodder,</b> <b>Honey,</b> Moringa ( <i>Moringa oleifera</i> )
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**Source:** Results from country consultation workshops and exploitation of secondary data

As highlighted in the above summary table, honey and fodder have been systematically identified and prioritized by the stakeholders as strategic value chains in all the beneficiary countries. Both these value chains are relatively straightforward to implement and can provide additional income to the communities. As noted above, the integration of fodder grasses among the restoration species guarantees a quick return to the communities' efforts, avoiding a long wait for benefits and increasing the economic incentives for restoration. Honey production benefits directly from the land restoration activities, as the flowers of many of the NTFP tree species produce nectar. In addition to honey and fodder value chains, *Balanites* and *Acacia* spp have been also considered as very important tree crops as all the beneficiary countries (except from Djibouti) have considered them in their list of prioritized NTFP. Baobab is also considered as an important tree crop as 6 out the 8 beneficiary countries have been identified it as priority NTFP.

## STRATEGY OF THE PROJECT: WITHOUT ECONOMIC INCENTIVES, NO LONG-TERM COMMUNITY INVESTMENT IN LAND RESTORATION AND MANAGEMENT

The component 2 interventions aim at addressing the main constraints and challenges that face the stakeholders in the NTFP sector, particularly the direct value chain actors: producers/collectors, processors, distributors/off-takers/exporters. The sustainability of these interventions is based on the strategy adopted in the design and the approach for the implementation: (i) All the interventions have been identified through the **participation and inclusion of all the actors** throughout the diagnostic and consultation phases at different levels to ensure that their needs and specificities have been considered. This will ensure their buy-in as well their full participation during the implementation phase; (ii) **The mobilization and participation of the private sector actors** has received ample attention. The lessons learned from the previous interventions, projects and initiatives have shown a failure in mobilizing the private sector consistently.<sup>53</sup> The design of component 2 of

<sup>53</sup> See e.g. FAO 2022

SURAGGWA has addressed this issue by engaging with the private sector at an earlier stage of the design process. The support to the development of NTFP value chains is adopting a market-oriented approach that focuses on the requirements of the demand side to enhance market demand for the benefit of NTFP producers/collectors and processors. The programme will adopt the 4P mechanism (Public-Private-Producer Partnerships) in the implementation of its interventions to engage with the different actors in the NTFP value chains. A strong, win-win partnership between the value chain actors and the private sector (off-takers) contributes to the sustainability; (iii) **Build on the engagement/commitment and contributions of the actors** in the project interventions: During the implementation phase of the programme, the value chain actors should engage and/or make contributions in order to increase their ownership and improve sustainability and impact, since the interventions aim at responding to their actual needs. For each of the interventions, the SURAGGWA programme staff will make sure that a suitable mechanism is put in place to ensure ownership, continuity of the activities beyond the programme lifetime and sustainability. The complementarity between the land restoration activities and the NTFP value chains support is very important to ensure ownership and guarantee sustainable management of restored lands because of the benefits provided to the communities by the tree crops.

## LESSONS LEARNED FROM EXPERIENCE WITH NTFP AND FODDER VALUE CHAIN DEVELOPMENT

Several lessons have been learned and capitalized through findings from studies and implementation of projects and programmes within and outside the GGW zones including the Action Against Desertification (AAD) project;

### Fodder Production

Fodder is produced in all the GGW zones, where livestock grazing is of great economic importance for the communities and the country.

The AAD project has promoted this value chain by helping communities restore degraded pastoral lands, providing high-quality seeds and seedlings of well-adapted fodder tree, shrub and grass species, and assisting in large-scale soil preparation. The AAD approach has obtained the buy-in and contributions of agro-pastoralists and pastoralists, in places where it has never previously occurred. Implemented at scale, this restoration method brings multiple benefits to communities, providing more feed for livestock and recovered arable land for farmers and thus reducing conflicts over natural resources. In Burkina Faso, more than 480 kg of seeds of herbaceous fodder species (*Andropogon gayanus*, *A. pseudapricus*, *Eragrostis tremula*, *Panicum laetum*, *Pennisetum pedicellatum* and *Senna tora*, etc.) and 12 multifunctional tree species were planted in 2017 to restore 2 754 hectares of degraded land across 45 sites<sup>54</sup>. A year after planting, an average of 1.2 tonnes of fodder grasses was harvested per hectare from restored plots. More than 32 tonnes of fodder were harvested on just 14 of the sites, generating revenues of XOF 1.6 million (USD 3 000), equivalent to additional income of XOF 80 000 (USD 150) for each of the 20 participating farmers. This income is comparable with revenue derived from traditional annual yields of millet and

<sup>54</sup> Restoration of one hectare of degraded land requires approximately 5-10 kg of seeds, using mixed grass fodder species; The average yield of fodder per hectare is approximately 1,2 tonnes, after the first year on restored sites in Burkina Faso;

maize (0.53–0.85 tonnes per hectare and 1.22–1.69 tonnes per hectare, respectively) in Burkina Faso and Niger (FAO, 2016). Similar activities were carried out in Niger. A project beneficiary in Baguira in the municipality of Tera (Niger), for example, reported that he was able to feed 22 cows, 15 sheep, 106 goats and 2 donkeys all year and still sell surplus fodder, earning himself XOF 100 000 (about USD 190) over the year. Collecting grass and herbs from restored areas for selling as fodder may motivate farmers to continue to engage in similar land restoration activities<sup>55</sup>.

The following are the bottlenecks along the fodder value chain: unpredictable changes in weather patterns and soil erosion, poor land tenure, inadequate grazing and animal mobility, equate inputs for fodder production such as good quality, nutritious fodder seeds, lack of skills and knowledge around fodder production and processing (inadequate access to technical assistance services)<sup>56</sup>, lack of storage facilities causing poor quality fodder and post-harvest losses, no market information system on fodder prices and trends, no adequate infrastructure and regulatory framework preventing the engagement of the private sector actors in the business. Interventions that aim at addressing the above-mentioned challenges could contribute to the development of a profitable and sustainable fodder value chain, especially in the GGW zones.

***Overall, fodder production can provide a way to generate quick returns from restoration efforts, while also promoting sustainable land use practices and providing multiple benefits to local communities. In addition, better-fed livestock produce much less methane, thus reducing GHG emissions per kg of milk produced.***<sup>57</sup>

## Honey

Honey is the “natural sweet substance produced by honey bees from the nectar of plants (...) which the bees collect, transform (...) deposit, dehydrate, store and leave in the honey comb to ripen and mature” (FAO, 2001). Honey is widely known and consumed throughout Africa. The most widely used honeybee species is *Apis mellifera*, which is indigenous to Africa. Its primary natural ranges in Africa are savanna and semiarid lands, including in the GGW core area. Beekeeping is an integral part of sustainable natural resource management in the Sahel, where it has been practised since ancient times using traditional hives made of mud or woven grass<sup>58</sup>.

Honey producers must ensure that their bees have access to flowers, water and shelter/shade, and beekeeping therefore provides an incentive for farmers to protect and manage flowering trees, grasses and shrubs. This is a key reason why various projects including AAD has promoted beekeeping in communities: because beekeeping is highly valued, it helps ensure the appropriate management of restoration sites, the sustainable management of village woodlots, and actions to prevent forest fires. Beekeeping is feasible in arid and otherwise marginal environments when drought-resistant, nectar-bearing trees are able to reach deep

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<sup>55</sup> FAO 2022. Evaluation of the project “Action Against Desertification in support of the implementation of the Great Green Wall for the Sahara and the Sahel Initiative, the United Nations to Combat Desertification and Drought action plans in Fiji and Haiti, and South–South cooperation in the African, Caribbean and Pacific Group of States”

<sup>56</sup> Farmers lack skills and training on improved farming practices and management, including fodder production, harvesting, preservation and storage and value addition at farm level;

<sup>57</sup> FAO 2019 Climate change and the global dairy cattle sector: the role of the dairy sector in a low-carbon future. <https://www.fao.org/3/CA2929EN/ca2929en.pdf>

<sup>58</sup> It is mentioned that Ethiopia has long tradition of beekeeping and it is stated to be a deep-rooted household activity

water tables (Bradbear, 2004). Many flowering dryland trees are sources of nectar and pollen for bees and can be used in restoration. AAD and other projects and initiatives have selected species with honey-producing potential for use in large-scale restoration. *Acacia senegal*, *Acacia seyal*, *Balanites aegyptiaca* are some the key melliferous tree and shrub species used by the projects. Many lessons and advantages have been drawn from honey production:

(i) Honey contributes to nutrition and food security, and its production is an excellent way by which rural communities can generate and diversify incomes without harming ecosystems. Few microorganisms grow in honey; thus, sealed honey does not spoil and can be conserved for long periods. Other bee products, such as wax, pollen, propolis, royal jelly and venom, can also be sold for their medicinal and traditional uses.

(ii) Beekeeping benefits both biodiversity and agriculture by enhancing the pollination of wild and cultivated plants. This increases crop yields and thereby contributes to food security.

(iii) Beekeeping can be done in many places (e.g. cultivated land, forests, grasslands and wastelands) using minimal space, which reduces the risk of land-related conflict. Hence, beekeeping should be promoted and encouraged **systematically** along with other restoration initiatives<sup>59</sup>.

The following are the plant species supporting beekeeping and honey production: *Pterocarpus erinaceus*, *Ziziphus mauritiana*, *Dichrostachys cinerea*, *Dombeya quinqueseta*, *Acacia mellifera* and other *Acacia* species.

Improved beekeeping and honey production (in all countries) with modern hives and adequate technical support offer a sustainable source of income, while also providing important ecosystem services (pollination), and are immediately operational.

## Gum Arabic

Gum arabic (or acacia gum) is a hardened edible plant exudate obtained from the stems of *Acacia senegal* and *A. seyal* trees. *A. senegal* produces about 90 percent of the gum arabic sold commercially and produces superior-quality “hard” gum. Gum from *A. seyal*, also called gum talha, is more friable. *Acacia senegal* is one of the most important species used by the AAD project to restore degraded land.

Gum arabic is a common ingredient in the soft drinks industry, where (in essence) it binds the sugar to the drink, and it is an important component of chocolates and sweets, such as the Cuberdon, a famous Belgian candy. Gum arabic is the most commercially important plant based gum worldwide. Plants (either wild or domesticated) are the only sources of the product, which has never been synthesized successfully because of its complex composition and multiple biochemical properties. In most countries, women dominate the gum arabic sector, underlining the value of this product as an entry point in efforts to improve the livelihoods of women. *Acacia* forests and trees outside forests are not only important for producing gum arabic and other livelihood products: they also sequester large amounts of

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<sup>59</sup> Africa produced 188 966 tonnes of honey in 2016. Ethiopia is the continent's largest honey producer, at 47 700 tonnes (about one quarter of Africa's total production) in 2016 (FAO, 2018). Like many other African countries, however, Ethiopia falls far short of its full potential in honey production in terms of both product quality and yield, hindered by the type of hives used and poor processing and storage methods and facilities. A modern beehive produces up to 23 kg of honey per year, compared with 6 kg produced by traditional beehives. Beekeeping accounts for 1.3 percent of Ethiopia's agricultural GDP, and one in ten (10) rural households keeps honeybees.

carbon and provide important ecosystem services, including those that increase people's resilience against climate change, such as water infiltration, erosion control and soil improvement (through nitrogen fertilization and litter fall), and they also produce feed for livestock. The conservation, sustainable management and restoration of *Acacia* (agro-)forests, therefore, are important climate change adaptation and mitigation strategies.

Key data/information and lessons on Gum Arabic:

- 30% of all seedlings planted for restoration in the GGW core area in Burkina Faso, Mali and Niger were *Acacia senegal* trees as chosen by local communities;
- The annual growth rate of the global gum market between 2017 and 2021 was about 8.6%;
- African countries export 100 000 tonnes of gum arabic annually, mostly to Europe and the United States of America, and demand is increasing;
- More than 15 countries in sub-Saharan Africa produce gum arabic (NGARA, 2017), both for export and local use;
- Gum arabic can be harvested 6–8 years after tree planting and two weeks after the first scarification to initiate bleeding. A single tree can produce 100–1 000 g of gum per year, although individual trees in the Sudan have been observed to produce up to 10 kg per year;
- It is important to use appropriate techniques and equipment to harvest gum from acacia trees to avoid killing or damaging them and to maximize the quality of the gum. Harvested gum must be cleaned, dried and sorted (Poda et al., 2009).

## Balanites oil

*Balanites aegyptiaca* is a high-value multipurpose tree and also one of the most common species in the northern Sahel. It has considerable potential to improve soil quality by increasing nutrient levels. It is also very tolerant of drought and overgrazing, and it can survive up to two years without rainfall and live for up to 100 years.

Balanites oil is obtained from the kernels of the *Balanites aegyptiaca* fruit, which are also called “desert dates”. The oil is edible and also used in cosmetics, and it can be mixed with other oils to produce soap. The oil-extraction process produces a protein-rich oilcake suitable as animal feed. Balanites trees begin flowering and setting fruit after 5–7 years; maximum seed production occurs when the trees are 15–25 years old (Chothani and Vaghasiya, 2011). The balanites fruit is harvested from November to February; a single tree can produce up to 100 kg of fruit per year<sup>60</sup>. The following are the lessons learned from different initiatives on the Balanites oil value chain:

- One of the major challenges constraining oil production is the difficulty in cracking the kernels, which are very hard;
- Women's producer organizations are often involved in the production of Balanites oil through informal networks of collectors and producers;
- The oil is produced all across the Central and Western Sahel, from Chad to Senegal, and the local and international markets are growing. Prices can vary from USD 3.5 to USD 14 per litre in local markets but can reach USD 75 in international markets (as observed on

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<sup>60</sup> Evaluation of the project “Action Against Desertification in support of the implementation of the Great Green Wall for the Sahara and the Sahel Initiative and of the UNCCD action plans in Fiji and Haiti, and South-South cooperation in the Africa Caribbean and Pacific countries”

the websites of online retailers<sup>61</sup>). Balanites oil therefore has tremendous potential to generate foreign exchange and create employment, especially for women;

- Balanites oil is used in different domains and industries: Traditional medicines, cosmetics, food;
- Up to 100 kg of fruit can be harvested from a tree each year. the fruit is harvested from November to February, on trees from 15 to 25 years old;
- Unlike some other NTFP, Balanites fruit production is much lower in times of drought. The fruit, however, can be stored without spoilage for more than a year, so steady supplies can be assured.

## Moringa

Moringa (*Moringa oleifera*) is a fast-growing deciduous tree native to the Indian subcontinent. It grows well in various climates, including the Sahel, where it has been present for over a century and is considered non-invasive. The tree grows exceptionally quickly and is productive six months after planting. Tolerant of drier climates and poor soil quality, it can be cultivated throughout the year with the addition of compost or manure in either monoculture systems – with potential negative impacts on biodiversity, environmental services and water use – or intercropping on private plots. Moringa is one of the most nutrient-rich plants in the world, being a rich source of vitamins, calcium and iron, as well as antioxidants.

The three moringa-derived products currently marketed include dried leaves, powdered leaves and moringa oil. These products are well-known internationally, particularly moringa powder, which is deemed a superfood. All moringa-derived products have anti-inflammatory and antioxidant properties. The fruits and leaves are rich in protein, vitamins A, B and C, and minerals, while the leaves also contain calcium and iron. Moringa oil is also known for its anti-ageing properties and is high in protein and oleic acid (a monounsaturated fat beneficial for restoring the skin's natural barrier to pollution).

Some lessons learned include:

- Moringa-derived products have a substantial market size, estimated to be more than \$5.8 billion (2018);
- Demand for moringa is growing, especially in the US market, due to increasing consumption of dietary supplements and plant-based products, as well as growing awareness of the medicinal benefits of moringa-based products;
- Most moringa production occurs in India and Thailand, with India accounting for approximately 80% of global moringa supply;
- Moringa production in the Sahel region is estimated at \$10 million for powder and \$1 million for oil. Considering its production complexity, processing would need to be improved at scale to meet international quality standards;
- Local SMEs would also need to emerge to increase the Sahel's market share. Entrepreneurs could exploit the tree's rapid growth to expand their business and further develop the as yet limited production of Sahelian moringa;

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<sup>61</sup> See e.g., <https://www.toogga.com/>

- Moringa production can be increased substantially by irrigation and can be successfully integrated with vegetable gardening to promote diversification and counter-seasonal production
- However, as moringa is not endemic to the Sahel, there are some competitiveness challenges, especially when it comes to pricing. Nevertheless, the Sahel may be able to capture some of the growing market as it has an advantage over Asian moringa, which is sometimes of poor quality and contaminated with heavy metals, resulting in a failure to meet European market standards. This challenge provides a potential opportunity for GGW moringa to meet growing international demand, specifically when farmed naturally and without pesticides. In addition, investment in improved processing is required to deliver cost reductions and ensure that GGW products meet international quality requirements at scale.

## Baobab

Occurring in seasonally arid areas, the African baobab (*Adansonia digitata*) is present in all GGW countries (except Djibouti). Due to its tolerance of various precipitation levels, it can be found across the continent, from the drier Sahel to the savannahs of southern Africa, and it demonstrates excellent environmental resilience. Its non-flammable bark means it is resistant to wildfires and is not used for fuel, leaving it subject to fewer human pressures. However, baobab is vulnerable to animals, including livestock that graze on its roots, and elephants, which use the bark as a source of hydration when water is scarce. Baobab saplings are propagated naturally and can then be wild-harvested and cultivated in agroforestry systems without fertilizer. The baobab is slow-growing, requiring 25 to 60 years before being productive, but can then remain productive for more than 1,000 years. Its deep roots offer high potential for below-ground carbon sequestration. Baobab fruit powder is used locally in traditional beverages and for cooking and medicinal purposes. Internationally, it is deemed a “superfood” due to its antioxidant and anti-inflammatory properties, outstanding nutritional characteristics (vitamins C, B1, B2 and B6), and extensive health and prebiotic benefits (including promoting digestive health and balancing blood sugar levels). Baobab oil is used in cosmetics for its moisturizing, healing and rejuvenating properties. Powdered leaves are used locally as a meal condiment, snack or binding agent. However, further peer-reviewed scientific studies are required to demonstrate baobab’s outstanding properties. Despite its high potential at the international level, baobab has an emerging, relatively unstructured value chain, and production remains low. Current production of powder and oil are estimated at approximately \$10 million and \$1 million respectively<sup>62</sup>.

Although not yet mature, structuring of the baobab industry is under way. Its early development was boosted by sector support organizations, such as PhytoTrade, and more recently by the African Baobab Alliance. These organizations have played a crucial role in securing regulatory approval for baobab products to access vital global export markets, including the EU and North America (with the notable exception of China, largely due to the complexity of product registration). In addition, wider awareness of baobab’s benefits is required to increase demand. A 2018 survey of UK consumers showed that only 23% had heard of baobab, and only 6% had tasted it. Although a growing number of brands and ingredient companies are incorporating baobab into their products, the number doing so

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<sup>62</sup> WEF, 2022

remains small. From 2013 to 2017, there was 53% annual growth in new food and beverage products containing baobab, with Europe accounting for 52% of new product launches and the US for 35%. The African Baobab Alliance is central to the promotion of a sustainable industry. It aims to increase baobab's use in local and international markets, and support the adoption of a research agenda to validate baobab's health benefits, and ensure its members (representing an estimated 70% of the baobab powder industry) adopt common quality practices and standards.

## CONCLUSIONS FROM EXPERIENCE WITH NTFP VALUE CHAIN DEVELOPMENT

Lessons learned from different initiatives related to land restoration and NTFP value chains shown that, with sufficient support and investment, rural communities in the GGW core area have the potential to earn a decent income from land restoration while preserving the environment.

The NTFPs described herein are used and sold locally, but they also have significant national and international market value. Generating income and providing other benefits is crucial for ensuring the commitment of local communities to restoration. When adequate support is lacking, some external operators take unscrupulous advantage of rural communities, who tend to be "price takers" with little market power. Armed with relatively basic technical training, equipment and market knowledge, however, communities can increase the benefits they obtain by grading, conditioning and processing harvested raw materials into higher-value products.

From experiences and lessons learned, it is recommended to (1) mobilize the private sector to support the acceleration of land restoration in the GGW through a market-based approach; (2) emphasis on commercially viable tree crop value chains that show the highest potential for environmental and social impacts; (3) put communities, grassroots SMEs and ecopreneurs at the centre of the strategy to ensure local value capture, by adopting a management model that would give more responsibility to local/decentralized levels. Central authorities should provide leadership and support, and only perform tasks that cannot or should not be performed at a decentralized level; (4) develop NTFP value chains by linking NTFP groups to private enterprises that could help create and develop viable markets for the products; (5) collect all baseline data and set up a performant, quantitative and qualitative M&E system to monitor all aspects of project implementation, including progress, deviation from initially agreed upon planning, impact, etc. Go beyond pure metrics and focus on the processes, successes and failures of the project, and the reasons why these occurred; and (6) guarantee sustainability by building in specific, sustainability-focused mechanisms into interventions right from their conceptual phase. Secure (moral) ownership and buy-in from beneficiaries and build in sustainable financing mechanisms at all stakeholder levels.

## SUPPORTING SMALLHOLDERS IN NTFP AND FODDER PRODUCTION/PROCESSING/MARKETING

Constraints facing smallholders in NTFP markets: problems in meeting quality and quantity requirements, demand for regularity.

The smallholder actors in the NTFP sector face various constraints at different levels associated to quantity and quality requirements of the products that affect their access to the international markets and their competitiveness. These constraints are occurring at different levels of the value chains:

**Production/Collection:** (i) Weak structuring and organization of producers; (ii) Rudimentary or non-existent storage facilities; (iii) Challenges of resource regeneration; (iv) Overexploitation that could increase carbon emissions through degradation of vegetation; (v) poor governance of the resources, including lack of information on its potential, spatial distribution, uses and how the resources can be sustainably managed and used<sup>63</sup>; (vi) lack of capacities and technical and business skills of the producers/collectors; and (vii) lack or inadequate access to finance and investment;

**Processing:** (i) Rudimentary processing tools (lack of improved/efficient equipment and technology for processing NTFPs), some of which will increase carbon emission; (ii) Poor product quality/packaging; (iii) lack of norms and standards as well as evidence on the proprieties<sup>64</sup> of most of the NTFP; (iv) difficulties of access to packaging material.

**Trading/marketing:** (i) Markets not well developed structured and organised; (ii) insufficient marketing and branding of the products; (iv) lack of market information systems and poor market access and market intelligence; (v) insufficient information and guidance on the conditions and requirements to access regional and international markets.

In addition to the above-mentioned specific constraints, the NTFP actors also face various crosscutting constraints applying to all three levels mentioned above, which include: (i) insufficient financial sources and appropriate mechanisms to guide investments into NTFPs<sup>65</sup>; (ii) weak legal and regulatory frameworks suitable for the development of NTFP sectors; (iii) weak organization of actors at different levels of the value chain; As examples, Balanites oil is prioritized in almost all targeted countries, but the processing capacity and techniques used for its production are still very poor although market opportunities exist at national, regional, and international levels<sup>66</sup>. Similarly, for honey, the development of the value chain is constrained by very poor processing technologies and

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<sup>63</sup> A lack of robust baseline data on the number of trees, production levels and export volumes and values from GGW countries makes it difficult to accurately quantify the market potential of the prioritized value chains. Except for shea and gum arabica, few market studies have been conducted at the regional level. However, functionalities and pricing trends in leading markets allow some conclusions to be drawn on the value chains with the greatest potential. Based on the medicinal and nutritional properties of the prioritized tree crop value chains, the personal care and superfood markets are of most interest.

<sup>64</sup> Very little scientific data exists showing evidence of potential for balanites, which would be a prerequisite for accessing international markets given its current price point. Technologically advanced manufacturing processes and significant R&D investments (refining, quality etc.) would be required to achieve competitiveness.

<sup>65</sup> Particularly regarding financing, business development is hampered by insufficient capital. Currently, the actors concerned have not yet found a source of funding that can meet their funding requirements.

<sup>66</sup> With the exception of shea, GGW oils currently have limited competitiveness in the natural cosmetic oil market due to higher prices coupled with low productivity, quality and processing challenges, and limited market demand

production capacity in targeted countries, both of which affect the product quality and quantity to meet the increased demand for natural honey at national, regional and international level.

Options for improving the benefits that local communities derive from NTFP and fodder production, processing and marketing: organization, technical assistance and facilitation

A set of upgrading strategies based on specific observations and findings for each category of actors has been proposed to improve the benefits for local communities and SMEs. Among the recommendations and actions to improve the selected NTFP value chains include that: (i) the production of NTFPs should be improved by training, structuring and mobilizing of networks of actors including women's associations; (ii) enhancing NTFP processing and packaging to improve quality; (iii) facilitating access to information, finance and investment opportunities<sup>67</sup>; (iv) supporting value chain actors in the branding and commercialization of their NTFP (v); improving the enabling environment for the promotion of the NTFP including regulatory framework and norms and standards<sup>68</sup>.

Addressing the constraints: [technical assistance](#) to improve smallholder producer groups

Many of the constraints faced by the NTFP's actors require capacity building that will vary according to the type of the value chain. However, for almost all of the value chains, capacity needs to be built on the following:

- a. Farm establishment/production methods for plants that can also be produced on farm;
- b. Sustainable collection and harvesting methods and techniques;
- c. Use of accessories and protective equipment (honey);
- d. Improved and cost-effective processing technologies and equipment that are environment friendly;
- e. Branding and marketing of NTFP and fodder value chains;
- f. Storage methods for raw and processed products;
- g. Formation/establishment and management of associations and cooperatives
- g. Distribution, management, and protection of resource base to ensure that sustainability of NTFP production and conservation of carbon stocks are not jeopardized;

Through the technical assistance, the SURAGGWA programme will support the organizations of actors and their members, particularly the smallholder groups, to overcome the constraints they face. The technical assistance will be implemented through different actions: (i) Capacity building and technical trainings that will target specific thematic and groups of actors in order to provide specific responses and solutions to identified issues; (ii) Support to the structuring and organization of the actors. This technical assistance will focus on the support of the groups of actors and their organizations/groups at different levels to be professional, more organized and business oriented; The literature review and findings

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<sup>67</sup> Overcome regulatory complexity Access to finance remains a challenge and prevents local SMEs from expanding to meet domestic and international demand. SMEs need financing mostly for small capital expenditure or working capital requirements, which are well below the threshold of traditional investments.

<sup>68</sup> The political, regulatory and business environment in the Sahel is complex and if not adequately addressed could hinder the success of commercially viable land restoration projects in agricultural value chains. The role of supranational and national governments, as well as international organizations and development finance institutions (DFI). Efforts should ensure the active participation of all relevant stakeholders (from SMEs to international off-takers and NGOs) to advance the regional agribusiness ecosystem in support of the GGW.

from the consultations with the various actors have shown many weaknesses in the organization and the management of the groups; (iii) Coaching and mentoring. In addition to the previous interventions, the programme will provide to the groups of actors and their members with coaching and mentoring support. This will contribute not only to ensure the effectiveness of the technical assistance provided to the actor groups and their members but also to provide additional support as needed based on a participatory assessment of the interventions. The programme will be also supporting the establishment of platforms of actors at local/regional levels as well as national level. Contributions of the beneficiary groups, ownership of the interventions and responsibilities of the actors will be the strategic aspects of these interventions.

Organizational and technical capacity; facilitation of partnerships with responsible buyers, facilitation with financial service providers (the latter two are also a key element of exit strategy): Promoting Public private producer partnership 4P;

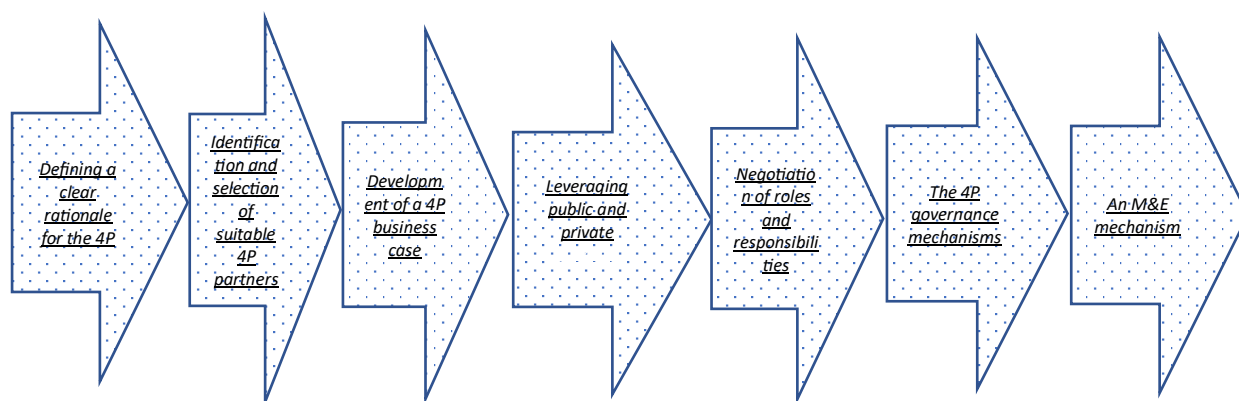
Under component 2, public private producer partnerships (4P) have been identified as a mechanism to promote partnership and to offer opportunities to the NTFPs value chain actors in a sustainable manner. A series of actions have been considered in the interventions to pave the way and support the design and implementation of the 4P.

*Public private producer partnership PPPPs (4P)* involve cooperation between a government, business agents and small-scale producers, who agree to work together to reach a common goal or carry out a specific task while jointly assuming risks and responsibilities, and sharing benefits, resources and competencies. 4Ps is a mechanism to include targeted groups in value chains (NTFPs) led by private companies, to facilitate access to markets, technical assistance, knowledge, technology and capital and finally, to generate significant employment opportunities.

Examples of guiding questions for designing and implementation of 4P: 1. What is the nature of the problem and why do we partner? 2. What does the partnership seek to accomplish? 3. Who are the partners? 4. What are the incentives for each party? 5. When will the partnership do what? 6. How will the partnership be implemented? 7. How will the partners communicate? 8. What will be the monitoring and evaluation mechanism of the partnership? 9. What if something does not go as planned? Etc.

*Contributions of the parties in a 4Ps mechanism:* In a 4P, each partner brings an essential feature or holds a specific responsibility; all partners share risks and benefits. The mutual benefits of partnership and the incentives for each potential partner should be reflected at an earlier stage of the process. In this regard, the final design and implementation of the 4Ps will be country specific as some key and specific questions and considerations need to be taken into consideration.

The responses to the questions above will provide the necessary elements for a consistent design and implementation of the 4P. It ensure that the interest of the parties have been captured and it provides mechanism for anticipation. The following steps needs to be followed in the design and implementation of a 4P programme:



(a) Defining a clear rationale for the 4P should be a priority from the outset. What is the nature of the problem (access to finance, access to technology, etc.)? Why is there a need for a partnership? Does it need to be a full-fledged 4P or is there a better alternative? What is the aim and what are the objectives to be achieved from and for the different parties involved in the partnership? To what extent are the interests (incentives) of different actors aligned towards a common objective? Is the partnership responding to a sustainable market demand? How are all parties going to profit/benefit from the partnership? Establishing the rationale requires an assessment of major opportunities and challenges to be addressed by the 4P, and the main incentives for each actor to commit to the partnership on a long-term basis for sustainability.

(b) Identification and selection of suitable 4P partners. Partners can be selected either through a competitive process, or through a careful investigation and due diligence process based on an agreed set of criteria. The selection process of the private sector partners will be guided by the needs and characteristics of the NTFP value chain actors. This process should also identify from the outset any areas requiring capacity-building for partners (particularly producers/collectors) so as to enable the latter to perform their expected roles within the partnership. During the programme design phase (country consultations) some private-sector partners<sup>69</sup> have already been identified and consulted, whether by the government through its agencies and institutions, or by FAO and the NTFP value chain actors based on previous experience and lessons learned. Private sector partners here refer to big buyers, off-takers and exporters of the NTFP intervening at national, regional or international levels.

(c) Development of a 4P business case. Once a clear rationale for a 4P is defined and suitable partners are identified and selected, the business case for the partnership needs to be developed and formalized. To this end, producers/collectors/aggregators/processors and companies should negotiate and agree on the business model that will bind their partnership together. This could be a contract-farming scheme, an out-grower scheme, a joint-venture shareholding scheme, a loose supply-based arrangement or a cooperative-led

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<sup>69</sup> Private sector partners identified during the programme formulation phase include Sahara Sahel Foods in Niger, and Toogga in Mauritania.

model, depending on the interest and the objectives of the parties involved in the business. Other partners involved in the NTFP value chains should also be included in the partnership and the conditions of success should be discussed and agreed upon.

(d) Leveraging public and private funding. The 4P business case should consider all financial requirements for making the partnership successful, including: public goods and services (such a transport, market infrastructure, training and capacity-building, etc.); semi-public assets (such as collective production or processing assets for small-scale producers); and the private working capital and assets of individual producers and private-sector partners. **A main tenet of the 4P model is to use public funds provided by governments and partners to leverage financing and investments from the private agribusiness and financial sectors, and producers/collectors themselves.** The aim is to ensure the long-term financial viability of the 4P.

(e) Negotiation of roles and responsibilities. Developing a partnership requires time to build trust among the partners, understand each partner's strengths and weaknesses, and learn how to interact most effectively. This is especially important at the start of a 4P, but requires continuous engagement; a re-adjustment after two or three trading cycles is usually required. In the negotiation process, the partners must agree on their respective roles and responsibilities, including each partner's share of risks and benefits. In addition to its facilitation role the programme will support the NTFP actors especially the smallholders in the preparation for the negotiation. This is very important to guarantee a fair and equitable win-win partnership.

(f) The 4P governance mechanisms: conflict mitigation, rules for communication and risk management. This component involves establishing the decision-making bodies and internal rules and regulations that all 4P partners (including the public sector and donors) agree to abide by throughout the partnership in order to respond to unforeseen circumstances and steer the 4P towards its objectives. Governance should also include a dispute-settlement mechanism and risk- mitigation measures. To some extent, the governance mechanism is an outcome of the negotiation process, but it often requires further adjustment during implementation.

(g) An M&E mechanism measuring success towards identified goals and business sustainability must also be agreed upon and implemented. Effective M&E serves both the programme's needs and the 4P business case, ensuring smooth and sustainable implementation. A good M&E mechanism captures progress towards set objectives and warns partners of deviations from their goals. The M&E mechanism should be participatory and inclusive.

A 4P should be seen as an entry point to scaling up project results through private-sector investment.

The main characteristics of a 4P (as opposed to PPPs) include the following: (a) Private-sector involvement is planned early on so that it becomes part of project design and implementation, and partnership results are systematically monitored and evaluated as part of the programme's results framework. (b) To the extent possible and relevant, the private-

sector partner is selected through a competitive or rigorous selection process that ensures transparency and objectivity, and meets the project's social, economic and environmental objectives. (c) Producers play an active role in the negotiations and partnership arrangements (both formal and informal), governance and monitoring. (d) A 4P is a true partnership in which each partner has clear roles and responsibilities, and shares risks and benefits. Private-sector partners are expected to allocate matching financial resources. (e) Linking with the private sector through a 4P ensures that interventions are sustained beyond the project lifetime because they follow business logic and that all involved parties benefit equitably.

To maximize the likelihood of achieving the planned objectives, the following issues need to be addressed throughout the 4P. (i) Create the space and time to meet and re-learn positive interactions, with the facilitation of the programme staff; (ii) Ensure that 4P stakeholders fully understand their role; (iii) Ensure that 4P actors have the capacity to perform their roles. This will be achieved through the different interventions in support to the NTFP value chains actors and their organizations; (iv) Ensure accountability and transparency; (v) Provide 4P facilitation (brokerage). This facilitation process should be run keeping in mind ownership and sustainability of the partnership beyond the programme lifetime.

#### Coaching of NTFP value chain actors/businesses

Business coaches are professionals who provide guidance, support, and advice to individuals and organizations to help them achieve their business goals. In addition to the specific capacity building activities, the project will programme with provide to the NTFP value chain actors/entrepreneurs/SME with coaching support that consist of a tailored and continuous support. In this regard, the programme will partner with specialised and experiences institutions that show a consistent presence in the country, especially at local level given the security conditions in some of the project implementations zones.

The identification and selection of partners (private or public) to collaborate with in the implementation of the coaching activities will be carried out by the programme staff in the respective beneficiary countries. This selection will be done in a rigorous manner using a set of specific criteria. The following are some of the characteristics of a business coach:

- ✓ Experienced: A good business coach has extensive experience and knowledge in various aspects of business (NTFP sector), such as marketing, finance, leadership, and strategy. They have a proven track record of success in their own business or have worked with successful businesses.
- ✓ Good listener: A business coach must be an active and attentive listener, able to understand the unique challenges and goals of their clients/coaches. They listen without judgment and provide objective feedback for improvement.
- ✓ Empathetic: A business coach should have a strong sense of empathy to be able to understand their client's perspective and offer tailored solutions that fit their needs.
- ✓ Communication skills: A good business coach has excellent communication skills, both verbal and written. They can clearly and effectively communicate complex concepts and ideas to their clients.

- ✓ Strategic thinker: A business coach is a strategic thinker who can identify opportunities and risks for their clients and develop effective strategies to address them.
- ✓ Accountability: A business coach helps their clients stay accountable for their actions and decisions, encouraging them to set and achieve their goals.
- ✓ Flexible and adaptable: A business coach must be able to adapt their coaching style and approach to meet the unique needs of their clients.
- ✓ Trustworthy: A good business coach maintains confidentiality and builds a trusting relationship with their clients, providing a safe and supportive environment for them to share their challenges and concerns.

In general, a successful business coach must possess a unique combination of knowledge, experience, empathy, and communication skills to help their clients achieve their goals and succeed in their business.

The process of conducting coaching for a business can vary depending on the needs and goals of the business. However, the following steps provide a general framework for conducting coaching for a business in the NTFP value chains: (i) Identify the coaching needs: start by identifying the areas where coaching is needed. This could be in the form of identifying skills gaps or performance issues that need to be addressed (quality of the product, branding and marketing, access to efficient technologies and finance, etc.); (ii) Set goals: Once the coaching needs have been identified, set specific goals for the coaching program. The setting of the goals should be conducted in a participatory manner (accountability and ownership). Goals could be related to increasing productivity, improving communication skills, access to profitable markets, branding and marketing or enhancing leadership abilities; (iii) Select a coach: Choose a coach who has experience in coaching for the specific needs of the business. The coach should be someone who has a good understanding of the business culture and values (refer to the section of the characteristics of a business coach); (iv) Develop a coaching plan: Develop a detailed coaching plan that outlines the objectives, methods, and timelines for the coaching program. This plan should be tailored to the specific needs of the business; (v) Implement the coaching program: Implement the coaching program according to the plan. This could involve one-on-one coaching sessions, group training, or a combination of both depending on the specificity and the needs of the businesses; (vi) Monitor progress: Regularly monitor the progress of the coaching program to ensure that goals are being met. This could involve setting up regular check-ins with the coach and employees to track progress and make adjustments to the coaching plan if needed; (vii) Evaluate results: Evaluate the results of the coaching program to determine its effectiveness. This could involve gathering feedback from employees, analyzing performance data, and comparing the results to the original goals set for the program. A set of SMART indicators agreed in the planning process will be determinant in the evaluation of the results; (viii) Make adjustments: Based on the evaluation results, make any necessary adjustments to the coaching program to further improve its effectiveness. By following these steps, businesses can create a successful coaching program that addresses the specific needs of their employees and helps them achieve their goals in a sustainable manner.

