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G5 SAHEL REGION

World Bank Group

COUNTRY CLIMATE AND DEVELOPMENT REPORT

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Preface

This report is one of the first Country Climate Development Reports undertaken by the World Bank that looks at a group of countries. The G5 Sahel Countries Climate and Development Report (G5 Sahel CCDR) covers Burkina Faso, Chad, Mali, Mauritania, and Niger. Each of the G5 countries have individual macroeconomic and poverty analysis undertaken.

The G5 Sahel CCDR is accompanied by an Annex. The Annex contains additional modeling details and supplemental background material.

While the report makes regional recommendations, the recommendations can also be used at the country level. Both regional and individual country analysis is found both in the main report and in the Annex.

Executive Summary

ES1. Introduction and Purpose

The five countries of Burkina Faso, Chad, Mali, Mauritania, and Niger (the G5) in the Sahel region of Africa are among the least developed countries in the world. The region is currently facing multiple crises and challenges as it continues its fragile recovery from the economic and social impacts of the COVID-19 pandemic: increased political instability, rising insecurity, and a growing food security crisis that is now being exacerbated by elevated global energy and food prices due to the war in Ukraine. The now regular and growing climate shocks are causing large losses in outputs, reducing human capital accumulation, and leading to potentially devastating ecological and economic tipping points in the region.

This World Bank Country Climate Development Report (CCDR) has examined the most critical actions and policy changes needed to accelerate the region's economic recovery, sustainable and inclusive development, and adaptation to the impacts of climate change.

This report has three main messages. *First*, the opportunities for a resilient and lower-carbon development of the G5 countries are significant. The G5 countries can diversify their economies in more resilient and inclusive ways with judicious investments and policies. They can reverse environmental degradation and maximize the benefits of climate action for the poor.

Second, rapid, resilient, and inclusive growth is both the best form of adaptation to climate change and the best strategy for meeting development goals in an effective, sustainable, and productive manner. The more prosperous a nation and its citizens are, the more resources the government, firms, and households will have to invest in adaptation technologies. A country that makes agriculture resilient and diversifies its economy will be better prepared to handle climate-related shocks. Finally, an effective and comprehensive social protection system will be needed in the Sahel to reduce climate change's much stronger negative impacts on the poor.

Third, the costs of *inaction* are far greater than the costs of action. Early and targeted action on policies and programs presented in this report can move the G5 Sahel countries towards a greener, more resilient, prosperous, and inclusive future.

ES2. The Challenges

The G5 Sahel countries are – with the exception of Mauritania – low-income countries with an average gross domestic product (GDP) per capita of US\$790 in 2021. Thirty-one percent of the population falls below the international poverty line. Economic diversification remains very limited with more than half of total employment coming from agriculture – a sector that faces multiple threats of water stress, environmental degradation, and competition between farmers and pastoralists for scarce resources. Each country sits near the bottom of both the Human Development Index and the Human Capital Index, so that children born today in the G5 Sahel countries will be only 30-38 percent as productive as they could have been with better education and health. All five countries have long histories of conflict and display a fragile social contract, with more than 30 military coups just since independence in 1960.¹

Despite the difficult political and security environment, the G5 Sahel countries had maintained relative macroeconomic stability and high growth in the past decade until the multiple crises experienced in 2020. Real GDP growth in the region averaged 5 percent per year during 2010-19, compared with an average of 3.9 percent in Sub-Saharan Africa (SSA). However, real GDP per capita growth in the region averaged only 1.65 percent per year in that period due to very high population growth rates. This high

¹ <https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/Economic%20Brief%20-%20Political%20Fragility%20in%20Africa%20Are%20Military%20Coups%20d%E2%80%99Etat%20a%20Never%20Ending%20Phenomenon.pdf>

population growth, combined with migration and internal displacement from rural areas to cities, has contributed to rapid, uncontrolled urbanization. It is projected that over the next 20 years, the population of the G5 will double to 160 million inhabitants.

Countries' capacity to build human capital – improving learning, skills training, and productivity – and accelerate the demographic transition depends on their ability to better realize the potential of their youth, including those who are most vulnerable. Currently, more than 14 million adolescent girls (80 percent of all girls 10-19 years old) are at risk of child marriage, teenage pregnancy, and early school dropout across the 10 countries in the Sahel. High adolescent fertility in the Sahel is accompanied by high maternal mortality and malnutrition, low levels of education and productivity, and a low use of modern contraceptive methods. Thus, investing in the human capital of children, especially of girls, is essential for the G5 to reduce fertility rates and achieve sustainable growth. Furthermore, for human capital, a resilient growth trajectory will require resilient health and education facilities, preparedness of these for climate shocks, and early warning systems.

The COVID-19 crisis stopped the growth momentum. GDP growth in the region became almost negligible (averaging 0.2 percent) in 2020 and pushed an additional 2.7 million people into extreme poverty. Fiscal rules were relaxed in many countries, leading to rapid increases in the debt stock. At the same time, political instability rose sharply with the region experiencing three new coups since the summer of 2020.

The Region Could Be One of the World's Tipping Points

Climate change is putting even more stresses on the Sahel countries. The region is one of the most vulnerable in the world to more extreme droughts, floods, heatwaves, and other impacts caused by climate change. Three of the G5 countries, Chad, Niger, and Mali, rank among the top seven most vulnerable countries to climate change.² Not only is the Sahel region expected to experience temperature increases 1.5 times greater than the world average, it is also particularly susceptible to land degradation and desertification. Indeed, the region has been identified as being one of the world's tipping points if the global average surface temperature rises by 3 °C above pre-industrial levels. According to the IPCC, most climate scenarios show that temperatures in the Sahel will rise by at least 2 °C in the near term (2021-2040).

Already, communities across the region are being threatened by frequent – and often more severe – droughts and floods. Since 2000, an average of 248,000 people per year³ have been affected by floods that have damaged homes, roads, and other infrastructure and assets, and disrupted services. Meanwhile, droughts harmed more than 20 million people between 2016 and 2020 because of food insecurity or economic hardship. Repeated droughts are driving rural migration, but cities can offer only limited economic opportunities to rural migrants.

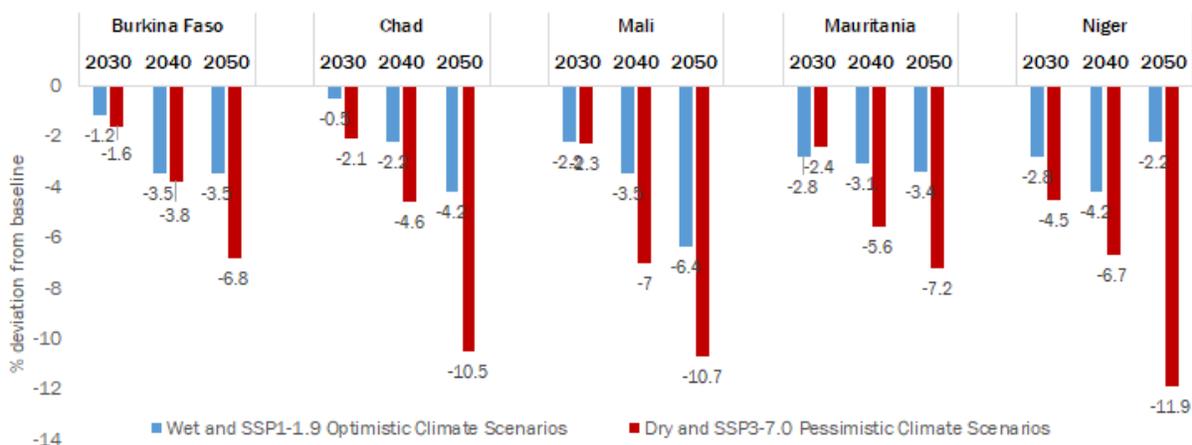
Large economic losses are expected from climate change for the G5 Sahel countries, and substantial adaptation interventions are needed to reduce negative impacts on growth and poverty reduction. Significant GDP losses are expected from the combined effects of six impact channels that have been modeled (rainfed crop yields, livestock yields, heat-labor productivity, human health-productivity, flooding damages, and road and bridges damages). The negative impacts increase over time and are higher under the dry and pessimistic climate scenarios. By 2050, annual GDP compared to a medium-growth baseline would be reduced by between 2.2 percent (Niger) and 6.4 percent (Mali) under the wet and optimistic climate scenarios, and by between 6.8 percent (Burkina Faso) and 11.9 percent (Niger) under the dry and pessimistic climate scenarios. The negative impacts are large enough to wipe out most or all annual growth in real GDP and GDP per capita. These estimates are likely to underestimate the impact of climate change on GDP because not all impact channels are included, and because they do not include the magnifying effects of climate-induced increases in conflicts, ecosystem shifts, and migration. For comparison, a 2016 World Bank study estimated that the Sahel's GDP could drop by as much as

2 <https://gain.nd.edu/our-work/country-index/rankings/>

3 EM-DAT, CRED / UC Louvain, Brussels, Belgium – www.emdat.be

11.7 percent by 2050 because of climate-related water scarcity alone.⁴

Figure 0.1 Annual GDP losses (percentage deviation from the medium-growth baseline) from the combined impacts of six channels with no adaptation⁵



The impacts of the different channels vary significantly by economic sectors and by the climate scenario, highlighting the challenges of adaptation under climate uncertainty and the need for sector-specific interventions. Among the impacts: (i) rainfed crop yields and livestock yields will decline under the dry climate scenario while increasing under the wet climate scenario in some countries, with the impacts affecting the agriculture sector; (ii) the reduction in labor productivity from heat stress will be higher in the pessimistic climate (hotter) scenario and higher in the agriculture and industry sectors as they have higher shares of outdoor workers; and (iii) the roads and bridges damages will be higher in the wet climate scenario.

An additional challenge for the agriculture sector, with consequences for food security, is the very large annual variability in the shocks to rainfed crop and livestock yields. Even if across a period the net impact is small, the annual shocks matter; the volatility creates challenges for rural (generally poorer) households and the wider economy, and contributes to the serious food insecurity crises in the Sahel.

The estimated annual GDP losses are higher for the low-growth scenario compared to the medium- and higher-growth scenarios for Chad, Mali, and Niger⁶ because in this scenario there is little or no structural transformation, and the economy continues to be dominated by the traditional agriculture sector, which is subject to larger negative shocks. It is important to note that the modeling does not fully capture the positive effect of inclusive development on reducing vulnerability as it does not account for how higher incomes and better access to infrastructure and financial support will enable adaptation responses by households and firms.

Even without any impacts from climate change, it will be challenging to reduce poverty in the Sahel if growth remains only moderate while population growth continues to be rapid.⁷ Climate change will

⁴ World Bank. 2016. "High and Dry: Climate Change, Water, and the Economy." World Bank, Washington, DC. License: Creative Commons Attribution CC BY 3.0 IGO.

⁵ The challenge to define a pure "no adaptation" baseline is a common issue in macro-modeling. The results assume some autonomous adaptation by economic agents (e.g., changing agricultural practices), but no adaptation policies and investments.