## CHAPTER VI – ACCESS TO FINANCE – OUTPUT 2.3

This feasibility study assesses the access to finance landscape for the SURAGGWA programme. It is divided into four sections. First, in Section A, it takes stock of existing projects in Great Green Wall countries related to enhancing access to finance. It particularly takes note of the features of the Green Climate Fund-financed iGREENFIN project, with which there are complementarities. It identifies specific entry points for SURAGGWA given iGREENFIN's activities and gaps, particularly with respect to capacity development to increase take-up of credit to be deployed under iGREENFIN. Beyond iGREENFIN, it describes other relevant regional and country-specific projects in the region. Second, Section B summarizes the main constraints to access to finance in the region overall using literature and information collected during field visits. Third, Section C provides a background on the financial landscape in the programme countries. It summarizes each country's position on financial sector health, financial inclusion, role of the agriculture sector and country specific access to finance barriers. Finally, Section D assesses the feasibility of a particular approach to enhance access to financing, "Value Chain Financing," and describes its advantages and disadvantages. It concludes that while it is unfeasible in the immediate term, the programme's activities can lay the groundwork for its adoption as an additional source of finance in the medium term.

### SECTION A: SUMMARY OF INTERNATIONAL FINANCIAL INSTITUTIONS' ACCESS TO FINANCE-RELATED PROJECTS IN GREAT GREEN WALL COUNTRIES

SURAGGWA will build upon past and ongoing projects funded by various technical and financial partners. Several regional projects are particularly relevant for SURAGGWA, with respect to complementarities and common objectives, co-financing and scaling up. As background, it is also important to note that BNDA Mali -- Mali's agricultural development bank -- will be providing USD 10 million in parallel financing to the project, primarily for credit to the agriculture sector, including for NTFPs.

#### IGREENFIN I and II (2022-2028)

SURAGGWA will build upon and coordinate with the GCF-financed and IFAD-led project Inclusive Green Financing Initiative (IGREENFIN): Greening Agricultural Banks & the Financial Sector to Foster Climate Resilient, Low Emission Smallholder Agriculture in the Great Green Wall (GGW). IGREENFIN covers Burkina Faso, Côte d'Ivoire, Ghana, Mali and Senegal for its first two components (concessional loans and technical assistance for green business projects). It provides regional capacity development support to Burkina Faso, Chad, Djibouti, Eritrea, Ethiopia, Mali, Mauritania, Niger, Nigeria, Senegal and Sudan. With total financing of 177 million euros, the project is financed primarily by the Green Climate Fund (104 million Euros).

The main objective of IGREENFIN is to build and scale up the resilience and adaptive capacity of farmers' organizations (FOs), cooperatives and micro, small and medium-sized enterprises (MSMEs) in these countries by removing key barriers to farmers' access to

financial and non-financial services that support the adoption of best climate change adaptation and mitigation practices and solutions. IGREENFIN intends to directly build the resilience and adaptive capacity of 378,600 smallholder farmers organized around 1500 MSMEs and 2500 farmer organizations or cooperatives, and approximately 2.49 million indirect beneficiaries in the five selected countries (Burkina Faso, Côte d'Ivoire, Ghana, Mali and Senegal).

Component 2 of IGREENFIN sets up a green business financing facility that will offer special lines of credit for green business projects by farmer's organizations (FOs), women and youth organizations, cooperatives and MSMEs. National agricultural banks will operate these credit lines. The local agricultural banks present in the SURAGGWA countries include the Agricultural Bank of Burkina Faso, Banque Nationale du Développement Agricole Mali and Banque Nationale du Sénégal. Component 3 on technical assistance will target the GCF Direct Access Entities such as the Banque Agricole du Sénégal, Attijariwafa Bank and the Centre de Suivi Ecologique (CSE). It will also work with the Central Bank – the West African Monetary Union (WAMU) – to provide a supportive enabling environment for green finance. The project has not started implementation as of December 2022. Table A2.1 provides financing allocations under the Green Business Financing Facility across the different countries under IGREENFIN.

Table A2.1: IGREENFIN FINANCING UNDER COMPONENT 1 (GREEN FINANCING FACILITY -- CREDIT LINES + TA) TO SURAGGWA TARGET COUNTRIES

PHASE 0 COUNTRIES (2019 - )		
		Component 1 Financing (Millions USD)
Niger	Niger	9.32
PHASE 1 COUNTRIES (2023 - )		
Burkina Faso	Burkina Faso	18.47
Mali	Mali	18.92
Senegal	Senegal	26.01
PHASE 2 COUNTRIES (Indicative)		
Chad	Chad	37.56
Mauritania	Mauritania	35.07
Djibouti	Djibouti	36.31
Nigeria	Nigeria	100.86

Notes: Financing amounts for Phase 2 countries are indicative based on the IGREENFIN 2 Concept Note. Component 1 funding includes the proposed GCF financing amount plus the total co-financing amount divided among Phase 2 countries (7).

SURAGGWA will coordinate with IGREENFIN to address the demand and supply side barriers to access to finance. From the demand side, it will target its interventions on support around financial literacy, awareness raising and financial record keeping, commonly challenges for smallholder farmers, MSMEs and farmers organizations. The iGREENFIN

project does not have any activities targeting the financial literacy or other demand side capacity in the region. In this way, SURAGGWA will fill an important gap. On the supply side, its interventions will strengthen the capacity of the selected national agricultural banks and other financial institutions to disburse credit to the potential beneficiaries, develop tailored financial products and services specific to green finance and partner with entities to use innovative channels such as digital finance and e-weather advisory to enhance the repayment of loans. While IGREENFIN provides technical assistance to larger financial institutions (central and national banks), it does not target microfinance or other rural finance institutions. The latter group often fill gaps in bank branch penetration in rural areas and are the providers of credit in more remote areas. SURAGGWA will target its technical assistance to this group as well.

While targeting more specific value chains – agriculture, and in particular, nontimber forest products, SURAGGWA will also benefit from the strengthened enabling environment that IGREENFIN aims to build through its cooperation with the West African Central Bank.

#### World Bank West Africa Food System Resilience Program (FSRP) Phase I and II

The project uses matching grants to facilitate access to financing for value chain players' activities. Value chains include cowpeas, maize, market garden crops (Burkina Faso), rice, maize, and onions (Mali) and cowpeas and onions (Niger). The recipients of matching grant subprojects would be farmers groups and enterprises operating on targeted value chains for each country. A selection committee will select and approve subprojects. Beneficiaries will provide cash contributions of up to 20% for subprojects financing.

For value chain entrepreneurs, including youth and women, this subcomponent will provide support to invest in activities such as aggregation centers, improved cold-chain infrastructure that reduce food loss and waste (FLW), storage facilities to reduce post-harvest losses, warehouse receipt systems, agro-processing, and agricultural trade services, all aimed at integrating the selected value chains with regional markets.

#### Great Green Wall Climate Change Adaptation Regional Support Project

The project aims to improve access to best practices, foster innovation and digital transformation and facilitate cross-learning across Great Green Wall countries for enhanced resilience to climate change impacts. It is financed primarily by the Global Environment Facility (GEF-7) and executed by IFAD.

#### Selected Country-Specific Projects

##### *Agri-jeunes Tekki Ndawñi in Senegal (2019 - 2025)*

The IFAD-financed Agri-Jeunes project facilitates access to finance for 15,000 young agripreneurs in Senegal who have received business coaching and prepared business plans that the project deems feasible. To reduce institutional risk, the project will help implement two cost-sharing instruments: agricultural insurance and mutual guarantees as well as customize financial products to the demand of young agripreneurs. With respect to the

mutual guarantees, it serves as a risk pooling fund or cooperative that guarantees the loans of all the young people who subscribe to it. It covers the risk of their default. In order to subscribe to the MC (mutuelles de cautionnement), each young agripreneur must contribute between 0.5 and 1% of the amount borrowed to the fund. The project then replenishes the fund by quintuple its capitalization. The project aims to set up 10 such MCs. Each MC will be housed at a financial institution and will generate income from the interest earned that will be capitalized annually.

*Rural Youth Vocational Training, Employment and Entrepreneurship Support Project (FIER) in Mali (2013 - 2023)*

The Access to Finance component in this IFAD-funded project is based on a shared cost and risk scheme. Under the scheme, young rural entrepreneurs contribute between 10% and 40% (including 30% through financial institutions) toward their microenterprises. Vocational training through the project is a prerequisite for receiving financing and entrepreneurs must enter into an in-principle agreement to receive the subsidy component. If the entrepreneur repays the loan on time, s/he receives the subsidy in the form of a bonus at the end of the repayment period. The subsidy is received in the form of a guaranteed deposit. The mid-term review (MTR) of the project highlights that after the end of the first loan period and receiving subsidy amount, beneficiaries' use of financial services declined. The MTR suggests establishing a mechanism through which the retroceded grant could be used partially as a guarantee for subsequent loans.

The project piloted an innovative approach to use crowdfunding by Malian diaspora in France to leverage remittances as complementary funding for rural entrepreneurship in Mali. The rationale behind this is that remittances, as a stable source of funding, can be channeled into productive activities through refinancing to Microfinance Institutions.

*Agro-Climatic Resilience in Semi-Arid Landscapes (ACReSAL) Nigeria (2022-2028)*

The World Bank-financed ACReSAL project will set up community revolving funds (CRFs) in Nigeria, similar to those implemented successfully in East Africa, to support enterprises and community interest and farmer groups registered under and supported by ACReSAL to invest in climate smart rainfed crop interventions. In addition, the project will address barriers faced by women in accessing credit for irrigation equipment in particular. It will provide technical assistance and build capacity to link beneficiaries to credit access. It will review credit screening and score cards used by service providers to ease barriers to women's access to finance and especially asset-based financing.

*Inclusive Finance in Agricultural Value Chain Project (INCLUSIF) Mali (2018-2024)*

The IFAD-financed INCLUSIF project in Mali aims to improve financial inclusion for smallholders and small and medium agrifood enterprises in Mali. INCLUSIF aims to bring 440,000 smallholders and 360 agricultural professional organizations into the banking system, build five financial products in the areas of savings, credit and micro-insurance for the Malian financial sector and partner with rural financial institutions to build a rural credit portfolio of CFAFs 20 billion during the project lifecycle. It also aims to build the capacity of

smallholders and enhance incomes of entrepreneurs and micro-enterprises. The project amount is USD 105.5 million, of which IFAD is financing USD 45.7 million. INCLUSIF covers some of the SURAGGWA intervention states such as Kayes, Koulikoro, Ségou, Mopti, Tomb. However, it does not cover the GGW states of Tombouctou, Kidal and Gao.

#### *PAFA Burkina Faso (2019-2026)*

The “Projet d'appui à la chaîne de valeur Agricole” (PAFA) and PAFA-4R project aims to s improve food security and incomes of farmers engaged in production and value addition of supported value chains (nontimber forest products and fish farming) in the Southwest, Hauts-Bassins, Cascades and Boucle du Mouhoun regions, which are outside the country’s GGW zone. The project cost is USD 129.9 million, of which, USD 66.9 million will be financed by IFAD and USD 35.2 million by the African Development Bank.

#### *Burkina Faso - Support Project for Establishing an Agribusiness Bank (PACBA) (2018-2022\*)*

Under PACBA, the African Development Bank aims to improve access to finance in the agriculture and agribusiness sectors through greater capitalization of the recently established Banque Agricole du Faso (Agricultural Bank of Burkina Faso) (BADF) and the establishment of an agricultural insurance system and a warrantage mechanism.

## SECTION B: CONSTRAINTS TO ACCESS TO FINANCE IN THE GREAT GREEN WALL REGION

Financial inclusion is a challenge in most Great Green Wall countries, including with respect to mobile money. In Djibouti and Niger in particular, very few people have either a bank account or even mobile money. In Senegal and Nigeria, digital payments are better developed than in other countries but still remain underdeveloped.

Formal financial sector health is another barrier to financing. Defaults are extremely high in many countries, making it risky for financial institutions to lend. Though we do not have data available on default rates by sector – or particularly for the agriculture sector or NTFP value chains – we use the economy-wide nonperforming loan rate as a proxy.

**Table 33: Selected Finance Indicators for SURAGGWA (2021 or latest available data)**

	Lending interest rate (%), average	Nonperforming Loans (NPLs) as a % of Gross Loans to all sectors	Financial Inclusion (% of adults with a bank account or mobile money)
Burkina Faso	6.3%	9.0%	36.11%
Djibouti	11.26%	13.3%	12.27%
Mali	5.10%	10.70%	43.50%
Mauritania	17%	21.5%	20.87%
Chad	9.30%	25.90%	21.76%

Niger	5.10%	12.60%	15.52%
Nigeria	11.50%	5.3%	45.32%
Senegal	5.10%	13.30%	55.96%

Sources: Central Banks, WDI, IMF Balance of Payments, Countries' Article IV Consultations

**There are several barriers to access to finance in the SURAGGWA countries, both for the users and suppliers of finance.** Figure 1 summarizes these barriers.

**Figure 22: Constraints to Access to Finance in the Sahel**

Demand Side	Supply Side	Cross Cutting
<ul style="list-style-type: none"> <li>• Limited access to financial services, especially in rural areas</li> <li>• Lack of Collateral</li> <li>• High interest rates</li> <li>• Cumbersome documentation requirements</li> <li>• Lack of awareness and information around financial offerings</li> <li>• Low financial literacy</li> </ul>	<ul style="list-style-type: none"> <li>• High risk of default and high risks</li> <li>• Lack of information on credit worthiness</li> <li>• Lack of documentation of potential clients (no land titles, assets or credit history)</li> <li>• Limited understanding of the agriculture sector</li> <li>• Complex processes for assessing risks</li> <li>• High transaction costs</li> </ul>	<ul style="list-style-type: none"> <li>• Security risks in the Sahel</li> <li>• Limited understanding of climate related risks and their impact on finance</li> <li>• Low physical bank branch penetration</li> <li>• Lack of infrastructure</li> <li>• Limited digital infrastructure</li> <li>• Lack of transparent regulations and policies</li> </ul>

Source: Authors' compilation using literature and information gathered during field visits.

Demand-side barriers to access to finance in agriculture include limited access to financial services in rural areas, lack of collateral, security risks and high interest rates. Financial institutions cited several barriers to lending to the sector including the long harvest cycles for crops or tree species, unviable or absent business plans from potential borrowers and lack of guarantees due to no land titles, assets or credit history. Supply-side constraints to lending to the agriculture sector include also a limited understanding of the agricultural sector, financial institutions' perceptions of high risks, complex processes for assessing credit and risks and high transaction costs.

## SECTION C: BACKGROUND ON FINANCIAL SECTOR IN GREAT GREEN WALL, BY COUNTRY

The feasibility study assesses the access to finance situation for the eight programme countries: Burkina Faso, Chad, Mali, Mauritania, Niger, Nigeria, Senegal and Djibouti. Four of the countries (Burkina Faso, Niger, Senegal and Mali) are part of the West African Economic and Monetary Union (WAEMU) and thus have the same monetary policy.<sup>70</sup> Overall, some of the other trends that emerge is low productivity in the agriculture sector, low financial inclusion in countries except Senegal, a gender gap in access to financial products and services, and access to finance being cited as a constraint for the agriculture sector and micro, small and medium enterprises (MSMEs). Mobile money or digital payments exhibit

<sup>70</sup> <https://www.uemoa.int/en/about-uemoa>

high potential to reach the unbanked though regulatory, infrastructure and policy barriers lead it to being underdeveloped.

## Burkina Faso

**In 2021, value added from Agriculture, Forestry and Fisheries accounted for 17.5% of the country's GDP while the sector accounted for 26% of employment in 2019.**<sup>71</sup> Agriculture is the largest economic sector (30% of GDP), and the most widespread economic activity; farmers make up the largest single economic group of economically active adults, around 80% of the labor force.<sup>72</sup>

**Banking dominates the financial sector, with a fragmented landscape and low credit to the private sector.** Overall, the Burkinabe banking system was capitalized though banks prefer to invest in West African or regional and domestic government bonds rather than lend to the private sector. In 2017, the financial sector provided domestic credit (public and private) accounting for 34.07 % of GDP. The ratio of private credit to GDP was 31.3% in 2017, an increase from 30.4% in 2016. Credit also remains concentrated to a few large borrowers and sectors of the economy.<sup>73</sup>

**The banking and microfinance sector remain concentrated in the hands of a few players.** Burkina Faso's banking sector is made up of 14 banks. Of these, the top five banks made up more than 70% of total assets as of June 2018. The three largest banks—Coris Bank, EcoBank, and Bank of Africa hold 55 percent of the total assets.<sup>74</sup> The microfinance sector consists of 133 MFIs, with 130 of these being cooperatives. The microfinance sector is highly concentrated, with one MFI—Réseau des Caisses Populaires du Burkina, or RCPB—representing more than 73 percent of the clients and 70 percent of the deposits. While large MFIs appear to be in good health, a majority of medium and small MFIs are struggling to operate, with some having negative equity and/or negative returns.<sup>75</sup>

**Financial inclusion remains low.** Although the government adopted a financial inclusion strategy in 2017 to enhance mobile banking, microfinance, and the reduction of administrative barriers, the operationalization of the strategy remains lagging. In 2017, 36,1% of adults aged 15 and over had a bank account or reported using mobile money.<sup>76</sup>

**Access to finance is a constraint for agriculture, and NTFP value chains such as fodder.** Limited access to finance is particularly harmful for the development of agriculture/agribusiness. An IFC report cites infeasible collateral requirements, interest rate caps on the banking sector —at a high 15%, bank's preference to invest in government securities rather than the private sector due to payment guarantees in the former and

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<sup>71</sup> World Development Indicators, World Bank. Accessed February 20, 2023.

<sup>72</sup> Burkina Faso: Priorities for Poverty Reduction and Shared Prosperity - Systematic Country Diagnostic. March 2017. Washington, DC: World Bank

<sup>73</sup> IMF Article IV Consultation for Burkina Faso, 2019

<sup>74</sup> IFC Burkina Faso Country Private Sector Diagnostic. <https://www.ifc.org/wps/wcm/connect/f45fd7a3-f8be-430b-bd9f-eb958ebe2d89/201907-CPSD-Burkina-Faso-EN.pdf?MOD=AJPERES&CVID=mNf5Bxk>

<sup>75</sup> IFC Burkina Faso Country Private Sector Diagnostic. <https://www.ifc.org/wps/wcm/connect/f45fd7a3-f8be-430b-bd9f-eb958ebe2d89/201907-CPSD-Burkina-Faso-EN.pdf?MOD=AJPERES&CVID=mNf5Bxk>

<sup>76</sup> World Bank, Global Financial Inclusion Indicators (Global Findex), accessed February 20, 2023

limited access to bank branches are key barriers to accessing finance.<sup>77</sup> In the context of NTFPs, a background study on the fodder and value chain identifies the lack of financing or capital as a reason behind low adoption of forage production in Burkina Faso. Women also find it hard to access credit for fodder production since typically, men are household heads and control resources.<sup>78</sup>

## Chad

**Chad exhibits low financial depth with a few banks dominating the landscape.** Nine commercial banks make up total assets equaling 19% of the GDP. Overall, banks' asset quality remains poor. In 2018Q3, 28.9% of gross banking loans were in arrears. The Commercial Bank of Tchad (CBT) and Banque Commerciale du Chari (BCC) account for about 45% of total assets and 40% of all government T-bills and T-bonds. The government pays a large role in at least two of the major banks. Beyond banks, there are 100 microfinance institutions (MFIs) but their activities remain limited.<sup>79</sup> The government aims to scale up access to finance through expanding microfinance and mobile money.<sup>80</sup>

**Smallholders and MSMEs remain largely excluded from the financial sector.** Lending by the banking system is concentrated on a few large enterprises and some SMEs with business relationships with the larger corporations. Financial products and services are limited and not adapted to SME's needs. The absence of long-term resources limits the ability of banks to finance investment needs. Further, banks do not have access to reliable financial or credit information on potential borrowers.

**Financial inclusion remains extremely limited.** In 2017, only 12.4% of adults (age 15+) had access to a bank account or mobile money. The gender gap in access to an account was about 4 percentage points. Similarly, only 8% of the youth had a formal account.<sup>81</sup> Access to microfinance also remains at an "embryonic stage."<sup>82</sup>

**Investment and Finance in Gum Arabic have high potential for scaling up.** A 2022 World Bank Report highlighted the potential for private investment in the gum Arabic value chain given Chad's comparative advantage in it.<sup>83</sup> In 2019, Chad exported 6.7% of global gum Arabic exports, or USD 21.27 million. However, only the early stages of the gum Arabic value chain occur in Chad and processing and manufacturing does not take place in the country. It

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<sup>77</sup> Ibid.

<sup>78</sup> Study on "FODDER AND FORAGE SEED VALUE CHAIN ANALYSIS IN THE SAHEL REGION" March 2021. Prepared by KALRA as a background report for Action Against Desertification.

<sup>79</sup> IMF Article IV Consultation for Chad, 2019. Annex 5: Macro-Financial Linkages in Chad

<sup>80</sup> IMF. 2021. "CHAD--REQUEST FOR A THREE-YEAR ARRANGEMENT UNDER THE EXTENDED CREDIT FACILITY—PRESS RELEASE; STAFF REPORT; AND STATEMENT BY THE EXECUTIVE DIRECTOR FOR CHAD," IMF Country Report No. 21/267

<sup>81</sup> World Bank, Global Findex, 2017.

<sup>82</sup> IMF Article IV Consultation for Chad, 2019.

<sup>83</sup> Tchana Tchana, Fulbert; Noumedem Temgoua, Claudia; Kuate Fotue, Landry

Brice; Aboudrahyme Savadogo. *Chad Economic Update : Resilience in Uncertain Times - Harnessing Agriculture and Livestock Value Chains (English)*. Washington, D.C. : World Bank

Group. <http://documents.worldbank.org/curated/en/09944510512222517/P17725406284230130938f02d6a518fd2be>

is currently the second largest producer and exporter of crude gum Arabic, trailing Sudan, highlighting the potential for scaling up the value chain particularly through higher value added activities.

## Senegal

**Agriculture, Forestry and Fisheries play an important role in the economy, though they exhibit low productivity.** Agriculture, Forestry and Fisheries made up about 15% of value added in GDP in 2019-21 though it accounted for 30% of total employment in 2019, highlighting its low productivity.<sup>84</sup> Agriculture only accounted for 3% of total loans in June 2021.<sup>85</sup>

**The banking sector remains relatively resilient, even in the aftermath of the COVID-19 pandemic.** Asset quality shows an improving trend; Gross NPLs to total loans declined from 13.3 % in December 2020 to 12.9% at end-June 2021. Credit to the economy grew 8.1% year on year as of end June 2021, driven by an increase in medium-term loans to public entities and energy sector firms.<sup>86</sup> Overall, domestic credit to the private sector was about 29.35% of the GDP in 2020.<sup>87</sup> Average interest rates on loans have been declining over time but remain high; they have declined from 8.2% in 2015 to 7.2% in 2021.

**Several studies identify access to finance as a major constraint, particularly for MSMEs that make up 90% of the economy.**<sup>88,89</sup> Further, financial inclusion remains relatively high compared to other Sahelian countries. In 2021, 56% of Senegalese adults (age 15+) had a bank account or mobile money. A gender gap in account ownership existed with only 50% of women having a bank account.<sup>90</sup> The government has taken several steps to enhance access to credit and financial inclusion, most notably through the development of a national financial inclusion strategy and extending the credit bureau's access to data. Special funding arrangements, such as the Fonds de Garantie des Investissements Prioritaires (FONGIP) – a partial credit guarantee program designed to reduce the credit risk for banks and microfinance institutions financing MSMEs – aim to lower the credit risk for lending to MSMEs.<sup>91</sup>

**Financial technologies and digital payments exhibit high potential but remain untapped to a large extent.** The fintech sector, which in many emerging markets has fueled access to financial products, has untapped potential in Senegal.<sup>92</sup>

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<sup>84</sup> World Bank, World Development Indicators database. Accessed March 7, 2023.

<sup>85</sup> BCEAO

<sup>86</sup> IMF Senegal Article IV Consultation, 2021.

<https://www.imf.org/en/Publications/CR/Issues/2022/01/14/Senegal-2021-Article-IV-Consultation-Fourth-Review-Under-the-Policy-Coordination-Instrument-511932>

<sup>87</sup> World Bank, World Development Indicators database, Accessed March 7, 2023.

<sup>88</sup> World Bank “Strategic County Diagnostic” (2018), MCC Senegal Constraints Analysis Report (2017), IFC “Private Sector Diagnostic: Creating Markets in Senegal” (2021) and Republic of Senegal “Plan Sénégal Émergent: Plan D’Actions Prioritaires 2019-23” (2018).

<sup>89</sup> <https://www.fongip.sn/presentation/>

<sup>90</sup> World Bank, Global Findex, 2021

<sup>91</sup> <https://www.fongip.sn/>

<sup>92</sup> UNSGA: <https://www.unsgsa.org/country-visits/fintech-financial-health-and-msmes-drive-senegals-financial-inclusion-agenda>

## Mauritania

**Financial inclusion remains low and the gender gap is larger than other countries.** 21% of adults (age 15+) reported having a bank account at a formal financial institution in 2017, lower than in most other SURAGGWA countries (36% in Burkina Faso and 43.5% in Mali) except Niger. The gender gap in financial inclusion is also higher in Mauritania relative to comparator countries. 15.5% of women aged 15+ reported having an account vs. 26.3% of men.<sup>93</sup>

**Individuals report borrowing money, but largely through informal sources.** Nearly 45% of adults reported borrowing money during the past year but a large share was from informal sources.<sup>94</sup> In 2021, credit to the private sector accounted for 9.4% of the economy. The bank lending interest rate is about 7%.<sup>95</sup>

**Agriculture and allied sectors account for a fifth of the economy and third of employment; they remain informal.** Agriculture, forestry and fishing accounted for 21.7% of the country's GDP but 31% of employment in 2019, suggesting low productivity, informality, and potential self-consumption. In 2020 and 2021, the AFF sector contracted by 2.6% and 3.8% respectively. The economy is highly informal, especially in agriculture, artisanal fisheries/mining and animal husbandry. Mauritania's main exports are iron ore, fish, gold. Extractive industries – in particular iron – make up a large proportion of its revenue.

**Financial sector health is weak.** Non-performing loans (NPLs) as a % of total loans rose to 26% in September 2021 vs 22% at end-2019. Asset quality is weaker than comparator countries (Algeria, Tunisia and Morocco). Although banks remain well-capitalized, the overall capital adequacy ratio declined to 21% in September 2021 against 25% at end 2019. The Central Bank (BCM) has 18 registered banks, of which 7 were Islamic Banks and 5 were foreign owned banks. The BCM has 30 Microfinance institutions registered with them, with 2 new MFIs registered in 2021.<sup>96</sup>

## Djibouti

**Overall, the Djiboutian financial sector remains fragile, and financial inclusion is low.** The demand-side constraints to accessing credit include high interest rates and lack of collateral. According to the Central Bank of Djibouti, 10 conventional banks, 3 Islamic Banks and 4 Microfinance Institutions operate in Djibouti as of August 2022.<sup>97</sup>

**The health of the financial sector remains weak and interest rates remain high.** First, the ratio of nonperforming loans to gross loans was 18.2% in 2019, an increase of about three percentage points since 2013 indicating worsening asset quality. The average lending

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<sup>93</sup> World Bank, Global Findex, 2017 and 2021

<sup>94</sup> World Bank, Global Findex, 2017

<sup>95</sup> IMF Article IV for Mauritania, 2021

<sup>96</sup> [https://www.bcm.mr/IMG/pdf/rapport\\_annuel\\_2021\\_v-fr.pdf](https://www.bcm.mr/IMG/pdf/rapport_annuel_2021_v-fr.pdf)

<sup>97</sup> [Banking Institutions – Central Bank of Djibouti \(banque-centrale.dj\)](https://www.banque-centrale.dj/)

interest rate was 11.26% in 2017.<sup>98</sup> Interest rates for personal loans range between 8.5% and 11.5%. Interest on loans to enterprises or private entrepreneurs depend on the loan amount and type of credit. For instance, credit below USD 56,000 incurs interest rates between 8 and 17%. For medium and long term credit, the interest rate ranges between 6% and 15%.<sup>99</sup>

**Access to credit remains weak, but half of the disbursed credit is for equipment.** First, Djibouti ranks 132 out of 190 countries in getting credit, with a score for ease of getting credit below that of the regional average for Middle East and North Africa and below Egypt (ranked 67<sup>th</sup>). Second, domestic credit to the private sector only made up 21% of GDP in 2020. As of December 2021, 66% of the total credit in the economy was denominated in US Dollars while only about one-third was in Djiboutian Francs. The credit was used largely for equipment, with 52% of credit cited for equipment loans. The majority of credit, about 43%, was long term. Taken together, short and medium term credit made up 37% of total credit.

**Financial inclusion remains low for individuals and firms.** Only 12.3% of adults, aged 15 and over, reported having a bank account or mobile money. Although a small share of firms report facing difficulties in accessing finance in Djibouti, a large number of firms remain disconnected from the financial sector altogether. According to the World Bank's Enterprise Survey (2013), only 24.3% of Djiboutian firms reported using banks to finance investments. Nearly 80% of investments were financed internally while 13.8% were financed by banks. Only 11.8% firms identified access to finance as a major constraint, lower than in the Middle East and North Africa region overall where 25.6% of firms identified it as a major constraint.<sup>100</sup> One possible reason for the lower share of Djiboutian firms pinpointing access to finance as a major constraint is the high level of informality – both in terms of a low number of firms being registered and in terms of high sources of informal finance for the registered firms.

**Larger and formal firms were more likely to report having a bank account.** Nearly all SMEs reported having a bank account while only 58% of micro enterprises had one. 87% of formal businesses had a bank account while only 22% of informal businesses had one. The main banks used were Salaam Africa Bank, BCIMR, Bank of Africa and East Africa Bank. Only 21% of MSMEs reported using a bank loan for their last source of funding. Less than 1% of firms had a microfinance loan from the Caisses Populaires d'Épargne et de Crédit (CPEC). The main sources of funding for MSMEs are family members and tontines.

**Digital Finance, including mobile money, is dominated by only one provider.** Djibouti Télécom (DT), which is state-owned, remains the country's only telecommunications operator (internet, fixed and mobile telephone services). Take-up of digital channels of banking and finance remains low among MSMEs, in part due to lack of financial education around digital money solutions. Less than 1% of MSMEs reported using a debit card, credit card, SMS payment alerts, ATMs or internet banking.

Mali

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<sup>98</sup> Moody's : <https://www.economy.com/djibouti/lending-rate>

<sup>99</sup> [Microsoft Word - conditions des banques janvier 2020 \(banque-centrale.dj\)](#)

<sup>100</sup> [Explore Economies \(enterprisesurveys.org\)](#)

**Agriculture receives only a small portion of the overall private credit, and interest rates and defaults remain high.** In 2021, Mali's Agriculture, Forestry and Fishing sector made up 35.7% of value added to GDP. Banks typically provide finance to larger agro-industries, processing companies and input manufacturers such as the Malian Textile Company, CMDT.<sup>101</sup> The national agricultural development bank, BNDA, provides credit directly to farmers and cooperatives, with a portfolio of about USD 131 Million in 2019.<sup>102</sup> The average bank lending rate in Mali was at 8.3% in 2016, which is above the regional average of 7.0%. Further, the spread between the deposit and the lending rates (4.8%) in Mali reflects the relatively high credit risk and risk transformation in the economy. Mali's banks exhibit a high share of nonperforming loans as a proportion of their total loans. Between 2018 and 2019, the share of overdue loans in total loans for BNDA increased from 6.9% to 9.0%.<sup>103</sup> Data on the economy-wide non performing loans ratio were not available.

**Low levels of credit hinder access to productive inputs.** Limited financial resources make it difficult for households and enterprises to access agricultural equipment and other inputs such as improved seeds and specific fertilizers and enhance scale of production. In 2017-18, only 4.19% of individuals (aged 18+) obtained a formal loan in Mali. Of these (people who obtained credit), 32.71% did so for agricultural equipment and 6.28% for agricultural inputs.<sup>104</sup> A smaller proportion of women than men access formal credit for agricultural purposes.<sup>105</sup>

**Most of Mali's population works in agriculture, though firms remain small.** Most Malians work in the agriculture sector yet sectoral productivity remains low. In 2017-18, 74% of households were engaged in agriculture,<sup>106</sup> though value added in Agriculture, Forestry and Fishing only accounted for 37.3% of GDP in 2019.<sup>107</sup> Further, small family farms of less than 5 ha accounted for around 68% of the total farms.<sup>108</sup>

**Informal lenders and microfinance are important sources of credit to the economy.** Mali's farmers use cash as the primary mode of transactions. In 2017, only 35.4% of adults over the age of 15 had a formal bank account.<sup>109</sup> More than two thirds of adults remain outside the formal banking system. They meet their financial needs through other farms, family, and microfinance institutions. According to the Global Findex database, while 43.5% of adults reported borrowing in the past year, only 6.3% of adults reported borrowing from formal

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<sup>101</sup> World Bank FSAP; Compagnie Malienne pour le Développement des Textiles (CMDT) is the country's largest cotton manufacturer.

<sup>102</sup> BNDA website. Accessed June 24, 2021. <https://www.bnda-mali.com/la-banque/bndaccles>; A more recent estimate from December 31, 2021 cites that BNDA injected FCFA 500.7 million in the Malian economy, of which FCFA 271.4 million were in agriculture.

<sup>103</sup> Tableau 4, Annual Report BNDA 2019. [https://www.bnda-mali.com/images/PDF/rapport\\_activite/rapport\\_activite\\_2019.pdf](https://www.bnda-mali.com/images/PDF/rapport_activite/rapport_activite_2019.pdf)

<sup>104</sup> Agricultural inputs include seeds, fertilizers and training while agricultural equipment is mainly technology (including labor-saving animals).

<sup>105</sup> Cellule de Planification et de Statistiques. Enquête Agricole de Conjoncture Intégrée aux Conditions de Vie des Ménages (ECA-I) 2017. <https://microdata.worldbank.org/index.php/catalog/3409>

<sup>106</sup> Cellule de Planification et de Statistiques. Enquête Agricole de Conjoncture Intégrée aux Conditions de Vie des Ménages (ECA-I) 2017. <https://microdata.worldbank.org/index.php/catalog/3409>

<sup>107</sup> World Development Indicators, World Bank

<sup>108</sup> WTO TPR for WAEMU, 2017; Annex 5

<sup>109</sup> Global Findex, World Bank.

sources. While the formal lending interest rate was about 5%, we expect the informal rate to be higher though there is no systematic data on the same.

**Microfinance plays an important role in the provision of credit to agricultural households.**

Ten microfinance institutions (MFIs) account for about 3% of total assets in the country's financial sector.<sup>110</sup> While individual MFIs are considerably smaller than commercial banks in terms of assets, they have the same number of deposit accounts. Nearly half of MFIs loans are associated with agricultural purposes.<sup>111</sup> However, Mali's microfinance sector experienced a crisis starting in 2009 and after the 2012 Coup. The crisis, including the closure of two major MFIs, led to loss of credibility, created new regulatory hurdles, and made it more challenging for MFIs to obtain funds from traditional banks.

**The role of digital financial services has been increasing and has further potential to reach the previously unbanked.**

About 80% of Malians have access to mobile phones (95.8% mobile penetration rate by SIM, 60.4% unique subscribers, in 2017).<sup>112</sup> 31% of adults (15+) made or received digital payments in 2017, which reflects the growing adoption of mobile money, P2P transfers and utility bill payments. Digital tools also exhibit potential for expansion and attracting investment; for example, the investment fund I&P is creating a fund for fintechs.<sup>113</sup>

**Novel financing facilities have increasingly been providing credit for agriculture and agribusiness.**

Other innovative financing facilities have cropped up to provide resources to rural financial institutions that serve the credit needs of smallholders and agri-SMEs. For example, the "Mechanism for the refinancing of decentralized financial systems" (MEREF-SFD) provides refinancing funds for term deposits and technical assistance to its clients to finance food systems.<sup>114</sup> This facility now services loans worth approximately 72 million to 12 institutions at competitive interest rates (~5.85%).

### *Other Sources of Finance*

**Private investment in Malian agri-food systems remains low, though there is growing investor interest in food processing.**

Between 2015 and 2020, only 2% of reported private equity deals by value (totaling USD 5.4 Billion) in West Africa took place in Mali.<sup>115</sup> Some private funds, including impact funds and venture capital funds have a presence in Mali, but it remains small as a share of their total portfolio. Further, given its economic and social returns (employment), the fruit and vegetable processing sector in Mali has been attracting some investor interest. For example, the fund I&P Afrique Entrepreneurs has two Malian

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<sup>110</sup> There are 101 licensed MFIs in Mali. Of these 33 are considered operational and out of the 33 operating MFIs, ten are subject to Article 443 of the Central Bank because they "attain a threshold of two (2) billion CFAF of outstanding deposits or credits after two consecutive years."

<sup>111</sup> <https://www.imf.org/en/Publications/CR/Issues/2018/05/31/Mali-Selected-Issues-45922>

<sup>112</sup> GSMA (2017)

<sup>113</sup> <https://www.microsave.net/wp-content/uploads/2020/07/Inclusive-FinTechs-in-Francophone-Africa-Mali-country-report.pdf>

<sup>114</sup> <http://www.microfinance.ml/index.php/meref-sfd-2/>

<sup>115</sup> African Private Equity & Venture Capital Association (AVCA). 2020 Annual African Private Equity Data Tracker.

investees in its portfolio of 29 companies, though neither of them focuses on agriculture.<sup>116</sup> The Agri-Business Capital (ABC Fund) announced a loan of nearly USD 300,000 to a Malian mango exporter for working capital.<sup>117</sup> The Common Fund for Commodities also announced funding of about USD 1.5 Million for a mango processing in 2019.<sup>118</sup>

**Though Foreign Direct Investment (FDI) and remittances are important in the Malian economy, we cannot assess their role in financing agri-food systems due to lack of disaggregated data.** International remittances accounting for USD 1.03 Billion or nearly 6% of GDP in 2019. Internal transfers also constitute a significant share of household income. In 2017-18, income from transfers made up about 15% of income at the household level. Similarly, FDI net inflows to Mali were USD 493 million in 2019, distinct from remittances.

## Nigeria

**Less than 5% of commercial banks' lending portfolios are concentrated in agriculture and agribusiness.** Nigeria's Bank of Agriculture has the express mandate to lend to the sector, with 70% of its portfolio going to the sector. BOA has three branches each in all Nigerian states. It does not have an agent-banking model. Thus, individuals must physically travel to one of the branches in their states to be able to open an account, access credit or make payments. This may not be possible in rural and remote areas. However, commercial banks may not have a presence in these areas at all.

**Financial inclusion is high, especially relative to other Great Green Wall countries and second only to Senegal.** 45.3% of Nigerian adults, aged 15 and over, have a bank at a formal financial institution. Though nearly 55% of adults reported borrowing any money in the past year, but only 7% reported doing so from a formal financial institution or using a mobile money account.

**The National Financial inclusion strategy identifies demand and supply side barriers to access to finance.** Demand-side barriers include irregular income, lack of employment, low literacy, low trust in financial service providers and cumbersome regulatory requirements. Supply side barriers include long distances to access points, high cost of financial services and lack of tailored financial products.<sup>119</sup>

**The Central Bank of Nigeria offers several funding schemes and programs for the agriculture sector.** These include the Agricultural Credit Guarantee Scheme Fund (ACGSF), Nigeria Incentive-Based Risk Sharing System for Agricultural Lending (NIRSAL), Commercial

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<sup>116</sup> The two investments by I&P are: Carrières et Chaux du Mali and the Société Malienne de Blanchisserie. Source: <https://www.ietp.com/en/content/funds-ipae-ends-its-investment-period-2-new-investments-mali>

<sup>117</sup> The mango exporter is Etablissement Yaffa et Frères (EYF), one of the largest local mango exporters in Mali. The company received EUR €250,000 in working capital to purchase mangos and related export costs to meet the increased European demand for the product. The ABC Fund's financing will enable EYF to continue buying mangos from the current 310 farmers and employing 200 seasonal workers on the packaging site.

<sup>118</sup> The CFC is an autonomous intergovernmental financial institution established within the framework of the United Nations. Source: <https://www.common-fund.org/project-view/timini-mali-mango-processing/>

<sup>119</sup> Access to Financial Services in Nigeria 2010 Survey, cited in the Nigeria National Financial Inclusion Strategy

Agriculture Credit Scheme (CACS) and the Anchor Borrower's Program (ABP)<sup>120</sup>. The ABP targets smallholder farmers, organized in groups/cooperatives between 5 and 20, engaged in selected commodities such as cereal, legumes, livestock and certain tree crops (oil palm, cocoa, rubber). The ABP does not include non-timber forest products. Under the program, financial institutions can access money at 2% interest rate and offer loans at up to 9% interest.

**The Central Bank of Nigeria offers a risk sharing mechanism for credit to the agriculture and agribusiness sectors through a non-bank financial institution, the Nigeria Incentive-Based Risk Sharing System (NIRSAL).** CBN set up the USD 500 million institution to facilitate investment into the sector and build its long-term capacity. NIRSAL's instruments include interest rate drawbacks for borrowers, credit risk guarantees ranging from 20% to 75% of the loan amount for financiers and investors to reduce their risk in lending to agribusinesses.

**In Nigeria, lack of adequate financing at different stages of gum production is a challenge to scaling up the value chain.** In general, wholesalers finance the purchase of gum from buying agents or dealers, who in turn buy the gum from farmers. The agents are likely embedded in the communities.<sup>121</sup>

## Niger

**Financial Inclusion in Niger remains low, especially compared to other West African countries in terms of access to and use of formal financial services, including for women and youth.**<sup>122</sup> In 2021, the use of financial services (in the form of banking, microfinance, or e-money) stood at about 15 % of the population in Niger relative to 67% in the WAEMU overall.<sup>123</sup> There is also a gender gap in access to finance and mobile money. Only 11% of women reported having access to a bank account in Niger while 20% of men had an account.<sup>124</sup> In a 2018-19 survey, households cited the following main reasons preventing them to demand credit from formal financial institutions: (i) do not meet the requirements, (ii) not able to repay, (iii) absence of banks, (iii) do not know how to apply for credit, (iv) do not have the capacity to repay.<sup>125</sup>

**Microfinance has experienced a significant contraction in recent years.** The use of MFI loans rose from 6 % of the population in 2010 to 11% in 2015 but dropped to 5% at the end of 2021. This reversal, which was not offset by other pillars of financial inclusion, mostly

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<sup>120</sup> [https://www.cbn.gov.ng/Out/2021/CCD/ABP%20Guidelines%20October%2013%202021%20-%20Final%20\(002\).pdf](https://www.cbn.gov.ng/Out/2021/CCD/ABP%20Guidelines%20October%2013%202021%20-%20Final%20(002).pdf)

<sup>121</sup> Study on "Strengthening the Gum Arabic Sector for Sustainable and Resilient Landscapes and Livelihoods of Women and Youth in Africa's Drylands: Report on Trade and Markets of Gum Arabic (Business Perspective)" prepared by Network for Natural Gums and Resins in Africa (September 2020).

<sup>122</sup> IMF 2023. Financial Inclusion in Niger: Challenges and Opportunities. <https://www.imf.org/en/Publications/selected-issues-papers/Issues/2023/02/27/Financial-Inclusion-in-Niger-Challenges-and-Opportunities-Niger-530242>

<sup>123</sup> BCEAO data as cited by the IMF 2023.

<sup>124</sup> World Bank, Global Findex.

<sup>125</sup> Enquête Harmonisée sur le Conditions de Vie des Ménages (EHCVM) Niger 2018/19

explains the decline in the overall use of financial services in Niger during the 2015-2021 period.<sup>126</sup>

**Overall financial sector health also remains weak.** In end 2021, bank credit to the private sector was 13% of the GDP, almost half of the regional average (24%). Banks' portfolio continued to be risky in Niger with poor asset quality. The Gross Non Performing Loans (NPLs) ratio in the Niger banking sector was 21 % in 2021. The weak portfolio quality of the banking sector poses a risk to financial inclusion, particularly for SMEs to access credit.<sup>127</sup>

**Mobile money use in Niger remains particularly low.** The number of e-money accounts in Niger have increased from less than 1% of the population in 2010 to 11% in 2021. At the same time, WAEMU countries overall have gone from 1% of the population having e-money accounts to about 80% having access to these accounts in 2021.

#### SECTION D: VALUE CHAIN FINANCING AND ITS FEASIBILITY FOR SURAGGWA

“Value chain finance” (VCF) refers to *the way in which* value chains support their participants by tailoring services and products to one or more points in the chain in order to reduce the risk and cost of financing and increase the efficiency of the chain as a whole.<sup>128</sup> VCF can be internal, which takes place within the value chain such as when an input supplier provides credit to a farmer, or when a lead firm advances funds to a market intermediary, or external which involves value chain relationships and mechanisms: for example, a bank issues a loan to farmers based on a contract with a trusted buyer or a warehouse receipt from a recognized storage facility.<sup>129</sup> It differs from conventional agricultural financing in that the latter does not have a direct link with the value chain. Further, most VCF is short term and linked to specific value chains and contexts.

It is important to note that VCF is not a financial tool or instrument, rather an assessment or series of mechanisms that take a systemic view. A key feature of VCF is that while finance is a critical part of the business model and approach, it is not the starting point. Financing can only take place in a sufficiently strong (formalized) value chain with a transparent and clear business environment and with value chain partnerships, often requiring capacity strengthening of the stakeholders in the value chain.<sup>130</sup>

VCF offers an opportunity to lower the risk from traditional lending and expand financing opportunities, improve efficiency and repayments in financing, and consolidate value chain linkages among participants in the chain. They can particularly help in addressing the short-term financial needs of actors and link previously financially excluded actors to the formal financial sector. Value chain actors may information advantages over formal financial institutions, including an understanding of the production cycles, market linkages, financial

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<sup>126</sup> IMF 2023. Financial Inclusion in Niger: Challenges and Opportunities.

<sup>127</sup> Ibid.

<sup>128</sup> IFAD, 2012. Agricultural value chain finance strategy and design, Technical Note.

<sup>129</sup> Miller, Calvin and Linda Jones. 2010. Agricultural Value Chain Finance: Tools and Lessons. World Bank.

<sup>130</sup> FAO and AFRACA. 2021. Agricultural value chain finance innovations and lessons Case studies in Africa. P. 20: Comparative Assessment. <https://www.rfilc.org/wp-content/uploads/2021/07/Agricultural-value-chain-finance-innovations-and-lessons.pdf>

needs, asset base, payment capacity and overall creditworthiness of individual participants. These information advantages lower costs and risks of providing credit. Financial institutions can build on the strengths of relationships within value chains to profitably deliver financial services to farmers and other actors by leveraging the knowledge and relationships of more informed agent.<sup>131</sup>

**Figure 23: Advantages of Value Chain Financing for Different Actors**

Producers	Agribusiness Suppliers, Buyers, Processors	Financial Institutions / Investors	Social Benefits
<ul style="list-style-type: none"> <li>• Helps overcome lack of collateral</li> <li>• Lower transaction costs</li> </ul>	<ul style="list-style-type: none"> <li>• Strengthen buying and selling relationships</li> <li>• Grows markets</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce costs of financing and risks</li> <li>• Enhance information</li> <li>• Improve repayment</li> </ul>	<ul style="list-style-type: none"> <li>• Innovation</li> <li>• Inclusive -- finance to smallholder farmers</li> </ul>

*Source: Authors Adaptation using FAO and AFRACA (2021) and World Bank (2010).*

In the SURAGGWA Programme target countries, there are very few examples of existing agricultural value chain financing (ACVF) arrangements and none to our knowledge on NTFP value chains in these countries. This is a key barrier to the utilization of this mode of financing. The limited examples in these countries are concentrated in Nigeria and Senegal. In Northern Nigeria, an initiative by the National Agricultural Extension, Research, and Liaison Services Institute (NAERLS) linked with a University facilitated Producer Organizations for financing improvements in rice and maize and another in soybean. In Senegal, Credit and Savings Alliance for Production (ACEP), a mutual savings and loan institution, used loan guarantees to reduce risk and promote increased AVCF to smallholders.<sup>132</sup>

In the target countries, low existing capacity of smallholders and NTFP producer organizations are barriers to using VCF though project activities will address these constraints, laying the groundwork for VCF in the medium term. The capacity of actors and a supportive enabling environment, including quality and safety standards are prerequisites for value chain financing to succeed.<sup>133</sup> Since most SURAGGWA countries do not have systematized quality and safety standards in place for NTFP products, this makes it difficult to adopt a VCF approach at the outset. Still, the project activities around incubation and business support to NTFP entrepreneurs and producer organizations will help strengthen capacity, improve quality and develop standards, laying the foundation for considering VCF approaches after their implementation.

<sup>131</sup> Ibid. FAO and AFRACA 2021.

<sup>132</sup> Ibid. FAO and AFRACA 2021.

<sup>133</sup> Miller, Calvin and Linda Jones. 2010. Agricultural Value Chain Finance: Tools and Lessons. World Bank.

## Chapter VII: COMPONENT 3 CAPACITY DEVELOPMENT

This section explains the underlying logic of the component structure and activities and assesses the relevance and realism of the component 3 activities as foreseen by the funding proposal.

### SECTION A : CONTEXT AND COMPONENT BACKGROUND

#### Institutional framework of the intervention sector

The Great Green Wall was first envisioned in 2005 – during the seventh session of the Community of Sahel-Saharan States (CEN-SAD) heads of state conference held in Ouagadougou on the 1st and 2nd of June 2005 – by the former President of Nigeria, Chief Olusegun Obasanjo, and greatly advocated by President Abdoulaye Wade of Senegal. In 2007 the Initiative gained momentum when the African Union Declaration 137 VIII was adopted, approving the “Decision on the Implementation of the Great Green Wall for the Sahara and Sahel Initiative” (AU 2007) (from here on referred to as GGW). On 17 June 2010 the 11 Sahel states south of the Sahara created the Pan-African Agency of the GGW to coordinate its implementation and support resources mobilisation.

The Great Green Wall initiative is governed by a complex network of actors, including the African Union (AU), the Pan-African Agency of the Great Green Wall (PAGGW), and national agencies responsible for implementing the project in individual countries.

**The PA-GGW was established to coordinate the implementation of the Great Green Wall across the continent.** The agency is currently based in Mauritania and is responsible for providing technical assistance and guidance to national agencies, as well as mobilizing resources and coordinating the efforts of other stakeholders. At the national level, the governance of the Great Green Wall involves the establishment of national agencies responsible for implementing the project in individual countries. These agencies are typically established by national governments and work closely with the PAGGW to coordinate their efforts and ensure that the project is implemented in a coordinated and effective manner. The relationship between national agencies and the PAGGW is one of collaboration and support. The **PanAfrican GGW Agency (PA-GGW)** is an Inter-states organization established under the Aegis of the African Union and Cen-Sad and has legal international capacity and operational autonomy. The PA-GGW has four statutory bodies :

**The Conference of Heads of State and Government (CCEG)** is composed of the Heads of State and Government of the Member States of the PA-GGW and is the supreme organ of the PA-GGW. It determines the orientations of the PA-GGW, appoints the Executive Secretary and determines the location of the headquarters. The decisions of the Conference are taken by consensus.

The **Council of Ministers (CM)** is composed of the Ministers in charge of the Environment of the APGMV Member States and has the following missions : (i) to ensure the implementation of the guidelines defined by the Conference of Heads of State and Government ; (ii) to adopt

the strategic framework and the global action plan of the APGMV ; (iii) to adopt the budget and the investment plan of the Executive Secretariat; (iv) to assist the Executive Secretariat in mobilizing resources ; (v) to adopt the technical and financial activity reports of the Executive Secretary; (vi) to approve the organization chart, the internal regulations and the procedures manual of the APGMV. The Presidency of the Council of Ministers is held by the Minister designated by the host country holding the Presidency of the CCEG.

The **Executive Secretariat** is the statutory technical body in charge of translating the vision, orientations and strategic frameworks as well as implementing strategies for the realization of the Great Green Wall Initiative. The Executive Secretariat : (i) ensures the leadership, communication and advocacy of the Great Green Wall Initiative, the design, planning and coordination of programs and projects for the realization and operation of the Great Green Wall; (ii) mobilizes and coordinates resources to support the implementation of cross-cutting and national programs and projects ; (iii) ensures the monitoring and evaluation of the implementation of programs and projects and of the state of execution of the Great Green Wall; (iv) develops in particular an efficient Scientific and Technical Information System (SIST); (v) initiates thematic research actions; (vi) ensures the management and capitalization of knowledge; (vii) facilitates technical support to national projects, synergy and coherence with the interventions of sub-regional, regional and international institutions. The agency is headed by an Executive Secretary appointed by the Conference of Heads of State and Government.

**Technical Committee of Experts (CTE)** meets once a year and its members are (i) Representatives of the States, Directors of Forests and Advisors to the Ministers in charge of GGW, (ii) Representatives of partner institutions: CILSS, OSS, NEPAD, AUC, IGAD, COMIFAC, CENSAD, (iii) APGMV Executive Secretariat, other participants upon invitation by the Executive Secretary.

This following table provides information on the member countries of the Great Green Wall (GGW) Initiative, the year in which the country signed or ratified the GGW Initiative, indicating its commitment to the initiative, the year in which the country created its national agency responsible for coordinating and implementing the GGW Initiative, the legal text or instrument that establishes the legal basis for the GGW Initiative in the country, the most recent national strategy and action plan developed by the country for implementing the GGW Initiative, which outlines its specific goals, priorities, and activities for the initiative.

Table 1. Summary of key information on the establishment of the National Great Green Wall Agencies

Country	Signature/Ratification	Creation of GGW Agency	Legal text	Latest GGW National Strategy and Action Plan
<b>Burkina Faso</b>	2010	2012	Law No. 081-2016/AN	2018-2022
<b>Chad</b>	2010	2012	Law No. 008/PR/2010	2013-2017
<b>Djibouti</b>	2010	2018	Decree No. 2018-018/PR/MARN	2018-2022
<b>Mauritania</b>	2007	2010	Decree No. 206-2009	2013-2022
<b>Senegal</b>	2007	2014	Law No. 2014-10	2018-2022
<b>Niger</b>	2007	2013	Law No. 2013-31	2017-2021

<b>Nigeria</b>	2007	2015	N/A	2015-2025
<b>Sudan</b>	2007	2015	Presidential Decree No. 107/2015	N/A
<b>Ethiopia</b>	2007	2014	Proclamation No. 866/2014	2018-2030
<b>Eritrea</b>	2007	N/A	N/A	N/A
<b>Mali</b>	2007	2011	Law No. 2011-087	2017-2026

Source : author compilation from various source including the GGW website (<https://www.grandemurailleverte.org/>)

### Institutional context in relation to the main areas of capacity development planned under SURAGGWA Component 3

In addition to the official mandates of the GGW institutions, the definition of the roles and functions of the Great Green Wall institutions is the result of a process underpinned by several reference documents marking individual steps. The following chapters provide as complete and accurate an overview as possible of the state of play, by component 3 intervention theme, and based on documents officially approved by the GGW authorities.

#### *Strategic planning in the great green wall initiative*

The operational approach in the implementation of the GGW Initiative is executed by the GGW operational and steering institutions at the regional, national and local levels. The PA-GGW (regional level) is relayed to each member state by a national GGW structure.

**Strategic planning has been identified as a key element in ensuring the success of the program.** Over the past ten years, several initiatives have been taken under the Great Green Wall initiative in terms of planning such as and continental-level plans to guide the implementation of the program.

At regional level, the most comprehensive and up to date of such plans is the **Ten-Year Priority Investment Plan 2021-2030 (PIP)**. The PIP was developed with the goal of restoring 100 million hectares of degraded land by 2030, creating 10 million green jobs, and sequestering 250 million tonnes of carbon dioxide per year. The plan is centered around five key areas of intervention: sustainable land management, agroforestry and ecosystem restoration, renewable energy and energy efficiency, water management, and capacity building and governance. The plan aims to leverage investments in these areas to achieve a range of economic, social, and environmental benefits, including improved food security, increased biodiversity, and greater resilience to climate change. To achieve these goals, the PIP outlines a series of specific interventions and investment priorities. These include promoting sustainable agricultural practices such as agroforestry and conservation agriculture, developing renewable energy projects such as solar and wind power, and investing in water harvesting and storage infrastructure. The PIP also places a strong emphasis on private sector engagement and investment. The plan calls for the development of public-private partnerships to support the implementation of priority projects and the mobilization of private sector resources to fund restoration activities. In addition to investment priorities, the PIP also outlines a range of institutional and policy reforms that will be necessary to support the implementation of the plan. These include strengthening governance structures, improving coordination and collaboration across sectors and between countries, and increasing capacity and technical expertise at the national and regional levels.

The Major Strategic Axes (MSAs) or Portfolios (FPs) of the 2021-2030 Decennial Priority Investment Plan (DPIP) of the GGW include (i) Sustainable land use management and restoration ; (ii) Promotion of agro-sylvo-pastoral value chains ; (iii) Development of renewable energy and energy efficiency ; (iv) Promoting sustainable water management: This portfolio focuses on improving water management and increasing access to clean water in the Sahel region ; (v) Strengthening resilience and adaptation to climate change and (vi) Institutional and policy support (note : this portfolio focuses on strengthening the institutional and policy frameworks for sustainable development in the Sahel region, including through the promotion of regional cooperation and the involvement of local communities in decision-making processes).

**Other documents of programmatic, or planning nature include :** (i) the PAGGW Roadmap 2022-2023; (ii) the strategy 2016 – 2020 (including a Five-Year Action Plan) ; (iii) the 2011 - 2015 Action Plan.

In 2012, the GGW Initiative adopted a Global Harmonized Strategy (GHS) (AU & PA-GGW 2012), which consolidated national strategies and action plans of the GGW member states (supported by FAO, EU and GM-UNCCD) and arrived at a coordinated strategy for implementation, structured into five-year planning steps. Drawing on the GHS, member countries have elaborated national action plans to develop clear steps for achieving the GGW national objectives.

- The first cycle 2011-2015 aimed at the establishment of the institutional and organizational framework of the GGW structures, conceptualization, awareness and appropriation of the concept, as well as the establishment of pilot activities at the level of each country and the development of the national GGW strategies and action plans.
- The second cycle 2014-2020 focused more on operational activities and aimed at accelerating concrete actions. The 2020 is a good point in time to look back and assess what has been achieved so far.
- The third cycle 2021-2025 is expected to consolidate the implemented activities and measures and scale them up.
- The fourth and final cycle 2026-2030 will focus on further **upscaling the activities** to ensure a substantial contribution of the GGW to the achievement of the Sustainable Development Goals and to international commitments of the member states under the Rio Conventions.

Also, member countries have developed and implemented national strategies and action plans to guide the implementation of the initiative at the national level. These plans outline specific actions to be taken in areas such as agroforestry, sustainable land management, and community engagement to support the restoration and rehabilitation of degraded lands in the Sahel and Sahara regions. Table 1 indicates the latest available national strategies / plans.

### *Monitoring and reporting of landscape restoration efforts*

In principle, the Great Green Wall Initiative needs to be equipped with a monitoring and evaluation system to track the progress of land restoration activities. The system aims at comprehensiveness and includes :

- **Baseline data collection:** Before restoration activities begin, baseline data is collected to establish the current state of the land, including vegetation cover, soil fertility, and water availability.
- **Monitoring of restoration interventions:** The implementation of restoration interventions is closely monitored to track progress and identify any issues that may arise.
- **Impact assessment:** The impact of restoration interventions is assessed to determine whether the objectives of the Great Green Wall initiative are being met. This includes monitoring changes in vegetation cover, soil fertility, and water availability.
- **Socio-economic monitoring:** The socio-economic impact of restoration interventions is monitored to assess whether they are improving local livelihoods and contributing to poverty reduction.

The envisioned monitoring and evaluation system of the Great Green Wall Initiative is organized at both the national and regional levels. At the national level, each participating country is responsible for developing and implementing a monitoring and evaluation plan to track the progress of restoration activities within their jurisdiction. The regional level involves in principle coordination and collaboration among participating countries to ensure that monitoring and evaluation activities are consistent and aligned with the objectives of the Great Green Wall initiative. National focal points are required to submit regular reports on the status of restoration interventions within their jurisdiction to the Pan African Agency of the Great Green Wall, which in principle consolidates this information into a regional progress report. The regional progress report is to be then shared with participating countries and other stakeholders to provide an overview of the progress of the Great Green Wall initiative<sup>134</sup>. The DPIP does not specify the frequency or format of reporting but notes that national monitoring and evaluation plans should be aligned with regional monitoring and evaluation frameworks to ensure consistency and comparability of data.

In addition to the DPIP, the Great Green Wall Initiative has also published a Monitoring and Evaluation Framework (MEF), which provides guidance to participating countries on the development and implementation of monitoring and evaluation plans. The MEF also emphasizes the importance of standardizing data collection and reporting processes to ensure that data is comparable across different countries and interventions.

### *Resource mobilization*

The Great Green Wall Initiative mobilizes resources from a variety of sources to support the implementation of restoration interventions, capacity building, and monitoring and evaluation activities. The initiative's approach to resource mobilization is based on partnerships and collaboration with a range of stakeholders, including multilateral development banks, bilateral donors, philanthropic organizations, private sector investors, and governments. **The PAGGW is responsible for providing strategic guidance and support at the continental level, while the national agencies are responsible for mobilizing resources and implementing activities within their respective countries.**

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<sup>134</sup> Great Green Wall Initiative's 2021-2030 Decennial Priority Investment Plan (DPIP) and Monitoring and Evaluation Framework (MEF)

According to the Great Green Wall Initiative's 2021-2030 Decennial Priority Investment Plan (DPIP), the PAGGW is responsible for developing and implementing a resource mobilization strategy, which includes identifying potential sources of funding, engaging with donors and other stakeholders, and coordinating resource mobilization efforts across participating countries. The PAGGW is also responsible for managing the/a Great Green Wall Multi-Partner Trust Fund (MPTF), an envisioned pooled funding mechanism that allows donors to contribute to the initiative's core funding pool.

At the national level, the DPIP states that the national agencies are responsible for mobilizing resources to support the implementation of restoration interventions and other activities within their respective countries. This includes engaging with national and local governments, private sector investors, philanthropic organizations, and other stakeholders to secure funding and support for Great Green Wall projects.

Also, to achieve its ambitious goal, the GGW institutions have developed various strategies and frameworks, such as the Partnership Framework, Resource Mobilization Strategy, Strategic Framework 2016-2030, and Investment Plan 2016-2020, to mobilize resources and investments from various stakeholders, including governments, development partners, and the private sector.

The Partnership Framework, launched in 2018, is a collaborative framework that outlines the GGW's vision, mission, and objectives, and sets out the roles and responsibilities of various stakeholders in achieving these goals. The framework also outlines the GGW's governance structure, which includes the African Union Commission, the Permanent Interstate Committee for Drought Control in the Sahel (CILSS), and the Pan-African Agency of the Great Green Wall (PAGGW).

The Resource Mobilization Strategy, launched in 2016, is a comprehensive strategy that outlines the financial resources needed to implement the GGW's activities over the short, medium, and long term. The strategy identifies potential sources of funding, such as governments, development partners, and the private sector, and outlines the mechanisms that will be used to mobilize and manage these resources.

The Strategic Framework 2016-2030 is a roadmap that outlines the GGW's objectives and priorities for the period 2016-2030. The framework is organized around three strategic objectives: improving the livelihoods of local communities, restoring and sustainably managing land and water resources, and strengthening regional cooperation and coordination.

The Investment Plan 2016-2020 is a detailed plan that outlines the GGW's investment priorities and activities for the period 2016-2020. The plan includes a range of activities, such as agroforestry, soil and water conservation, sustainable land management, and the development of renewable energy sources. The plan also identifies the financial resources needed to implement these activities and outlines the mechanisms that will be used to mobilize and manage these resources. Taken together, these documents provide detailed information on the GGW's goals, strategies, and activities, as well as the financial resources needed to implement them.

## *Knowledge Management*

Based on various sources of information including the 2021-2030 Decennial Priority Investment Plan (DPIP), the Great Green Wall Knowledge Management Framework, and the Great Green Wall Monitoring and Evaluation Framework during the formulation of SURAGGWA, it is evident that the Great Green Wall institutions are committed to promoting effective knowledge management. The following strategies are being used or envisioned :

**Establishment of a knowledge management system:** The Great Green Wall institutions are working towards the establishment of a comprehensive knowledge management system. This system will be designed to enable the collection, storage, and dissemination of information related to the Great Green Wall Initiative. The system will be accessible to all participating countries, institutions, and stakeholders and will facilitate collaboration and knowledge sharing.

**Development of a knowledge management strategy:** The Great Green Wall institutions have recognized the need for a knowledge management strategy that outlines the processes and procedures for capturing, sharing, and utilizing knowledge. The Great Green Wall Knowledge Management Framework provides guidance on the key elements of a knowledge management strategy, including knowledge capture, knowledge sharing, and knowledge utilization.

**Use of technology:** The Great Green Wall institutions are using technology to facilitate knowledge management efforts. This includes the development of online platforms and databases that enable the sharing of information and best practices.

**Training and capacity building:** The Great Green Wall institutions recognize the importance of building capacity in knowledge management. They are investing in training and capacity building programs to equip staff and stakeholders with the necessary skills and knowledge to effectively manage knowledge.

**Monitoring and evaluation:** The Great Green Wall Monitoring and Evaluation Framework includes a specific focus on knowledge management. The framework outlines key indicators for monitoring and evaluating the effectiveness of knowledge management efforts, including the extent of knowledge sharing and utilization.

## *Communication*

The Great Green Wall Communication Strategy<sup>135</sup>, developed in 2017 by the African Union Commission (AUC) and its partners, outlines the key principles and approaches that should guide communication and outreach efforts. The strategy emphasizes the importance of participatory communication and engagement, as well as the need to tailor communication efforts to the local context and audience. It also highlights the importance of using multiple channels and platforms, including traditional and social media, to reach a diverse range of stakeholders. Capacity building is another important element of the Great Green Wall's communication strategy. The Capacity Development Strategy for the Great Green Wall, also

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<sup>135</sup> African Union Commission. (2017). Great Green Wall Communication Strategy. Retrieved from <https://au.int/sites/default/files/documents/34818-doc-ggw-communication-strategy-en.pdf>

developed by the AUC and its partners, outlines the key capacity building needs for the initiative and provides guidance on how these needs can be addressed. The strategy highlights the importance of building capacity among local stakeholders to enable them to participate in decision-making processes and to contribute to the initiative's success.

The following are some additional ways in which communication is considered by the Great Green Wall institutions:

**Stakeholder Engagement:** One of the key communication strategies of the Great Green Wall is to engage with all stakeholders involved in the initiative, including local communities, government agencies, NGOs, and international partners. Through regular consultation and feedback mechanisms, the initiative seeks to build trust and understanding among stakeholders and ensure that their voices are heard in the decision-making process<sup>136</sup>.

**Awareness-raising Campaigns:** The Great Green Wall institutions use various communication channels, including traditional media, social media, and community radio, to raise awareness about the initiative's objectives, activities, and outcomes. These campaigns aim to mobilize public support for the initiative and encourage communities to participate actively in the restoration of degraded land.<sup>137</sup>

**Information Management:** The Great Green Wall institutions have established robust information management systems to ensure that accurate and up-to-date information is available to all stakeholders. This includes the development of a comprehensive database that tracks the progress of the initiative and provides information on the impact of the interventions<sup>138</sup>.

**Capacity Building:** The Great Green Wall institutions also prioritize capacity building initiatives that focus on enhancing communication skills among stakeholders. This includes training on effective communication, advocacy, and community mobilization techniques<sup>139</sup>.

## SECTION B : ASSESSMENT OF THE RELEVANCE AND FEASIBILITY OF EACH OUTPUT

### Main governance challenge

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<sup>136</sup> Great Green Wall Initiative. (2021). Communication and Outreach Strategy. Retrieved from <https://www.greatgreenwall.org/communication-and-outreach-strategy>

<sup>137</sup> United Nations Development Programme. (2020). The Great Green Wall: Restoring Africa's Landscapes. Retrieved from <https://www.undp.org/content/undp/en/home/librarypage/environment-energy/the-great-green-wall--restoring-africas-landscapes.html>

<sup>138</sup> Food and Agriculture Organization of the United Nations. (2021). The Great Green Wall: A Landscapes Approach to Sustainable Development in the Sahel and Sahara. Retrieved from <http://www.fao.org/in-action/great-green-wall/about-the-initiative/communication-and-awareness-raising/en/>

<sup>139</sup> Great Green Wall Initiative. (2021). Capacity Building. Retrieved from <https://www.greatgreenwall.org/capacity-building>

A summary of the main governance challenges faced by the Great Green Wall initiative is presented hereafter, drawing essentially from assessment commissioned by the African Union Commission (AUC) and the New Partnership for Africa's Development (NEPAD) Agency. The report<sup>140</sup> was prepared through a participatory process involving various stakeholders, including government officials, non-governmental organizations, and local communities.

**Lack of political support and weak institutional structures:** One of the main challenges facing the Great Green Wall initiative is the lack of high-level political support for environmental policies in the region, which leads to a lack of underlying legislation and mandates to establish and properly resource the required institutional structures and processes. In addition, weak organizational structures and processes for implementing environmental projects or larger environmental development initiatives, such as the Great Green Wall, are linked to and caused by a lack of related financial and human resources allocated to the respective government institutions.

**Limited engagement with relevant sectors:** Another governance challenge is the limited engagement of the Great Green Wall national agencies with other relevant sectors, beyond just the environmental sector. The successful implementation of the initiative depends not only on the efforts of the Great Green Wall agencies but also on the participation of organizations and agencies from other sectors, such as agriculture, land use, rural development, and energy.

**Difficulty in endorsing a landscape approach:** The Great Green Wall initiative has also faced challenges in endorsing a "landscape approach" - an inter-sectoral approach that goes beyond jurisdictional borders and usual sectors (agriculture, environment, forests, energy, land-use planning, and decentralization). The national agencies responsible for the Great Green Wall are often under the ministry of environment and may not have the institutional power to promote landscape approaches. In addition, some of these agencies are relatively new in the institutional landscape and may not always have the required capacities.

**Limited mainstreaming of environmental management practices:** Another challenge facing the Great Green Wall initiative is the limited mainstreaming of environmental management practices into sector strategies, policies, and action plans and programs. For the initiative to receive the required support from the government, environmental policy and action must be integrated into the strategies, policies, and action plans and programs in key sectors relevant to the Great Green Wall. Full mainstreaming is needed for the impact to reach the local level through local policies, planning, and actions.

**Limited coordination and knowledge sharing:** Finally, there is a lack of coordination, exchange, and flow of information and knowledge at the regional and national levels and between the respective Great Green Wall structures. Insufficient coordination and collaboration between Great Green Wall countries, as well as between project developers at the national level and cross-border, results in a lack of proper and managed knowledge/information sharing and coordination mechanisms at the national and regional levels. This is especially important for lessons learned and success stories, as the only way

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<sup>140</sup> "The Great Green Wall Initiative: 2011-2017 Achievements and Challenges to the 2030 Path Special Edition.

forward to a rapid and efficient expansion of the initiative is through developing pilot projects that can be replicated in many locations after they have been successfully implemented.

Alignment of the component design and scope with functional capacity development areas identified

The GGW initiative suffers from limited public sector capacity to facilitate implementation, unsupportive regulations, poor coordination and weak monitoring ability. An overarching issue appearing in most GGW countries is weak governance in the field of environmental change, which is a main barrier to implementation.

Other institutional challenges include the lack of high-level political support for the environmental policy agenda from the governments of the GGW member states and weak organizational structures and processes for the implementation of environmental projects, development initiatives or programmes. GGW institutions have weak ability to finance, implement, monitor, evaluate or scale up successful experiences implemented by development agencies. Even where the GGW National Agencies have put in place mechanisms for decentralization and coordination they have not adequately resourced the institutions with staff or funds.

The lack of managed knowledge, information sharing and coordination mechanisms at the national and regional level leads to insufficient coordination and collaboration between GGW countries, project developers and donors. This is especially important for taking advantage of lessons learned, innovations and success stories, whose replication and scaling up could accelerate and ensure an efficient expansion of the GGWI's activities.

Another key barrier in the public sector is the lack of a system to monitor and report on GGW activities on the ground. M&E expertise is absent in general, which hampers the establishment of proper M&E systems at the project and national levels and across the GGW Initiative as a whole. It also results in shortcomings in documentation and hinders the sharing of lessons learned, which is key to avoiding negative developments and capitalize positive results achieved by the projects under the GGW.

**Based on the above, it is clear that weak governance in the field of environmental change is a major barrier to implementation in many GGW countries. The lack of high-level political support, weak organizational structures, and processes for implementation, and limited capacity for monitoring and evaluation are just a few of the challenges faced by GGW institutions. However, the SURAGGWA project takes this diagnosis as a starting point and has aligned its intervention themes with the most salient needs.**

Moreover, the project recognizes that these issues are interconnected and that addressing them requires working together on several fronts of capacity development. By taking a holistic approach that emphasizes sustainability and coherence, the project is well-positioned to achieve results and make a meaningful impact. It is essential that the GGW countries collaborate and coordinate their efforts to take advantage of lessons learned, innovations, and success stories in order to scale up and expand their activities efficiently. In this regard, the

SURAGGWA project aims to be recognized as an excellent example of a comprehensive approach to capacity development in the GGW countries.

#### Alignment with beneficiary needs at output level:

FAO began supporting the capacity building process of the GGW initiative at an early stage. This process has provided an opportunity since its inception to begin joint work on needs analysis and formulation of work areas. The process had already identified in 2013<sup>141</sup> a number of capacity building needs, which are summarized below.

**Monitoring:** The needs assessment recommended capacity building in areas such as data collection, analysis, and reporting, as well as the development of standardized indicators to facilitate monitoring across different countries and regions.

**Communication:** The needs assessment recommended capacity building in areas such as strategic planning for communication, as well as messaging, media relations, and community outreach, with a particular focus on reaching marginalized and vulnerable populations.

**Coordination:** The needs assessment recommended capacity building in areas such as coordination mechanisms, stakeholder engagement, and conflict resolution, as well as the development of partnerships and networks to facilitate collaboration.

**Resource Mobilization:** the needs assessment recommended recommends the establishment of funding mechanisms, such as a dedicated GGW trust fund, to ensure sustainable financing for the initiative.

**Knowledge Management:** The needs assessment recommended capacity building in areas such as knowledge sharing platforms, research and analysis, and the development of learning communities. It emphasizes the importance of building the capacity of national institutions to generate and use knowledge, as well as the need to promote South-South cooperation and exchange of best practices.

**These findings have since been greatly enriched and the needs more fully analyzed as well as the reinforcement needs have been refined and officially expressed by the GGW initiative :**

The 2021-2030 Decennial Priority Investment Plan (DPIP) of the Great Green Wall (GGW) recognizes the importance of capacity development for achieving the initiative's goals. The document highlights the need to build the capacity of stakeholders at various levels, including local communities, civil society organizations, government agencies, and private sector actors. In particular, the DPIP notes that capacity development is essential for implementing sustainable land management practices, promoting sustainable value chains, and improving access to clean energy and water. The document emphasizes the need for capacity development programs that are tailored to the specific needs of different stakeholder groups, and that promote participatory approaches and local ownership. To support capacity development efforts, the DPIP proposes a range of activities, including training and education programs, exchange visits, and mentoring and coaching programs. The document also emphasizes the need for institutional capacity development, including the strengthening of

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<sup>141</sup> Strategy and Action Plan for Capacity Development in support of the implementation of the Great Green Wall for the Sahara and Sahel Initiative. June 2013.

technical capacities within government agencies, the development of monitoring and evaluation systems, and the promotion of regional cooperation and knowledge sharing.

In relation to the main areas of intervention for SURAGGWA component 3, the 2021-2030 Decennial Priority Investment Plan (DPIP) recognizes the importance of the following elements :

**Monitoring landscape restoration (addressed under SURAGGWA Output 3.1) :** The DPIP emphasizes the need for GGW agencies to take the lead in developing and implementing monitoring and evaluation systems that are standardized, transparent, and participatory. To achieve this, the DPIP proposes several actions to strengthen the role of GGW agencies in monitoring landscape restoration:

*Developing standardized monitoring and evaluation frameworks:* GGW agencies shall develop standardized frameworks for monitoring and evaluating landscape restoration interventions. These frameworks will be used to measure progress towards the GGW targets and to identify areas where additional interventions are needed.

*Implementing participatory monitoring and evaluation:* The DPIP advocates for the participation of local communities, civil society organizations, and other stakeholders in monitoring and evaluating landscape restoration interventions. GGW agencies will work with these stakeholders to establish participatory monitoring and evaluation systems that involve communities in data collection and analysis.