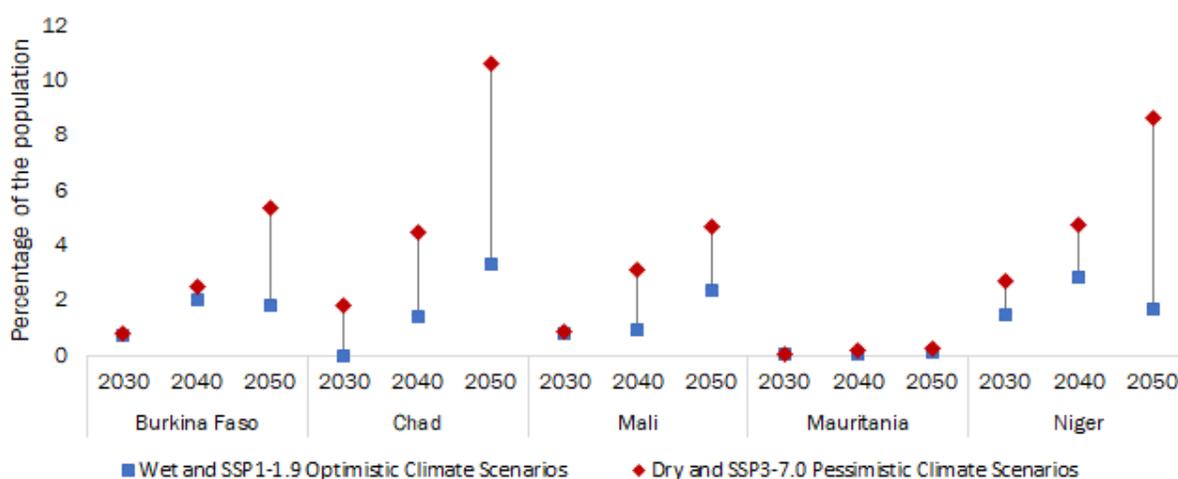
⁶ Annual GDP loss in percentage terms is more similar across growth scenarios for Burkina Faso and Mauritania as agriculture is not their dominant sector – less than 25 percent of GDP.

⁷ Except for Mauritania, which has a significantly higher income per capita and lower extreme poverty rate than the other countries – at 5.8 percent in 2021 – and is projected to decline under all the growth scenarios.

increase the poverty challenge in the Sahel. Climate change shocks reduce productivity through a myriad of ways. They include declines in rainfed crops and livestock yields, increased heat stress making it difficult to work outdoors, increases in morbidity and mortality levels, and reductions in productive capital and infrastructure, which translates into lower average household incomes. Moreover, impacts like drought often force marginalized groups into negative coping strategies, such as cutting forests for fuel, that perpetuate and deepen cycles of poverty, fragility, and vulnerability.

Given the estimates of economic losses from climate shocks from six impact channels with no adaptation policies and investments, it is estimated that by 2050 there would be an increase in the poverty rate of the G5 Sahel countries from 27 percent in the medium-growth baseline (no climate change) to 29 percent in the wet and optimistic climate scenarios and to 34 percent in the dry and pessimistic climate scenarios.⁸ This would translate into an additional 4.1 million and 13.5 million people falling into poverty, respectively. The increase in the poverty rate rises over the projection period and varies across countries, with Niger and Chad projected to have the highest increases. Inequality will increase and climate change will have a heterogeneous spatial effect in the Sahel with higher poverty impacts in rural areas, including in some of the most vulnerable border communities in Chad, Niger, and Mali. Given the large negative impacts of climate change on poverty and the challenge to fully adapt, expanding adaptive safety nets and other poverty reduction programs will be critical.

Figure 0.2 Increase in the Poverty Headcount Rate (deviation from the medium-growth baseline in percentage points) from the combined impacts of six channels with no adaptation (US\$1.9 per day, 2011 PPP)



In summary, climate change is severely affecting people and undermining hard-won development gains, poverty reduction efforts, and the accumulation of human capital. It threatens livelihoods and productivity, worsens health and nutrition, reduces learning and educational attainment, and can exacerbate the already high poverty rates in the Sahel. Climate stresses also have the potential to initiate negative feedback loops: climate stresses exacerbate further conflict, which makes it even harder to cope with the impacts of climate change, thus further increasing the chances of conflict and violence. The burden is likely to fall disproportionately on the poor and most vulnerable – women, youth, ethnic

⁸ The estimates of poverty and inequality impacts are likely to be lower bounds given the caveats on the GDP loss estimates. They assume climate-related effects are translated into changes in economic output that vary across different sectors of the economy, which in turn affect household incomes depending on which sector they are employed in. Additional distributional impacts across households due to other factors, such as household characteristics or geographic location, are not accounted for, which could also lead to an underestimate of the (negative) distributional impacts.

minorities, nomadic groups, displaced people, and people with disabilities, including casualties of conflict. Unfortunately, the G5 Sahel countries have not yet started to make serious adaptation investments, which are themselves undermined by lack of development.

Stepping up development efforts is thus an urgent priority for the region. It will provide adaptation capacity in the face of climate change. In addition, as the report also documents, combinations of adaptation and mitigation measures can be powerful tools for development, working together to achieve wider goals and increase resilience.

ES3. The Opportunity

The G5 Sahel countries have strengths and comparative advantages, although these have remained largely untapped. Some are particularly relevant in the context of climate change. The countries are relatively close to markets in Europe and Middle East. They have a young and growing labor force, which could expand into local manufacturing and other labor-intensive industries.

The Sahel region is rich in mineral resources, including oil, gold, copper, uranium, and the minerals and metals needed for a variety of “green” technologies that are in high demand globally as countries work to reduce their emissions of greenhouse gases. The countries also have immense renewable energy resources, allowing for the large-scale development of renewable energy projects and avoiding locking into high-carbon, polluting growth models. On- and off-grid solar and other renewable electricity generation could bring affordable, reliable electricity to two-thirds of the population who currently don’t have access, unleashing economic and entrepreneurial opportunities, such as more agricultural processing within rural communities. Such renewable generation could turn the Sahel into an energy supplier for European and West African markets.

All G5 countries are commodity exporters, and Mauritania, Chad, and Niger are developing their gas and oil sectors. Other commodities such as gold are also relevant. There are also significant opportunities to diversify exports beyond basic commodities through value-adding agricultural production and manufacturing.

The G5 Sahel countries now have a window of opportunity to realize the demographic dividend, raising incomes, living standards, and economic growth, while simultaneously increasing the region’s resilience to the impacts of climate change and setting the region on a sustainable, low-carbon growth pathway.

ES4. Climate Commitments and Capacities

Though the G5 Sahel countries combined contribute less than 1 percent of global GHG emissions, all five countries have set targets for greenhouse gas emissions reductions in their Nationally Determined Contributions (NDCs) under the Paris Agreement, updated at the COP26 meeting in Glasgow in 2021, and have pledged to achieve net-zero emissions by 2050.

All countries have national adaptation plans for coping with the impacts of climate change, covering agriculture and livestock; conservation of ecosystems, biodiversity and forests; water and sanitation; energy and infrastructure; gender and social protection; land use planning; health; education; and fisheries and aquaculture. The NDCs and the additional calculations developed in this CCDR show that billions of dollars are needed across the G5 Sahel countries for climate action. The climate adaptation investment requirements to 2030 calculated by the countries in their most recent NDCs are as much as US\$33 billion for the five countries. The equivalent figure for climate mitigation action is close to US\$50 billion. The average annual NDC financing needs range from 2.2 percent to 54.2 percent of 2021 GDP and 31.6 to 704 percent of 2021 capital spending.

Table 0.1 Estimates of investments needed for mitigation and adaption based on G5 NDCs

Sahel Country	Est. Mitigation NDC Investment (US\$ bn by 2030)	Est. Adaptation NDC Investment (US\$ bn by 2030)	Total NDC Investment Est. (US\$ bn by 2030)	Average annual NDC Investment as % of 2021 GDP	Average annual NDC Investment as % of 2021 total capex
Burkina Faso	1.34	2.79	4.12	2.2	31.6
Chad	6.70	5.00	11.70	12.2	181.4
Mali	4.34	8.00	12.34	7.4	110.7
Mauritania	34.26	10.63	44.88	54.2	704.2
Niger	3.17	6.74	9.91	7.7	61.1
Total	49.80	33.16	82.96	N.A	N.A

Benefits of Adaptation Outweigh the Costs

Priority climate investments should be those that deliver more benefits, in terms of economic damages avoided, at lower costs. The analysis of potential adaptation interventions for three of the impact channels – expanded irrigation for rainfed crops, improvements in livestock feed practices, and investments in climate resilient road and bridges – shows that damages from climate change can be significantly reduced. Furthermore, the analysis also illustrates how some adaptations could bring about gains above the losses avoided. For example, the expanded irrigation results show an improvement from the baseline economic output by addressing existing large productivity gaps in agriculture and infrastructure deficits in the Sahel countries. As all recommendations in this report, this would need to be climate-informed in view of changing climate conditions and would need to conform to Environmental, Social, and Governance (ESG) standards to avoid issues of over-abstraction or other potential maladaptation practices. For the selected adaptation interventions analyzed, the benefits generally outweigh the costs. There is some variation in the cost-benefit ratios of these investments (which have been standardized for the purpose of the modeling) across countries, highlighting the need to customize adaptation to individual countries’ contexts.

An additional analysis of clean cooking investments to reach G5 clean cooking targets estimates annual benefits in health (reduced mortality and morbidity), gender (time saved collecting fuel), and climate (reductions in greenhouse gas (GHG) and black carbon emissions) that are 20 times higher than the estimated annual investment costs. Providing universal access to clean cooking would also mean the area of forests and shrublands would increase by 2 million hectares by 2050, bringing enhanced ecosystem services.

The costs of adaptation investments – especially in the earlier years when capital expenditure needs are higher – are still significant compared to the countries’ fiscal capacities. Making the investments will require significant resource mobilization, including from the private sector. There will likely be adaptation tradeoffs as choosing a resilient option to invest in may mean that funding is not available for another investment. Often adaptation investments, including those listed in the G5 NDCs, are also traditional development investments. However, in some cases adaptation will not be possible as temperature tolerance limits of plants and animals may be exceeded.

Finding the financial support, however, is only part of the challenge ahead. There is also an urgent need to expand, or in some cases create, the institutions, capabilities, planning processes, and regulatory frameworks necessary for countries to achieve their climate and development goals. It is necessary to expand or improve disaster risk management, risk finance instruments, urban land use planning, environmental regulations, hydrological and meteorological capabilities, early warning systems, agricultural insurance, land ownership and governance policies, and social protection systems.

There also are few mechanisms for local communities to participate in decisions about natural resource management, climate adaptation, or disaster risk management, making it challenging to leverage local knowledge and build community ownership for climate-smart solutions.

ES5. Policies and Recommendations for the Path Forward

This report is designed to help the G5 Sahel countries identify, prioritize, and realize the benefits of sustainable development and successful adaptation to climate change.