*Developing capacity for monitoring and evaluation:* The DPIP highlights the need for capacity development in monitoring and evaluation, including the development of monitoring and evaluation skills among GGW agency staff, community members, and other stakeholders. GGW agencies will be responsible for developing and implementing capacity-building programs to ensure that monitoring and evaluation activities are effective.

*Strengthening data management systems:* GGW agencies shall establish robust data management systems to ensure that data on landscape restoration interventions are collected, stored, and analyzed in a standardized manner. This will enable GGW agencies to track progress towards their targets and make informed decisions on where to allocate resources.

**Coordination (addressed under SURAGGWA Output 3.2). :** The DPIP notes that effective coordination is crucial for ensuring that different interventions and activities are well-aligned and implemented in a harmonized and efficient manner. The document highlights the need for capacity development programs that focus on coordination and management skills, including communication, collaboration, and leadership. To support capacity development in coordination, the DPIP proposes a range of activities, including the development of coordination frameworks and mechanisms, the establishment of coordination platforms and networks, and the promotion of participatory approaches that involve different stakeholder groups in the coordination process. The document emphasizes the need for a participatory and inclusive approach to coordination, in which different stakeholders are involved in the planning, implementation, and monitoring of interventions. This includes the involvement of local communities, civil society organizations, and private sector actors in the coordination process.

**Resource mobilization (addressed under SURAGGWA Output 3.3) :** The DPIIP notes that mobilizing financial and other resources is crucial for implementing interventions and sustaining the progress of the Great Green Wall initiative. The document highlights the need for capacity development programs that focus on financial planning and management, resource mobilization strategies, and building partnerships with different stakeholders. To support capacity development in mobilizing resources, the DPIIP proposes a range of activities, including the development of resource mobilization strategies and tools, the establishment of partnerships and collaborations with public and private sector actors, and the promotion of entrepreneurship and innovation. The need for capacity development programs that focus on carbon finance and investment is also highlighted, including carbon market regulations and standards, project development and financing, and monitoring and reporting of greenhouse gas emissions. The DPIIP proposes a range of activities, including the development of carbon finance mechanisms and tools, the establishment of partnerships with carbon market actors, and the promotion of entrepreneurship and innovation in carbon finance.

**Knowledge Management (addressed under SURAGGWA Output 3.4) :** The DPIIP notes that effective knowledge management is crucial for promoting evidence-based decision-making and ensuring that interventions are grounded in the best available knowledge and experience. The document highlights the need for knowledge management systems that promote collaboration and sharing among different stakeholders, and that capture and disseminate knowledge in a way that is accessible and useful. To support capacity development in knowledge management, the DPIIP proposes a range of activities, including the development of knowledge management strategies and tools, the establishment of networks and communities of practice, and the promotion of knowledge sharing and exchange through training and education programs. The document emphasizes the need for a participatory approach to knowledge management, in which different stakeholders are involved in the generation, capture, and sharing of knowledge. This includes the involvement of local communities, civil society organizations, and private sector actors in knowledge management efforts.

**Communication (addressed under SURAGGWA Output 3.4) :** The DPIIP notes that effective communication is crucial for building awareness and support for the Great Green Wall initiative, and for promoting the exchange of information and knowledge among different stakeholders. The document highlights the need for communication strategies that are tailored to the specific needs and contexts of different stakeholder groups, and that promote two-way communication and engagement. To support capacity development in communication, the DPIIP proposes a range of activities, including the development of communication strategies and tools, the establishment of communication networks and platforms, and the promotion of communication skills through training and education programs. The document emphasizes the need for a participatory approach to communication, in which different stakeholders are involved in the development and implementation of communication strategies. This includes the involvement of local communities, civil society organizations, and private sector actors in communication efforts.

**Overall, the above illustrates how the SURAGGWA project's outputs are well-aligned with the identified needs of the GGW institutions, as each output addresses a specific area of concern, such as coordination, resource mobilization, knowledge management, and communication. This alignment highlights the importance of addressing multiple aspects of a project to ensure its success and sustainability.**

## Alignment with the specific capacity development needs in the member countries

The SURAGGWA project's success lies in its ability to adapt to the unique needs of each participating member country and the GGW institutions themselves. Through a comprehensive design process, the project team engaged in specific interactions with each member country to identify and address their individual needs. This culminated in a workshop that brought together all participants, resulting in a detailed report that synthesized the findings from each country. The report, titled "GCF/FAO-GGW MULTI-COUNTRY PROJECT BUILDING RESILIENCE IN THE GREAT GREEN WALL OF AFRICA COMPONENT 3 'Institutional Strengthening of the PAGGW and the GGW national structures through the implementation of climate initiatives and dissemination of successful restoration experiences'. Synthesis of the National Workshops' Proceedings & Content proposals for Component 3," focused on the institutional strengthening of the PAGGW and the GGW national structures through the implementation of climate initiatives and the dissemination of successful restoration experiences. With its tailored approach and strong foundation, SURAGGWA component 3 is therefore is poised to help build a more sustainable future for the participating member countries and support the GGW institutions in achieving their goals.

The preparation of Component 3 was also conducted taking into account what other ongoing initiatives have identified as priority needs of the national agencies of the Great Green Wall or more generally for each participating country. In particular, elements from the consultations conducted by UNCCD under the Great Green Wall Accelerator initiative. The table below, adapted from the technical brief #2 of the GGW Accelerator Initiative, shows that all countries share many commonalities, thus justifying the regional approach of SURAGGWA, which will allow for joint learning, economies of scale, and harmonization of systems, such as the Land Restoration Monitoring System, where useful, feasible and relevant.

Type of needs for support	Burkina Faso	Chad	Djibouti	Mali	Mauritania	Niger	Nigeria	Sudan
Q1: A more coordinated GGW approach in-country	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Q2: Needs assessments	Medium	Very high	Very high	Very high	High	Very high	Medium	High
Q3: Strategy development	Medium	Very high	Very high	Very high	No needs	Very high	Medium	High
Q4: Interaction with other agencies & local actors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Q5: Project identification	Very high	Very high	Very high	Very high	High	Very high	Medium	High
Q6: Development of national data platforms	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Q7: Project preparation	Very high	Very high	Very high	High	High	Very high	High	High
Q8: Project submission and approval	Very high	Very high	Very high	High	High	Very high	High	High
Q9: Project implementation	High	Very high	Very high	Medium	Medium	Very high	Medium	High
Q10: Training, capacity building, advisory services	High	Very high	Very high	High	Medium	Very high	Medium	Very high
Q12: Fostering absorptive capacity of donor funds	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source : GGW Accelerator technical brief n°3. UNCCD. June 2022.

The information presented in the table highlights that countries place distinct levels of significance on the various work areas. The SURAGGWA project has taken note of this aspect and, accordingly, will offer a personalized approach that caters to these priorities. The SURAGGWA PMU expert team at the regional level coordinates the project, and FAO expert

teams stationed in each country will work towards fine-tuning the requirements and moving forward with their tasks based on the demand and the varying degrees of importance given to different themes. This ensures that the project implementation is in line with the specific needs of each country.

### Implementation approach and intervention strategy

The component aims to make a significant contribution to building the capacity of GGW institutions, in coherence and synergy with the efforts of other partners, notably the Accelerator Initiative, and in close complementarity with capacity building activities financed by the GCF, in particular through the IGREENFIN programme.

The establishment of the institutional architecture for the GGW was undertaken due to a strong political commitment at the country and African Union level. The GGW impetus led to the creation of GGW NAs in all member countries included in the initiative. However, the level of institutional embedding as well as the degree of structuring of the GGW NAs varies from one country to another. In identifying the areas of institutional support, SURAGGWA will complement the work of several on-going initiatives such as the Action Against Desertification project, the Accelerator Initiative, as well as the Regional Support Platform initiative. The choice of thematic areas for these contributions is based on four elements:

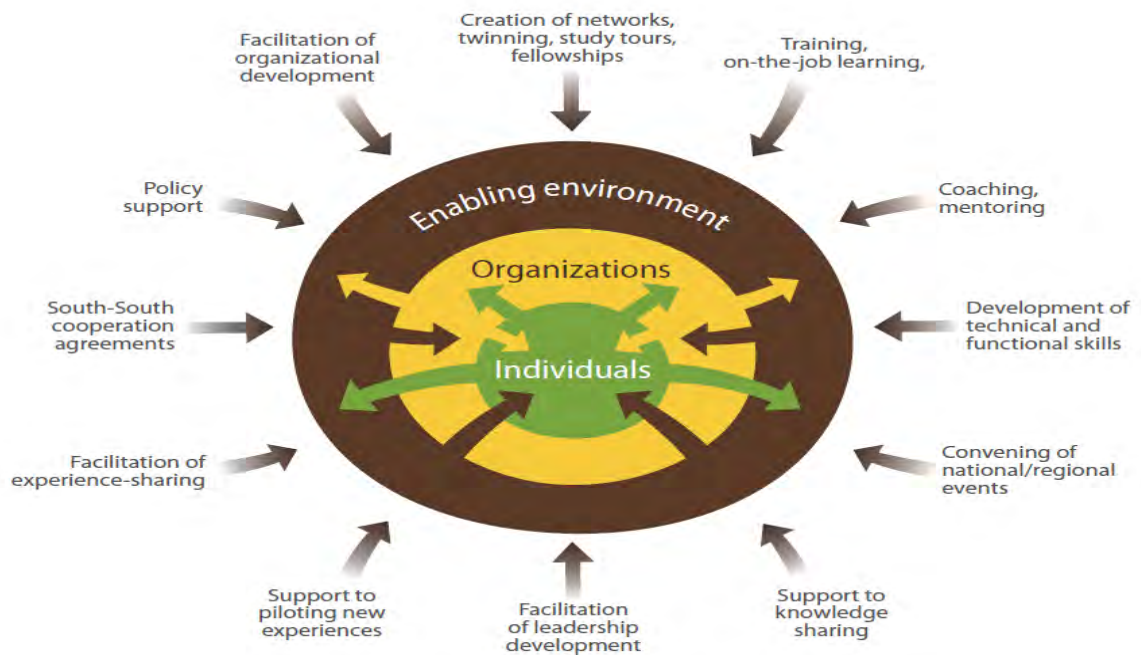
- (i) on the experience gained from the AAD project;
- (ii) areas of expertise where FAO has a recognized technical edge and comparative strength at the international level
- (iii) Based on needs gleaned through consultations with GGW institutions and NDAs and
- (iv) taking into account capacity building activities already planned by other GGW partners (including UNCCD, UNEP, UNDP and IFAD).

**The intervention strategy of the Component is based on three principles: joint work at the regional and national levels, adaptability to the realities and specific needs of member countries, and a holistic approach to capacity building.**

The three principles underlying the intervention strategy of the Component are critical to its success. Firstly, working jointly at the regional and national levels will lead to efficient implementation of capacity building activities and promote convergence towards common and interoperable tools and practices. This is particularly important for land restoration monitoring, where common indicators and cross-country learning are essential for success. By working together, the Component can ensure that capacity building activities are tailored to the needs of each country while also promoting regional integration.

Secondly, the principle of adaptability to the realities and specific needs of each member country is crucial. It acknowledges that each country has varying levels of capacity that must be taken into account, and the specific contexts in which they operate may mean that different approaches to capacity building are required. The Component will provide a menu of capacity building activities from which countries can select the most appropriate options. This approach ensures that the Component is flexible enough to meet the diverse needs of member countries and provides them with the support they need to build their capacities and develop their GGW institutions mandates.

Finally, the Component recognizes the importance of a holistic approach to capacity building, which involves action at three levels: individual, organizational, and systemic. By coordinating and complementing actions at each level, the Component can maximize the impact of its capacity building activities. This approach ensures that individuals have the skills and knowledge needed to implement GGW initiatives effectively, that organizations have the capacity to manage these initiatives, and that systemic barriers to the success of GGW initiatives are identified and addressed.



### Component 3 as a contribution to the Regional Support Program

To improve the Great Green Wall (GGW) project, regional and international coordination is needed, as well as increased exchange of knowledge and experiences among countries and project developers/managers. A facilitation mechanism or platform is needed to provide assistance at both the regional and national levels, which can include targeted technical assistance, capacity development, and media activities. Institutionalization of knowledge management and information sharing measures is important, with necessary resources allocated without over-complicating administrative structures. The platform can be used to build the GGW network and create a project portfolio at both the regional and national levels, conduct regular information-sharing activities, and develop integrated international partnerships.

The overall objective of the Regional Support Program is to improve accessibility of best practices and monitoring information within GCF Great Green Wall Umbrella Program portfolio while fostering innovation, digital transformation and private sector engagement in

the Great Green Wall to increase the collective impact of individual projects under the GCF GGW UP.

The Regional Support Program specifically aims at increasing GCF funding to GGW countries through:

- i. enhance knowledge management and exchange to accelerate the uptake of good practices and increase collective impact of GCF projects.
- ii. consolidate reporting and monitoring of the impacts of GCF portfolio projects and programs in support of the GGW initiative
- iii. foster pilot digital transformation technologies
- iv. Increase private sector engagement across the GGW.

**The SURAGGWA project component 3 is designed to contribute to the effectiveness of the Regional Support Program in the context of the Great Green Wall initiative through several outputs and outcomes.**

Component 3 of the SURAGGWA project aims to strengthen the capacity of GGW institutions to make effective decisions through the implementation of a land restoration monitoring, evaluation, and reporting system at the national and regional level. This directly contributes to the Regional Support Program sponsored by GCF/IFAD IGREENFIN, which aims to enhance knowledge management and exchange to accelerate the uptake of good practices and increase the collective impact of GCF projects. The upgraded and functional monitoring and reporting system will provide valuable data and information on land degradation/restoration, which can be shared among GGW countries to accelerate the uptake of good practices and increase the collective impact of GCF projects.

Furthermore, output 3.3 of the SURAGGWA project seeks to strengthen the resource mobilization capacities of regional and national GGW structures, including through facilitated access to carbon finance opportunities for sustainability and scaling up of land restoration. This directly aligns with the Regional Support Program's aim to increase GCF funding to GGW countries by fostering pilot digital transformation technologies and increasing private sector engagement across the GGW. The strengthened resource mobilization capacities of GGW institutions will increase their ability to access climate-specific resource mobilization opportunities, such as carbon finance, which will contribute to the success of GCF projects in the GGW region by allowing more financial resources to be leveraged as cofinancing.

Finally, output 3.4 of the SURAGGWA project seeks to strengthen GGW knowledge management and communication capacities. This aligns with the Regional Support Program's aim to enhance knowledge management and exchange to accelerate the uptake of good practices and increase the collective impact of GCF projects. By highlighting SURAGGWA results and lessons learned through various knowledge products and communications channels, the project will contribute to the exchange of good practices and lessons learned among GGW countries, which will increase the collective impact of GCF projects in the region.

Efficiency and effectiveness of the intervention

The effectiveness of the capacity development approach adopted by SURAGGWA component 3 relies on the systematic use of appropriate and efficient technologies and including their development and transfer. All four outputs include capacity building activities.

Output 3.1 focuses on capacity building at national and regional level on land degradation / restoration monitoring and will be critical to ensure the production of data that are timely, reliable, accurate and target to the needs of users.

Output 3.2 focuses on building the much needed and awaited capacities at the level of the GGW institutions in all 8 countries as well as at regional level in relation to planning and coordination. Tangible benefits will include : (i) GGW National Coalitions are operational in the 8 SURAGGWA countries and reporting annually on their progress (ii) a GGW Outlook Report is available (iii) regulatory frameworks / mechanisms are developed in all 8 countries GGW for better monitoring, coordination and planning.

Output 3.3 will focus on capacity development in relation to resource mobilization. On carbon finance, the project mentoring activities will enhance understanding of how these expanding resources can be effectively tapped into in the coming years.

Output 3.4 focuses on capacity building in relation to communication and Knowledge Management. For the later, efforts deployed by SURAGGWA to share lessons learned will benefit from the regional dimension of the project that underpin collaboration, harmonization of approaches, and knowledge sharing and provide an opportunity for countries to leverage each other's strengths. Communication activities are expected to result in an increased mobilization of local populations (understanding of the benefits of GGWi, clarification of expectations, participation, investment management) through the use of social media notably.

The component will complement and contribute incidentally to other ongoing capacity development activities notably those delivered through (i) the IGREENFIN initiative on Knowledge Management ; (ii) UNCCD on building up national coalition, streamlining the GGW's M&E system and resource mobilization ; (iii) UNDP on multi-year planning and establishing coordination mechanisms ; (iv) UNEP on understanding capacity development needs. Component 3 will also directly capitalize on the multi-country nature of the Programme, and therefore focus on regional learning and knowledge management to support cost-effectively the objectives of the Programme.

## SECTION C : ELEMENTS FAVOURING RESULTS, IMPACT AND SUSTAINABILITY

### Country and regional ownership of the component

The design of component 3 is the outcome of a two-year staged consultation process with the selected beneficiary countries as well as regional and international partners. Undertaking a significant consultation process at the concept and design stages is expected to produce a high level of ownership, greatly contributing to the sustainability of outcomes and capacity development.

In particular, the preparation of the concept note was based on a series of workshops that allowed participants to express their needs and to align future program activities with existing

programmatic frameworks at the national and regional levels. At the end of this first phase of work, all countries and the GGW PA identified monitoring of land degradation/restoration, coordination and planning, communication, resource mobilization and knowledge management as the priorities in which SURAGGWA should invest to help strengthen their Great Green Wall institutions. These priorities are also directly consistent with those expressed in the GGW strategies prepared by the countries in 2011-2012.

The second round of consultations that led to this proposal allowed for a second round of consultative work to identify more specific areas of work - among the themes listed above - where SURAGGWA would have the most value, taking into account the needs but also the capacity building initiatives of other Development Partners.

Finally, the most fundamental element to ensure ownership of both the project implementation processes and the capacity building outcomes (Component 3) is that Component 3 will target existing institutions, and seek to strengthen them without creating new institutions or parallel mechanisms. The expertise deployed by FAO will be as much as possible physically positioned in the institutions in question and will work in symbiosis with them while pursuing a gradual exit strategy to allow the institutions themselves to take over.

#### Viability, risks, exit strategy and sustainability

The viability of the component has been assessed as solid, with risks ranging from Low to medium.

The component 3 outcomes and sustainability could be affected by the limited capacity of National and Regional GGW institutions to operationalise and sustain the mechanisms and upgraded tools, and to implement project. This could happen if: i) the National and Regional GGW institutions do not appoint appropriate experts to operationalize the monitoring system; ii) Staff members of the GGW institutions are not involved in project implementation; or iii) Operation costs after project cannot be met by the GGW institutions.

These risks will be mitigated through the following: i) the preparation and signature of annual work plans with each GGW institutions to confirm their involvement and mutual commitment of the project and the institution, ii) SURAGGWA will deploy a large offer in terms of trainings and capacity development opportunities which should attract and motivate counterpart staff to join and actively participate (iii) project staff will be hired (as needed) to enable effective project implementation and coordination on a temporary basis with a gradual withdrawing agreed upon with the GGW institutions (iv) the project has been designed in consultation with the GGW institutions of each beneficiary country, which will be involved in project implementation and also be represented during biannual national project steering committees and annual regional steering committee to ensure their commitment and engagement; and (v) the GGW institutions will be accompanied in the preparation of resource mobilization plans to ensure adequate coverage of operation costs after project.

#### Exit strategy

Component 3 was designed to address select critical constraints to strengthening the Great Green Wall institutions with respect to some of their important functions, particularly land

restoration monitoring, coordination and planning, and communication and knowledge management.

The component's results sustainability will be ensured through the delivery of a coherent set of activities for capacity building, knowledge management and learning, which will also enhance country ownership and responsibility for the GGW initiative.

The key elements of the exit strategy that will ensure sustainability beyond the life of the component 3 results and outcomes can be summarized as follows :

1. Selected activities are demand-driven and respond to long-standing requests from national and regional Great Green Wall institutions, their political tutela, and development partners. Capacity gaps have been diagnosed repeatedly and their strengthening has been the subject of several plans and commitments in the past. These have been amply renewed in the framework of the Accelerator initiative in particular. The GGW institutions have been closely involved in the component formulation process and this ensures that they will continue to be invested in the success of SURAGGWA beyond its implementation period.
2. SURAGGWA will seek to strengthen existing institutions and mechanisms in the countries and at the regional level and will not create new or parallel structures. Similarly, existing coordination and governance frameworks will be used to the fullest extent possible, while making improvements where appropriate. The work of strengthening monitoring services will be done in a manner that is consistent with national and international standards and expectations and will evolve to constantly adapt to those standards and expectations to better meet the needs of users. This will contribute to long-term sustainability by ensuring that the functions of the GGW agencies remain relevant. The GGW-NAs will be asked to formally commit to maintaining some of the core functions that will be introduced by SURAGGWA after its implementation period.
3. The component will promote and integrate cost-effective technologies and tools for strengthened land restoration monitoring. The national and regional GGW institutions will subsequently be able to generate information of significant value to their decisions makers and their development partners at a reasonable cost. The Component will create an enabling environment for the GGW-National Agencies to provide accurate land restoration monitoring services which will provide the foundation for uptake of the generated information in decision-making. The observed value of improved datasets and regular reporting of positive outcomes will reinforce support for the ongoing maintenance of observation tools and services including human resources.
4. The phasing out of technical assistance and the financing of selected recurrent costs necessary for the functioning of the supported functions (in particular for monitoring) will be gradual and will take place before the last year of the project. Technical assistance will be mobilized intensively at the beginning of the program and then withdrawn gradually as the institutions gain in competence. Similarly, the assumption of certain recurrent operating costs of certain services that SURAGGWA seeks to strengthen, such as monitoring land degradation/restoration, will be programmed in a degressive manner and will become nil at least 12 months before the end of the program. This phase-out will be accompanied by assistance in finding alternative sources of funding, including country budget contributions. This last option will be the best guarantee to maintain certain functions once the project funding ceases.

## SECTION D: CAPACITY DEVELOPMENT IN CARBON FINANCE (OUTPUT 3.3)

### Introduction

Carbon markets have the potential to mobilize financial resources for sustainable, low-carbon, resilient growth and pose a particular opportunity for forestry and agriculture.<sup>142</sup> To ensure carbon markets and carbon finance help countries meet the goals of the Paris Agreement, country and private sector actions must deliver emissions savings and purchase of carbon credits must not displace efforts by buyer companies or countries to achieve ambitious emission reductions.

*Carbon markets can be divided into ‘compliance’ or ‘voluntary’ markets, depending upon the purpose or use of carbon assets. Compliance markets are markets created and regulated by mandatory national, regional, or international carbon reduction regimes, generally through a cap-and-trade system where carbon credits<sup>143</sup> are bought and sold in an Emission Trading Scheme (ETS). An ETS imposes a cap on total emissions and issues tradeable allowances to market participants.<sup>144</sup> Those that generate greater emission reductions than their specific target can sell their remaining allowances to other market participants who have not (fully) met their targets through their own efforts and can use purchased allowances for compliance. The Voluntary Carbon Market (VCM) is a decentralized market where private actors voluntarily buy and sell carbon credits that represent certified removals or reductions of greenhouse gases (GHGs) in the atmosphere.<sup>145</sup> Voluntary carbon markets involve private or public entities, including governments, generating and buying/selling activity-based credits. In the international context, this distinction has become somewhat blurred under the Paris Agreement, which obliges countries to pursue climate action but under which countries agree in carbon trading on a voluntary basis.<sup>146</sup>*

*Carbon market rules under Article 6 of the Paris Agreement allow countries to attract finance for mitigation projects from other governments seeking to meet their Nationally Determined Contributions (NDCs), as well as from non-state actors pursuing voluntary climate objectives (e.g., science-based targets or “net zero” commitments). The Article 6.4. mechanism remains under design by the COP, but it will allow projects to issue credits if they meet specific criteria and processes that could be counted against NDC targets as well as corporate net zero goals.*

Compliance markets currently exist predominantly at the national or regional level (e.g. European Union’s Emissions Trading System (ETS). Credits generated by voluntary activities can be used in some compliance schemes, but most ETS’ currently restrict the use of credits. Further to domestic or regional compliance markets, international institutions may set up and use compliance markets in specific sectors for emissions that fall outside of the scope of nationally-determined climate action. The pioneer has been the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

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<sup>142</sup> Songwe V, Stern N, Bhattacharya A (2022) Finance for climate action: Scaling up investment for climate and development. London: Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science.

<sup>143</sup> In compliance markets “carbon credits” can refer both to emission quotas allocated to operators through regulation (allowances), or emission reduction credits generated by activities outside the scope of the cap, where the rules allow such credits to be used as offsets to meet compliance targets.

<sup>144</sup> Partnership for Market Readiness; International Carbon Action Partnership. 2021. Emissions Trading in Practice, Second Edition: A Handbook on Design and Implementation.

<sup>145</sup> Dyck, M, 2022, So, what is the voluntary carbon market exactly?. <https://climatefocus.com/so-what-voluntary-carbon-market-exactly/>

<sup>146</sup> Songwe et al, 2022

In addition to the distinction – if partially blurred – between compliance and voluntary markets, it is important in the context of SURAGGWA to distinguish between international carbon finance, where international buyers purchase credits generated in the region, and domestic carbon finance, where companies purchase credits to meet, or reduce liabilities linked to national targets. The project aims to explore and harness specific financing opportunities for restoration in both contexts: domestic and international.

### Proposed activities on carbon finance in SURAGGWA

The project aims to harness opportunities and strengthen capacities in GGW countries to access carbon finance as a potential source of additional revenue from their land restoration activities. The additional revenues should enhance incentives to scale up restoration. The Africa Carbon Markets Initiative (ACMI) identifies “forestry and land use” as one of the types of projects capable of generating significant carbon credits (Roadmap Report, p.17), but there are considerable challenges, in particular in drylands contexts.

International financing opportunities exist through the Voluntary Carbon Market (VCM) or emerging transactions under Article 6 of the Paris Agreement, also linked to compliance markets in buyer countries. In addition, new opportunities for carbon finance in the region are emerging related to policy commitments to create domestic compliance carbon markets or carbon taxes with potential offset mechanisms, in particular in Nigeria.

The programme will coordinate and partner with national and regional initiatives that strengthen country capacities for Article 6, voluntary carbon markets and the creation of domestic carbon tax or carbon markets (Nigeria) across sectors. It will collaborate with these initiatives to harness specific opportunities and strengthen capacities for carbon finance for agriculture and forestry, with a particular focus on restoration.

The carbon finance support under the programme aims to unlock financing for additional removals beyond those financed directly through the GCF grant and hence enhance country NDC achievements.

The output on carbon finance will address relevant constraints within the sectoral and geographical scope of the programme, through two categories of interventions: strengthening countries’ capacities to access finance from international carbon market opportunities and supporting the creation of carbon finance opportunities for restoration as part of developing national and regional carbon markets.

The programme proposes two specific activities in the target countries:

1. Facilitate access to international carbon finance for restoration.
  - Assess and enhance Region-(Sahel) and context- (dryland landscape) specific carbon finance options.
  - Strengthen countries’ understanding of and capacity to pursue carbon finance for landscape restoration in the GGW through training, knowledge sharing and peer to peer exchanges (as part of regional carbon market initiatives).
  - Facilitate access to concrete carbon finance opportunities in restoration for selected countries.
2. Enhance carbon finance opportunities for GGW restoration from emerging carbon markets in the region.

- Enable access to domestic carbon finance opportunities by helping integrate agriculture and forestry in Nigeria’s planned domestic carbon markets or carbon tax (and offsets).
- Support the integration of agriculture and forestry in the planned ECOWAS regional carbon market.

## I. Voluntary Carbon Market (VCM) opportunities

### a. Carbon finance opportunities for agroforestry in the VCM

Voluntary carbon markets (VCM) have grown significantly in volume and value, reaching approximately USD 2 billion in 2021.<sup>147</sup> They are expected to grow significantly in the coming years. So far, agriculture, including agroforestry, has only accounted for a small fraction of credits and transactions, but there is clear potential for growth.<sup>148</sup> Recent trends in buyer interest favour credits from removals (e.g., sequestration from agroforestry and restoration) over credits linked to avoidance of emissions. Credits from removals can also attract a price premium.<sup>149</sup> Buyers are increasingly interested in credits that bring co-benefits beyond carbon, including Sustainable Development Goals (SDG) impacts, and particularly nature-based solutions.<sup>150</sup> Overall, there is broad consensus that “integrity”, in particular the achievement of genuine emission reductions is essential to VCM success and growth.

These trends offer increasing opportunities for carbon finance for agroforestry from small producers, but the track record of smallholder carbon finance is limited, and there are significant barriers, including (i) high cost due to fragmented land holdings (absence of economies of scale) and high support needs, (ii) high reversal risks over 20-30 year lifespan due to changing farming opportunities, (iii) unclear land tenure, (iv) need for long term incentive structures, (v) additionality risk if agroforestry value chains are commercially viable without carbon finance, (v) challenges in benefit and risk sharing and (vii) risk of negative impacts on farmers if tied to certain production system when circumstances change.<sup>151</sup>

Intermediaries, such as Nongovernmental Organizations (NGOs), and/or grant financed donor support, such as through the GCF, is essential to unlock longer term carbon finance for small producers.

A recent review of agroforestry carbon finance projects highlighted that public international finance/donor support is particularly relevant in (i) overcoming upfront investment constraints, (ii) providing technical assistance for design, transparency and governance, (iii) coordinating to foster relevant scale to attract carbon finance, enhancing localised farmer support models and (iv) clarifying and strengthening the legal and regulatory frameworks to facilitate carbon finance, including tenure.<sup>152</sup>

There is broad consensus that activities within a VCM operating with a high level of integrity should be additional (i.e., they would not have been implemented without the incentive created by carbon credit

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<sup>147</sup> “State of the Voluntary Carbon Markets 2022 Q3”, Ecosystem Marketplace, August 2022

<sup>148</sup> Landholm et al, 2022, Unlocking Nature-based Solutions through Carbon Markets: Global Analysis of Available Supply Potential, Climate Focus, Technical Report

<sup>149</sup> TechnoServe, 2022, Carbon Finance for Smallholder Farmers and Agribusinesses – Analytical briefing on agroforestry solutions

<sup>150</sup> VCM Status Check, Ecosystem Marketplace Insights Briefing, 23 February 2023 ([webinar](#))

<sup>151</sup> TechnoServe 2022

<sup>152</sup> TechnoServe. (2022). Carbon finance for smallholder farmers and agribusinesses—analytical briefing on agroforestry solutions. CASA Learning Paper. <https://www.technoserve.org/wp-content/uploads/2022/12/Carbon-finance-for-smallholder-farmers-and-agribusinesses.pdf>

revenues), should be relatively permanent (i.e., they should lead to long-term changes in atmospheric carbon), and should avoid leakage (i.e., emissions should not rise outside the activity boundary). All else being equal, projects that create further social and environmental benefits will be of higher quality than those that do not provide these co-benefits.<sup>153</sup>

### *b. Past Voluntary Carbon Market Experience in the Region*

A recent assessment of the state of carbon finance in West Africa, including a number of the SURAGGWA countries, highlighted that the region is at an early stage in accessing carbon finance. Only 0.3% of all carbon projects registered<sup>154</sup> are hosted in West Africa.<sup>155</sup> The dominant project sectors are clean cookstoves and clean water.

Figures 1 and 2 summarize the volume of carbon credits issued in West Africa, by country and by category, respectively. They show SURAGGWA countries' limited experience in with carbon credits overall, and a very low presence of projects on removals, as will be generated from restoration through agroforestry in the region. Figure 3 shows the relative composition of projects by sector within West African countries.

Figure 1: Historical issuance of carbon credits in West Africa for the VCM and the CDM, by country<sup>156</sup>

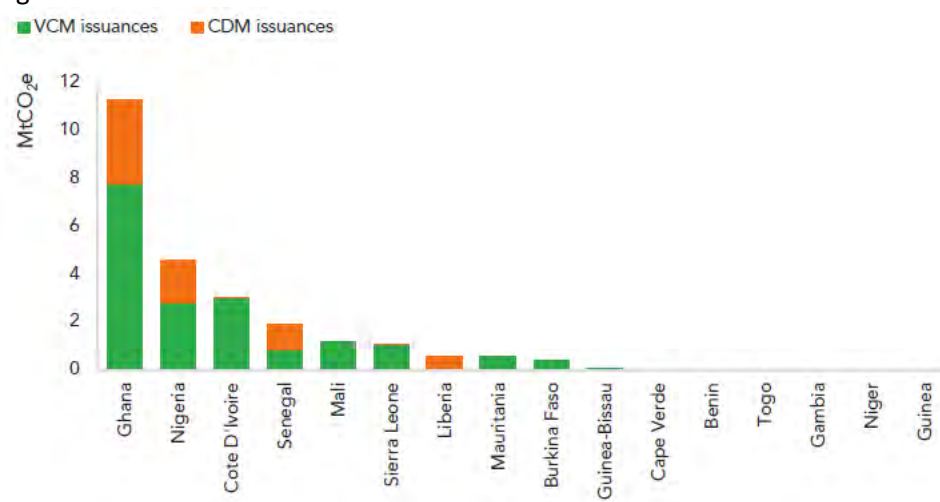


Figure 2: Overview of registered activities under the CDM and VCM by category (Q1, 2022)<sup>157</sup>

<sup>153</sup> Songwe et al, 2022

<sup>154</sup> Compliance (CDM) and Voluntary Markets (VCM)

<sup>155</sup> Greiner et al, 2022, Stakeholders' Perspectives on Carbon and Climate Finance in West Africa – Barriers and Opportunities, Climate Focus & West African Alliance on Carbon Markets and Climate Finance

<sup>156</sup> Greiner et al, 2022 based upon data sourced from the Gold Standard Impact Registry and Verra's Registry System and CDM

<sup>157</sup> Greiner et al, 2022, based upon data sourced from the Gold Standard Impact Registry and Verra's Registry System and CDM

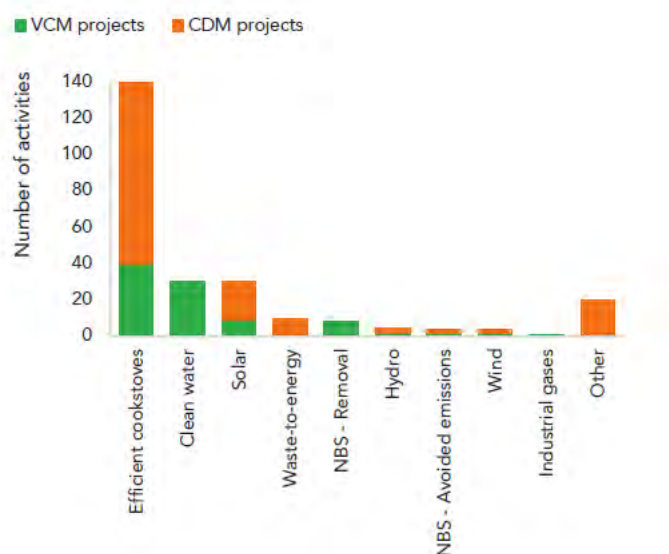
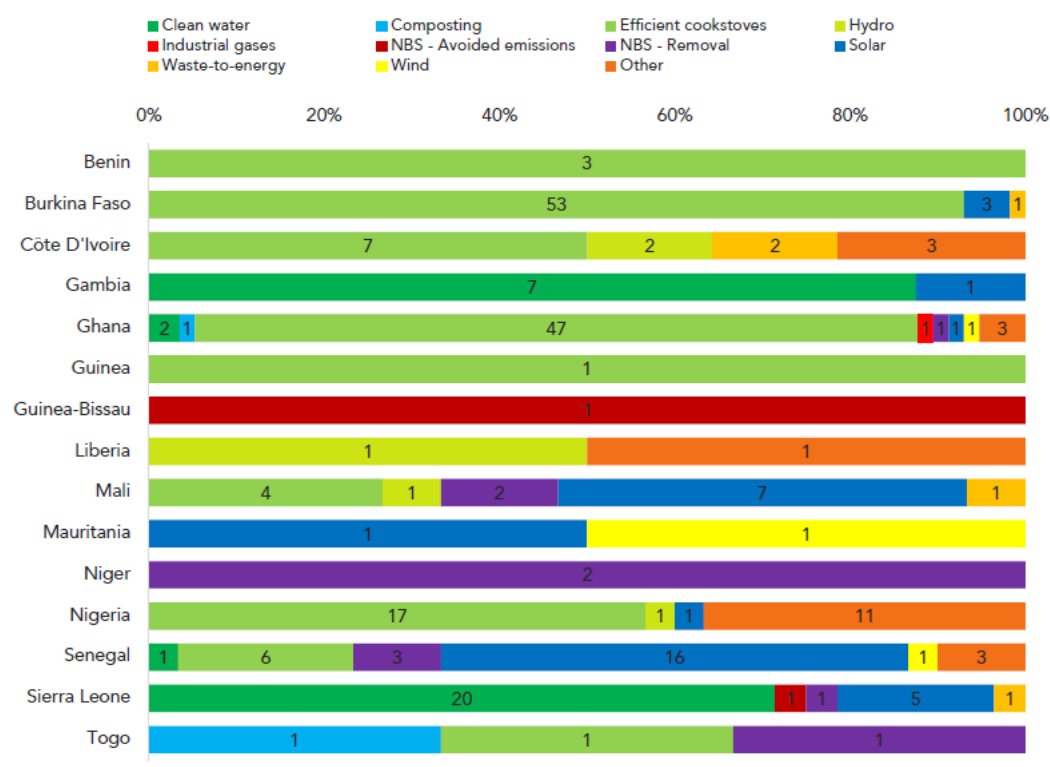


Figure 3: Dashboard of registered activities under the CDM and the VCM per West African country, by project type<sup>158</sup>



### c. Experience in Selected GGW Countries on Voluntary Carbon Markets (VCM)

#### Mali

Mali has prior experience with carbon finance projects, though their efforts are not systematized and data on them are outdated. Mali's Ministry of Environment and Sustainable Development cited past experiences and partnerships around carbon markets in the forestry sector. Their portfolio of 45

<sup>158</sup> Greiner et al, 2022 based upon data sourced from the Gold Standard Impact Registry and Verra's Registry System and CDM

carbon projects was last updated in 2011. Their portfolio includes 15 carbon credit projects in the forestry sector. The SURAGGWA team has requested details on the forestry carbon projects, including which ones are currently active and their institutional setups.

Several stakeholders expressed the complexity of the area and lack of internal capacity to engage: CMDT, the state-owned textiles company, expressed that carbon finance was a complex initiative and they do not have the capacity – both human and financial – to approach it at this time. Two NGOs – DONKO and MACFE – operate in the regions of Segou and Kaye. They have previously been involved in restoration activities in these two areas and have collaborated with FAO-Mali in the past. They have also received \$1 million from the Mali Climate Fund but not directly for carbon credits projects.

The Malian government expressed interest in learning more about the carbon finance opportunities and particularly in the Acorn initiative of Rabobank during the Hand-in-hand forum at FAO in Rome in 2022.

## Senegal

The country has recently launched several carbon credit projects, including in the solid waste management sector,<sup>159</sup> electricity,<sup>160</sup> mangrove restoration<sup>161</sup> and solar energy.<sup>162</sup> To our knowledge, they do not have any restoration projects in the dryland context generating carbon credits.

## Niger

The Niger government expressed interest in learning more about the carbon finance opportunities and particularly in the Acorn initiative of Rabobank during the Hand-in-hand forum at FAO in Rome in 2022.

## Burkina Faso

Burkina Faso has an existing pool of carbon credit projects, notably in energy and biogas. There is no systematic list of these projects. Research has identified the establishment of effective MRV frameworks in Burkina Faso and leveraging the potential of nature-based solutions and the voluntary carbon credit market as key policy recommendations.<sup>163</sup> The Green Climate Fund has a 2021 project titled the Burkina Faso Agricultural Carbon Project at the Concept Note stage. The proposal identifies that the voluntary carbon credit market has largely remained inaccessible to foreign investors due to a lack of regulatory framework and technical capacity to implement large scale Nabs Afforestation, Reforestation and Revegetation (ARR) projects.<sup>164</sup>

## Nigeria

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<sup>159</sup> <https://www.allcot.com/en/senegal-anuncia-la-primera-asociacion-de-itmos-con-el-sector-privado-del-mundo/>

<sup>160</sup> <https://blogs.worldbank.org/climatechange/senegal-pilots-carbon-finance-connect-people-power>

<sup>161</sup> <https://carbonoffsetcompany.org/senegal/>

<sup>162</sup> <https://www.meridiam.com/news/meridiam-closes-its-first-carbon-credits-sales-for-two-solar-power-plants-in-senegal/>

<sup>163</sup> <https://www.climatepolicyinitiative.org/publication/landscape-of-climate-finance-in-burkina-faso/>

<sup>164</sup> <https://www.greenclimate.fund/sites/default/files/document/27180-burkina-faso-agricultural-carbon-project.pdf>

**Nigeria has limited experience in international voluntary carbon markets in the agriculture and forest sector, but there are relevant recent initiatives in other sectors.** Nigeria has a number of Clean Development Mechanism (CDM) projects but these are in the energy and industry sectors. There are also a few voluntary carbon market projects, mostly related to energy efficiency. Nigeria does not have existing carbon market projects in agriculture and forestry. The team tried but was unable to identify any NGOs working on related activities. Recently, the government has submitted a proposal to Lowering Emissions by Accelerating Forest Finance (LEAF) involving jurisdictional credits from REDD+ that will be sold to private buyers. They also presented a REDD+ readiness package to the World Bank with the intention of engaging in the Bank's new SCALE programme, successor to the Climate Investment Funds. In addition to international finance, the Nigeria National Sovereign Investment Authority (NSIA) is has recently initiated a partnership with a global trading company, Vitol, to invest in restoration for offsets in Northern Nigeria.<sup>165</sup>

d. Emerging Carbon Finance Investors/Initiatives linking Small-scale Producers to Carbon Markets

Based on literature and targeted interviews, we identified at least four initiatives and investors already present or expressing interest in enhancing carbon finance in the Sahel that aim to link small-scale producers to carbon markets.

These initiatives aim to reduce barriers that hinder smallholder access to carbon finance, in particular, by reducing transaction costs through standardised approaches in partnerships with intermediaries, and reducing monitoring, reporting and verification (MRV) costs through innovative technologies.

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<sup>165</sup> <https://nsia.com.ng/nigeria-sovereign-investment-authority-and-vitol-launch-carbonvista-a-joint-venture-for-carbon-removal-and-abatement-projects/>

Table 2 summarizes their main features and points of entry in the region.

Table 2: Overview of selected initiatives and investors linking small producers to carbon markets

Name of Investor	Features	Country Presence in the SAHEL
Carbon Asset Management (CAM), HSBC <sup>166</sup>	<ul style="list-style-type: none"> <li>• <b>Costs and Revenue:</b> The CAM model developed with their partners foresees an investor receiving a maximum of 50% of the returns, communities would get a minimum of 45% of credits. The project developer (e.g., Global Evergreening Alliance) maintains 5% of credits as a risk buffer</li> <li>• <b>Carbon Pricing and Sale:</b> They bundle and sell carbon credits to investors.</li> <li>• <b>Land Tenure:</b> Currently CAM only works with land that is privately owned or community owned.</li> <li>• <b>Project Duration:</b> They only work with partners for 15 years. But the methodology allows them to generate for 30 years.</li> <li>• <b>Certification:</b> Verra and Gold Standard. Also looking at Plan Vivo.</li> <li>• <b>Minimum Project Size:</b> USD 50 million</li> </ul>	<p>CAM's existing engagements are in East and Southern Africa and not yet in the Sahel.</p> <p>CAM are partnering with the Global Evergreening Alliance to organize an event in Nigeria or Senegal, in collaboration with UNCCD, WEF and GGW initiative for Q2/2023. The event will include capacity building on Article 6.</p>
ACORN, Rabobank <sup>167</sup>	<ul style="list-style-type: none"> <li>• ACORN have done some pilot projects on coffee farmers switching to agroforestry with a Carbon Removal Unit (CRU) potential of 4-6 CRUs.<sup>168</sup></li> <li>• <b>Costs and Revenue:</b> Acorn does not charge up-front certification costs. They keep 10% of sales of CRUs after they are sold</li> <li>• <b>Income Potential:</b> 80% share of carbon removal unit revenues directly to farmer. They estimate an income of about EUR 80-120 per year. For instance, a farmer with 1 ha can earn by EUR 25 per CRU. They place CRUs on a public registry and individuals and companies can purchase through the registry.</li> <li>• <b>Carbon Pricing and Sale:</b> They use a minimum price of EUR 20/ton of carbon. At a recent auction, they sold at a price of EUR 31/ton.</li> <li>• <b>Technology:</b> They use traceable satellite-based remote sensing to measure and monitor. They only need to collect field data from a small number of farmers.</li> <li>• <b>Certification:</b> They have their own certification scheme, linked to Plan Vivo.</li> <li>• <b>Project Duration:</b> 20 years</li> <li>• <b>Average Farm Size:</b> 0.1 – 10 Ha of land)</li> <li>• <b>Minimum Project Size:</b> 2000 Hectares in one ecoregion</li> <li>• <b>Land Tenure:</b> They currently work only with individual farmers who have proof (formal or informal) of tenure.</li> </ul>	<p>No existing projects but ongoing conversations in Nigeria (for large scale projects), Senegal and Mali.</p> <p>During the FAO Hand-in-Hand Forum 2022, the Niger and Mali governments expressed interest in the ACORN Model.</p>

<sup>166</sup> <https://climateassetmanagement.com/about/>

<sup>167</sup> [https://assets.ctfassets.net/9vhdnop8eg9t/3eBM1X1W2dZmO1cINRFHNz/bb02af4176d8c287fa91f732dad34081/Acorn\\_Agroforestry\\_Methodology\\_v1.0\\_2021.pdf](https://assets.ctfassets.net/9vhdnop8eg9t/3eBM1X1W2dZmO1cINRFHNz/bb02af4176d8c287fa91f732dad34081/Acorn_Agroforestry_Methodology_v1.0_2021.pdf)

<sup>168</sup> Every Acorn CRU represents one metric tonne CO2

TIST <sup>169</sup>	<ul style="list-style-type: none"> <li>• The TIST model works with as a small group (6-12) rather than an individual farmer. It builds mutual trust, accountability in the group</li> <li>• Each cluster is 40-50 groups within a small region.</li> <li>• <b>Costs and Revenue:</b> 30% of the profit goes to the project developers. Of this, 6% will go to TIST</li> <li>• <b>Carbon pricing and sale:</b> REDD+ projects at \$15 min; TIST sold a project at \$37 / tonne</li> <li>• <b>Income Potential:</b> 70% of the profits go back to the small group</li> <li>• <b>Project Duration:</b> 60 years</li> <li>• <b>Certification:</b> They have 16 projects on VERRA: Triple Gold CCB and VCB</li> <li>• <b>Land Tenure:</b> The farmer does not need to have a deed to the land; it is a payment for ecosystems services model. <ul style="list-style-type: none"> <li>○ On public access land, the landowner gets 20% of profits.</li> </ul> </li> <li>• <b>Average farm size:</b> 0.4 ha</li> <li>•</li> </ul>	<p>They are present in four project countries but not in the Sahel.</p> <p>They have a “DIY TIST” model being rolled out in Zambia, Madagascar and Tanzania, that could be applicable to the Sahel.</p>
Earthbanc <sup>170</sup>	<ul style="list-style-type: none"> <li>• Earthbanc’s model relies on low cost MRV solutions and pre-selling some of the carbon credits. <ul style="list-style-type: none"> <li>○ They can aggregate the carbon that can be sequestered in a project and turn it into a sustainable land bond</li> <li>○ They sell this to sustainable asset managers and then use these funds to finance restoration activities</li> </ul> </li> <li>• <b>Carbon Pricing and Sale:</b> Price of carbon is discounted because it is a forward contract. They only pre-sell a smaller percentage of the carbon (20% or 30%) at a discounted price <ul style="list-style-type: none"> <li>○ The discounting could work with respect to future prices (\$80-150) or depending on the buyers and amount sold.</li> <li>○ The credits are bundled and they sell to asset managers</li> </ul> </li> <li>• <b>Income Potential:</b> Smallholders get close to 50-60% of the revenues</li> <li>• <b>Land Tenure:</b> They specialize in landowner agreements and making sure traditional land rights are protected</li> <li>• <b>Project Duration:</b> not fixed yet. They have some flexibility on this.</li> </ul>	<p>They are present in Kenya and have an expression of interest from the state of Meghalaya in India but no planned presence in the Sahel yet.</p>

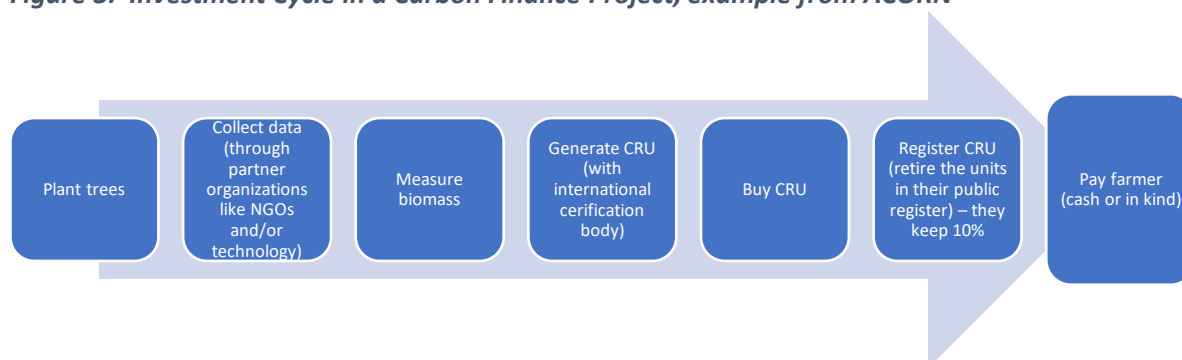
\* The list is not intended to be exhaustive but maps selected relevant initiatives with an existing or potential presence in the region.

**Figure 3 summarizes the steps of a carbon finance investment in agroforestry, using an example of Rabobank’s ACORN initiative.**

<sup>169</sup> <https://program.tist.org/>

<sup>170</sup> <https://earthbanc.io/plus-offsets-checkout/>

**Figure 3: Investment Cycle in a Carbon Finance Project, example from ACORN**



Source: Interview with ACORN, <https://acorn.rabobank.com/en/agroforestry/>

## II. Domestic Carbon Finance Opportunities and Entry Points in SURAGGWA countries

### *Agriculture and Forestry in domestic carbon markets and tax and offsets schemes*

Agriculture and forestry emissions are not currently included in any compliance emissions trading schemes or carbon taxes, beyond energy emissions in the sectors that are covered through the energy sector.<sup>171</sup> Particular challenges to include the agriculture sectors relates to the difficulties in accurately measuring emissions in view of diffuse activities and variability linked to climatic conditions.

In some countries, including Colombia and South Africa, that levy carbon taxes on other sectors, such as energy, companies can reduce their carbon tax liabilities by purchasing carbon credits from selected standards. In Colombia eligible credits must be generated from national projects and this policy has led to significant investment in carbon credits from land use, in particular Reducing Emissions from Deforestation and Forest Degradation (REDD+), afforestation and reforestation. The growth in providing credits for domestic use has helped mature and improve quality of supply, and new opportunities are now opening up to reach the growing international voluntary markets.<sup>172</sup>

When it comes to *domestic* carbon finance opportunities in the SURAGGWA countries, the barriers to incentivize restoration relate to the lack of existing models in the GGW countries and capacity gaps in integrating agriculture and forestry into domestic carbon market or tax and offset schemes.

### Nigeria

Among SURAGGWA countries, Nigeria is the first mover in promoting carbon pricing and markets. Nigeria offers the potential and has expressed interest to explore the integration of agriculture and forestry, and specifically restoration, in the set-up of its carbon pricing mechanism:

**Nigeria exhibits strong political support for developing carbon pricing and markets but the technical capacity and thinking remains at an early stage.** Nigeria's government shows strong commitment and political will to establish a carbon tax or domestic carbon market, as exhibited by the Climate Change Act of 2021 and the formation of the NCCC, with the President officially at its helm. The NCCC and other government ministries are still at an early stage in their decisions around carbon pricing (taxes

<sup>171</sup> World Bank, 2022, State and Trends of Carbon Pricing, 2022

<sup>172</sup> IETA, 2022, GHG market report

or emissions trading). This is an innovative and evolving policy field and most countries, including Nigeria, start out with a low existing knowledge base.

**Opportunities exist in defining Nigeria's domestic carbon tax and/or market establishment to enable carbon finance for restoration.** While the exact approach to establish a carbon tax or trading scheme is not yet clarified, stakeholders universally expressed interest in the programme's support to consider integrating positive incentives for restoration (and agriculture and forestry more broadly) as part of the overall framework, possibly through domestic offsets.

**The institutional landscape is complex but streamlining is underway.** Information flows and coordination of approaches between the newly formed National Council on Climate Change (NCCC), the Ministry of Environment and the Ministry of Agriculture who work on issues related to carbon markets are not yet fully consolidated.

The National Council for Climate Change has a mandate to serve as a coordinating body was constituted in February 2023. The Director General in charge of the NCCC has also been designated as the national UNFCCC Focal Point. The alignment of functions and responsibilities is expected to enhance information flows and concerted follow-up to implement the Climate Act.

**Donors and international bodies play a key role in supporting the preparation of the carbon markets framework.** Currently, donor technical support complements the government's efforts in an important way. For example, UNDP, GIZ and the EU support different government departments on carbon finance aspects and domestic carbon taxes or markets, all still at an early stage<sup>173</sup>. International organizations view Nigeria as a potential first mover in the region to develop its carbon markets (or tax), a model that could be replicated in other Africa countries.

## Senegal

Senegal identified carbon pricing as one of the instruments to consider in reducing GHG emissions under its NDC in 2021. Subsequent studies conducted by the government and experts identified a carbon tax as the most appropriate instrument for carbon finance in the country, though the agriculture and forestry sector was not included as a priority.<sup>174</sup>

## Regional Initiatives and Potential Partners in SURAGGWA

**Four regional initiatives could serve as entry points for the programme's capacity building activities around carbon markets.** These include: (1) the West Africa Alliance on Carbon Markets, (2) the Africa Carbon Markets Initiative (ACMI), (3) the Economic Commission of West African States (ECOWAS) and (4) Restore Africa – Global Evergreening Alliance.

The initiatives and their activities are not yet fully aligned, but there is some collaboration between ECOWAS and the West Africa Alliance. Nigeria plays a leading and visible role in the ACMI, which was launched at COP27 in 2022 to galvanize the development of carbon markets and carbon finance in Africa, at the highest political level, through the Vice President. The Nigerian National Council on Climate Change (NCCC) is expected to play a more active role in the ACMI going forward. ECOWAS plans to create a regional carbon market for its 15 member states, including Nigeria, as indicated in its Regional Climate Strategy and Action Plan, but it is still at the concept stage. Finally, another

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<sup>173</sup> status Q1, 2023

<sup>175</sup> <https://westafricaclimatealliance.org/category/activities/>

initiative, currently active in East and Southern Africa, that offers opportunities for collaboration is Restore Africa/the Global Evergreening Alliance.

### *(1) West Africa Alliance on Carbon Markets and Climate Finance*

West African states created the West Africa Alliance in 2016 after COP22 in Marrakech, given that the region did not take advantage of financing instruments. Its main objectives include participating in the UNFCCC negotiations on climate finance and markets, pilot the transition of CDM-related capacities, and prepare their member countries to engage with Article 6, with a supportive enabling environment and institutional arrangements. They also aim to raise awareness among key stakeholders on climate and carbon finance across sectors, and eventually work on an integrated carbon market in West Africa.<sup>175</sup>

Its membership comprises all ECOWAS countries (Benin, Cape Verde, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, **Mali, Niger, Nigeria**, Liberia, **Burkina Faso**, Sierra Leone, **Senegal**, and Togo) plus **Mauritania**. Their secretariat is based in Dakar.

**Partnerships:** They are partnering with ECOWAS on its regional carbon markets initiative. Funders include the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and the BOAD regional collaboration centre in Lome. Technical partners include Climate Focus, Enda Energie, AERA, Perspectives Climate Group and AEE.

**Potential Entry Point:** Given that they are an existing network with member-representatives from all SURAGGWA countries except Chad and Djibouti and have experience organizing capacity building activities and workshops, the program can partner with them on their art 6 and VCM related capacity development activities to specifically consider agriculture, forestry and restoration. They have expressed interest in partnering with SURAGGWA as their membership has highlighted land use activities for carbon finance as promising and high priority but at the same time noted significant technical capacity constraints in harnessing these. A Letter of Support is included with the Full Funding Proposal

### *(2) Africa Carbon Markets Initiative (ACMI)*

ACMI was launched at COP27 in Sharm-el-Sheikh in 2022, in collaboration with The Global Energy Alliance for People and Planet (GEAPP), Sustainable Energy for All (SEforALL), and the UN Economic Commission for Africa.<sup>176</sup> They aim to expand African countries' participation in voluntary carbon markets. From their launch and early report, the initiative has wide political support and has garnered international attention. For instance, the Nigerian Vice President and the Colombian ex-President are among the 13-member steering committee.

Their target is to reach 300 million credits produced annually by 2030. One of their action programme's include the establishment of a biodiversity / nature credit model. Given the recent launch and setup of this initiative, their activities have not been fully operationalized as of early 2023. While specific collaboration opportunities could not yet be established, the project plans to maintain close contact with the ACMI to capitalise on political momentum and potential synergies.

### *(3) Economic and Social Commission for West African States (ECOWAS)*

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<sup>175</sup> <https://westafricaclimatealliance.org/category/activities/>

<sup>176</sup> [https://www.seforall.org/system/files/2022-11/ACMI\\_Roadmap\\_Report\\_Nov\\_16.pdf](https://www.seforall.org/system/files/2022-11/ACMI_Roadmap_Report_Nov_16.pdf)

[ECOWAS Regional Climate Strategy and Action Plan 2022-2030](#) includes the "creat[ion] and co-lead[ership of] platforms and coalitions for capitalisation on the cross-cutting implementation of the Paris Agreement (in relation to carbon markets, loss and damage, etc.) including non-state actors" with an allocated budget of USD 1.2 million.

In preparatory discussions, ECOWAS representatives noted the intention to create a regional carbon market, possibly gradually building upon pilot country level initiatives, such as in Nigeria. ECOWAS are partnering with the West Africa Alliance on some of its carbon markets opportunities.

SURAGGWA can collaborate with ECOWAS and support capacity development for the regional carbon market initiative, with specific focus on the inclusion of and financing opportunities for agriculture, forestry and particularly restoration.

#### *(4) Restore Africa – Global Evergreening Alliance*

The Global EverGreening Alliance (GEA) targets small-scale farmer-driven land restoration project through its Restore Africa initiative. This program aims to accelerate and massively scale up the adoption of Farmer Managed Natural Regeneration (FMNR) and other complementary Evergreening practices in Tanzania, Uganda, Malawi, Zambia, Kenya and Ethiopia by building on existing successful projects and proven-effective approaches.

The Restore Africa programme proposes inclusive and collaborative implementation in partnership with the governments of participating countries, members of the GEA, and grassroots organizations.

The GEA is exploring opportunities for engagement in West Africa and the Sahel, including in Nigeria. The programme plans to explore collaboration opportunities with this relevant multi-stakeholder initiative to facilitate intra-African and inter-regional knowledge exchange and collaboration if Restore Africa become active in the Sahel.

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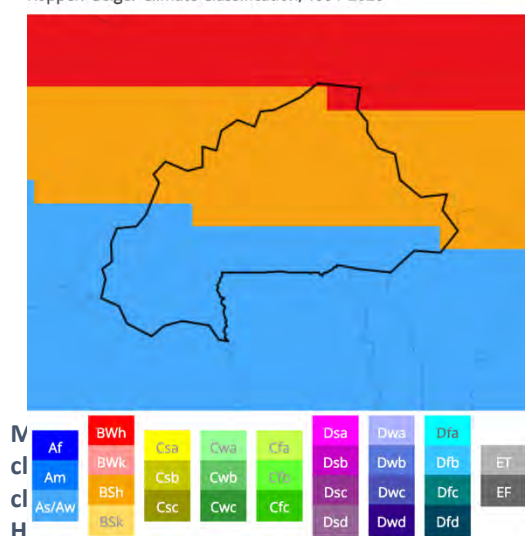
## APPENDIX- Characterization of rural production systems and their vulnerability in the SURAGGWA countries

### Characterization of production systems in Burkina Faso

#### Agro-climatic and physical contexts

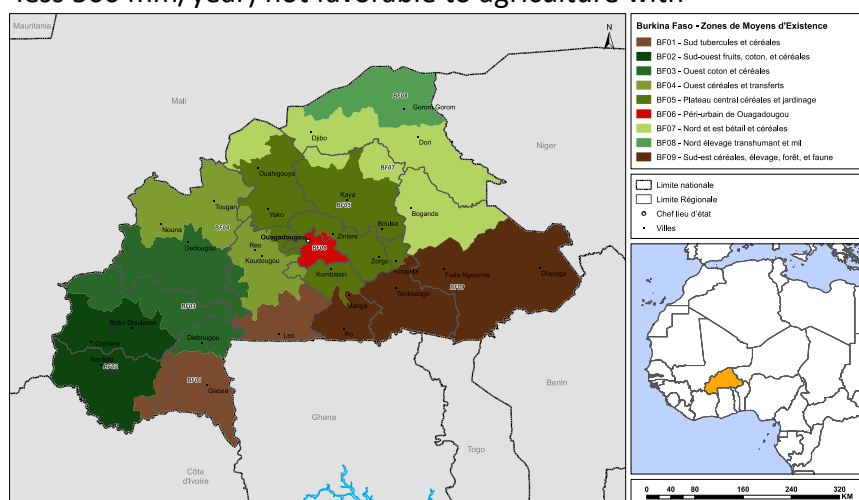
The relief is rather flat, with a few localized landform, and an important hydrographic network in the south. Its average altitude is 400 m and the difference between the two

Köppen-Geiger Climate Classification, 1991-2020



a few possible crops such as millet and groundnuts and a predominance of livestock; ii) a Hot semi-arid zone (+/- 50%, 600 to 900 mm/year) Mix of crops with low water requirements (millet, peanuts, sesame), with sorghum, corn and cotton. Attractive area for livestock because of its rich pasture and the presence of permanent river ; iii) a Tropical savannah zone (+/- 40%, 900 mm/year to 1,200 mm), adapted to cotton, sorghum, corn, rainfed rice and tubers.

extreme points does not exceed 600 m. Burkina Faso is a Sudano-Sahelian country with a tropical climate, marked by two seasons: a dry season from November to May and a rainy season from June to Mid-October. Regarding Köppen-Geiger Climate Classification<sup>177</sup>, rainfall decreases from south to north following a general trend of isohyet shifts observed over the past few decades (e.g., Map 1). This allows the country to be divided into 3 major agro-climatic zones : i) a Hot desert zone in the northernmost part (+/- 10% of the total area, with less 500 mm/year) not favorable to agriculture with



**Agricultural, pastoral and fishery overview.** Of the 12.1 million hectares available for agriculture and livestock production, 7.1 million hectares (UAA), or 51%, are cultivated, including 4.1 million hectares of cereals (sorghum, millet, maize, rice), 2.3 million hectares of legumes/nuts/oilseeds, 513,485 hectares of roots and tubers, and 169,000 hectares of fruits

<sup>177</sup> Burkina Faso's climate zones and its seasonal cycle for mean temperature and precipitation for the latest climatology, 1991-2020. Climate zone classifications are derived from the Köppen-Geiger climate classification system, which divides climates into five main climate groups divided based on seasonal precipitation and temperature patterns. The five main groups are A (tropical), B (dry), C (temperate), D (continental), and E (polar). All climates except for those in the E group are assigned a seasonal precipitation sub-group (second letter).

and vegetables. The total area under irrigation remains small but has increased from 58,000 ha in 2008 to 134,000 ha in 2015.

The agricultural sector employs some 86% of the working population,

**Map 2. Burkina's livelihood zones. Source: USAID 2014.**

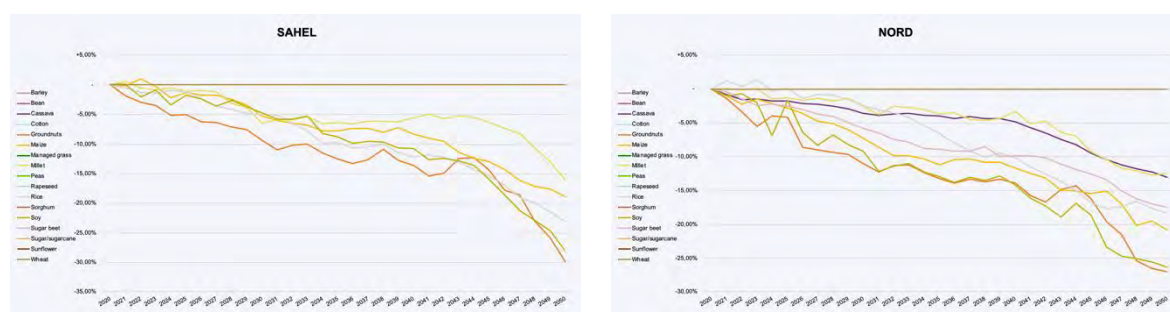
contributes 35-40% of GDP and is the main source of food and income. Agricultural production systems dominated by cereals (sorghum, millet, corn and rice) and are organized around family farming. Livestock farming is essentially pastoral, agropastoral, more sedentary and extensive. Semi-intensive and intensive livestock farms are developing around urban centers. The livestock consists mainly of cattle, sheep and goats, and to a lesser extent pigs and poultry.

Since 2007, local dry cereals availability has been on an upward trend, from an average of over 3,000,000 tons in 2007 to over 4,800,000 tons in 2019 including: i) 2,107,578 t of maize (43%), 1,439,029 t of sorghum (30%), 841,000 t of millet (17%), 395,000 t of rice (8%), and 10,031 of fonio. Production of 2,216,800 of horticultural crops (vegetables and fruit), 1,456,800 t of pulses, nuts & oilseeds and 136,795 t of roots and tubers, are also important (FAOstat, 2020).

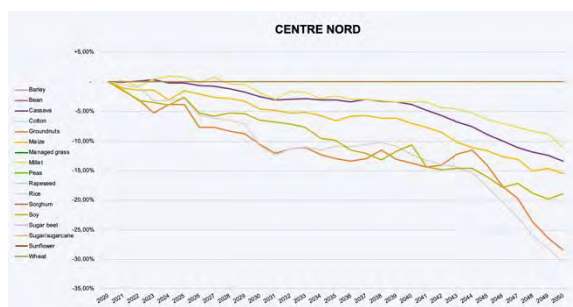
Livestock occupies nearly 86% of the country's active population and represents about 15% of the country's GDP and is the second largest contributor to agricultural value added, after gold and cotton<sup>178</sup>. The national livestock population is estimated at 10 million head of cattle, 26 million sheep/goats, 2.8 million cattle and 50 million poultry (FAOstat, 2020). Pastoral and agro-pastoral livestock systems ensure a large part of the supply of meat, milk and derived products. This is essentially a meat-based or sometimes mixed meat-milk farming system. The pastoral system, characterized by the mobility of the herds and extensive grazing, is a suitable means of developing the pastoral area and preserving the livestock.

Domestic fish production varies between 18,000 and 23,000 tons of fresh fish equivalent. Almost all of this production is consumed locally at a rate of 6 to 8 kg/pers/year. However, domestic production is far from meeting national needs, leading to a significant and growing import of fish (from 10,000 tons in 1998 to 13,700,000 tons in 2021) to fill the gap.

### Forecast on the yield evolution of the main agricultural productions in the selected areas between 2020 and 2050:



<sup>178</sup> FAO-2007, FAO-2018.



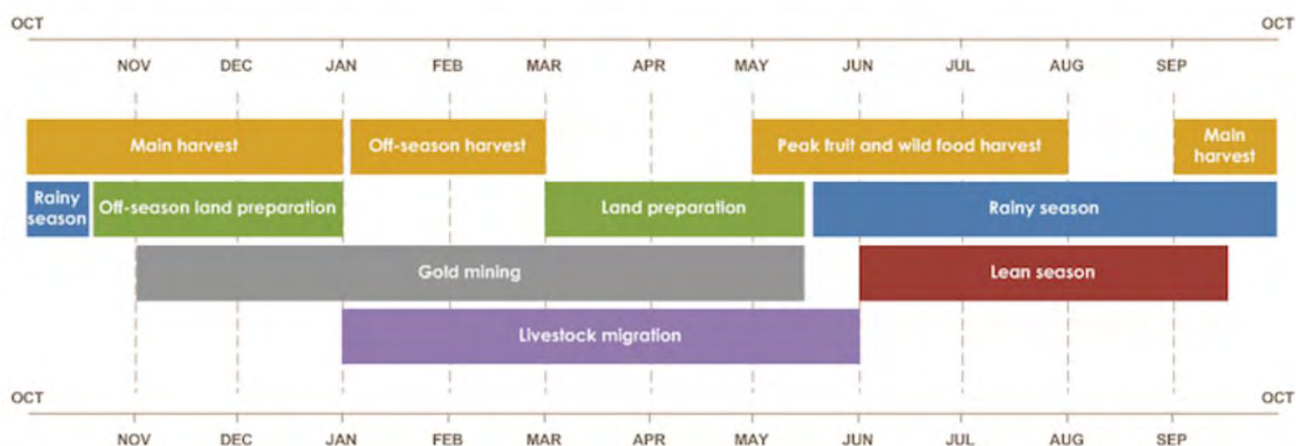
### Typologies of Burkinabè rural agricultural households

Target group typology	Characteristics / Major constraints
Agropastoral Family Farm (AFF)	<p><b>Characteristics:</b> · Rainfed agriculture organised around basic food crops (millet, sorghum) associated with cash crops (mainly cowpeas, groundnuts and sesame) in BF05 and BF07, with a majority of cereals production in deficit. Located lowland rice cultivation and near dams in BF05 and BF07 with significant market gardening in the dry season in BF05 due to severe soil degradation in recent years ; · Irrigated and rainfed production system based on food crops (sorghum, millet, maize) and cash crops (maize, cotton, rice, sesame, vegetables and cowpeas) in zones BF09, with surplus agricultural production ; · Average cultivated area (mixed farming) on the farm is 4,9 ha ; · Sedentary small-scale livestock (&lt;20 head of cattle, sheep/goat) and oriented on medium size poultry in BF05 (30&gt; heads in average). Extensive pastoral medium-sized livestock farming (30&gt;90 heads) in BF07 and BF09 ; · Zone 9 has vast forests and large areas of animal reserves, home to a remarkably diverse wildlife ; · Types of water sources for market gardening are mainly wells equipped with motor pumps for middle-income and better-off households in BF05, the high water availability and potential of dams allow year-round irrigation in BF09, and for pastoral livestock in BF07 mainly, ponds, boreholes and wells are water deficient ; · Farms faced with hunger periods between june and mid-september ; · All members of the household - with an average number of people on a farm of 11 (men, women, youth) - work in the cereal crop fields ; · Economic deficits of the farm compensated by gold mining from november to mid-may, and occasional work, exodus to the departmental/regional capitals and/or the capital of the country from january to may in BF09 and BF07 ; · Complementary activities: gold panning mainly in BF05, NTFP gathering (tamarind fruits, baobab leaves, wild fruits and seasonal tubers), processing of agro-pastoral products and handicraft ; · Off-farm income collection represents up to 39% of rural farm income, of which 30% comes from self-employment</p> <p><b>Major constraints:</b> · 44% of the adult population feel insecure in their land and property overall<sup>179</sup> ; · Difficulty in accessing quality production factors in sufficient quantity (seeds, fertilisers, equipment, efficient technologies, credit) due to distance and/or lack of availability on the market ; · Mortality of ruminants, small ruminants and poultry due to insufficient access to veterinary advice, high cost of inputs, and zoonotic outbreaks in livestock ; · Yield loss due to soil leaching, flooding, granivorous birds, crop pests, drought and low access to organic input ; · Insufficient storage and conservation capacity at family, famers organisation and village level (obligation to sell at harvest (low price), and purchase during the lean season (high price) ; · Weak entrepreneurial spirit ; · Insufficient or no mastery of management and planning tools.</p>
BF05-BF07-BF09	
Integrated NTFPs in	<p>BF07 : (i) Arabic gum (<i>Acacia laeta</i> and <i>Acacia senegal</i>) ; (ii) Medicinal plant - fruits and leaves (<i>Sclerocarya birrea</i>) ; (iii) Superfood - fruits and leaves (<i>Adansonia digitata</i>)</p>

<sup>179</sup> Prindex, 2022

BF05-BF07-BF09	<p>BF05 : (i) Superfood – leaves (<i>Adansonia digitata</i>) ; (ii) Food – tamarind pods (<i>Tamarindus indica</i>) ; (iii) Cosmetic - shea almonds (<i>Vitellaria paradoxa</i>)</p> <p>BF09 : (i) Superfood – leaves and fruit (<i>Adansonia digitata</i>) ; (ii) Food/Medicinal – néré seed (<i>Parkia biglobosa</i>) ; (iii) Cosmetic - shea almonds (<i>Vitellaria paradoxa</i>) ; (iv) Food – tamarind pods (<i>Tamarindus indica</i>)</p>
<p>Pastoral Family Farm (PFF)</p> <p>BF08</p>	<p><u>Characteristics</u> : · Farm organised around the transhumance of livestock (mainly for cattle) ; · Small to medium-scale extensive pastoral livestock (15&gt;150 heads) ; · Farming confronted with lean periods ; · Dense hydrographic networks include a large number of ponds and natural shallows ; · Relative importance of livestock to crops ; · Small-scale, strictly rain-fed, manual family farming with a predominance of millet and cowpea cultivation ; Agricultural production is in deficit ; · The livestock capital is mainly owned by men ; · The area is increasingly dependent on agriculture and other sources of income, such as labor migration and gold panning.</p> <p><u>Major constraints</u>: · Reduction and degradation of grazing areas for agricultural activities, drought, bush fires ; · Difficulties in accessing water, due to the drying up of water points (drought) or insufficient or poorly maintained infrastructure ; · Competition and conflicts for access to natural resources between farmers and herders, as well as between herders (sedentary and transhumant). · Risk of decapitalization due to conflicts and subsistence needs in crisis situations ; · Significant increase in epizootics outbreak over the last 10 years ; · High winds increasing erosion, evapotranspiration and decreasing cereal yields ; · Innodations and lack of growth of water reservoirs ; · Bush fires and forage deficit increasing ; · Difficulties in accessing veterinary care (vaccination pens, etc.) ; · Transhumance patterns and traditional pasture and water resource management mechanisms destabilised by the effects of climate change, the COVID-19 health crisis and conflict ; · Lack of clarity and accessibility in terms of pastoral legislation</p>
Integrated NTFPs in BF08	<p>BF08 : (i) Arabic gum (<i>Acacia senegal</i>, <i>Acacia tortilis</i>) ; (ii) Food/Medicinal – seeds and fruits (<i>Ziziphus jujuba</i>) ; (iii) Food - wild fonio (<i>Digitaria exilis</i>)</p>

**Rural farm household activities calendar.** The family agropastoral season begins in March with soil preparation for the agricultural season, followed by soil preparation from mid-October to January for off-season crops (see Figure 1). Harvesting of the main cereal crops (millet, sorghum) then takes place between September and January, depending on the species. Then, in the off-season, from January to March, households organize themselves around the harvesting of off-season crops, and the collection of NTFPs from May to August. We note that a majority of youth and men sell their labor from November to mid-May for gold mining. The lean season for households extends from June to mid-September. For pastoralist households, the organization of their livestock around transhumance from January to June. It is mainly the men in the households who go on transhumance and/or hire young herders to manage their herds. The remainder of the household is more sedentary, remaining in the village of origin and practicing seasonal agriculture during the rainy and off-season.

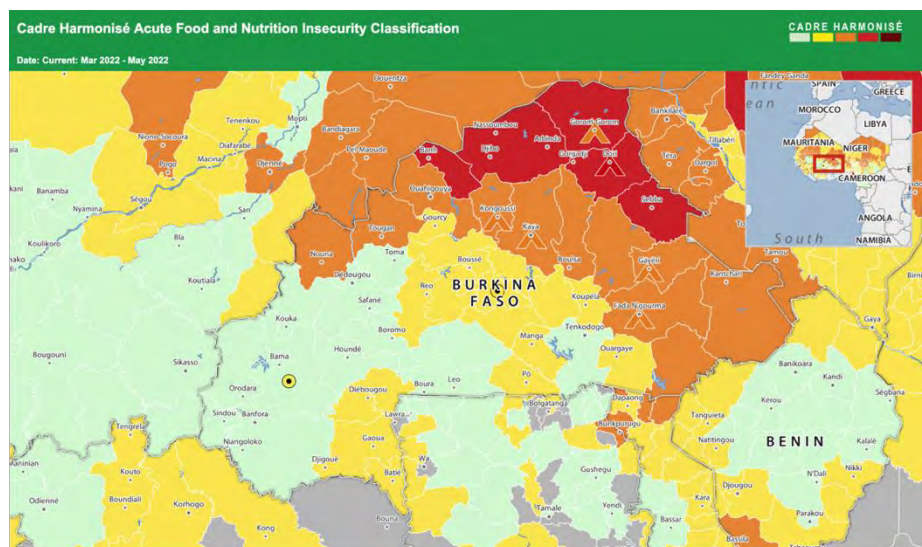


**Figure 24.** Burkinabe rural farm household activity calendar, *Source : FEWS, 2013.*

### Farm household vulnerability (IPCC /Cadre Harmonisé)

The *Cadre Harmonisé* is a unifying tool tool for monitoring areas at risk and populations

affected on current and projected food and nutrition situations in the Sahel and West Africa. It allows the severity of food and nutrition insecurity to be classified on the basis of the international classification scale through an approach that refers to well-defined functions and protocols. The results of the CH are communicated in a clear, consistent and effective manner, supporting decision-making by linking information to action. CH is also a tool to help plan the response to food and nutrition crises as part of the Intervention



**Map 3.** Burkina Faso *Cadre Harmonisé* current situation. *Source : CH,2022*

Analysis - Planning - Implementation - Monitoring/Evaluation continuum.