Conflict-sensitive investments and policies are especially important in the G5 Sahel and resilient and inclusive growth is especially important in the context of climate change. In addition to specific recommendations on climate-related policies and investments, it is important to emphasize that climate change has made the overall growth agenda in the Sahel even more urgent. Growth in many ways is the best form of adaptation, as long as it is sustainable and inclusive. The richer a country is, the more resources the government, firms, and households will have to invest in adaptation technologies. The richer firms and households are, the more resilient they are to negative climate-related shocks. A country that has made a greater structural transformation by shifting away from agriculture to industry and services will be less harmed by climate-related shocks. Finally, since climate-related shocks are expected to cause significant economic damages, even with large-scale and improved adaptation efforts, addressing the constraints to the economic transformation and resilient and inclusive growth will be critical to offset these damages.

Therefore, in addition to the specific recommendations contained in this report, addressing the constraints to sustainable, resilient, and inclusive growth remains a priority. This would require accelerating the structural transformation, realizing the potential of the demographic dividend through addressing gender inequality and strengthening human capital, and addressing the drivers of fragility and conflict. As there will be important distributional impacts, strengthening adaptive social protection systems and ensuring that education and skill sets are climate-informed – through enhanced curricula, developing green skills, and fueling research and development to combat climate risks – are needed in parallel to the growth agenda to reduce the negative impacts of climate change on poverty reduction. Social protection programs provide immediate relief to affected households and contribute to the adaptation agenda by building household resilience. Multi-year cash transfer and productive inclusion programs are effective to boost investments and diversify off-farm income-generating activities of poor households across the Sahel, which is central to reducing households' vulnerability to climate-related shocks. As climate-related shocks can have long-term negative consequences on households, especially affecting children's health, nutritional status, and education, emergency cash transfers are critical in protecting human capital. Meanwhile, the use of school and adult learning centers for training in disaster preparedness, emergency procedures, adaptation to climate change, and in general, teaching healthy and climate-friendly choices, is key to ensure a sustainable policy implementation in each country and the region. Investing in human capital is a foundational need for addressing climate change and economic development.

The report provides detailed recommendations and policy prescriptions for making development and adaptation gains in five specific sectors or areas: Institutions, Climate Financing and Risk Mitigation, Energy, Landscapes, and Cities. The five topics do not attempt to cover every sector or issue in these countries. Instead, they were chosen because judicious policies and actions in each of these areas have potential to rapidly stimulate sustainable economic growth over the next five years, because these areas are now highly exposed and vulnerable to climate change impacts, and because all are in urgent need of investment and reforms.

The first two issues are both cross-cutting and crucial. At the core of climate action, the G5 Sahel countries must focus on defining an institutional strengthening roadmap, building the capacities of institutions, and mobilizing the financial resources required.

1) Increasing Institutional Capacities

Even with the best sectoral plans, the capacity of institutions in the G5 Sahel countries is the most critical stumbling block for action. Policies needed to increase resilience require pragmatic prioritization and focus based on the principles of proportionality (directing resources toward the greatest needs) and feasibility (aligning goals with available resources and capacities). Institutional challenges likely amplify the negative effects of climate change and reduce the impact of climate policies, exacerbating conflict and fragility.

The challenges facing the G5 Sahel countries across all sectors are immense and surging, and resources and capacities are limited. Governance and accountability systems are inadequate. A fundamental review and reimagining of institutional capacities and stakeholder roles is therefore needed. The traditional World Bank portfolio delivery model must overcome significant challenges (such as technical, organizational, institutional, and regulatory) to assist an overburdened public sector to disburse aid faster. Given the urgency, governments might consider delegating oversight and leadership roles to capable stakeholders while retaining accountability, which would help build capacity at the local level. Local communities should be engaged as partners in resilience-building and climate change should be approached as an opportunity to build a stronger social contract. This option would benefit from strong dedicated technical assistance (TA) to help national and local authorities play their role as project owners.

Policy recommendations for increasing institutional capacities include:

- Build the institutional foundations that are essential for both development and effective climate action, especially planning and monitoring of budgetary processes, managing land governance, and strengthening social protection systems.
- Clarify the roles and responsibilities for climate action among the many government agencies, paying particular attention to *planning and finance* functions. Deploy public resources and civil servants beyond capital cities and move towards climate-smart investments, public procurement, and public asset management.
- Identify and support the specific areas of technical expertise needed in the key agencies for climate action, paying particular attention to program design skills and implementation capacities. Establish a centralized, open-access country-focused technology portal, and define a robust coordination mechanism across agencies, sectors, geographies, businesses, and populations. Build capacities to help inform strategic decision-making on climate-related financial risk management.
- At the local level, build inclusive institutional processes that support climate action in a conflict-sensitive manner and promote social cohesion and the inclusion of all groups, including marginalized ones.

2) Increasing Financing for Climate Action and Managing Climate Risks

Billions of dollars are needed across the G5 Sahel countries (see below, ES6). However, financing for climate action is currently insufficient, and fiscal space for government-led financing will continue to be limited, particularly after the COVID-19 induced economic slowdown led to higher debt levels and increased debt vulnerabilities.

The G5 Sahel countries need to mobilize additional finances from international, private, non-governmental, and national sources, while also making more effective use of their existing financial resources. The CCDR highlights how governments can mainstream climate considerations into existing budgeting and planning processes, and how the private sector may be increasingly mobilized. Domestic public resources, even with expanded support from traditional donors, are not enough; climate finance and the private sector must provide significant new investment.

Using existing national resources – government and household – but more climate-informed

Recommendations for actions that can be taken quickly – in the next three years – include:

- Strengthen governments' financial resilience to natural disasters with pre-arranged risk retention, risk sharing, and risk transfer instruments that provide rapid, cost-efficient liquidity in the aftermath of climate shocks. These include disaster funds, insurance (agriculture and infrastructure), and contingency financing such as the Bank's catastrophe deferred drawdown option instrument (CAT-DDO).
- Explore the use of the IMF Special Drawing Rights and the Resilience and Sustainability Trust for climate action financing, including "debt-for-adaptation" swaps.
- Accelerate the rollout of mobile money and Digital Financial Services (DFS).

Additional policies that could be implemented in the medium term (by 2030) include:

- Improve access to finance for resilience by leveraging digital financial services and using regional risk pooling solutions for social safety nets.
- Increase access to finance, including climate insurance and risk mitigation products, and support resilience of microfinance institutions, particularly in conflict-affected areas, to ensure wide outreach in rural areas.
- Adopt systems for transparent monitoring of and decision-making for the national budget allocation for priority climate actions and strengthen anti-corruption initiatives.

Increasing private finance

Recommendations to attract large-scale private sector project finance in the next three years include:

- Convene a private sector roundtable with investors, developers, governments, and donors to resolve barriers to climate investments, specifically around energy access, and establish a donor-funded technical assistance and capacity facility to help identify bankable projects.
- Develop a clear and transparent strategy to use limited concessional resources to leverage private capital through blended capital investments, and reach out to development partners on possible access to concessional funding under the Desert to Power initiative.

Recommendations for actions by 2030:

- Use green and sustainable bonds (by sovereigns or regional development banks) for new climate projects.
- Develop regional cooperation and a regional approach for risk financing.

Increasing climate finance

Although the benefits of the climate action measures proposed in the CCDD are typically much higher than the costs, the G5 countries have so far benefited little from climate adaptation and mitigation finance. Recommendations for increasing climate finance in the next three years include:

- Implement the commitments made in Glasgow by developed nations to double adaptation finance by 2025.
- Support countries in delivering on their NDCs by linking NDC commitments to WB policy and project finance, beyond climate-co-benefits.
- Mobilize climate trust funds to mainstream climate considerations into existing decision-making in Ministries of Finance, Economy, or Budgeting.

Over the medium term (by 2030):

- Develop the capacity, regulations, and institutions to support the preparation of projects and programs that can access climate finance and benefit from revenues potentially available in carbon markets and leverage new private sector financing.
- Explore opportunities for mitigation finance, such as payments for emissions reductions, in renewable energy and transport.

3) Energy access and clean cooking

In the energy sector, providing universal access to affordable, reliable electricity can transform the G5 Sahel countries, bringing much-needed economic growth, business opportunities, and health benefits. This transformation will lead to more resilient households and communities. Fortunately, the region has abundant renewable energy resources, and technologies such as solar, wind, or hydropower are often the least-cost options. The G5 Sahel countries can leverage these opportunities for a low-carbon development trajectory, leading to more resilient economies. In recent years, renewable energy-based mini-grids have been producing electricity at a very competitive cost. In remote communities in the Sahel, renewable energy-based mini-grids, in addition to their potential as the least-cost electrification option, can contribute to increased resilience from both natural hazards and human attacks. The G5 Sahel countries have an opportunity to move away from a heavy reliance on expensive oil-fired generation, inefficient operations with high network losses, and weak sector finances due to poor collection rates.

The CCDR proposes a series of policy and program actions on energy access for immediate attention:

- Adopt national electrification plans that scale up the development of least-cost renewable energy projects and the transmission lines needed to deliver electricity equitably.
- Put in place institutional, legal, and regulatory frameworks that attract independent power producers to access markets.
- Strengthen governance mechanisms to improve the operational and financial performance of utilities and foster regional trade.

Over the medium term (by 2030), countries could:

- Develop business models to encourage the electrification of schools and health centers, and to attract long-term investment, including provisions for maintenance services, remote monitoring, and incentives to extend coverage to more remote areas.
- Deepen regional integration and develop cross-border plans and regulations to identify least-cost power generation and expand trade across borders, making it easier and cheaper to integrate large amounts of variable renewable electricity (VRE) in the electricity grid, as the WB has shown (Annex, 2.1.1).
- Explore other technologies when using renewably-produced electricity such as biogas or green hydrogen.

Regional power integration can further advance energy access at reduced costs and lower carbon emissions. It will also enhance grid stability and reliability. Four of the five Sahel countries are either members of (Burkina Faso, Mali, and Niger) or connected to (Mauritania via Senegal) the West African Power Pool (WAPP), which covers 14 countries from Nigeria to Senegal in an effort to create a unified regional electricity market. By 2025, the region aims to be interconnected, paving the way for regional power trade. Realizing this potential will require establishing commercial and operating frameworks and ensuring that utilities have the financial strength to be credible trade counterparties and to honor their payment obligations.

In addition, providing modern energy cooking services for the 80 million people that do not have access can reduce both diseases from air pollution and deforestation.

For clean cooking, recommendations for short-term actions include:

- Include clean cooking in the Sahel region's climate agenda, scale up public and private financing for clean cooking, and leverage existing business models and clean energy businesses.
- In each country, make clean cooking part of national energy planning. The effort needs to be led by a designated institutional champion responsible for coordinating with key stakeholders, with accountability for achieving results.
- Develop and enforce regulations and standards that promote market development for clean cooking solutions, and provide targeted subsidies to low-income households.

Actions over the medium term (by 2030) include:

- Incentivize biomass for cooking through reforestation, which will also reduce deforestation.
- Leverage results-based financing (RBF) to create incentives for private-sector investment and deliver clean and efficient cooking solutions with pre-defined result levels and triggers for payment.
- Expand data collection efforts and monitor progress.

4) Landscapes

In the landscapes sector, climate change impacts require coordinated actions among environment, agriculture, infrastructure, and water for a resilient development path. It is crucial to address the threats facing agriculture, water, and the environment, collectively maintaining or restoring natural capital. It is particularly important to undertake any policy or investment action in landscapes that is conflict-sensitive.

Environment

In the area of environment and natural capital, the critical policy and program recommendations of this CCDD in the next three years are:

- Ahead of investments, map the mosaic of different land uses (agricultural, pastoral, forests, grasslands, and settlements) and identify the investments that would maximize natural capital and productive uses through an integrated landscape approach based on sustainable management of the land.
- Continue or initiate policy reforms and investments to scale up re-greening, including local land use participatory planning in the Great Green Wall Initiative (GGWI) countries.

Policy recommendations for actions in the medium term (by 2030):

- Ensure funding for universities or specialized regional research centers promoting education in landscape management with climate change integrated, and ensure social inclusion of women and marginalized groups to promote better management of natural and land resources and prevent or reduce conflicts.
- Strengthen the key pillars of the landscape approach through: (i) *Participation*: involving local communities, especially marginalized groups like women; (ii) *Governance*: including clarity of land rights, access to funding, integrating climate resilience; and (iii) *Sustainability*: empowerment and capacity building, addressing conflict-sensitive land interventions, and assuring resilience to climate impacts.

Agriculture

For agriculture, policy recommendations for action for the next three years:

- Professionalize farmers, including smallholder and women farmers, and disseminate information and assistance to (i) adopt effective practices such as improved soil, water, and agronomic

practices, (ii) increase the uptake of relevant irrigation technologies; (iii) improve crop selection (such as using drought-tolerant varieties); and (iv) mainstream the use of early warning system and hydro-meteorological information for enhanced productivity and resilience of farms.

- Reform land tenure policies, strengthen women's formal land rights, secure land titles, and support inclusive land management and conflict resolution mechanisms at the local level as the basis for increased investment and productivity of croplands and pastoral lands.
- Liberalize fertilizer supply and promote efficient distribution by the private sector.

Policy recommendations for actions by 2030:

- Scale up adaptation programs, ranging from stronger strategic grain reserves and management systems for food crises to crop and livestock insurance schemes, effective food storage systems, and more robust extension and advisory services specialized in climate adaptation and resilience.
- Invest in sustainable land husbandry, animal nutrition, vaccines, and improved veterinary services, as well as sustainable fisheries practices for more resilient livestock and fisheries sectors.
- Develop and strengthen agroforestry value chains to enable farmers to benefit from crop and tree products and to reap other benefits from re-greening.
- Expand efficient irrigation systems and water harvesting practices.

Water

For rural water security, the CCDR recommends for policy recommendations (next three years):

- Develop better information and support for resilient water storage infrastructure planning and improved water resources management.
- Improve water productivity by strengthening water governance and formalize a policy framework for integrated water resources management (IWRM).

Policy recommendations (by 2030):

- Assess and rehabilitate, if necessary, the many existing hydraulic structures, including dams, hydro-agricultural infrastructure, and water supply systems.
- Adopt a multi-sectorial approach to watershed planning so that all stakeholders are onboard to allow for rapid economic and sustainable development.
- Diversify and make more resilient all possible water sources by: (i) leveraging both surface water and groundwater; (ii) developing multipurpose large- and medium-scale storage facilities alongside rainwater harvesting and storage at the local level; (iii) investing in nature-based solutions, such as forest and wetland restoration, to regulate flows and reduce floods; and (iv) coordinating extraction and use of water through integrated water resources management plans.

For rural water services, quality, and sanitation, the CCDR recommends these actions over the next three years:

- Expand water, sanitation, and hygiene (WASH) investments equitably to significantly increase coverage, especially in high climate risk areas.
- Support sector institutions in developing action plans for establishing and operationalizing necessary policy, institutional, and regulatory reforms for improved sustainability.
- Support service providers in developing risk, resilience, and emergency response plans to secure long-term resilience to climate-related and other threats in the provision of water supply and sanitation services.⁹

⁹ Plan development should follow the approach outlined in the World Bank's Resilient Water Infrastructure Design Brief, Building the Resilience of WSS Utilities to Climate Change and Other Threats: A Road Map.

- Increase water quality monitoring to spot the increasing threats posed to water supplies from waterborne disease, droughts, and floods.
- Finance country-specific sector diagnostics that identify the most critical bottlenecks to improved sector performance and climate resilience.

Policy recommendations for actions by 2030:

- Support health and educational institutions in delivering climate-informed trainings and capacity building to current and future water and sanitation professionals, including the development of young professionals' programs to facilitate the participation of youth and women.
- Provide safe and sustainable water and sanitation services, such as by using private water kiosks and vendors, and by avoiding depleting or contaminating water resources.

5) Cities

In cities, rapid and uncontrolled urbanization has led to growing informal settlements, with low-income communities finding themselves in areas highly vulnerable to floods and other climate change-related risks such as droughts, heatwaves, and poor access to potable water. As cities in the G5 Sahel countries are growing rapidly, there is an opportunity to prevent risky urban growth and create climate-resilient cities.

Recommendations for policies to create a resilient urban development pathway over the next three years:

- Develop systems to collect data and perform risk assessments, such as on water basin hydrology or climate risks of informal settlements.
- Create energy and climate plans to mainstream climate mitigation and adaptation into public policies, including strategies to control urban sprawl.
- Support climate champions in cities and hire staff with resilience expertise.
- Add water kiosks and, where feasible, household connections to supply safe drinking water.
- Add water meters to encourage water conservation, reduce non-revenue water losses, and enable more efficient tariff schemes.
- Identify informal settlements with the highest climate risk or which present the highest economic potential through densification.
- Begin to improve public spaces, such as creating public plazas and green spaces and paving roads.
- Engage local urban communities to create a real-time feedback loop to sharpen the focus on areas and services. Participatory approaches, such as Urban Labs, are already showing encouraging results.

Recommendations for actions by 2030:

- Develop a public and green space policy that prevents future settlements in risk-prone areas.¹⁰
- Preserve or add green spaces in informal settlements to reduce the impacts of heatwaves and floods while also capturing carbon and improving living conditions.
- Support service providers in developing risk, resilience, and emergency response plans to secure long-term resilience. This should include enhanced water quality monitoring.
- Reduce waste by preventing, reducing, reusing, recycling, composting, recovering materials.

¹⁰ Lessons learnt from the Karachi Neighborhood Improvement project – public spaces are classified into 3 main categories: (i) streets and sidewalks; (ii) public open spaces like markets, parks, playgrounds, plazas, squares, urban forests, and waterfronts; and (iii) public buildings such as community centers and libraries.

- Establish guarantee systems for local banks to finance waste collection by local private operators.
- Improve drainage systems and flood defenses (including nature-based solutions such as urban river restoration, erosion management, greening of upstream and flood prone areas) to reduce flooding risks.
- Provide housing opportunities in parallel with limiting new informal settlements.
- Improve sanitation (see WASH section).

Although this CCDR focuses on spurring growth over the next three or seven years, governments and development partners should also consider ideas for supporting growth in the longer term. Areas with especially large potential for sustainable and resilient growth are mining and transportation.

The Sahel countries are rich in “climate action” minerals and metals that, if sustainably exploited and pitfalls related to “rent seeking” and capacity constraints are addressed, could contribute to diversifying their economies. Investing in green transport transitions in Sahelian cities should include both road infrastructure and passenger transport. A greener, safer, more efficient and inclusive transport system would ensure a more stable and resilient network, which is especially critical in the land-locked countries.

ES6. Overall Investment Needs until 2030

This CCDR estimates that the cost of adaptation and mitigation measures for the G5 Sahel countries are extremely high as a share of GDP and a share of the countries’ public expenditures. It is also envisioned that a significant percentage of these costs are unlikely to materialize in the near term, given recent climate flows and the unmaterialized climate finance commitments post-COP26. Adaptation and mitigation costs needed for the G5 countries by 2030, as expressed in their NDCs, are US\$83 billion (US\$33.2 and US\$49.8 billion, respectively). Annual adaptation costs in the NDCs will on average account for 4.6 percent of a country’s GDP under the medium-growth scenario and 4.3 percent under a higher-growth scenario between 2023 and 2030.¹¹ The respective annual mitigation costs will on average account for 8.7 percent of a country’s GDP under the medium-growth scenario and 8.3 percent under a higher-growth scenario.¹²

¹¹ Medium-growth and higher-growth scenarios as described in Chapter 3.

¹² Mauritania’s mitigation needs (average 34 percent of GDP under a medium-growth scenario and 32 percent of GDP under a higher-growth scenario) drive these averages up. Excluding Mauritania, the corresponding average figures for the other four countries are 2.4 and 2.3 percent, respectively.

Table 0.2 Overall investment estimates in prioritized sectors in the G5 Sahel

	Estimated Investment Needs 2023 to 2030 (US\$ billion)	Details
Energy	18.14	Includes grid, mini grids, and standalone connections – resulting in a yearly increase of 2.7 million connections.
Clean Cooking	3.50	Includes universal urban and a significant push of rural stoves, covering 19 million households.
Environment	6.49	Restoration of 15,000 hectares of land and focusing on cropland, wetland, and grasslands with locally oriented tailored solutions.
Water and Sanitation	22.30	Estimated cost to achieve SDG 6, universal coverage (increasing water and sanitation coverage to 37.5 and 60 million people, respectively).
Agriculture and Irrigation	9.70	Increased productivity, improved trading, enhanced research. This will include rehabilitation of irrigation systems for 243,000 hectares, expansion of irrigation systems to an additional 1 million hectares and developing groundwater to service 3 million incremental hectares.
Cities	10.91	Flood management improvements, informal settlements upgrading, and improved solid waste management services (covering 55, 65, and 75 percent of the urban population, respectively).
Total	71.04	
Total as a share of projected 2023 to 2030 GDP	8.03%	

Source: CCCR Team calculations (details in Chapter 4)

This report has also conducted separate reviews for prioritizing investments in the five identified priority sectors (Energy, Water, Agriculture, Environment, and Cities). Mitigating climate risks through investments for the five sectors are estimated to cost US\$71 billion between 2023 and 2030.

The above investments were further prioritized to take into account the urgency of needs balanced by the limited absorption capacity of the G5 countries. Over the last decade, the WB disbursement in the G5 countries amounted to US\$7.13 billion. Its current overall portfolio is US\$7.7 billion. The CCCR team estimated that with a concerted effort to increase capacity, a “no regrets” portfolio for most urgent investment needs should be US\$16 billion over a period of the next seven years. This target is achievable with a significant external technical assistance package focusing on preparing, bidding, and supervising the activities. It will also be dependent on a delivery model that is not exclusively dependent on central governments. The prioritized investments would consist of the most urgent and impactful set of projects, urgently needed to spur growth to mitigate climate impacts.