The most commonly used indicators are related to socio-environmental impacts or parameters such as: (i) bushfires in terms of area; (ii) epidemics and infested areas; (iii) cereal balance; (iv) fodder balance; (iv) insecurity and the number of insecurity events or conflict shocks %; (v) extreme climate shocks and flood and drought events.

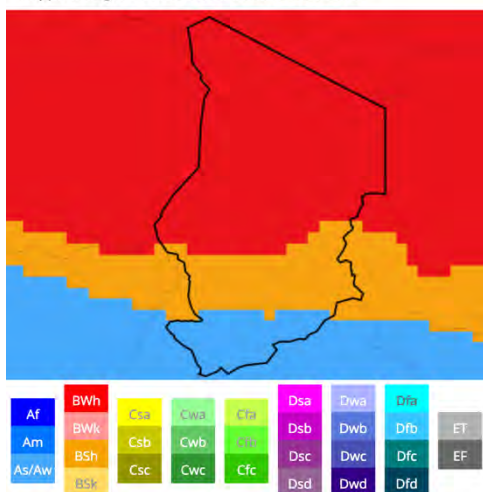
The analysis synthesizes the status levels (from 1- minimal to 5-famine) of the population in a given area with reference to: 1- minimal level of food and nutrition insecurity; 2- population under food and nutrition stress; 3- population in food and nutrition crisis; 4- population in emergency situation; and 5- famine level reached by the population.

**Land tenure :** Land tenure is still mainly managed by (i) the chief of the land (in charge of the invisible and the living) in relation to the village chief (in charge of the visible and the living), with regard to "definitive" or "temporary" allocations of "primary land" (not yet under cultivation), (ii) the head of the family or of the large family, in the case of inheritance, or

concessions to wives and/or young people (men and women). The land and village chiefs can also intervene on request to try to resolve disputes over land that has already been developed; - Widespread temporary loans: For adult men (in the case of young men/women and women in general, discussed below), whether they are indigenous or non-indigenous, the loan of land by a head of the family ("guardian") or a land chief is often possible - Resolution of land disputes: These are difficult to qualify and quantify, given that most are dealt with at the village level, through recourse to the land chief and/or village chief (little recourse to the elected members of the Village Development Committees - VDCs - and Communal Councils, which are often viewed with distrust because they are politicized). The Village Land Committees (VLC, "preventive") and Village Land Conciliation Committees (VLC, "curative") are not functional in the Communes and the Rural Land Services (RLS) are in the process of being set up. If the dispute is not resolved locally, it is referred to the Prefect, or even to the Tribunal de Grande Instance (TGI) after a statement of non-conciliation.

## Characterization of production systems in Chad

Köppen-Geiger Climate Classification, 1991-2020



Map 4. Chad's climate zone classification, with As/Aw : Tropical savanna climate ; BSh : Hot semi-arid climate ; BWh : Hot desert climate. Source : World Bank, 2021.

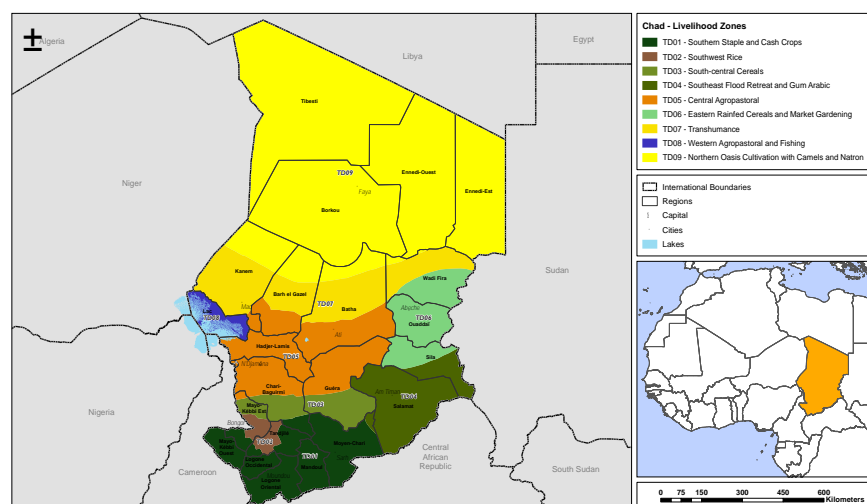
### Agro-climatic and physical contexts

More than the northern third of the country is part of the Sahara Desert, physically separating the populations of northern Chad from those of the south. The Chadian Sahara is a large basin bounded to the east by the Ennedi plateau and to the north by the Tibesti mountains, in which the Emi Koussi volcano rises to 3,415 meters above sea level and is the highest peak in the country. In the east, there is the Ennedi, a plateau culminating at 1,450 meters. Regarding Köppen-Geiger Climate Classification<sup>180</sup>, rainfall decreases from south to north following a general trend of isohyet shifts observed over the past few decades (e.g., Map 1). This allows the country to be divided into 3 major agro-climatic zones : i) a Hot desert zone in the northernmost part, which concentrates 2% of the population (+/- 47% of the total area, with less 300 mm/year) where oasis small irrigate subsistence agriculture and nomadic breeding of camelids and small ruminants can be practiced; ii) a

Hot semi-arid zone (+/- 43%, 300 to 800 mm/year) with agro-pastoral and pastoral systems, characterized by the association of rain-fed and irrigated agriculture with transhumant livestock and concentrates 51% of the total population ; iii) a Tropical savannah zone (+/- 10%, 800 to 1,200 mm/year), characterised by diversified sedentary production, combining food crops, market gardening, arboriculture and cotton growing with sedentary livestock.

### Agricultural, pastoral and fisheries overview.

Of the 126 million hectares of land and forests, 50.2 million hectares (UAA) are used for agriculture and livestock, including 4.1 million hectares of cereals (sorghum, maize, millet), 2.3 million hectares of pulses/nuts/oilseeds, 513,485 hectares of roots and tubers, 169,000 hectares of fruits and vegetables. Cereals account for 58% of cultivated areas. Most of the agriculture practiced is still rainfed, with a tremendous potential of 6 million potentially irrigable hectares, of which 335,000 hectares are easily irrigated (IFAD, 2021). Three agricultural systems are practiced in Chad: (i) a complex oasis system characteristic of the Saharan zone, where activities



Map 5. Chad's livelihood zones. Source: USAID 2021.

<sup>180</sup> Chad's climate zones and its seasonal cycle for mean temperature and precipitation for the latest climatology, 1991-2020. Climate zone classifications are derived from the Köppen-Geiger climate classification system, which divides climates into five main climate groups divided based on seasonal precipitation and temperature patterns. The five main groups are A (tropical), B (dry), C (temperate), D (continental), and E (polar). All climates except for those in the E group are assigned a seasonal precipitation sub-group (second letter).

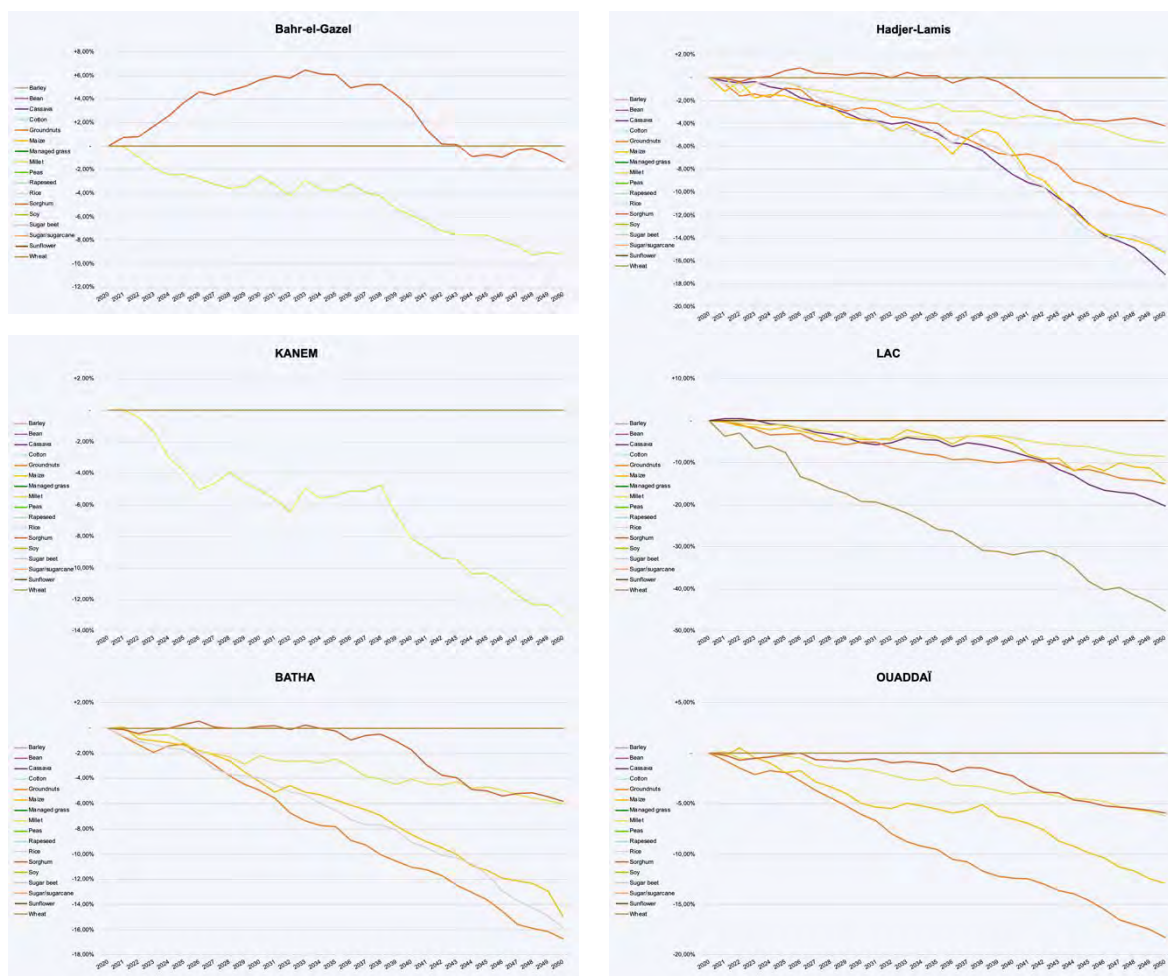
are essentially concentrated around the oases and totaling 6,000 to 7,000 ha; a three-stage cultivation system is practiced: A first stage of crops under traditional irrigation of cereals (wheat, millet) and vegetables associated with a sedentary livestock of small ruminants and a transhumant camel herd, a second stage of fruit tree cultivation and a third stage of palm groves producing dates and serving as shade (ii) pastoral and agro-pastoral, in the Sahelian zone, characterized by the association of rain-fed and irrigated agriculture based mainly on cereals and legumes with transhumant livestock farming consisting of herds of small ruminants, cattle and, to a lesser extent, camels. There are variants based on flood recession crops (berbéré), rice cultivation with or without water control, and market gardening such as onions and garlic around water reservoirs and riverbanks; and (iii) an even more diversified agricultural system in the Sudanian zone combining cereal, legume, root and tuber crops and cotton with sedentary livestock farming. The poor sales of cotton have led to the expansion of certain food crops (rice, groundnuts, beans, roots and tubers), which have become both food and cash crops. Cotton, tobacco and sugarcane are grown almost exclusively in the zone.

On average from 2017 to 2020, annual cereal production reached 2,806,000 t, including: i) 1,543,000 t of sorghum, 600,000 t of millet, 397,000 t of maize, and 264,000 t of rice. The production of pulses, nuts, and oilseeds reaches 1,292,000 t, with a marked increase in the production of peanuts and sesame in recent years. Production of 1,095,000 t of roots and tubers and 155,000 t of horticultural crops is also significant (FAOstat, 2020).

With an estimated livestock population of around 107 million heads in 2017 (FAOstat, 2020) Chad is the largest producer of livestock and meat in Central Africa. The growth in livestock numbers reflects progress in animal health, the increasing role of livestock as a means of diversifying capital and income, agricultural intensification, and the presence of animals on the markets, thus meeting the ever-increasing demand for meat and dairy products. There are three main livestock systems: (i) Nomadic or transhumant pastoral systems of ruminant herds (cattle, sheep, goats and camelids) located in the arid and semi-arid Saharan zone of the country. These systems are home to the majority of the national livestock population; (ii) Agro-pastoral systems in the Sahelian and Sudanian zones. These mixed systems that combine agriculture and livestock (poultry, small ruminants, cattle) for self-consumption and sale are experiencing significant growth; (iii) Urban and peri-urban systems driven by urbanization and the increase in demand for animal products, particularly poultry and dairy products. They compensate for the supply provided mainly by imports. The availability of agro-industrial by-products favors the development of these production systems.

The fishing industry is considered the third activity of the rural sector after agriculture and livestock. It has a significant potential estimated at 7 million hectares of land producing fishery resources. It is continental and artisanal, practiced in flood plains, rivers and lakes, the most important of which is Lake Chad. It is practiced by different categories of fishermen, both professional and seasonal, the majority of whom are women and a significant proportion of whom come from the sub-region. Production is estimated to have dropped from about 200,000 tons in the early 1960s to 110,000 tons in 2018 (FAO, 2020).

**Forecast on the yield evolution of the main agricultural productions in the selected areas between 2020 and 2050:**



## Typologies of Chad rural agricultural households

Target group typology	Characteristics / Major constraints
<b>Agropastoral Family Farm (AFF)</b>  TD05-TD06-TD08	<p><b>Characteristics (poor households):</b> · Rainfed agriculture organized around basic food crops (Berbere - flood recession sorghum, rainfed sorghum and millet) in zones TD05 and TD08, with a majority of agricultural production in deficit. Cash crops (groundnuts, sesame and recession okra) in zones TD05 and TD06 are in surplus. TD08 is characterized by rainfed millet cultivation on the dunes and corn along the lake and wadis. Wheat and maize are grown in the cold off-season in the modern polders and wadis ; · Average cultivated area (mixed farming) on the farm is 0,5-4.5 ha ; · Extensive very small-scale livestock farming (4&gt;50 heads) and poultry in TD06. Extensive transhumant medium-sized livestock farming (10&gt;160 heads) in TD08 and TD05 ; · The types of water sources for livestock are ponds, boreholes and wells in areas TD05 and TD06, and mostly the lake and its tributaries for agropastoralism in areas TD08.; · Farm faced with hunger periods between june and october ; · All members of the household - with an average number of people on a farm of 11 (men, women, youth) - work in the cereal crop fields ; · Economic deficits of the farm compensated by occasional work, exodus to the departmental/regional capitals and/or the capital of the country from february to april ; · Complementary activities: market gardening, gathering (mainly crops stubble and fodders) processing of agro-pastoral and crafts.</p> <p><b>Major constraints:</b> · Low security of tenure, which is a long process (over 5 years) and costs several hundred dollars<sup>181</sup> ; · Difficulty in accessing quality production factors in sufficient</p>

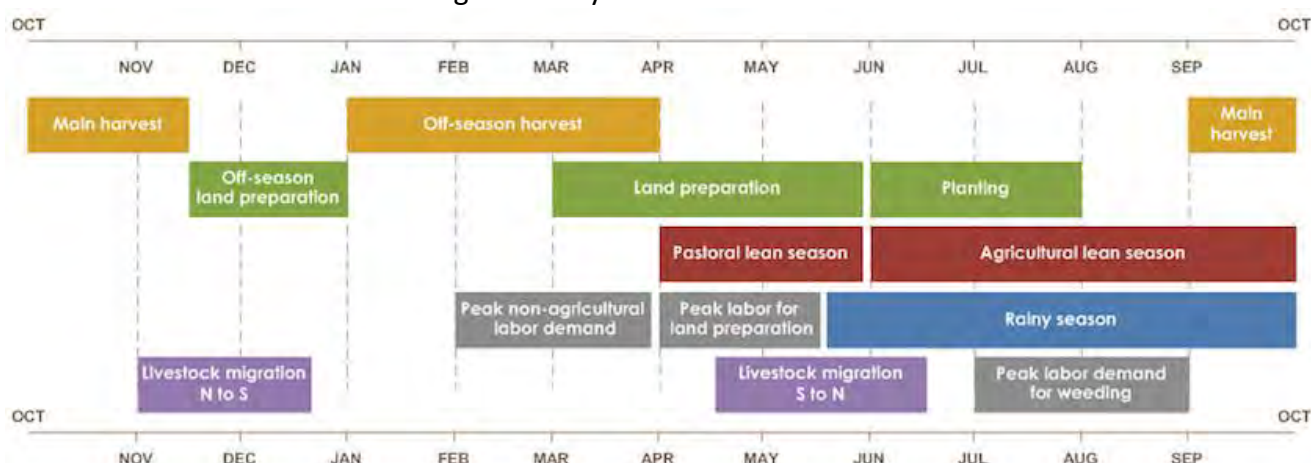
<sup>181</sup> World Bank, 2020

	quantity (seeds, fertilisers, equipment, efficient technologies, credit) due to distance and/or lack of availability on the market ; · Mortality of small ruminants and poultry due to poor access to veterinary care ; · Loss of yield due to soil salinization and alkalization, flooding, granivorous birds, land pressure, aquatic plants, drought, and soil fertility depletion ; · Insufficient storage and conservation capacity at family, famers organisation and village level (obligation to sell at harvest (low price), and purchase during the lean season (high price) ; · Weak entrepreneurial spirit ; · Insufficient or no mastery of management and planning tools.
Integrated NTFPs in TD05 TD06-TD08	TD05 : <i>Hyphaene thabaica</i> , <i>Phoenix dactylifera</i> , <i>Salvadora persica</i> , <i>Balanites aegyptiaca</i> , <i>Ziziphus mauritiana</i> , <i>Acacia raddiana</i> et <i>Acacia seyal</i>
<i>Pastoral Family Farm (PFF)</i>  TD07	<u>Characteristics</u> : · Farm mainly agropastoral in the south-west and nomadic and organized around pastoral livestock in the east (cattle, small ruminants, camels, donkey) with transhumance in the center and dromedary dominant in the north ; · Type of water source used: borehole, well, temporary ponds and watercourses ( <i>wadis</i> ) ; · Medium-large livestock farming (27<118 heads) ; · Relative importance of livestock to crops ; · Agriculture is strictly rainfed (mainly millet), manual and food-producing. Agricultural production is in deficit ; · High dependence of the poorest households on wild food (mainly wild fonio) ; · Farming confronted with lean periods from april to june ; · Recurrence of chronic food insecurity ; · Income generation also through trade and transport hire <u>Major constraints</u> : · Lack of rainfall affects local pastures and cereals from year to year ; · Animal diseases are the main threat to people's livelihoods (trypanosomiasis, anthrax and blackleg) ; · Competition and conflicts for access to natural resources between farmers and herders, as well as between herders (sedentary and transhumant) ; · Difficulties in accessing veterinary care (vaccination pens, etc.) ; · Transhumance patterns and traditional pasture and water resource management mechanisms destabilised by the effects of climate change, the COVID-19 health crisis and conflict ; · Livestock market shocks ; · Floodings blocking the transhumance of pastoralists
Integrated NTFPs in TD07	TD07 : (i) Food/Medicinal – seeds and fruits ( <i>Ziziphus jujuba</i> ) ; (ii) Arabic gum ( <i>Acacia senegal</i> )

**Rural farm household activities calendar.** The agricultural season for the family agropastoral farm is almost constant throughout the year with rainfed and off-season production on ponds in TD08 and marked by lower activity between February and May for TD05 and TD06. Cultivation of the main cereal crops takes place during the rainy season, beginning with soil preparation for the agricultural season in March to June, followed by sowing of the cereals from early June to mid-August. Harvesting of the main cereal crops (millet, sorghum, maize) then takes place between October and mid-November, depending on the species. Then, in the off-season, from January to April, households organize themselves around market gardening, berebere, maize and okra in particular. We note that young people and men generally migrate at this time to sell their labor force in the departmental/regional capitals and/or in N'Djamena.

For pastoralist households in TD07, the organization of their livestock around national transhumance with animal movements from December to June. The sale of livestock takes place on livestock markets from October to June, and the sale of milk from July to September (for better-off and medium households). All members of the households go on

transhumance and organize themselves around livestock, small-scale trade, and handicrafts. NTFPs are collected and sold throughout the year.



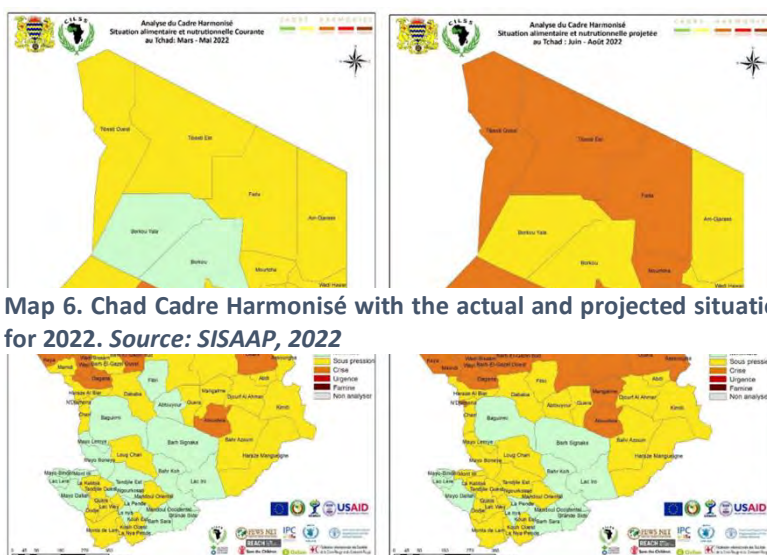
**Figure 25.** Chad rural farm household activity calendar, *Source: FEWS, 2013.*

### Farm household vulnerability (IPCC /Cadre Harmonisé)

The *Cadre Harmonisé* is a unifying tool for monitoring areas at risk and populations affected on current and projected food and nutrition situations in the Sahel and West Africa. It allows the severity of food and nutrition insecurity to be classified on the basis of the international classification scale through an approach that refers to well-defined functions and protocols. The results of the CH are communicated in a clear, consistent and effective manner, supporting decision-making by linking information to action. CH is also a tool to help plan the response to food and nutrition crises as part of the Intervention Analysis - Planning - Implementation - Monitoring/Evaluation continuum.

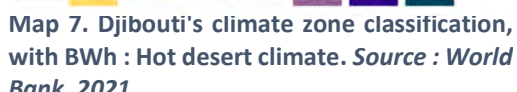
The most commonly used indicators are related to socio-environmental impacts or parameters such as: (i) bushfires in terms of area; (ii) epidemics and infested areas; (iii) cereal balance; (iv) fodder balance; (iv) insecurity and the number of insecurity events or conflict shocks %; (v) extreme climate shocks and flood and drought events.

The analysis synthesizes the status levels (from 1- minimal to 5-famine) of the population in a given area with reference to: 1- minimal level of food and nutrition insecurity; 2- population under food and nutrition stress; 3- population in food and nutrition crisis; 4- population in emerge



**Map 6.** Chad Cadre Harmonisé with the actual and projected situation for 2022. *Source: SISAAP, 2022*

## Köppen-Geiger Climate Classification, 1991-2020



Djibouti's climate varies across the country. The hinterland is warm, with average temperatures above 30°C during the summer months (May - September). With high temperatures fluctuating between 30°C and 40°C, rainfall during the hot period and a violent, hot and dry sand wind (khamsin), the warm and dry season is between June and September. The periods from May to June and September to October are the driest and mark a transition season with variable winds

**Map 8. Djibouti's livelihood zones. Source: USAID 2018.**

<sup>182</sup> Djibouti's climate zones and its seasonal cycle for mean temperature and precipitation for the latest climatology, 1991-2020. Climate zone classifications are derived from the Köppen-Geiger climate classification system, which divides climates into five main climate groups divided based on seasonal precipitation and temperature patterns. The five main groups are A (tropical), B (dry), C (temperate), D (continental), and E (polar). All climates except for those in the E group are assigned a seasonal precipitation sub-group (second letter).

importance, livestock development faces various challenges, including structural, cyclical, socio-economic, technological, and political issues.

Pastoral communities in Djibouti have traditionally relied on transhumance-based pastoral systems, which allow them to exploit different ecosystems based on seasonal variations. However, this system is currently threatened by rangeland degradation, degradation of natural resources, and drought. Water scarcity remains a limiting factor for rational rangeland exploitation. Moreover, livestock development has been hampered by recent epizootics, such as Rift Valley Fever, which has led to the decimation of livestock populations in the Horn of Africa. The embargo on animal imports from the sub-region has also contributed to the decline in livestock exports to Arabian Peninsula countries. As a response, the Republic of Djibouti has constructed a regional center for livestock exports to these countries, which includes marking equipment, quarantine facilities, and veterinary services to certify the origin and health of livestock for export.

In the fishery sector, small-scale fishing dominates, with an estimated fishery resource of 47,000 tonnes in Djibouti. However, only about 4.2% of the resources are currently exploited due to inadequate means of production, low levels of training, and limited number of boats. Artisanal fishing is practiced along the 372 km long maritime coast, employing approximately 1,000 people. The fishery sector is dominated by small-scale fishing and production is around 1,000 tons per year.

***Vegetation, soil, and hydrography.*** The total area of wooded land (woody biomass) in Djibouti is 70,000 ha, with 22,000 ha occupied by forest formations and 48,000 ha by steppe, tree, and shrub formations. The sparse vegetation in Djibouti consists of xerophytic shrubs or thorny bushes such as *Acacia flava*, *Acacia nilotica*, *Prosopis* spp., *Euphorbia godana*, *Balanites aegyptiaca*, and *Capparidaceae* (*Cadaba* spp., *Capparis* spp., *Maerua* spp., etc.). Thornbushes, acacias, *Tamarix*, and jujube trees are found along the banks of wadis and are the most favored areas for vegetation. The Moucha and Maskali islands, as well as certain points along the coast, are populated by mangroves. Dum palms are found in the western part of the Hanlé plain, at the foot of the Gamarré mountains, and on the edge of the Gagadé plain, and they are used for making containers and mats.

The coral reefs in Djibouti are well preserved due to the scarcity of divers, with coral gardens on La Moucha Island and the Seven Brothers Islands. However, the wooded areas in Djibouti are used for grazing, firewood, charcoal, and construction, which leads to soil exposure and promotes water erosion, especially during floods. Loss of vegetation cover exacerbates water and wind erosion, particularly in the only mountain forest in the country, Day. Overgrazing, resulting from the sedentarization of livestock breeders, also leads to degradation of pastures and natural resources.

Rangelands in Djibouti vary in quality, ranging from poor shrubby pastures on rocky massifs that produce only 10 kg of Dry Matter (DM)/ha/year, to richer pastures in sandy-clayey depressions that produce up to 4 tons of DM/ha/year. Of the 1.7 million ha of rangelands in Djibouti, only about 400,000 ha represent areas of greatest pastoral interest and are essential for transhumance systems. The project will focus on eight rangelands located in the Awdaac/Grabatsian, Deydey Weyn, Medeho, Petit Bara/Ambouli, and Grand Bara watersheds.

Soils in Djibouti are generally low in organic matter, poorly developed, thin, and stony, except for alluvial soils in accumulation areas. Basaltic formations dominate the west with fissured formations, while rhyolites (Miocene) occupy the east of the country. Sandstone and limestone formations (Jurassic/Cretaceous) occur southeast of Ali Sabieh. In the interior plains and endorheic depressions, the materials transported by the wadis have a finer texture, silty-clayey. Arable land represents only 0.25% of the country's surface area, according to PANE (2000).

Renewable water resources in Djibouti are estimated at 300 million m<sup>3</sup>/year. The hydrographic network is formed solely by temporary watercourses called "wadis". Flows are low, and only about 5% of rainfall is likely to infiltrate and recharge shallow (wadi sediments) or deep (basaltic aquifers) water tables. Djibouti has two continuous aquifers, one with Lake Assal as its base level, and the other between Djibouti City and Loyada. There are also discontinuous and alluvial aquifers in other areas. Recharging of the aquifers relies mainly on the infiltration of flood water into the wadis. About 95 per cent of water needs are met by groundwater resources. The use of groundwater for irrigation poses problems of excessive salinity, even in alluvial aquifers, except for water in the north-west of the country. On the other hand, it is possible to use water from underflows in the wadis with large catchment areas and regular floods

***Economy and Rural farm household activities calendar.*** Djibouti's economy is heavily reliant on the tertiary sector, which contributes to 83 percent of its GDP. The country's economy is highly dependent on port services, as the majority of Ethiopia's exports and imports pass through Djibouti. Over the past 15 years, Djibouti has experienced significant economic growth, with a GDP per capita growth rate of 3.1 percent per annum from 2001 to 2017, peaking at 6.5 percent in 2014 and 2016. However, the country has also seen an increase in total public and publicly guaranteed (PPG) debt, which rose from 50 percent of GDP at the end of 2014 to 85 percent of GDP at the end of 2016. The rapid accumulation of debt was due to loan disbursements for three large projects financed by China Exim Bank, including the Addis Ababa-Djibouti railway, water pipeline from Ethiopia, and construction of a multipurpose port, totaling USD 1.2 billion. Despite these investments, Djibouti's economy remains poorly diversified, making it vulnerable to external shocks.

Djibouti possesses important assets, including its geostrategic location in the Gulf of Aden, which serves as a crucial maritime corridor for trade in goods and petroleum products. The presence of military contingents and bases also presents a potential market for local companies. Additionally, Djibouti has advanced port infrastructure,

geothermal resources for electricity generation, and unexploited mining and fishing resources, such as salt from Lake Assal.

However, the country also faces significant challenges, including persistent poverty and unemployment, poor economic diversification, weak institutional capacity, an energy deficit that hampers private sector development, a water resource deficit that limits access to drinking water and agricultural activities, natural shocks due to climate change such as droughts and floods that negatively impact competitiveness, gender inequalities that limit women's participation in the economy, and chronic food insecurity affecting over 31 percent of the population. Djibouti is classified as one of the least developed countries (LDCs), with a GDP per capita of USD 2,180 in 2018 according to World Bank estimates. Djibouti ranked 166th out of 189 countries in the Human Development Index (HDI) with a score of 0.5246.

The family agropastoral season in Djibouti begins in January with vegetable gardening, followed by fruit market gardening from May to October (see. Figure 1). During this time, nomadic pastoralists organize their livestock around transhumance, moving from central areas to coastal plains from January to April, and then migrating within the Southeast from April to October. Men in the households are typically involved in transhumance or hire young herders to manage their herds, while the rest of the household remains more sedentary, staying in the village of origin and practicing seasonal agriculture during the rainy and off-season. It's worth noting that a majority of youth and men from Djibouti City sell their labor from June to September, and the lean season for households extends from June to October.

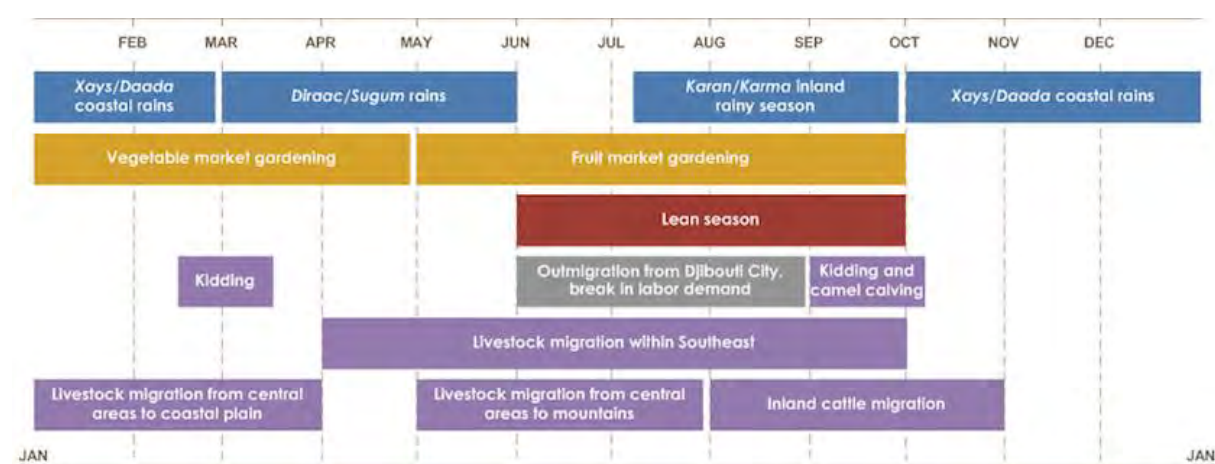


Figure 26. Djibouti rural farm household activity calendar, Source : FEWS, 2023.

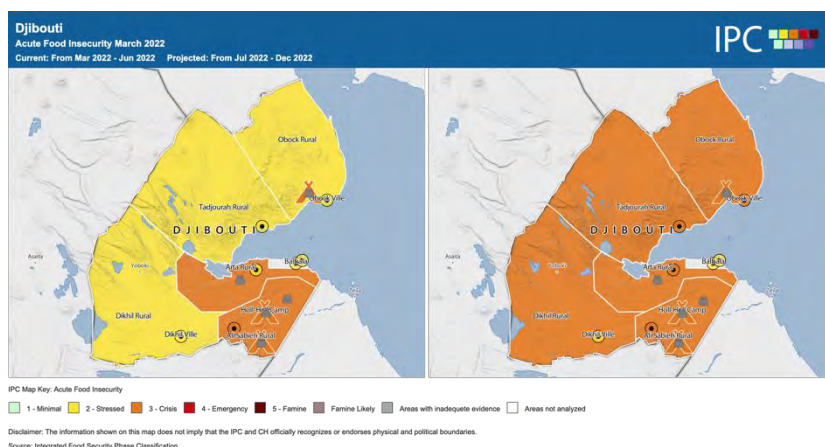
### Farm household vulnerability (IPC)

Despite a 26% decrease in the number of food insecure households, the country remains in a situation of permanent food deficit and high dependency on imports for almost all commodities. Thus, nine out of ten households in rural areas get their food from markets (cereals, oil and sugar, etc.), with only 38% of households consuming protein-rich food groups. Poverty and food insecurity are exacerbated by the presence of migrants from neighbouring countries, putting further pressure on an already limited labour market and natural resources. The four dimensions of food insecurity are therefore present: (i) insufficient overall availability, which is also marked by a strong dependence on imports; (ii) irregularity of supply (instability of international markets and cyclical shocks); (iii) precarious physical accessibility for certain sections of the population (landlocked areas, nomadism, etc.) and economic accessibility at the household level; and (iv) a significantly deteriorating nutritional situation, particularly among children (stunted growth) and women (emaciation). This food insecurity leads to (i) an increase in migratory movements towards the capital; (ii) a worsening of the degradation of natural resources; (iii) an increase in vulnerability to shocks; and (iv) a reduction in the capacity of households to cope with cyclical crises.

For the current analysis period of March through June 2022 (see figure 2), approximately 132,000 people, representing 11% of the analyzed population (of nearly 1.2 million people), are estimated to be acutely food insecure (IPC Phase 3 and 4). Specifically, an estimated 5,000 people (less than one percent of the population analyzed) are estimated to be in Emergency (IPC Phase 4) and approximately 127,000 people (11% of the population analyzed) are in Crisis (IPC Phase 3). In addition, approximately 423,000 people (36% of the population analyzed) are in Stress (IPC Phase 2).

Of the 15 areas analyzed (five rural, seven urban, and three refugee camps), the three areas of Ali Sabieh Rural, Ali Sabieh Ville, and Arta Rural, as well as the three refugee camps (Markazi d'Obock, Ali Addeh, and Holl-Holl d'Ali Sabieh) are identified as being in Crisis (IPC Phase 3), with at least 20 to 40 percent of their populations acutely food insecure (IPC Phase 3 and 4). The remaining areas are classified as Stressed (IPC Phase 2).

**Figure 27. Djibouti Acute Food Insecurity Situation March - June 2022 and Projection for July - December 2022. Source : IPC,2023**



**Land tenure :**  
tenure is  
combination

modern legal systems. The legal framework for land tenure in Djibouti is complex and includes both formal and informal systems.

Customary land tenure, which is based on traditional practices and customs, is prevalent in rural areas of Djibouti. Under customary law, land is often owned collectively by clans or tribes, and land use is regulated by customary authorities. However, customary land tenure in Djibouti is not well-documented or legally recognized, which can lead to disputes and conflicts over land ownership and use.

In urban areas, Djibouti has a formal legal system for land tenure that is based on French civil law, as Djibouti was a French colony until gaining independence in 1977. The government of Djibouti is the ultimate owner of all land in the country, and land can be leased or owned by individuals, companies, or other entities through formal legal processes. However, land ownership and tenure in urban areas can be complex and subject to overlapping claims, which can result in disputes and conflicts.

Land tenure in Djibouti is also influenced by its strategic location as a major international trade and logistics hub, which has led to increased foreign investment and infrastructure development. The government of Djibouti has been involved in large-scale land leasing and concession agreements with foreign companies, particularly for port and logistics facilities, which has raised concerns about land grabbing, displacement of local communities, and loss of traditional land rights.

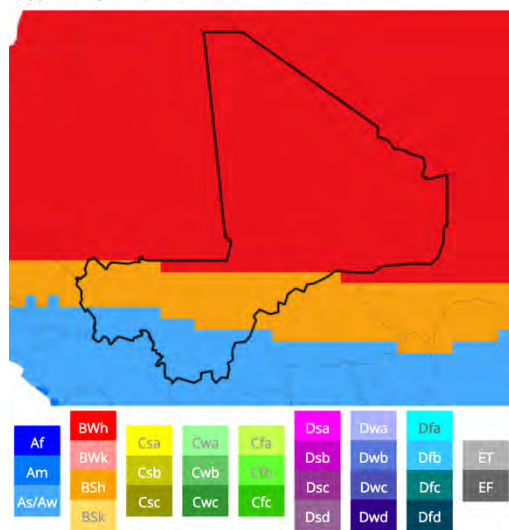
Overall, land tenure in Djibouti is characterized by a mix of customary and formal legal systems, with challenges related to land registration, recognition of customary land rights, and conflicts over land ownership and use. Efforts have been made by the government and international organizations to improve land governance and address land-related issues, but further reforms and capacity-building are needed to ensure secure and equitable land tenure for all citizens in Djibouti.