Table 0.3 Urgent investment estimates in prioritized sectors in the G5 Sahel

	Urgent Investment Needs by 2030 (US\$ billion)	Details
Energy	3	Expansion of mini-grids, grids, and standalone connections – resulting in a yearly increase of 0.45 million connections.
Clean Cooking	1	Initial push in urban and a partial push of rural stoves, covering 5.5 million households
Environment	1	Restoration of 3,000 hectares of land and focusing on cropland, wetland, and grasslands with locally-oriented tailored solutions.
Water and Sanitation	5	Expansion of water and sanitary services (increasing water and sanitation coverage to 8.2 and 13.5 million people, respectively).

Agriculture and Irrigation	3	Focusing on increased agricultural productivity and opening of trading markets. This will include rehabilitation of irrigation systems for 75,000 hectares, expansion of irrigation systems to an additional 310,000 hectares, and developing groundwater to service 1 million incremental hectares.
Cities	3	Flood management improvements, informal settlements upgrading, and improved solid waste management services (covering 15, 16, and 21 percent of the urban population, respectively).
Total	16	
Total as a share of projected 2023 to 2030 GDP	1.8%	

Source: CCDR Team calculations

ES7. The World Bank Group's Role

In recent years, the World Bank Group has been providing a record level of financial resources to the G5 Sahel countries as part of its institutional strategy to address fragility, conflict, and violence. It is also upgrading its delivery model to make it larger, faster, and more effective. However, the climate crisis and its growing impacts, combined with the post-COVID-19 economic recovery needs, the challenging debt situation of the G5 countries, and the effects of the war in Ukraine on global food, fertilizer and energy prices, require an even higher level of engagement.

This CCDR proposes four new ways to support scale-up action by the G5 nations. Specifically:

- Broaden the range of stakeholders for climate action. The World Bank has historically focused its efforts on working with governments. However, given the urgency of climate change, that model is no longer adequate. A new, upgraded delivery model should include not only centralized governments but also regional and local governments, traditional delivery systems, the private sector, and civil society. Direct engagement of the World Bank Group with all actors for financing action requires different and innovative modalities.
- Support a decisive push for stronger capacities and implementation responsibilities of diverse stakeholders. The capacity of government institutions needs to be strengthened without delay. At the same time, an overburdened public sector will be unable to deliver the climate action needed at scale. Every stakeholder in society is required to construct resilient communities and societies. Therefore, a fundamental review and reimagining of institutional capacities and stakeholder roles is needed. Given the urgency of the climate crisis, G5 governments may consider delegating oversight and leadership roles to capable stakeholders, while retaining accountability, which can build capacity at the local level.
- Assist in mobilizing climate financing at scale. The enormity of the climate challenge requires the mobilization of finance at different levels and from varied sources. The World Bank Group can put its convening and technical capacity at the service of the G5 societies to support the governments, the private sector, and non-governmental stakeholders to access, mobilize, and leverage new climate financing for the large-scale programs needed today. Partnerships with other donors are welcome.
- Scale-up internal capacity. The World Bank Group needs to increase its capacity and alliances with international agencies to support a broader range of stakeholders for climate action, build their capacity and implementation responsibilities, and assist in mobilizing climate financing at scale.

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Acronyms

ACLED	Armed Conflict Location & Event Data
AFD	<i>Agence Française de Développement</i>
AFW	Africa West
AFOLU	Agriculture, Forestry and Other Land Use
ARC	African Risk Capacity
ASM	artisanal and small-scale mining
ASP	Adaptive Social Protection
BAU	Business As Usual
bbl	Barrel (of oil)
BC	Black Carbon
BDEAC	Development Bank of Central African States " <i>Banque de Développement des Etats de l'Afrique Centrale</i> "
BOAD	West African Development Bank " <i>Banque Ouest Africaine de Développement</i> "
CAPEX	Capital Expenditures
CAT DDO	Catastrophe Deferred Drawdown Option
CCDR	Climate Change Development Report
CCKP	Climate Change Knowledge Portal
CC-MFMOD	Climate Change Macro-Fiscal Model
CEM	Country Economic Memorandum
CEMAC	Central African Economic and Monetary Community " <i>Communauté économique et monétaire de l'Afrique centrale</i> "
CIF	Climate Investment Funds
CMIP6	Coupled Model Intercomparison Project 6
COVID-19	Coronavirus Disease 2019
CO ₂	Carbon Dioxide
CO ₂ eq	Carbon Dioxide Equivalent
COP	Conference of the Parties
CPSD	Country Private Sector Diagnostic
CSM	Climate-Smart Mining
DALY	Disability-Adjusted Life Years
DFS	Digital Finance Services
DRF	Disaster Risk Finance
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
ECOWAS	Economic Community for West African States
ESG	Environmental, Social and Governance
ESMAP	Energy Sector Management Assistance Program
FCV	Fragile, Conflict, and Violence
FDI	Foreign Direct Investment
FSAP	Financial Sector Assessment Program
GCF	Green Climate Fund
GCM	General Circulation Model
GCAM	Global Change Analysis Model

GDP	Gross Domestic Product
GGWI	Great Green Wall Initiative
GHG	Greenhouse Gas Emissions
GNI	Gross National Income
G5	Group of Five (G5 Sahel countries)
ha	hectare
HAP	Household Air Pollution
HDI	Human Development Index
HFO	Heavy Fuel Oil
IAM	Integrated Assessment Model
IEC	Internal Combustion Engine
ICS	Improved Cookstoves
ICT	Information and Communication Technology
IDA	International Development Association
IEA	International Energy Agency
IEc	Industrial Economics, Incorporated
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IPM	Integrated Pest Management
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
IWRM	Integrated Water Resources Management
JMP	Joint Monitoring Programme for Water Supply and Sanitation (WHO and UNICEF)
km ³	Cubic kilometer
kWh	Kilowatt hour
LIC	Low Income Country
LMIC	Lower Middle-Income Country
LP	Labor Participation
LPG	Liquefied petroleum gas
LUCF	Land Use Change and Forestry
m ³	Cubic meter
MIGA	Multilateral Investment Guarantee Agency
MIS	Management Information System
MPO	Macro-Poverty Outlook
MSME	Micro, Small & Medium Enterprises
MTF	Multi-Tier Framework
MW	Megawatt
NBS	Nature-Based Solution
NDC	Nationally Determined Contribution
NGFS	Network for Greening the Financial System
NGO	Non-Governmental Organization
NPL	Non-performing Loans
O&M	Operation and Maintenance

OPEX	Operating Expenses
PFM	Public Finance Management
PIM	Public Investment Management
pp	per person
PPP	Purchasing Power Parity
PPP	Public Private Partnership
PV	Photovoltaic
QER	Quality Enhancement Review
RCP	Representative Concentration Pathway
RBF	Results-based Finance
RISE	Resilience, Inclusion, Sustainability, and Efficiency
ROA	Return on Assets
ROE	Return on Equity
RST	Resilience and Sustainability Trust (IMF)
SCD	Systematic Country Diagnostic
SDG	Sustainable Development Goal
SDR	Special Drawing Rights (IMF)
SLM	Sustainable Land Management
SME	Small & Medium-Size Enterprise
SOE	State-Owned Enterprise
SP	Social Protection
SSA	Sub-Saharan Africa
SSP	Shared Socioeconomic Pathway
SWM	Solid Waste Management
TFP	Total Factor Productivity
UE	Unemployment
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
UNSD	United Nations Statistics Division
VAT	Value-added Tax
VRE	Variable Renewable Energy
WAEMU	West African Economic and Monetary Union (UMEOA in French)
WAP	Working Age Population
WAPP	West African Power Pool
WASH	Water, Sanitation, and Hygiene
WB	World Bank
WBG	World Bank Group
WBG ^T	Wet Bulb Globe Temperature
WDI	World Development Indicators
WHO	World Health Organization

1 Climate and Development in the G5 Sahel: Current Situation and Challenges

1.1 Introduction

This report covers elements in common across the G5 Sahel. This chapter describes the current situation in the Group of Five (G5) countries of the Sahel. It covers the basics of geography, demographics, and economics. It describes the many challenges that these countries face, from low average incomes to limited institutions to frequent conflicts, and how climate change will make meeting these challenges even more daunting. But as the chapter also describes, the countries have strengths and comparative advantages, such as vast natural resources, that can help enable them to adapt in a world transformed by climate change.

1.2 Overview: Geography, Demographics, and Development Indicators

The five countries of Burkina Faso, Chad, Mali, Mauritania, and Niger (the G5) are in the Sahel region of Africa, which lies between the Sahara to the north and the Sudanian savanna to the south. The countries cover a substantial territory, spanning more than 5 million square kilometers. All of the countries except for Mauritania are landlocked. The Sahel is what's known as a transitional ecoregion. Much of the region is semi-arid grasslands and savannas, with shrublands and woodlands in the south.

The G5 nations are home to 89 million people, with population growth rates higher than in any other part of the world. Between 1960 and 2020, the number of people in the G5 jumped from 17.3 to 86.4 million, and by 2050, the population is projected to soar to between 180 and 211 million.¹³ The G5 nations continue to report high fertility rates, ranging from 4.6 children per woman in Mauritania to 7 children per woman in Niger, the highest rate of any country in the world. These high fertility rates are driving the region's high population growth, particularly in the context of significant progress made to increase life expectancy and to reduce the death rate by more than 50 percent since 1960, primarily due to lower infant and child mortality.

The overall population density, however, is still relatively low compared to other parts of Africa, ranging from a high of 35 people per square kilometer¹⁴ in Burkina Faso to only 4 in Mauritania, one of the lowest in the world. Those differences reflect, in part, differences in the amount of arable land in the five countries. Burkina Faso has the highest share of arable land, at 22 percent, and Mauritania the lowest, at only 0.4 percent.¹⁵

Agriculture is the single largest economic activity in the five Sahel countries. It contributes 40 percent of the region's combined regional GDP and is the largest employer. Much of the activity is subsistence dryland farming by smallholder farmers. With limited use of irrigation, this farming is heavily dependent on often-uncertain seasonal rainfall, which ranges from about 200 millimeters per year in the north to 600-700 mm per year in the south.

Pastoralism is also an integral part of livelihoods in the Sahel, providing meat, milk, and income. Livestock herding is responsible for 10-15 percent of the GDP in Burkina Faso, Chad, Mali, and Niger, and even a larger share in Mauritania, where half of the people are pastoralists. In addition, fishing offers one of the most common and cheapest sources of protein.

13 World Bank (2021), « Défis stratégiques des pays du G5 Sahel : L'évolution démographique », unpublished draft report supported by the State and Peacebuilding Fund (SPF).

14 The demographic situation in the Sahel: two times more inhabitants in the year 2015. Pop Sahel. 1992 Jul; (Spec No): 8-10. French. PMID: 12344772.

15 World Bank Group. World Bank Open Data. Data Bank. 2018.

With such a heavy dependence on agriculture, the five countries are still heavily rural. But their cities have been growing. Over the last thirty years, the urban population has increased from 18.8 percent of the population (7.7 million people) to 29.4 percent (24.6 million people).¹⁶ In general, urban dwellers are roughly evenly split between large urban areas – typically, capital cities like Bamako in Mali and Niamey in Niger – and a growing number of very small cities that are more closely tied to the surrounding rural regions.

Over the past decade, the G5 Sahel countries have managed to achieve significant economic growth. Real GDP for the region as a whole climbed by an average of 4.9 percent per year from 2010 to 2019, compared with 3.9 percent for Sub-Saharan Africa (SSA). However, the growth in GDP per capita has been much smaller – an average of 1.65 percent per year – because of the rapid rise in population. Average incomes are low, with nearly 31 percent of the population falling below the international poverty rate (Table 1.1). In 2021, the average GDP per capita was only US\$790.

Table 1.1 Selected country indicators of G5 Sahel countries, 2021

	Income classification	GDP (current US\$ billion)	GDP per capita (current US\$)	Debt (% of GDP, Risk of debt distress)	Population (million)	Land area (million sq km)	Agriculture employment (percent of total employment)	International poverty rate (US\$1.9 per day)	Human Development Index (0-1)
								(percent)	
Burkina Faso	LIC	18.0	839	55.0, moderate	21.5	0.3	76.2	30.8	0.452
Chad	LIC	11.4	673	52.1, in distress	16.9	1.3	75.1	37.8	0.398
Mali	LIC	18.5	887	52.7, moderate	20.9	1.2	62.4	17.6	0.434
Mauritania	LMIC	8.3	1,736	59.3, high	4.8	1.0	30.8	5.8	0.546
Niger	LIC	14.3	570	52.5, moderate	25.1	1.3	72.5	41.8	0.394
Sahel	n/a	70.5	790	n/a	89.2 ^a	5.1 ^a	69.2 ^b	30.8	n/a

Source: Macro-Poverty Outlook (MPO), April 2022. World Development Indicators (WDI), Human Development Index (HDI). Latest joint IMF-WBG DSAs as of April 2022.

Notes: Population and agriculture employment (modeled International Labour Organization estimate) show most recent available values (2018). Estimated poverty rate is based on the most recent value using 2011 PPPs. HDI ranks are from the 2020 Human Development Report with 2019 data from 189 countries. The index is the geometric mean of health, education, and income index with a value between 0 and 1. A value above 0.800 is classified as very high, between 0.700 and 0.799 as high, 0.550 to 0.699 as medium and below 0.550 as low. a = regional total; b = regional average.

The coronavirus disease 2019 (COVID-19) pandemic and concurrent political instability and security crises significantly reduced economic growth in 2020. The slowdown has pushed an additional 2.7 million people into extreme poverty, caused countries' debt to increase, and led to fiscal deficits in 2021 in every country except for Mauritania. In 2021, growth remained low in four of the G5 Sahel countries, with the only standout being Burkina Faso, where growth reached 7 percent in a one-off year of large private investment. GDP changes in the rest ranged from a 1.2 percent contraction in Chad to a 3.1 percent increase in Mali.¹⁷

1.2.1 Low Scores on Measures of Human Capital, Resilience, Inclusion, Sustainability, and Efficiency

While average lifespans have climbed substantially in the G5 countries since 1960, with life expectancy at birth soaring 71 percent in Burkina Faso (to 60.9 years), the countries' Human Development Index scores are among the lowest in the world for developing countries (Table 1.1). Because of poor education and health, a child born today in Chad will reach only 30 percent of her full productive potential, and the figures are barely higher in the other four countries.¹⁸ Women are at a particular disadvantage. Maternal

¹⁶ From 1990 to 2019, based on World Urbanization Prospects by United Nations Population Division.

¹⁷ The growth dynamics and impacts on poverty are detailed in the World Bank Spring 2022 Macro-Poverty Outlooks.

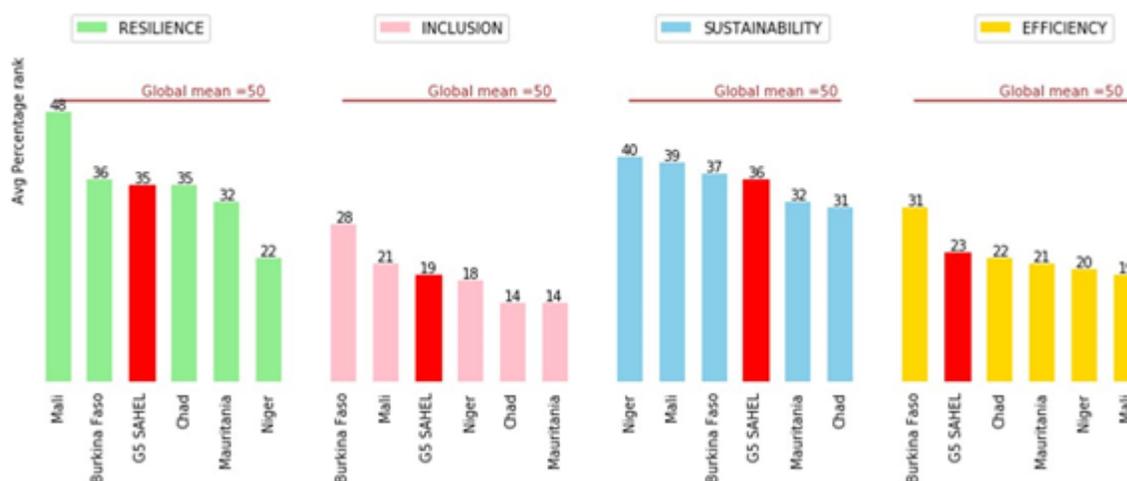
¹⁸ Based on the Human Capital Index: Chad 0.3; Mali 0.32; Niger 0.32; Burkina 0.38 and Mauritania 0.38.

mortality rates are high, between 371 and 856 deaths per 100,000 live births, and the gender gap in education is among the largest in the world.¹⁹

In addition, the number of people who are food insecure increased sharply between 2000 and 2015, from 2.9 million to 3.7 million in Burkina Faso, for instance, and from 3.3 million to 4.6 million in Chad. This is likely to further increase already high levels of malnutrition and stunting of children, which lowers cognitive development and educational attainment, leading to decreased future productivity and growth.

Another measure, the World Bank’s RISE Diagnostic (which assesses resilience, inclusion, sustainability, and efficiency), shows that the countries also lag behind the global mean in each category (Figure 1.1). The reasons include lack of basic services, like clean water and electricity; poor infrastructure for transportation, communications, and other activities; high inequality; environmental degradation and pollution; high food insecurity; and lack of quality health care. All these challenges are now being further exacerbated by the growing impacts of climate change.

Figure 1.1 Benchmarking of G5 Sahel countries and region (red column) by pillar source



Note: Percentage ranking of G5 Sahel and individual G5 countries against the global mean (RISE Sahel, World Bank 2021).

In particular, improving these measures of human capital in the face of climate change will require reducing existing gender inequalities. Currently, most women in the G5 countries are trapped in low-paid or informal jobs, mostly in the agricultural sector. Indeed, many women who work in agriculture are unpaid. Their access to markets for selling goods is restricted by conflict²⁰ and they typically are not allowed to participate in meaningful household decisions.²¹ These problems strongly constrain women’s abilities to sustain their livelihoods, to function productively in society, and to contribute to economic growth and poverty reduction. Creating a more equitable future for women will require better education for girls, improved access to quality reproductive, child, and maternal health services, and the creation of more economic opportunities for women (Annex 2.2.3).

1.2.2 A Conflict-Ridden Region

Over the last two decades, the Sahel region has become increasingly fragile, with waves of conflict destabilizing the region (Figure 1.2). The insurgency that started in 2009 in Nigeria rapidly spread from

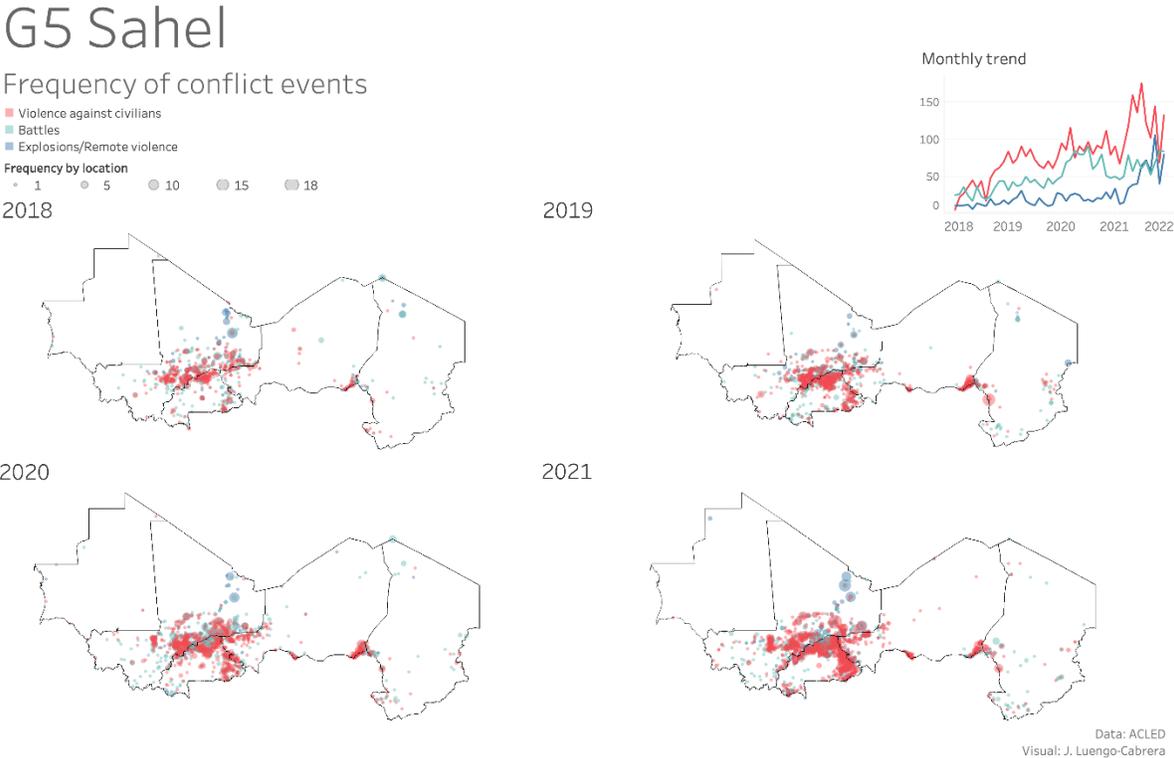
¹⁹ Sahel Alliance. Gender Equality and Women’s Empowerment: A Unique Opportunity for the Sahel. 8 March 2021. Available at: <https://www.alliance-sahel.org/en/news/gender-equality-sahel/>. Last accessed: May 11, 2022.

²⁰ Tarif K. and Grand A.O., “Climate Change and Violent Conflict in Mali”, ACCORD, 10 June 2021, available at: <https://www.accord.org.za/analysis/climate-change-and-violent-conflict-in-mali/>

²¹ Demographic and Health Survey 2018.