In Djibouti, land  
governed by a  
of customary and

modern legal systems.

## Characterization of production systems in Mali

Köppen-Geiger Climate Classification, 1991-2020



**Map 9. Mali's climate zone classification, with As/Aw : Tropical savana climate ; BSh : Hot semi-arid climate ; BWh : Hot desert climate.**  
Source : World Bank, 2021.

### Agro-climatic and physical contexts

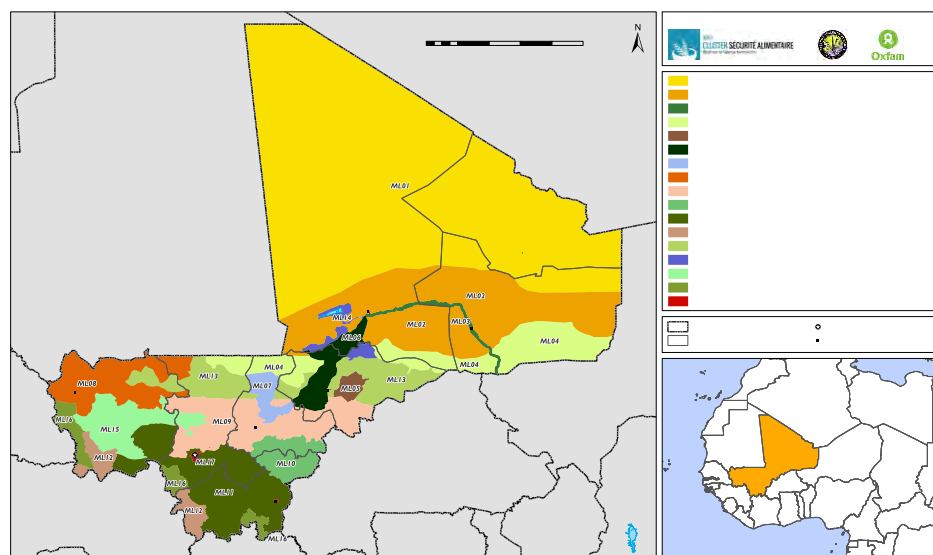
The relief (between 400 m and 1200 m) is characterized by plateaus in the south and west, an alluvial plain of the Inner Niger Delta in the center and crystalline massifs in the northeast, an extension of the central Sahara.

The climate is marked by very high temperatures (up to 45°C in the north) and by the alternation of a wet rainy season and a longer dry season. Regarding Köppen-Geiger Climate Classification<sup>183</sup>, rainfall decreases from south to north following a general trend of isohyet shifts observed over the past few decades (e.g., Map 1). This allows the country to be divided into 3 major agro-climatic zones : i) a Hot desert zone in the northernmost part (+/- 60% of the total area, 200 mm/year) where nomadic livestock and agriculture are practiced in the depression zones; ii) a Hot semi-arid zone (+/- 20%, 200 to 700 mm/year) that covers most of the interior delta of the Niger, an area with specific hydrological and ecological conditions, with numerous zones that are flooded for part of the year for irrigated agriculture and zones of rain-fed

agriculture; ii) a Tropical savana zone (+/- 20%, 700 mm/year to 1,400 mm), characterized by a more or less dense and varied vegetation cover in the center-south and characterized by a wooded savannah and gallery forests in the extreme south. Natural conditions in the central and southern zones are favorable for the development of diversified agriculture (cereals, roots, tubers, arboriculture, etc.) associated with family livestock.

### Agricultural, pastoral and fisheries overview.

Of the 145.2 million hectares available for agriculture and livestock production, only 7.6 million hectares (UAA), or 5%, are



**Map 10 Mali's livelihood zones.** Source : USAID 2021.

<sup>183</sup> Mali's climate zones and its seasonal cycle for mean temperature and precipitation for the latest climatology, 1991-2020. Climate zone classifications are derived from the Köppen-Geiger climate classification system, which divides climates into five main climate groups divided based on seasonal precipitation and temperature patterns. The five main groups are A (tropical), B (dry), C (temperate), D (continental), and E (polar). All climates except for those in the E group are assigned a seasonal precipitation sub-group (second letter).

cultivated, including 5.8 million hectares of cereals (rice, maize, sorghum, millet), 82,000 hectares of roots and tubers, 321,000 hectares of legumes/nuts/oilseeds, 213,000 hectares of fruits and vegetables, and 676,000 hectares of cotton. Cereals account for 74% of cultivated areas. Irrigated areas represent 432,252 ha, mainly concentrated in the Niger and Senegal river valleys. Land suitable for irrigation, subject to development, has an estimated potential of 2.2 million ha<sup>184</sup>.

Agricultural production systems are organized around family farming. Six out of ten people work in agriculture, which includes food crops (rice, millet, sorghum, corn, fonio), industrial crops (cotton, peanuts) and horticulture (fruit and vegetables). Other forms of organization, such as contract farming, are making progress in specific sectors (fruit, vegetables, sugar, sesame, soybeans), apart from cotton. Small-scale livestock farming is strongly integrated into family farming, where it provides many services (manuring of fields, transport, animal energy).

Cereal production would have grown even faster than the population. Between 2017 and 2020, cereal production reached 8,866,000 t, including: i) 2,631,000 t of rice (30%), 1,825,000 t of millet (21%), 1,788,000 t of maize (20%), 975,000 t of sorghum (11%), and 1,646,000 of other crops (18%). Production of 993,000 t of roots and tubers, 3,000,000 t of horticultural crops (vegetables and fruit), and 169,000 t of pulses, beans, and other crops (18%) are also important (FAOstat, 2020).

As a major livestock country, Mali has abundant and diversified animal resources (cattle, sheep, goats, camels, poultry) that are among the largest in the subregion. Converted into tons, the total available production is estimated at 387,000 t (FAOstat, 2020), including 179,000 t of cattle (46%), 154,000 t of sheep/goats (40%) and 54,000 t of poultry (14%). Livestock systems range from pastoral livestock exploiting the vast semi-arid areas and highly developed agro-pastoral livestock in agricultural areas, to peri-urban cattle, sheep, goat and poultry farming specifically targeting urban demands. The main products of livestock production are meat, milk, eggs and hides. The production of milk and milk products is estimated at 1,471,000 t and egg production at 25,000 t (FAOstat, 2020). In addition, cross-border trade in live animals occupies an important position in regional transactions of animal products, strengthening the economic scope of the sector and regional integration. The potential for continental fishing, including aquaculture, is considerable, with 5,500 sites covering 895,000 hectares inventoried in the major rivers (Niger, Senegal), rivers, lakes, ponds, shallows and ponds. Fish production is estimated at 40,000 t (FAOstat, 2020). Fish, especially dried and smoked fish, is a major source of protein. Fishing is mainly a small-scale enterprise, and the marketing and processing of fish employs many women. Aquaculture is developing as an alternative to the overexploitation of resources with important investments in the whole sector.

### **Forecast on the yield evolution of the main agricultural productions in the selected areas between 2020 and 2050:**

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<sup>184</sup> : Source : Stratégie Nationale de Développement de la Riziculture, 2009.



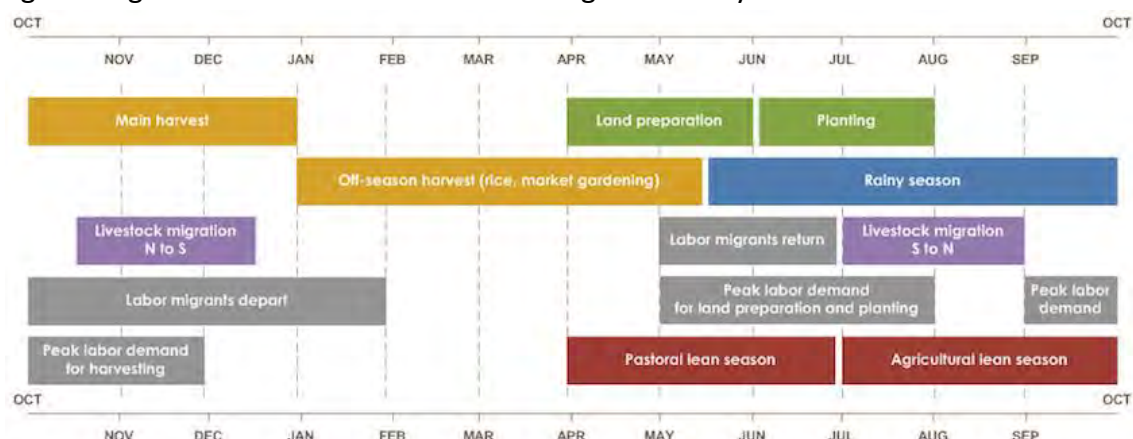
## Typologies of Malian rural agricultural households

Target group typology	Characteristics / Major constraints
Agropastoral Family Farm (AFF)	<p><b>Characteristics (poor households) :</b> · Farming organised around basic food crops (millet, sorghum, maize, rice). · Average cultivated area (mixed farming) on the farm is 7.07 ha, varying from 1.4 ha for the most desert areas (Timbuktu, Gao) to 10 ha for the most humid areas (Sikasso, Koulikoro) (World Bank, 2019) ; · Short-cycle livestock farming: small ruminants and poultry ; · Farm faced with hunger periods between june and august ; · All members of the household - with an average number of people on a farm of 11 (men, women, youth) - work in the cereal crop fields ; · Economic deficits of the farm compensated by occasional work, exodus to the departmental/regional capitals and/or the capital of the country from january to may ; · Complementary activities: market gardening, gathering (gum arabic, leaves, fruits and tubers), processing of agro-pastoral and fishery products, crafts ; · Income diversification for households and collection of off-farm income up to 3.5% of rural farm income.</p> <p><b>Major constraints:</b> · Poor land tenure security, especially in developed areas (only 8% have a property title) ; · Difficulty in accessing quality production factors in sufficient quantity (seeds, fertilisers, equipment, efficient technologies, credit) due to distance and/or lack of availability on the market ; · Mortality of small ruminants and poultry due to poor access to veterinary care ; · Insufficient storage and conservation capacity at family, PO and village level (obligation to sell at harvest (low price), and purchase during the lean season (high price) ; · Weak entrepreneurial spirit ; · Insufficient or no mastery of management and planning tools.</p>
NTFPs integrated	To be determine
Pastoral Family Farm (PFF)	<p><b>Characteristics :</b> · Farm organised around the transhumance of livestock (cattle, zebu, camels, small ruminants) ; · Farming confronted with lean periods ; · The man owns the capital (livestock) and often also manages the woman's livestock (e.g. cattle received as dowry).</p> <p><b>Major constraints:</b> · Reduction and degradation of grazing areas for agricultural activities, drought, bush fires ; · Difficulties in accessing water, due to the drying up of water points (drought) or insufficient or poorly maintained infrastructure ; · Competition and conflicts for access to natural resources between farmers and herders, as well as between herders (sedentary and transhumant). · Risk of decapitalization due to conflicts and subsistence needs in crisis situations ; · Difficulties in accessing veterinary care (vaccination pens, etc.) ; · Transhumance patterns and traditional pasture and water resource management</p>

	mechanisms destabilised by the effects of climate change, the COVID-19 health crisis and conflict ; · Lack of clarity and accessibility in terms of pastoral legislation
NTFPs integrated	To be determine

**Rural farm household activities calendar.** The season for the Agropastoral family farm starts in april with the preparation of the soil for the agricultural season in April-May, followed by the sowing of cereals at the first rains in June (cf. figure 1). The harvest of the main cereal crops (millet, sorghum, maize) is then spread out between October and January depending on the species. Subsequently, in the off-season, from January to May, households organise themselves around market gardening, the use of NTFPs (such as XXXX), and the crafting and processing of agro-pastoral and fishing products. It is noted that young men and men generally migrate at this time to sell their labour power in departmental/regional capitals and/or Bamako.

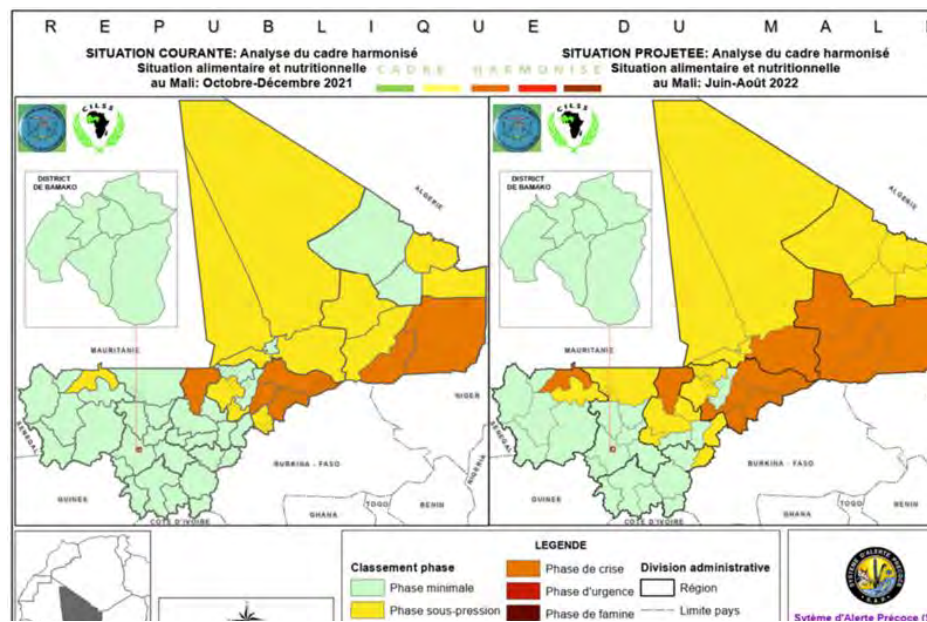
For pastoralist households, characterised by an organisation of their livestock around national transhumance (90% transhumance in Mali) from July to September from the south to the north and from mid-October to mid-December from the north to the south of the country. It is mainly the men in the households who go on transhumance and/or hire young herders to manage their herds. The rest of the household, which is more sedentary, stays in the village of origin and carries out seasonal farming in the rainy and off-season.



**Figure 28.** Malian rural farm household activity calendar, *Source : FEWS, 2016.*

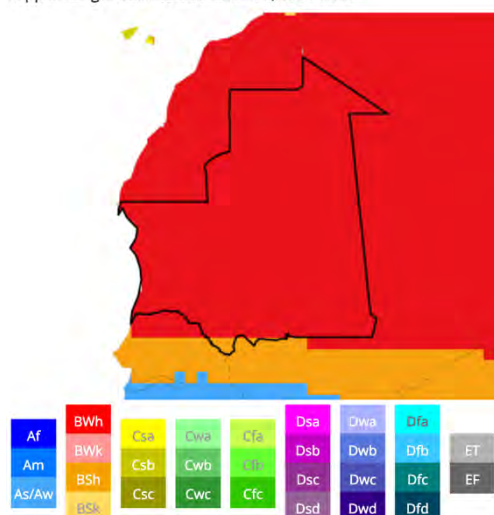
### Farm household vulnerability (IPC /Cadre Harmonisé)

The *Cadre Harmonisé* is a unifying tool for monitoring areas at risk and populations affected on current and projected food and nutrition situations in the Sahel and West Africa. It allows the severity of food and nutrition insecurity to be classified on the basis of the international classification scale through an approach that refers to well-defined functions and protocols. The results of the CH are communicated in a clear, consistent and effective manner, supporting decision-making by linking information to action. CH is also a tool to help plan the response to food and nutrition crises as part of the Intervention Analysis - Planning - Implementation - Monitoring/Evaluation continuum.



**Map 11. Mali *Cadre Harmonisé* on the latest current and projected situation. Source, CH, 2022**

The most commonly used indicators are related to socio-environmental impacts or parameters such as: (i) bushfires in terms of area; (ii) epidemics and infested areas; (iii) cereal balance; (iv) fodder balance; (iv) insecurity and the number of insecurity events or conflict shocks %; (v) extreme climate shocks and flood and drought events. The analysis synthesizes the status levels (from 1- minimal to 5-famine) of the population in a given area with reference to: 1- minimal level of food and nutrition insecurity; 2- population under food and nutrition stress; 3- population in food and nutrition crisis; 4- population in emergency situation; and 5- famine level reached by the population.



## Characterization of production systems in Mauritania

### Agro-climatic and physical contexts

Most of the territory (1.030.700 km<sup>2</sup>) is in the Sahara desert, with plains and reliefs not very uneven, as well as regs (rocky desert). In the north, there are high plateaus with a peak at 915 m altitude: the Kedia of Idjil. In the center of the country, the basin of Hodh El Chargui is bordered in the southeast by sandstone plateaus.

The climate is generally hot and dry. Maximum temperatures exceed 44°C in May-June, and minimum temperatures can drop to 10°C in January

and February. Winds are very frequent and favor the progression of silting. Regarding Köppen-Geiger Climate Classification<sup>185</sup>, rainfall decreases from south to north following a general trend of isohyet shifts observed over the past few decades (e.g., Map 1). This allows the country to be divided into 2 major agro-climatic zones: i) a Hot desert zone in the northernmost part (+/- 90% of the total area, less than 200 mm/year) where agropastoral productions are practiced ; and ii) a Hot semi-arid

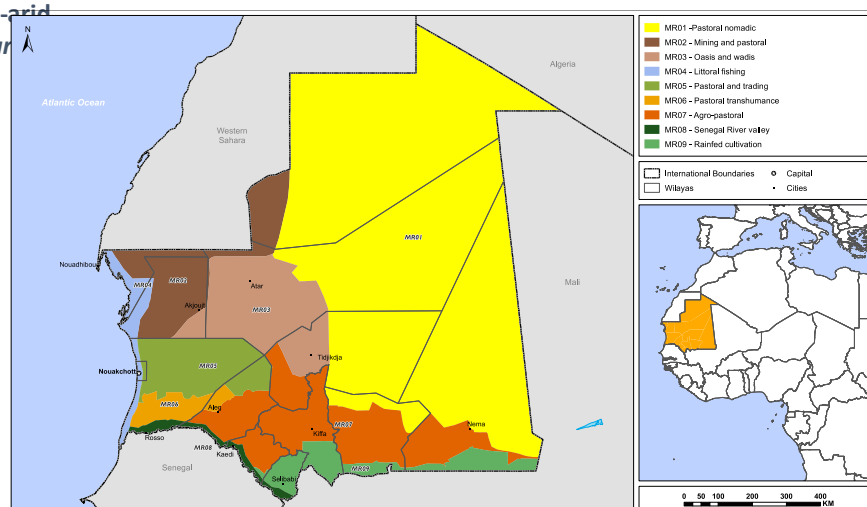
**Map 12. Mauritania's climate zone classification, with BSh : Hot semi-arid climate ; BWh : Hot desert climate. Source: World Bank 2021**

zone (+/- 10%, 400 mm/year) that covers most of the Senegal River Valley characterized by rainfed cultivation.

### Agricultural and pastoral overview.

Of the 39.7 million hectares available for agriculture and livestock production (UAA) 39.2 million hectares are under permanent meadows and pasture, 272,101

hectares of cereals (sorghum, rice, maize and millet), 3,765 hectares of roots and tubers and 97,268 hectares of legumes/nuts/oilseeds. Areas suitable for agro-pastoral activity cover barely 10% of the country, including only 513,000 hectares of cultivable land, including the 135,000 hectares of irrigable land along the only permanent river, the Senegal River. Five agro-ecological zones have been identified: i) the Saharan zone with annual rainfall of less than 150 mm/year. It covers 80% of the country's surface area; ii) the Sahelian zone, where irregular rainfall varying



**Map 13. Mauritania's livelihood zones. Source: FEWS 2014.**

<sup>185</sup> Mauritanian's climate zones and its seasonal cycle for mean temperature and precipitation for the latest climatology, 1991-2020. Climate zone classifications are derived from the Köppen-Geiger climate classification system, which divides climates into five main climate groups divided based on seasonal precipitation and temperature patterns. The five main groups are A (tropical), B (dry), C (temperate), D (continental), and E (polar). All climates except for those in the E group are assigned a seasonal precipitation sub-group (second letter).

between 150 and 500 mm/year allows for the practice of rainfed crops and transhumant livestock; iii) the Senegal River valley zone, which has water resources and vegetation that allow for the development of agro-sylvo-pastoral activities; iv) and the maritime zone on the Atlantic coast, which extends over a strip of coastline 800 km long and 50 km wide from Nouadhibou to the river delta. The country's two main cities (Nouakchott and Nouadhibou) are the most important in terms of intensive urban dairy and poultry farming, and market gardening.

Cereals (mainly sorghum, maize, millet) are grown through (i) extensive rainfed farming systems in sandy areas or "diéri", which are located in non-floodable areas, (ii) natural flood recession and controlled flood recession farming systems or "walo", which are practiced in floodable areas, and (iii) farming systems behind dams and lowlands, which are practiced in areas of local rainfall accumulation. Between 2017 and 2020, cereal production reached 340,115 t, including: i) 232,200 t of paddy rice (68%), mainly irrigated agriculture with water from the Senegal River and its tributaries, 80,218 t of sorghum (24%), 15,519 t of maize (5%), and 12,378 t of other crops (3%). The national production of 51,294 t of pulses, beans and oilseeds is of modest importance, as well as 8,210 t of roots and tubers and 4,720 t of horticultural vegetables and fruits produced in the oasis basins in the northern regions and in the Senegal River valley (FAOstat, 2020).

The number of livestock is estimated at 1.7 million cattle, 10 million sheep, 6.7 million goats and 1.4 million camels. The distribution of livestock and breeds depends on the area and the livestock production system. Livestock farming is in most cases extensive, but in recent years there has been an evolution towards other more intensive forms. As a result, three livestock farming systems coexist: (i) Traditional or transhumant breeding system characterized by annual movements of more or less great amplitudes of the herds, from north to south ; (ii) Semi-sedentary livestock system, where populations practice both livestock and agriculture and where herds alternate between the natural pastures of the diéri and walo after the harvest of flood recession fields and irrigated areas. Herd sizes in these areas are relatively smaller compared to transhumant herds; and (iii) Urban and peri-urban livestock systems developed in response to the effects of drought and as a corollary to urbanization. These systems are specialized in goat breeding and sheep fattening, as well as in poultry farming. Their objective is the production of goat milk, red and white meat and eggs.

Total livestock production is estimated at 136,710 t (FAOstat, 2020), including 35,650 t of sheep (26%), 30,180 t of cattle (22%), 25,360 t of camelin (19%), 19,020 t of goats (14%) and 4,720 t of poultry (14%). The livestock is sold on weekly markets in large towns or through the central slaughterhouse in Nouakchott. The sector generates a surplus of about 36,000 tons for export. The production of milk and milk products is estimated at 825,330 t and egg production at 5,510 t (FAOstat, 2020). In addition, the productions resulting from fishing amount to 277,160 t.

**Forecast on the yield evolution of the main agricultural productions in the selected areas between 2020 and 2050:**



### Typologies of Mauritanian rural agricultural households

Target group typology	Characteristics / Major constraints
Agropastoral Family Farm (AFF)  MR07, MR08, and MR09	<p><b>Characteristics :</b> · Rainfed agriculture (<i>diéri</i>) organised around basic food crops (sorghum,, millet, cowpeas, maize) in MR07 and MR09, with a predominance of lowland farming in MR07 compare to MR09. Multi-farming systems in MR08 areas with irrigated and mechanized food and cash crops (mainly paddy rice), with some recession crops (sorghum and maize), rainfed crops and irrigated vegetable crops (cabbage, eggplant, mint, etc) ; · Average cultivated area (mixed farming) on the farm is 1,81 ha, with 0,67 ha irrigated in MR08 · Extensive pastoral small-scale livestock farming (&lt;50 head small ruminants and cattle) in MR07 and MR09. Moderately extensive pastoral farming on a very small scale (&lt;30 heads small ruminants and cattle) in MR08; · The types of water sources for livestock are ponds, boreholes, and wells in MR07 and MR09, and the Sengal River and its tributaries, ponds, boreholes, and village irrigation schemes for agro-pastoralism in MR08; · Farm faced with hunger periods between april and july ; · Average number of people on a farm of 8,33<sup>186</sup> (men, women, youth); · Economic deficits of the farm compensated by occasional work (mainly pastoral labor), exodus to the departmental/regional capitals and/or the capital of the country from october to september in MR07 and december to april in MR09 ; · Complementary activities: MR07, MR09 gathering (jujube fruit, balanites, arabic gum, <i>Combret Unglutinosum</i>, <i>Cenchrus biflorus</i>, <i>Zizyphus mauritania</i>), processing of agro-pastoral and crafts ; · Off-farm income collection represents up to 42% of rural farm income.</p> <p><b>Major constraints:</b> · Low land tenure security, especially on national domain lands where 1% of the potential landowners has a official property title<sup>187</sup> ; · Difficulty in accessing quality production factors in sufficient quantity (seeds, fertilisers, equipment, efficient technologies, credit) due to distance and/or lack of availability on the market ; · Mortality of small ruminants due to poor access to veterinary care ; · Loss of yield due to over-flooding and granivorous birds in M08, · Loss of grazing area and yield in MR07 and MR09 due to drought ; · Insufficient storage and preservation capacity at family, farmer organization and village level (obligation to sell at</p>

<sup>186</sup> Average for poor, middle and better-off households (FEWS NET Data, 2019)

<sup>187</sup> [World Bank, 2015](#)

	harvest (low price), and to buy during the lean season (high price) ; · Dams damaged by floods resulting in water losses ; · Insufficient or no mastery of management and planning tools.
Integrated NTFPs in MR07-08 and MR09	MR07 : (i) Food/Medicinal – seeds and fruits ( <i>Ziziphus jujuba</i> ) ; (ii) Food/Medicinal – fruits ( <i>Balanites aegyptiaca</i> ). MR08: (i) Food/Medicinal – seeds and fruits ( <i>Ziziphus jujuba</i> ) MR09: (i) Food/Medicinal – seeds and fruits ( <i>Ziziphus jujuba</i> ) ; (ii) Arabic gum ( <i>Acacia spp.</i> ) ; (iii) Food – acacia pods ( <i>Acacia spp.</i> )
Pastoral Family Farm (PFF)  MR02-MR05-MR06	<u>Characteristics</u> : · Farming essentially focused on livestock with little opportunity for agriculture ; · Farm organised around the transhumance of livestock (mainly for goats) inner transhumance (25km from the farm) to exterior transhumance (>400 km from the farm) depending on the availability of forage; · Small to medium-scale extensive pastoral livestock (8>91 heads), with livestock more important in MR06 households ; · Farming confronted with lean periods ; · Sufficient precipitation water for fodder production and filling of water points, with more forage availability in MR05 compared to MR02-06; · Importance of mining activities in the constitution of household income in MR02 ; · The livestock capital is mainly owned by men and the transhumance is done with the valid members of the household and the young shepherds ; · Importance of external remittances in MR05, and sale of labor in MR02 for income generation. <u>Major constraints</u> : · Reduction and degradation of grazing areas due to drought and bush fires; · Difficulty in accessing water, due to the drying up of water points (drought) or insufficient or poorly maintained infrastructure; · Risk of decapitalization due to subsistence needs in a crisis situation and the drop in the sale price of livestock; · Significant increase in epizootics (every 3 years); · Increase in bush fires (every 2 years) and fodder deficit; · Difficulty in accessing veterinary care (vaccination parks, etc.) Difficulty in accessing veterinary care (vaccination parks, etc.); · Transhumance methods and traditional pasture and water resource management mechanisms destabilized by the effects of climate change and the COVID-19 health crisis; · High dependence on the volatility of international mineral prices.
Integrated NTFPs in MR06-05 and MR02	MR06 - (i) Arabic gum ( <i>Acacia senegal</i> ) ;  MR05 - (i) Food/Medicinal – fruits-leaves ( <i>Balanites aegyptiaca</i> ) ; (ii) Forages/Dune fixation - <i>Leptadenia pyrotechnica</i> and <i>Cenchrus biflorus</i> grasses.  MR02 – (not referenced in the study)

**Rural farm household activities calendar.** The season for the family agropastoral farm begins from June to September with the planting of rainfed crops and continues from October with the sowing of flood recession crops. Sowing of off-season vegetable crops follows from February to mid-March (see Figure 1). The harvest of the main cereal crops (millet, sorghum, cowpeas) is spread out from September to December depending on the species. Then, in the off-season, from January to April, households harvest market garden crops, followed by rice from May to mid-June. Young people and men migrate from March to July to sell their labor in the departmental/regional capitals and/or Nouakchott.

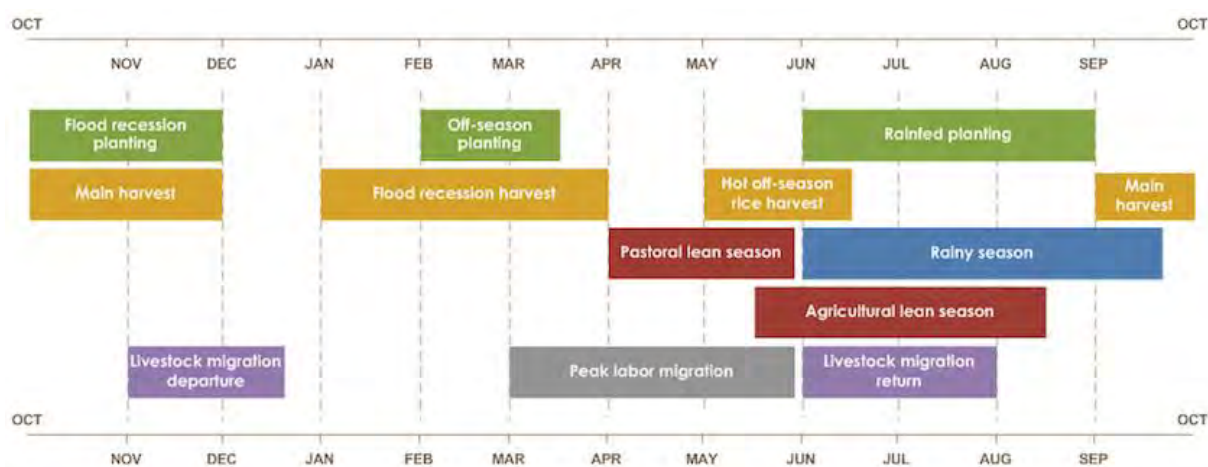
For pastoralist households, the organization of their livestock around national transhumance (60% of transhumance in Mauritania) runs from November to mid-December for departures and from June to August for returns. It is mainly the men in the households who go on transhumance and/or hire young herders to

manage their herds. The rest of the household is more sedentary, remaining in the village of origin and practicing seasonal agriculture in the rainy season and off-season.

**Figure 29.** Mauritanian rural farm household activity calendar, *Source : FEWS, 2013.*

### Farm household vulnerability (IPC /Cadre Harmonisé)

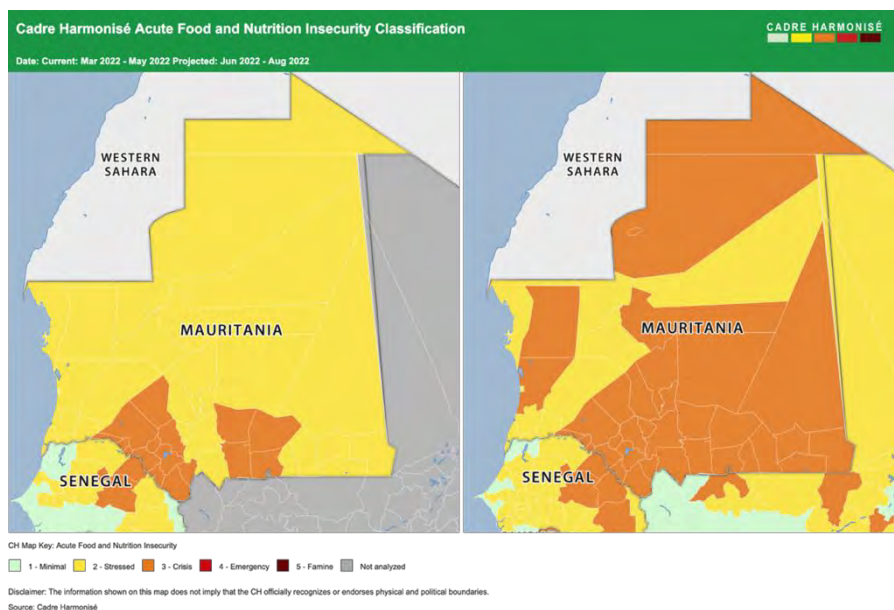
The *Cadre Harmonisé* is a unifying tool tool for monitoring areas at risk and populations affected on current and projected food and nutrition situations in the Sahel and West Africa. It allows the severity of food and nutrition insecurity to be classified on the basis of the international classification scale through an approach that refers to well-defined functions and protocols. The results of the CH are communicated in a clear, consistent and effective manner, supporting decision-making by linking information to action. CH is also a tool to



help plan the response to food and nutrition crises as part of the Intervention Analysis - Planning - Implementation - Monitoring/Evaluation continuum.

The most commonly used indicators are related to socio-environmental impacts or parameters such as: (i) bushfires in terms of area; (ii) epidemics and infested areas; (iii) cereal balance; (iv) fodder balance; (iv) insecurity and the number of insecurity events or conflict shocks %; (v) extreme climate shocks and flood and drought events.

The analysis synthesizes the status levels (from 1- minimal to 5-famine) of the population in a given area with reference to: 1- minimal level of food and nutrition insecurity; 2- population under food and nutrition stress; 3- population in food and nutrition crisis; 4- population in emergency situation; and 5- famine level reached by the population.



*Land tenure* : Traditional or “ancestral” collective land tenure is based on three essential principles: (i) the absolute inalienability of rights to land that has been effectively developed, (ii) the equal rights of community members to access and use land reserves, and (iii) free access to resources on pastoral rangelands. The communities thus have domains within which individuals have rights that vary according to their place in the social hierarchy. The individual can obtain: i) either a plot of community land to cultivate throughout his or her life, ii) or a plot of land for cultivation behind the dam that is intended for him or her each year, iii) or a plot of land on the community reserves that he or she clears, thus constituting a right of appropriation.

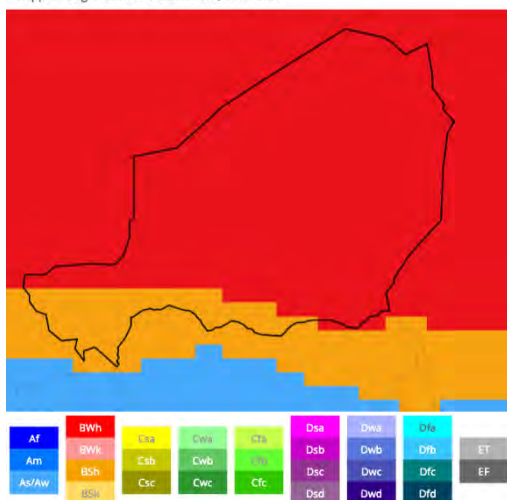
Modern land tenure transfer by the State of its private domain is carried out in three stages: i) the provisional rural concession, which gives the beneficiary priority over the land, provided that he carries out the program that he has detailed in his application; ii) the final concession is acquired after the provisional concessionaire has fulfilled the development conditions set out in the concession deed; iii) the Title Foncier (TF) is the final act of transfer of ownership. It has the same value as the land title in urban areas. Forms of precarious land tenure. The coexistence of two legal systems (ancestral law and law dictated by the will of the State) has led to numerous forms of insecure land tenure, as can be seen from the official laws in force in the country. These tenures can take the following forms: (i) a loan of land, which may be granted by a community for the benefit of an individual or another community; (ii) a lease, which consists of leasing land to communities or individuals in return for a sum expressed in money or grain; (iii) traditional leasing contracts or mouzaraa, which consist in authorizing a farmer with no land or with little land in relation to his needs, to cultivate a plot of land under certain conditions; (iv) irregular occupation of the State's private domain in urban as well as in rural areas, under the same conditions. It tacitly gives a sort of right of pre-emption in the event of regularization or restructuring of the area; v) abnormal private occupation of the urban, road, rail or maritime public domain grants the occupant rights, particularly in the event of eviction before the deadline set by the agreement or the authorization of the public authority.

In Mauritania, the main obstacle to the acquisition of land by a woman is the customary inheritance laws that favor men. In rural areas, women are increasingly accessing land collectively, through associations or cooperatives. In general, the laws governing land tenure from the colonial period to the present day are "gender neutral. However, practices in rural areas are diverse. Women have inherited land from their parents since the middle of the 18th century. In reality, however, women do not inherit family land and are paid compensation in the form of movable property. This practice, as well as the maintenance of family lands in joint ownership, aims to limit their fragmentation as a result of inheritance. The land is not divided up but the harvest is, in order to maintain the solidarity of the family, while taking into account the need for a division of labor within the family.

# Characterization of production systems in Niger

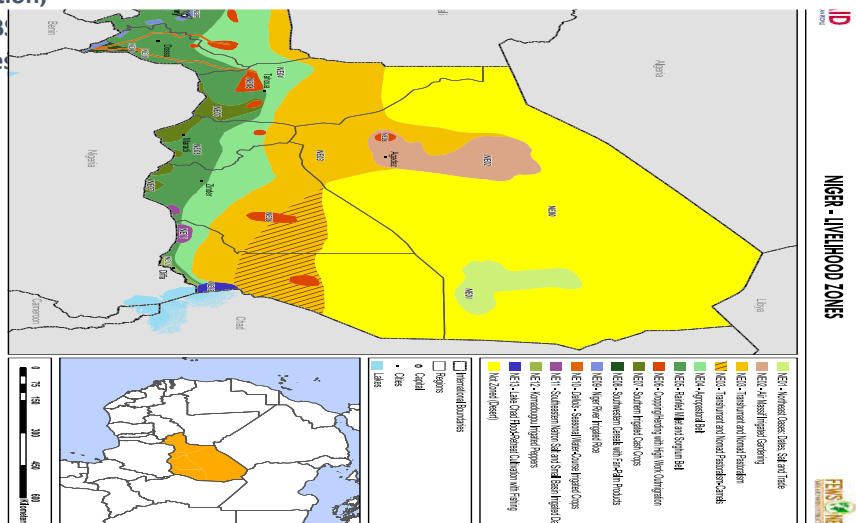
## Agro-climatic and physical contexts

Köppen-Geiger Climate Classification, 1991-2020



**Map 15. Niger's climate zone classification, with As/Aw : Tropical savana climate ; BSh : Hot semi-arid climate ; BWh : Hot desert climate. Source : World Bank, 2021.**

**Agricultural, pastoral and fishery overview.** Of the 46.6 million hectares available for agriculture and livestock production, 17.8 million hectares (UAA), or 38%, are cultivated, including 6.6 million hectares of cereals (sorghum, millet, maize, rice), 2.6 million hectares of legumes/nuts/oilseeds, 0.5 million hectares of roots and tubers, and 0.3 million hectares of fruits and vegetables (FAOstat 2020). The total area equipped for irrigation in Niger was approximately 190,000 hectares in 2020, while the actual area under irrigation was approximately 140,000 hectares.