Northeast Nigeria to Cameroon, Niger, and Chad. In addition, the conflict that began in northern Mali in 2011 has spread to Central Mali, northern Burkina Faso, and western Niger. Currently, all G5 Sahel countries are either actively in conflict or dealing with its aftermath, including internal displacement and flows of refugees. Initially led by the presence of violent extremist groups, the conflict has become more localized with inter-community tensions driving fragility in areas previously unaffected by violence. Furthermore, the withdrawal of the French operation Barkhane and the European Task Force Takuba from Mali and the withdrawal of Mali from the G5 Sahel could lead to new security dynamics across the region as armed groups may fill the security vacuum, particularly in the tri-border area between Mali, Burkina Faso, and Niger.

Figure 1.2 Frequency of conflict events in the G5 Sahel



Source: Data from the Armed Conflict Location & Event Data Project (ACLED), Visualization by J. Luengo-Cabrera.

The emergence of violent conflicts in the Sahel is associated with exclusion and perceptions of injustice and marginalization.²² Patterns of exclusion – both territorial and inter-group – can be found in the following four conflict drivers facing Sahel countries:

- Low public confidence and trust in state institutions, due in particular to a lack of inclusiveness in political life and institutions, has historically been the key factor mobilizing rebellions and non-electoral regime change. These tensions are perpetuated by Sahelian governance systems which are typically centralized, with 80-100 percent of public spending in capitals, reinforcing the territorial and political isolation of remote or border areas. “Floating populations” that are less integrated into the state ecosystem, including youth, women, and nomadic people, are particularly disadvantaged.

22 World Bank (2020). Sahel Regional Risk and Resilience Assessment.

- Natural resources competition is made worse by the triple effect of climate change, high demographic growth, and insufficiently inclusive development policies. The result is most pronounced in increased communal tension between pastoralists and cultivators. It is further exacerbated by insufficiently inclusive land management and agribusiness policies.
- The provision of basic services, including health, water, and education as well as transport and energy, is plagued by inequity and insufficient quality. Investments have overwhelmingly prioritized capital cities and densely populated areas, marginalizing remote and border areas and “floating populations”, and further weakening the link between communities and states while increasing rural-urban inequities. Rapid urbanization further fuels this trend, while budgetary pressures risk amplifying an existing decline in service quality.
- The judiciary and security services suffer from a lack of resources and territorial coverage, leading citizens to employ non-formal approaches. Defense and security forces have great trouble protecting citizens from asymmetric and multifaceted threats and reportedly fail to respect the rights of, or integrate members of, some communities, prompting the creation of self-defense groups.

Climate change, by putting additional stress on the livelihoods and economic space of essentially rural communities, interacts with these features and exacerbates fragility, as now amply discussed in the literature exploring the climate change-conflict nexus.²³ That, in turn, could touch off a negative feedback loop: more conflict makes it harder for communities to cope with climate change impacts, leading to more violence and conflict and further reducing resilience to climate change. The impacts fall hardest on the poorest and most vulnerable, including women, youth, ethnic minorities, nomadic groups, displaced people, and people with disabilities (including casualties of conflict). These marginalized groups are often forced to resort to a variety of negative coping strategies – further decreasing their resilience to climate change and creating even more conflict.²⁴ As climate change does not hit all sections of the society in the same way, imbalanced adaptation policies could eventually make some communities more vulnerable.

However, there is no direct causality between climate change and conflict, but rather there are meandering pathways that also involve historical and contemporary land use conflicts²⁵ – amplified by efforts at agricultural development²⁶ – and political choices that determine access to resources. Typically, pastoralist communities are often at odds with modern state-making efforts, which have tended to privilege sedentary populations across West Africa for decades. Some pastoralists decide to join violent extremist groups due to insurrectional, anti-state, and anti-elite narratives²⁷ or because these groups will help them defend livelihoods that are increasingly threatened by insufficiently inclusive policies.

In addition, as climate and conflict risks transcend national borders, a regionally coordinated approach in the Sahel is necessary. A new World Bank report²⁸ shows how climate change and FCV factors interact in the region, and how vulnerability data can be used to create more effective investments to reduce climate and conflict risks. Thus, there is a need to build regional institutional capacity to collect and analyze these data and perform research on climate and conflict risks, along with improved capacity for regional development diplomacy.

23 See Buhaug, H.; Von Uexkull, N. (2021) Vicious Circles: Violence, Vulnerability, and Climate Change. *Annual Review of Environment and Resources*. And Koubi, V. (2019). *Climate Change and Conflict*. *Annual Review of Political Science*.

24 Vivekananda, J.; Wall, M.; Sylvestre, F; Nagarajan, C.; Brown, O. (2019). *Shoring Up Stability: Addressing Climate and Fragility Risks in the Lake Chad Region*. Adelphi.

25 Benjaminsen T.; Ba B. (2021). *Fulani-Dogon Killings in Mali: Farmer-Herder Conflicts as Insurgency and Counterinsurgency*. *African Security*.

26 International Crisis Group (2020). *The Central Sahel: Scene of New Climate Wars*.

27 Benjaminsen T. and Ba B. (2018). *Why do pastoralists in Mali join jihadist groups? A political ecological explanation*. *Journal of Peasant Studies*.

28 World Bank, 2022 (forthcoming). *The Climate Change and Conflict Nexus in West Africa – a New Approach for Operationally relevant Vulnerability Assessments*,

1.2.3 Natural Resources, Demographic Dividend, and Renewable Energy Potential

The previous sections illustrate many of the challenges facing the G5 countries. But it's important to emphasize that the countries also have strengths and potential comparative advantages that could become more important in the context of climate change. The Sahel region is rich in mineral resources, including oil, gold, copper, uranium, and the minerals and metals needed for a variety of “green” technologies that are in high demand as countries try to reduce their emissions of greenhouse gases. The countries also have a large and growing labor force, which would make it possible to expand local manufacturing and other industries. Realizing the demographic dividend, however, will require investments in human capital and female economic empowerment, along with better governance and investments in the economy. The private sector also needs to play a larger role in climate-smart mining and other development. In order to enable the countries to benefit from mining investments over the next 5-10 years, it is important to expedite actions in this sector.

The G5 Sahel has a huge renewable energy potential, particularly wind and solar. The area receives some of the highest solar irradiation in the world. For example, in Chad, global horizontal irradiation is 5.8 kWh per m² per day in the South and 6.8 kWh per m² per day in the North.²⁹ Hydropower also represents an important source of renewable power in the region, with numerous water basins and lakes with hydropower potential, including the Niger and Senegal River Basins and Lake Chad. Solar photovoltaic and wind power are rapidly increasing, but still represent less than 5 percent of the electricity generated in most countries, with the exception of Mauritania.³⁰ The continuous decline in prices of solar and battery storage technologies represents a unique opportunity to develop these resources as part of the least cost energy mix.

1.3 Key Development Challenges and Growing Threats of Climate Change

As this chapter has described so far, the Sahel faces many critical development challenges, ranging from rising extremism and conflict to low measures of human capital, resilience, and sustainability. This section expands on those challenges by examining the barriers to development in each of nine specific sectors or topics, while also viewing those barriers through the lens of climate change. The details here will then guide the detailed analysis and recommendations in the following chapters of this report.

1.3.1 Cities: Urbanization, Urban-Rural Migration, and Disaster Risk Management

Cities could play major roles in raising living standards and increasing resilience to climate shocks in the Sahel countries, especially for climate and economic migrants. However, the current patterns of urbanization are failing to bring the economic and productivity gains that are possible from agglomerating people in cities, and are actually increasing the risks from climate change impacts (Annex, 2.1.3 and 2.1.10).

Urban growth in the G5 Sahel countries has been rapid, mostly uncontrolled, and fragmented. As a result, most towns and cities struggle to provide infrastructure and basic services,³¹ and lack the financial resources to keep up with the rapid increases in population. Unplanned and sprawling urban areas mean that the density of economic activity is low and travel distances are great. Roads are also typically of low quality. Thus, transport costs are high. That, in turn, inhibits trade, escalates conflict, and contributes to low levels of human capital and diminished access to social services.

These conditions cause “lock in effects” that make it even more difficult to tackle problems such as poor transportation, lack of clean water, poor sanitation, rising urban heat, inadequate inclusive and safe living

29 <https://solargis.com/maps-and-gis-data/download/chad>

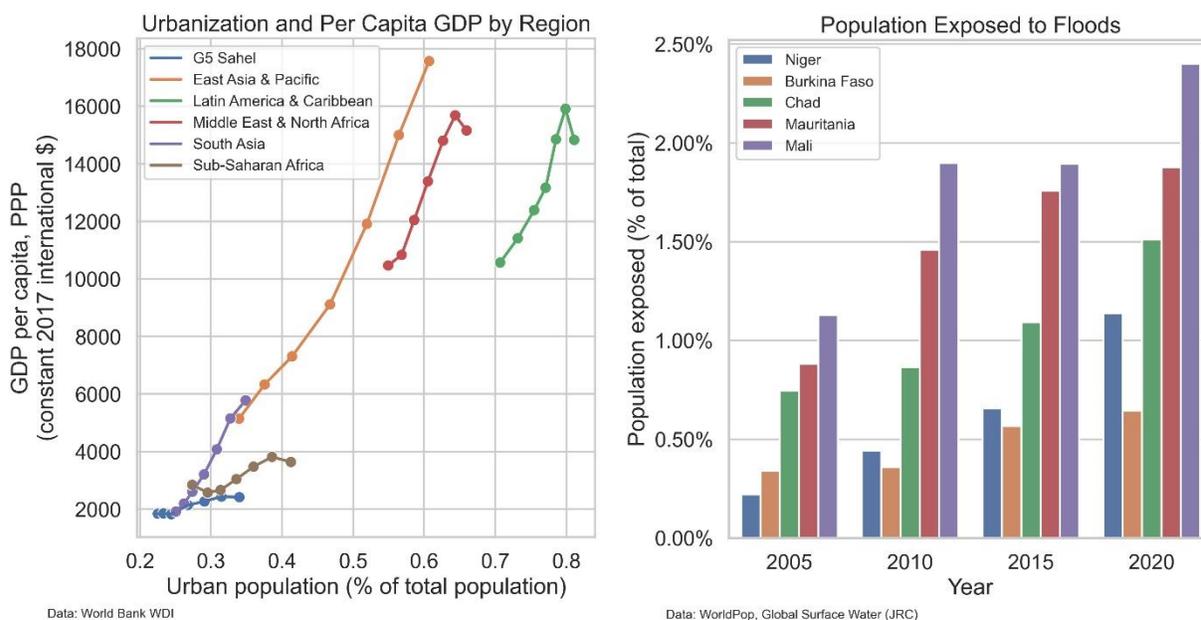
30 PV represents 12 percent of installed capacity in Mauritania.