**Map 16. Niger's livelihood zones. Source : USAID 2014.**

The agricultural sector is one of the most important sectors of the economy in Niger, employing over 80% of the population and contributing about 40% of the country's GDP. Niger's agricultural system is dominated by rain-fed agriculture, with farmers relying on seasonal rainfall to cultivate crops. Agricultural production systems dominated by cereals (mainly sorghum, millet) and are organized around family farming. Livestock farming is essentially transhumant and extensive. The livestock consists mainly of cattle, sheep and goats, and to a lesser extent poultry.

Average of the last 5 years, local dry cereals availability has been on an upward trend, to over 4,178,803 tons in 2020 including: i) 2,046,261 t of millet (49%), 1,232,365 t of sorghum (29,5%), 632,034 t of rice (15,1%), 218,116 t of other cereals. Production of 6,088,332 t of roots and tubers, 1,630,419 of horticultural crops (vegetables and fruit), 694,647 t of pulses, nuts & oilseeds are also important (FAOstat, 2021).

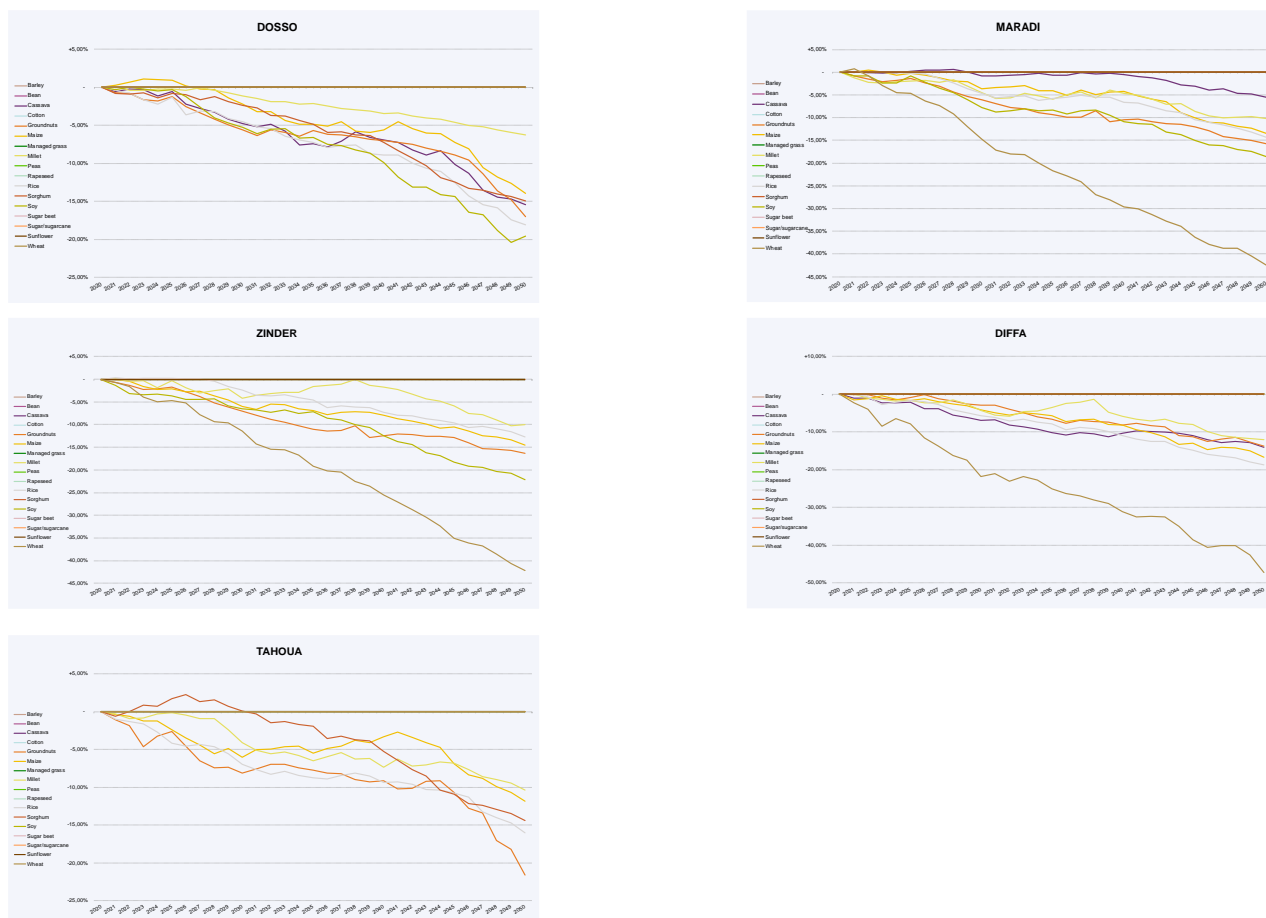
Livestock farming is a significant component of the agricultural sector in Niger. According to FAOstat data from 2020, the country had approximately 35.9 million head of livestock, including 19.5 million goats, 10.8 million sheep, and 3.3 million cattle. Livestock production is primarily based on a traditional pastoral system, with animals raised by nomadic or semi-nomadic pastoralist who move their herds across large areas in search of grazing land and water. This system is closely tied to the country's cultural and social identity, and it has played a critical role in sustaining livelihoods and promoting resilience in the face of environmental and economic shocks.

Domestic fish production varies between 23,000 and 25,000 tons of fresh fish equivalent. Almost all of this production is consumed locally at a rate of 1,9 kg/pers/year (FAO,2017). Regarding seafood imports, Niger imports a large portion of its

<sup>188</sup> Niger's climate zones and its seasonal cycle for mean temperature and precipitation for the latest climatology, 1991-2020. Climate zone classifications are derived from the Köppen-Geiger climate classification system, which divides climates into five main climate groups divided based on seasonal precipitation and temperature patterns. The five main groups are A (tropical), B (dry), C (temperate), D (continental), and E (polar). All climates except for those in the E group are assigned a seasonal precipitation sub-group (second letter).

fish and seafood needs from neighboring countries, such as Benin, Ghana, Nigeria, and Togo. Exact import quantities are not readily available, but according to World Bank data, the value of seafood imports into Niger was approximately \$47 million in 2019.

#### Forecast on the yield evolution of the main agricultural productions in the selected areas between 2020 and 2050:



#### Typologies of rural agricultural households in Niger

Target group typology	Characteristics / Major constraints
Agropastoral Family Farm (AFF)  NE05-NE04-NE07	<p><b>Characteristics:</b></p> <ul style="list-style-type: none"> <li>• Rainfed agriculture organised around basic food crops (millet, sorghum and cowpeas) associated with cash crops (groundnuts and sesame) in NE05 and NE07, with a majority of cereals production in deficit (expected certain areas of Zinder and Maradi with a production ok surplus grain). Cereal or cash crop systems associated with cowpeas in NE04 that can be surplus to requirements in years of good rainfall and not limited by the workforce. NE07 agricultural system is more diverse, with a combination of rainfed and irrigated farming. In NE07 irrigation systems, such as small-scale dams and wells, are used to support crop production during the dry season. The main irrigated crops grown include cassava, maize, vegetables (including onions- <i>Violet de Galmi</i>, chili peppers, tomatoes), fodder crops (alfalfa and cowpea) and other cash-crops (tobacco, sugar cane and watermelon), with surplus agricultural production ;</li> <li>• Average cultivated area (mixed farming) on the farm is 2,37 ha in rainfed and 0,46 ha in irrigated system;</li> <li>• Sedentary small-scale livestock (&lt;9 head of cattle, sheep/goat) and small size poultry (12 heads in average) including pigeon, guinea fowl and hen;</li> <li>• In NE05 and NE04, access to agricultural water is very poor, limiting the practice of market gardening and concentrating production systems on rainfed cereal crops. The main sources of water for livestock are wells, public fountains and ponds during the rainy season. In NE07, the greater availability of water allows for greater irrigation of lowland rice and vegetable crops (onions, cabbage, lettuce, carrots and sweet potatoes). Water sources are mainly wells with motor pumps for middle-income and better-off people, and irrigated lowland crops (mainly rice), and for livestock in NE07, it is mainly ponds, boreholes, and wells that lack water. ;</li> <li>• Farms faced with hunger periods between mid-june and october ;</li> <li>• All members of the household - with an average number of people on a farm of 10 (men, women, youth) - work in the cereal crop fields ;</li> <li>• Economic deficits of the farm compensated by casual labor, or the exodus to the departmental/regional capitals and/or the capital and increasingly with a trend to Nigeria in NE07;</li> <li>• Complementary activities: mainly in NE04 and NE05, gathering and sale of fodder grass, firewood, processing of agro-pastoral products in NE05 and NE07;</li> <li>• Agricultural income represents between 2 and 10% of agricultural income in NE05 and NE07 compared to 28% in NE04. Employment through local and/or seasonal labor and self-</li> </ul>

	<p>employment (mainly from the sale of wood, charcoal and straw from the bush) are the main sources of income for the poor and very poor socio-economic categories (85 to 98% of total income).</p> <p><u>Major constraints:</u> • Land registration in Niger is reportedly relatively low and women's access to land and land rights in Niger remains limited; • - Difficulty in accessing quality production factors in sufficient quantity (seeds, fertilizers, equipment, efficient technologies, credit) due to distance and/or lack of availability on the market; • Mortality of ruminants, small ruminants and poultry due to insufficient access to veterinary advice, high cost of inputs, and outbreaks of zoonotic diseases in livestock (including anthrax, pasteurellosis, sheep pox and piroplasmosis); • Yield losses due to localized flooding, crop pests (birds and grasshoppers, locusts), soil degradation (leaching), poor access to organic inputs, low capacity of communes to support the population; • Insufficient storage and conservation capacities at the level of families, farmers' organizations and villages (obligation to sell at harvest time (low price), and to buy during the lean season (high price)); • Weak entrepreneurial spirit; • Insufficient or non-existent mastery of management and planning tools</p>
<p>Pastoral Family Farm (PFF)</p> <p>NE03</p>	<p><u>Characteristics :</u> • Farm organized around the transhumance of livestock (mainly for cattle) ; • Small to large-scale extensive pastoral livestock (15&gt;200 heads) ; • Farming system based on pure pastoralism with a transhumance towards the North from July to November and towards the South from January to May ; • Lean periods from May to July ; • Dense hydrographic networks, mainly from Tarka bassin, include a large number of ponds and natural shallows; • Farming income comes mainly from the sale of livestock (60 to 90%), employment (10 to 50%) and small-scale trade (mainly sale of bush straw and NTFPs); • Daily employment (mainly animal caretaking/watering) is the main activity of the Very Poor and the second most important for the Poor and the Middle Classes; • The livestock capital is mainly owned by mans; • Low diversification of economic activities, mainly centered on pastoral activity.</p> <p><u>Major constraints:</u> • Reduction and degradation of grazing areas by drought, bush fires ; • Difficulties in accessing water, due to the drying up of water points (flash drought) or insufficient or poorly maintained infrastructure ; • Risk of decapitalization due to conflicts and subsistence needs in crisis situations ; • Significant increase in epizootics outbreak over the last 10 years (charbon, parasitose et pasteurellose) ; • Forage deficit increasing ; • Difficulties in accessing veterinary care (vaccination pens, etc.) ; • Transhumance patterns and traditional pasture and water resource management mechanisms destabilised by the effects of climate change and conflict ; • Lack of clarity and accessibility in terms of pastoral legislation ; • Non-incentive livestock prices and lack of organization of pastoralists ; • Increase in the price of basic foodstuffs (millet, rice).</p>

**Rural farm household activities calendar.** The family agropastoral season begins in April with soil preparation for the agricultural season, followed by off-season flood-recession harvest and off-season rice harvest from January to mid-June (see Figure 1). Harvesting of the main cereal crops (millet, sorghum) then takes place between October and January, depending on the species. Youth and men sell their labor from mid-November to May. The lean season for households extends from mid-June to October. For pastoralist households, the organization of their livestock around transhumance towards the North from July to November and towards the South from January to May. It is mainly the men in the households who go on transhumance and/or hire young herders to manage their herds. Pastoral lean is from mid-March to July.

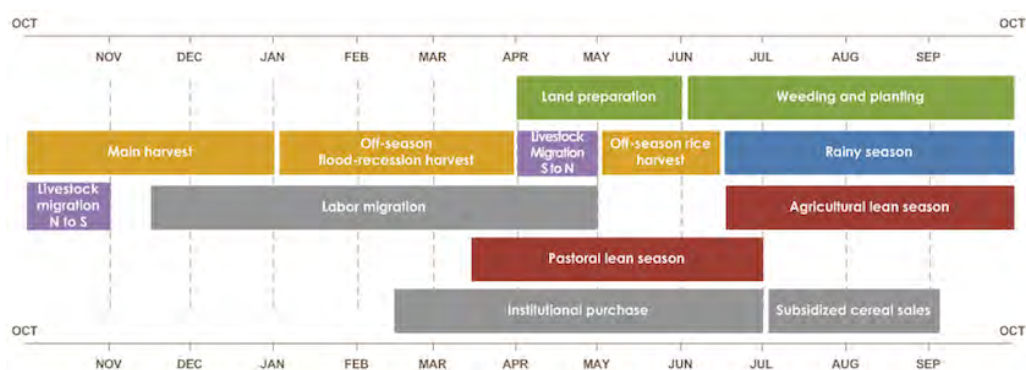


Figure 30. Nigerien rural farm household activity calendar, *Source: FEWS, 2013.*

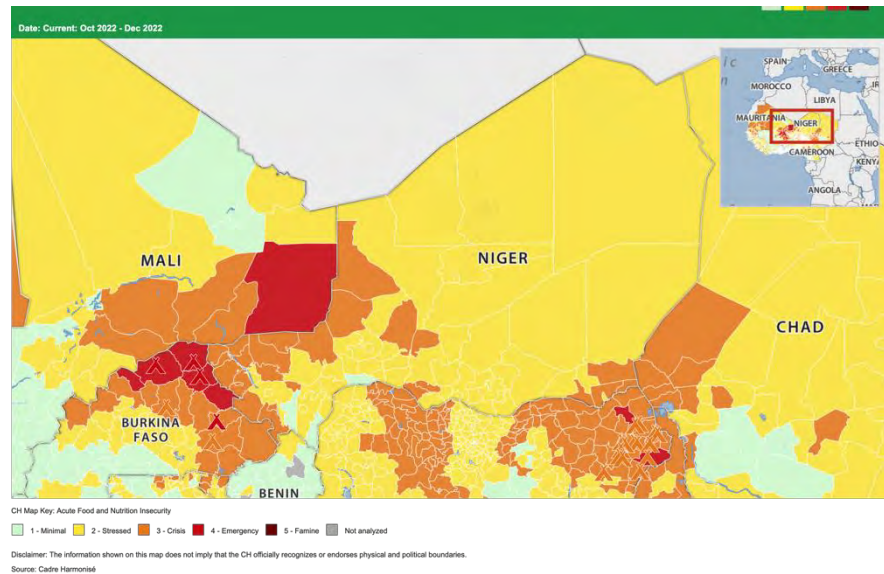
## Farm household vulnerability (IPC /Cadre Harmonisé)

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supporting decision-making by linking information to action. CH is also a tool to help plan the response to food and nutrition crises as part of the Intervention Analysis - Planning - Implementation - Monitoring/Evaluation continuum.

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The analysis synthesizes the status levels (from 1- minimal to 5-famine) of the population in a given area with reference to: 1- minimal level of food and nutrition insecurity; 2- population under food and nutrition stress; 3- population in food and nutrition crisis; 4- population in emergency situation; and 5- famine level reached by the population.



**Figure 31. Niger Cadre Harmonisé current situation. Source : CH,2022**

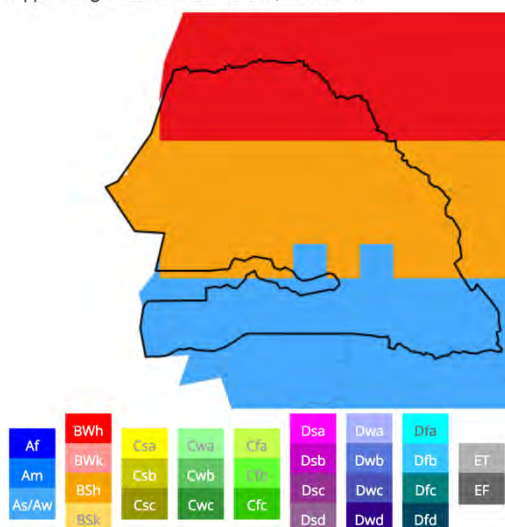
**Land tenure :** Land tenure in Niger is predominantly governed by customary practices, with over 80% of land in the country held under customary tenure. This system of land ownership is characterized by decentralized decision-making, membership in the community, and adherence to traditional rules and practices. However, lack of formal documentation and clear boundaries can lead to disputes and conflicts over land access and ownership.

The Nigerien government has introduced the Code Rural in 1993, a system of individual land tenure which provides a legal framework which allows individuals to acquire land through purchase, lease, or inheritance. However, the system is not well developed, and many rural people continue to rely on customary tenure.

Land tenure in Niger is further complicated by environmental factors such as recurrent droughts and desertification, which have led to a decline in agricultural productivity and increased pressure on land resources. The government has implemented land reform programs to promote sustainable land use and address conflicts over land access and ownership. Nonetheless, challenges remain, including weak institutional capacity and ongoing conflicts over land access and use.

Customary tenure is the predominant system of land ownership in Niger, with the government introducing a system of individual land tenure. Several land reform programs aimed at promoting sustainable land use and addressing conflicts over land access and ownership. One such program is the National Rural Land Policy, which was adopted in 2013 and aims to clarify land rights, promote sustainable land use, and improve land governance (USAID). Another program is the Sustainable Land Management Project, which aims to promote sustainable land use practices and increase agricultural productivity in selected areas of the country (World Bank).

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## Characterization of production systems in Senegal

### Agro-climatic and physical contexts

The whole country is flat and not very high. Only eastern Senegal is rugged with sandstone plateaus forming the foothills of Fouta-Djalón (highest point: 581 m) and small doleritic and granitic massifs. Senegal is a low-lying country with a tropical climate, marked by two seasons: a dry season from November to June and a rainy season from July to October. Regarding Köppen-Geiger Climate Classification<sup>189</sup>, rainfall decreases from south to north following a general trend of isohyet shifts observed over the past few decades (e.g., Map 1). This allows the country to be divided into 3 major agro-climatic zones : i) a Hot desert zone in the northernmost part (+/- 20% of the total area, 300 mm/year) where Sylvopastoral livestock and mainly rice agriculture are practiced in the depression zones; ii) a Hot semi-arid zone (+/- 50%, 400 to 800 mm/year) that covers most groundnut basin characterised by the production of groundnuts, maize, watermelons and cowpeas and most of the Ferlo sylvo-pasotral zone which concentrates 30% of the national livestock ; iii) a Tropical

**Map 17. Senegale's climate zone classification, with As/Aw : Tropical savanna climate ; BSh : Hot semi-arid climate ; BWh : Hot desert climate. Source : World Bank.**

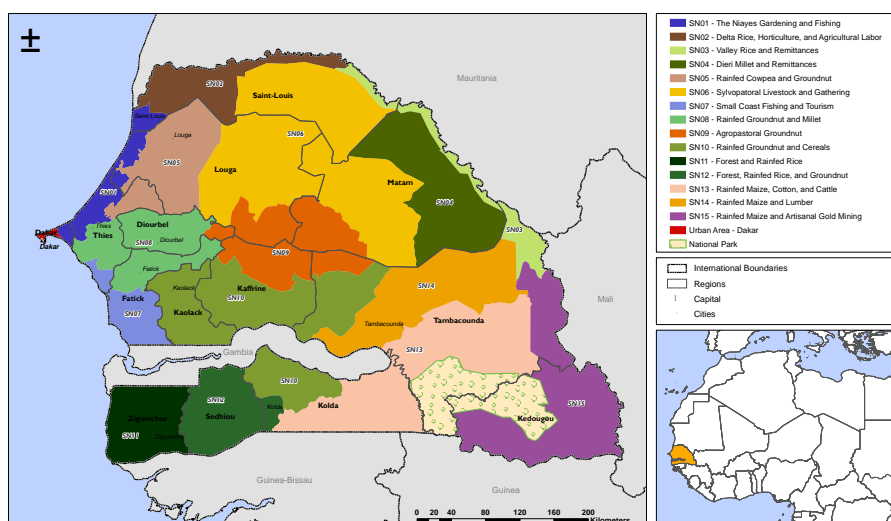
savannah zone (+/- 30%, 800 mm/year to 1,200 mm), characterised by essentially rain-fed agriculture including lowland rice, cotton, livestock and forestry.

### Agricultural and pastoral overview.

Of the 19.2 million hectares of land and forests, 8,9 million hectares (UAA) are used for agriculture and livestock, including 1.3 million hectares

of cereals (millet, maize, rice, sorghum), 54,144 hectares of roots and tubers, 983,487 hectares of legumes/nuts/oilseeds, 44,579 hectares of fruits and vegetables. Cereals account for 56% of cultivated areas. 95% of the agriculture practiced is still rain-fed, with only 130,000 ha of developed land out of the 350,000 ha of irrigable potential (MAAF, 2014).

Six agro-ecological zones have been identified with differentiated physical, climatic and socio-economic characteristics that give them their own potential and specific sensitivity to climate change: (i) *The Niayes*, encompassing the regions of Dakar, Thiès, Louga and Saint-Louis, are home to market garden and fruit producers who produce more



**Map 18. Senegal's livelihood zones. Source : USAID 2021.**

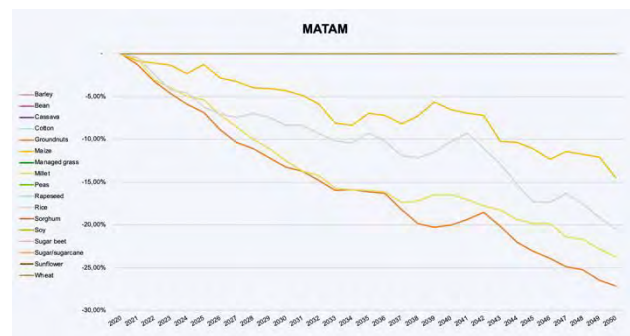
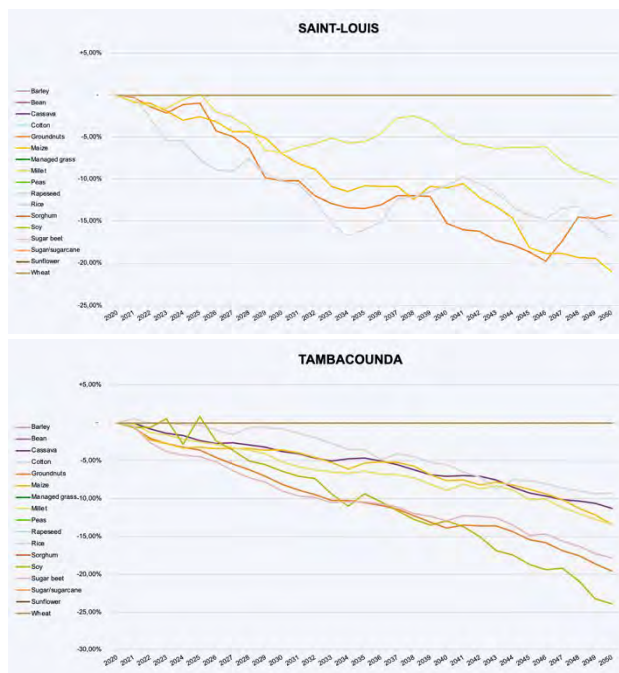
<sup>189</sup> Senegalese's climate zones and its seasonal cycle for mean temperature and precipitation for the latest climatology, 1991-2020. Climate zone classifications are derived from the Köppen-Geiger climate classification system, which divides climates into five main climate groups divided based on seasonal precipitation and temperature patterns. The five main groups are A (tropical), B (dry), C (temperate), D (continental), and E (polar). All climates except for those in the E group are assigned a seasonal precipitation sub-group (second letter).

than 80% of exports and modern meat, milk and egg farms. This area suffers from the advance of dunes, soil salinization, silting of lowlands and coastal erosion; (ii) *The groundnut basin* in the regions of Kaolack, Fatick, Thiès, Louga and Diourbel, which is seeing the emergence of corn, watermelon and cowpea crops. It is subject to accelerated soil degradation, wind and water erosion, recurrent droughts and high evapotranspiration; (iii) The sylvo-pastoral zone, also known as the Ferlo, mainly covers the regions of Louga and Matam. It comprises 22 to 30% of the national livestock population (Resnet-Valeur, 2019), and is characterized by low and irregular rainfall, a shortage of woody and fodder resources, and poor and unstable soils; (iv) *The Senegal River Valley*, where irrigated rice, market gardening and maize dominate. It suffers from scarce and irregular rainfall, high evaporation, salinization of the land and coastal erosion; (v) *Eastern Senegal and Upper Casamance*, covering the regions of Tambacounda and Kolda, is an area where rain-fed agriculture, including cotton, livestock and forestry, predominates. This area suffers from the effects of wind and water erosion, land degradation, deforestation, reduced rainfall and bush fires; (vi) *The Lower and Middle Casamance* are essentially areas of forest, lowland rice, millet, maize and peanut cultivation, as well as livestock production. Salinization of rice fields, acidification of lowland soils, wind and water erosion, decreased rainfall and degradation of vegetation cover are also strongly observed. Between 2017 and 2020, cereal production reached 1,791,876 t, including: i) 762,776 t of rice, 574,000 t of millet, 309,105 t of maize, 143,253 t of sorghum, and 2,742 t of fonio. Production of 915,700 t of groundnuts, 896,500 t of roots and tubers, and 750,144 t of horticultural crops (vegetables and fruit) are also important (FAOstat, 2020).

Senegalese production of cattle, sheep and goat meat is based on three livestock systems, depending on the agro-ecological situation of the country (i) a pastoral system located particularly in the sylvo-pastoral zone and in part of the Groundnut Basin, with relatively large herds of cattle and small ruminants, kept in extensive mode on natural rangelands; ii) an agro-pastoral system located in the groundnut basin, the Senegal River Valley and in the south of the country, with smaller herds that receive supplementary feed; iii) and an intensive or semi-intensive cattle fattening system in urban or peri-urban areas. Total production is estimated at 242,639 t (FAOstat, 2020), including 179,000 t of cattle, 57,000 t of sheep/goats. Livestock systems range from pastoral livestock. Dairy production is characterized by the coexistence of two channels: i) a local channel, reflecting the long-standing involvement of pastoral societies in trade, and ii) an import channel for milk and dairy products, reflecting the sharp increase in demand, linked to urbanization and the opening of international markets. The production of milk and milk products is estimated at 23,206 t (FAOstat, 2019). In addition, cross-border trade in live animals occupies an important position in regional transactions of animal products, strengthening the economic scope of the sector and regional integration.

Poultry farming presents a clear division between i) large and medium intensive production systems feeding integrated marketing chains and ii) extensive production systems generating small family incomes and supplying rural, peri-urban and urban markets. The primary role of the former systems is to provide food to urbanized populations with greater purchasing power, while the latter act as a safety net for livelihoods, often as part of a diversified portfolio of income sources and quality nutrition. Production in 2020 is estimated at 86,137 t of poultry meat.

#### **Forecast on the yield evolution of the main agricultural productions in the selected areas between 2020 and 2050:**



### Perspective of the agricultural and food situation in 2030, 2050 and 2063

The prospects for increasing food production are based on population growth and the need to cover household food needs with these main products. The current population of 16.3 million will increase to 21.5 million in 2030, 33.2 million in 2050 and 63.5 million in 2100 (UN, 2020). The projected productions for the horizons 2030, 2050, 2100 indicate that the productions of cereals, roots and tubers, and market gardening will remain in deficit, contrary to the productions of legumes and oilseeds. Production needs will be dominated by cereals and root crops. By 2030 and 2050, these are expected to reach 13,664,044 tons and 11,813,856 tons, respectively, compared to their current production of 1,791,876 tons and 896,500 tons. Fruits/vegetables present lower quantities but nevertheless exceed 2,000,000 tons in 2050, for a current production of 546,299, that is to say nearly 400% of necessary increase (IFAD, 2021).

### Water requirements for the main crops

An analysis of climate projections to 2050 in the Ferlo agro-sylvopastoral zone (SN06-SN04) based on the rates of change of reference evapotranspiration for market garden crops<sup>190</sup> in the zone and the rainfall projections of the RCP 4.5 and 8.5 scenarios yields the results presented in table below. The results show an increase in water requirements for the 2050 horizon for both projection scenarios. This increase is more pronounced for the RCP8.5 scenario.

Zones	Water requirements in m3/ha		
	Current situation	Horizon 2050/RCP4.5	Horizon 2050/RCP8.5
Dahara	31050	36100	36900
Ranérrou	23840	26400	27300
Ourossogui	23840	25950	27000
Louga	28700	35840	36910
Linguère	31440	36500	37000

### Typologies of Senegal rural agricultural households

Target group typology	Characteristics / Major constraints
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<sup>190</sup> Onions, tomato, pepper and potato

<p><i>Agropastoral Family Farm (AFF)</i></p> <p>SN02, SN03, SN04 and SN05</p>	<p><u>Characteristics</u>: · Rainfed agriculture organised around basic food crops (millet, cowpeas, groundnuts, cassava, watermelons) in SN04 and SN05, with a majority of agricultural production in deficit. Irrigated and mechanised food and cash crops (rice, potatoes, vegetables, maize) in zones SN02 and SN03, with some flood recession crops (sorghum and maize), with surplus agricultural production ; · Average cultivated area (mixed farming) on the farm is 5,21 ha, or 0.82 ha per person<sup>191</sup>; · Extensive sedentary small-scale livestock farming (&lt;50 head) and poultry in SN02 and SN04. Extensive transhumant medium-sized livestock farming (50&gt;100 heads) in SN03 and SN05 ; · Types of water sources for livestock are ponds, boreholes and wells in SN04 and SN05, and rivers (the river and its tributaries), ponds, boreholes and village irrigated perimeters for agropastoralism in SN02 and SN03 ; · Farm faced with hunger periods between june and september ; · All members of the household - with an average number of people on a farm of 10 (men, women, youth) - work in the cereal crop fields ; · Economic deficits of the farm compensated by occasional work, exodus to the departmental/regional capitals and/or the capital of the country from january to june ; · Complementary activities: market gardening, gathering (jujube fruit, bissap flower, leaves, seasonal fruit and tubers), processing of agro-pastoral and crafts ; · Off-farm income collection represents up to 46.8% of rural farm income, of which 30.4% comes from self-employment<sup>192</sup>.</p> <p><u>Major constraints</u>: · Low land tenure security, especially on national domain lands where less than 10% of the population has a property title<sup>193</sup> ; · Difficulty in accessing quality production factors in sufficient quantity (seeds, fertilisers, equipment, efficient technologies, credit) due to distance and/or lack of availability on the market ; · Mortality of small ruminants and poultry due to poor access to veterinary care ; · Loss of yield due to soil salinization and alkalinization, flooding, granivorous birds, land pressure, aquatic plants, drought, and soil fertility depletion ; · Insufficient storage and conservation capacity at family, famers organisation and village level (obligation to sell at harvest (low price), and purchase during the lean season (high price) ; · Weak entrepreneurial spirit ; · Insufficient or no mastery of management and planning tools.</p>
<p><i>Pastoral Family Farm (PFF)</i></p> <p>SN06</p>	<p><u>Characteristics</u> : · Farm organised around the transhumance of livestock (cattle, small ruminants, horses, donkeys, poultry) ; · Type of water source used: borehole, well, temporary ponds ; · Large livestock farming (≥100 heads) ; · Relative importance of livestock to crops ; · Agriculture is strictly rainfed, manual and food-producing. Agricultural production is in deficit ; · Farming confronted with lean periods ; · The man owns the capital (livestock) and often also manages the woman's livestock (e.g. cattle received as dowry at marriage).</p> <p><u>Major constraints</u>: · Reduction and degradation of grazing areas for agricultural activities, drought, bush fires ; · Difficulties in accessing water, due to the drying up of water points (drought) or insufficient or poorly maintained infrastructure ; · Competition and conflicts for access to natural resources between farmers and herders, as well as between herders (sedentary and transhumant). · Risk of decapitalization due to conflicts and subsistence needs in crisis situations ; · Difficulties in accessing veterinary care (vaccination pens, etc.) ; · Transhumance patterns and traditional pasture and water resource management mechanisms destabilised by the effects of climate change, the COVID-19 health crisis and conflict ; · Lack of clarity and accessibility in terms of pastoral legislatio.</p>
<p>Integrated NTFPs in SN06</p>	<p>SN06 : (i) Arabic gum (<i>Acacia senegal</i>) ; (ii) Food/Medicinal – seeds and fruits (<i>Ziziphus jujuba</i>) ; (iii) Food/Medicinal – fruits-leaves (<i>Balanites aegyptiaca</i>)</p>

**Rural farm household activities calendar.** The start-up season for the family agropastoral farm is almost constant throughout the year with irrigated and market gardening productions (mainly in SN02 and S03). The cultivation of the main cereals takes place during the rainy season, beginning

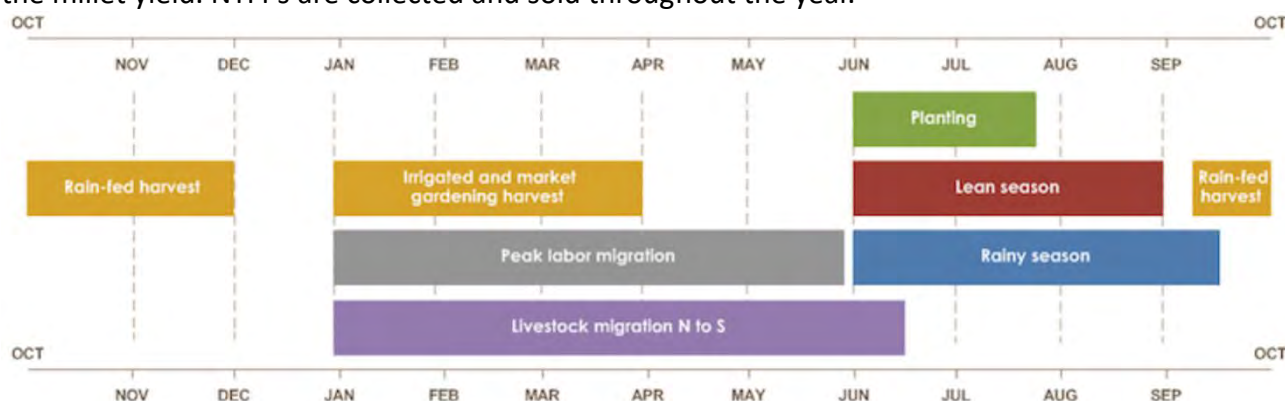
<sup>191</sup> IPAR, 2018

<sup>192</sup> CIRAD, 2017

<sup>193</sup> World Bank, 2021

with the preparation of the soil for the agricultural season in May-June, followed by the sowing of cereals from early June to mid-July. The harvest of the main cereal crops (millet, sorghum, maize) is then spread out between October and December, depending on the species. Then, in the off-season, from January to mid-April, households organize themselves around market gardening, the use of NTFPs, handicrafts and the processing of agro-pastoral products. We note that young people and men generally migrate at this time to sell their labor in the departmental/regional capitals and/or in Dakar.

For pastoralist households, characterised by an organisation of their livestock around national transhumance with arrivals in the SN06 area in July-August and November-December. The sale of livestock is carried out at livestock markets throughout the year, and the sale of milk from August to November. It is mainly the men in the households who go on transhumance and/or hire young herders to manage their herds. A part of the household, more sedentary, remains in the village of origin and practices seasonal agriculture in the rainy season from June (preparation) to October for the millet yield. NTFPs are collected and sold throughout the year.



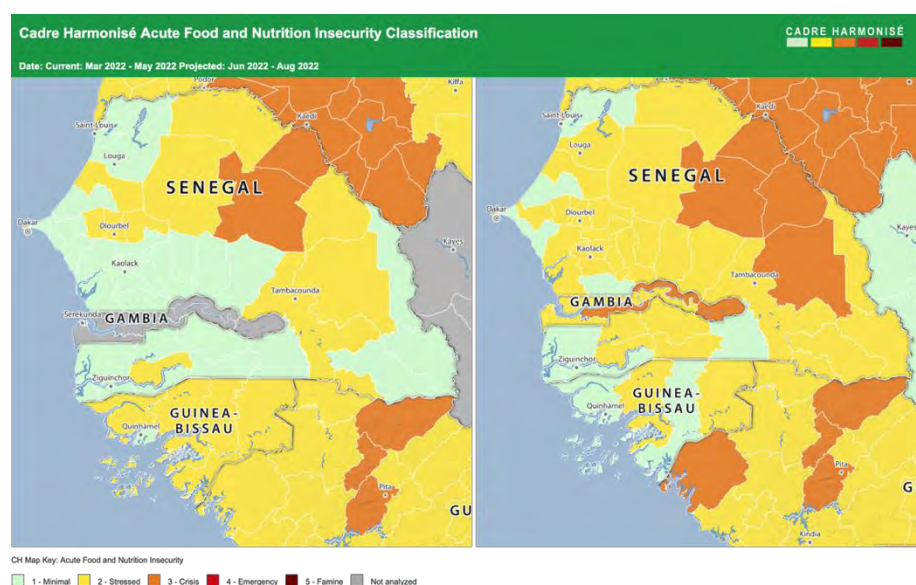
**Figure 32.** Senegalese rural farm household activity calendar, *Source: FEWS, 2013.*

## Farm household vulnerability (IPC /*Cadre Harmonisé*)

The *Cadre Harmonisé* is a unifying tool tool for monitoring areas at risk and populations affected on current and projected food and nutrition situations in the Sahel and West Africa. It allows the severity of food and nutrition insecurity to be classified on the basis of the international classification scale through an approach that refers to well-defined functions and protocols. The results of the CH are communicated in a clear, consistent and effective manner, supporting decision-making by linking information to action. CH is also a tool to help plan the response to food and nutrition crises as part of the Intervention Analysis - Planning - Implementation - Monitoring/Evaluation continuum.

The most commonly used indicators are related to socio-environmental impacts or parameters such as: (i) bushfires in terms of area; (ii) epidemics and infested areas; (iii) cereal balance; (iv) fodder balance; (iv) insecurity and the number of insecurity events or conflict shocks %; (v) extreme climate shocks and flood and drought events.

The analysis synthesizes the status levels (from 1- minimal to 5-famine) of the population in a given area with reference to: 1- minimal level of food and nutrition insecurity; 2- population under food and nutrition stress; 3- population in food and nutrition crisis; 4- population in emergency situation; and 5- famine level reached by the population.



**Map 19. Senegal *Cadre Harmonisé* on the current and projected situation. Source, CH,2022**