31 43.5 percent of the population in G5 Sahel still lacks access to basic water supply, and close to 74.6 percent do not have access to improved sanitation hindering human well-being and development, according to 2020 data from WHO (World Health Organization) and UNICEF (United Nations Children's Fund) and JMP (Joint Monitoring Programme for Water Supply, Sanitation and Hygiene).

spaces, low energy efficiency, air pollution, and greenhouse gas emissions. There is therefore a danger of locking in carbon-intensive growth.

The impacts of climate change will increase these challenges, while also causing further involuntary migration from rural to urban areas, as droughts³² and floods³³ push people to abandon agricultural activities. Moreover, many of the new, low-income urban settlements are likely to spring up in marginal areas that are more exposed to natural events, raising risks and damages from floods. Improving resilience, therefore, will depend on more social inclusion – in this case, the participation and collaboration of vulnerable groups like the urban poor and new migrants to cities.

Figure 1.3 Rapid urbanization fails to increase productivity but raises flood risks. Rapid urbanization is not associated with higher productivity in G5 Sahel countries (left) and the share of population living in urban areas with high exposure to flood risk has been increasing significantly (right)



1.3.2 Energy Access, Clean Cooking, and Extractives

1.3.2.1 Power

Access to power in the Sahel is one of the lowest in the world. Only a third of the population has access to reliable, affordable electricity, half the level in the Sub-Saharan countries. There are significant differences in the access rate across countries and between urban and rural areas (Table 1.2).

In addition, the G5 countries’ power supplies are mainly reliant on fossil fuels and biomass energy,³⁴ making it challenging to avoid locking in carbon-intensive technologies and leapfrogging to clean renewable technologies.

Sahel countries provide significant subsidies to state-owned energy utilities even if the electricity tariff is not directly subsidized. This makes the power from fossil fuels cheaper than it should be and reduces

32 Droughts regularly affect large parts of the population, around 2 percent of the 2020 G5 Sahel population each year (in total 63 million from 1980-2020), and can compound existing shocks (the mean drought event for the period of 1981-2018 reduced GDP per capita growth by -1.5 to -1.8 percentage points, with 40 percent annual exceedance probability), based on Van der Borgh (2021).

33 <https://openknowledge.worldbank.org/bitstream/handle/10986/35610/Rural-Urban-Migration-in-Developing-Countries-Lessons-from-the-Literature.pdf?sequence=1&isAllowed=y>

34 IEA (2021), Clean Energy Transitions in the Sahel, IEA, Paris <https://www.iea.org/reports/clean-energy-transitions-in-the-sahel>

incentives to move to renewable energy. On the other hand, fuel retail prices (gasoline and diesel at the pump) are not subsidized significantly, with fuel prices going up across the Sahel since 2021 as global oil prices have increased. Some authorities have reduced fuel excise taxes to cushion the impact of high fuel prices on the public. It will be important for the Sahel countries to avoid new fuel subsidies (as has happened in many countries around the world in response to rising prices) and to gradually eliminate existing electricity subsidies.

All five Sahel countries are committed to low-carbon economic growth. Except for Mauritania, they all have specific renewable energy targets in their Nationally Determined Contributions (NDCs). The combination of a very large renewable resource with falling solar and wind costs and new developments in battery storage technology will help G5 countries improve access to power while keeping greenhouse gas emissions down.

Table 1.2 Key power sector indicators for G5 Sahel countries

	Electricity access rate (latest, 2019-2020)	Installed Capacity (MW)	Share of private sector in generation (%)	Average electricity tariff (US\$/kWh)	Cost recovery (%)	Average Transmission & Distribution losses (%)	Electricity bill collection rate (%)	Energy mix
Burkina Faso	20% (66% urban, 3% rural)	402	12	0.20	83	16	97	47% thermal, 45% import, 5% hydro, 3% solar
Chad	6.4% (20% urban, <1% rural)	165	37	0.25	58	37	45	Almost entirely diesel/HFO
Mali	49%	836	32.5	0.18	64	23.9	93	38.5% thermal, 29.3% import, 30% hydro, 2.2% solar
Mauritania	46% (70% urban, 5% rural)	549	0	0.15	58	31	65	62% thermal, 9% hydro, 22% 12% wind solar, 4% wind
Niger	20% (65% urban, 1% rural)	272	20	0.17	100	25	97	76.7% imports, 22.3% thermal, 0.82% solar

Source: World Bank Energy Global Practice

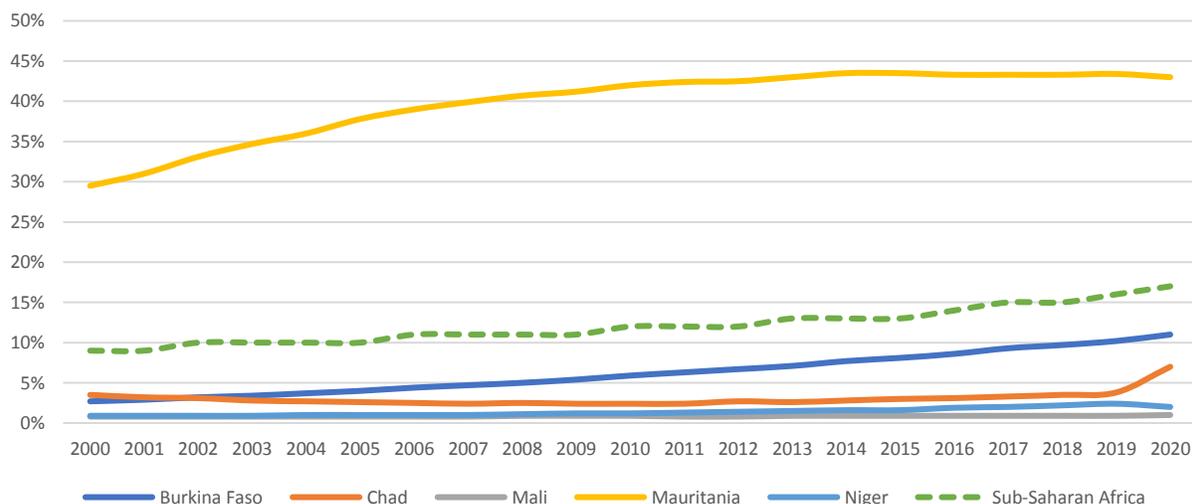
Note: import refers to energy imported from neighboring countries through regional trade. This imported energy is mostly produced from gas and some hydro.

1.3.2.2 Clean Cooking

Today, more than 80 million people in the G5 Sahel countries live without access to clean cooking fuels and technologies. According to the 2022 Sustainable Development Goal (SDG) 7 Tracking Report,³⁵ Mali and Niger are among the 20 countries with the lowest rates of access (2016-20 average), at only 1 percent and 2 percent respectively in 2020 (Figure 1.4).

35 IEA, IRENA, UNSD, World Bank, WHO. 2022. Tracking SDG 7: The Energy Progress Report. World Bank, Washington DC.

Figure 1.4 Access to clean cooking rate evolution and progress, 2000-20



Source: Global Health Observatory. Geneva: World Health Organization; 2022 36

Access to clean cooking is a key development issue, since low rates contribute to energy poverty and lead to negative impacts on health, the environment, and climate change mitigation and adaptation. The G5 Sahel countries’ low access to modern energy cooking services and high dependence on charcoal and wood for cooking, combined with inefficient cooking methods like three-stone fires and traditional stoves, have accelerated forest degradation and deforestation. That, in turn, is undermining the region’s agricultural productivity and food security, water security, and hydroelectric generating capacity³⁷ – leaving the G5 countries more vulnerable to climate shocks. But introducing new fuel-saving technologies has been difficult in the region, as poverty makes it challenging for households to afford those technologies.

1.3.2.3 Extractives - Oil, Gas, and Mining

Chad is currently the only net oil exporter among the G5 countries. Nigeria and Mauritania will likely reach this status by 2024. Given the importance of oil revenues for these countries, oil’s price uncertainty and volatility are likely to affect future economic growth rates. Mauritania possesses large offshore gas reserves and given the current geopolitical situation is likely to emerge as a supplier of gas to the EU market. The impact of lower global oil prices on the G5 countries’ economies are further analyzed in Chapter 3.

A clear but challenging opportunity exists in the growth in demand for minerals and metals in the region needed to supply low-carbon technologies – so-called climate action minerals.³⁸ While all G5 Sahel countries have at least some climate action minerals, the richest deposits are in Mali (bauxite, iron, copper, manganese, tin, zinc, lead, and lithium) and Mauritania (iron, copper, and silver). Mauritania has a fairly mature mining industry, in operation since the 1960s. It also has a developed steel sector that could be transformed to produce “green” steel. Niger has one of the world’s largest deposits of uranium (not included as a climate action mineral but technically a carbon-free option because of its utility in

36 Energy Sector Management Assistance Program (ESMAP). 2020. The State of Access to Modern Energy Cooking Services. Washington, DC: World Bank. License: Creative Commons Attribution CC BY 3.0 IGO.

37 Ibid.

38 Climate action minerals include bauxite, iron, copper, manganese, tin, tungsten, vanadium, zinc, lead, silver, and lithium.

nuclear power). Chad and Burkina Faso have discovered evidence of climate action minerals, but the amounts and quality of the deposits are not yet known.

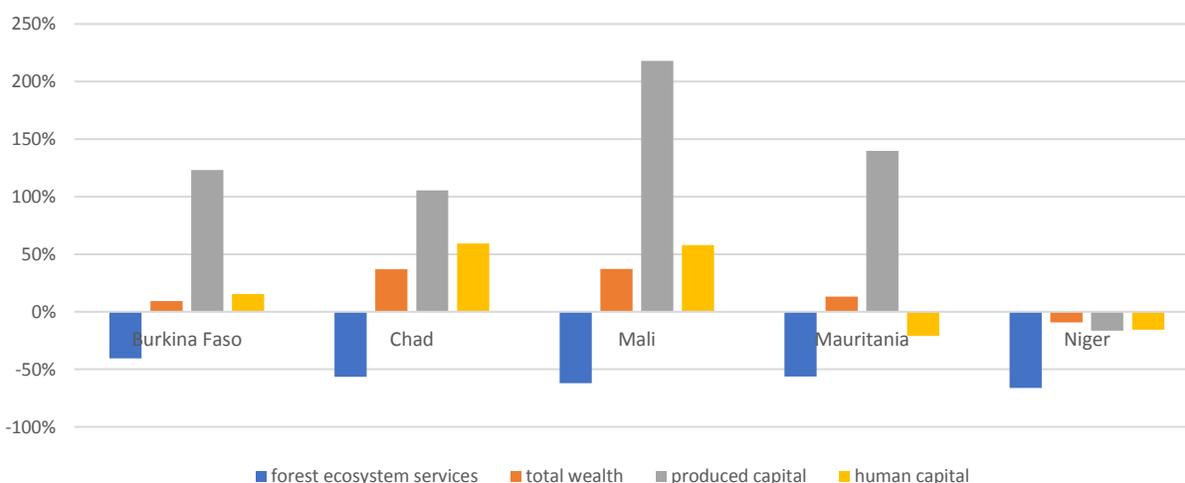
These operations will need to be developed with growing expectations from governments, investors, consumers, private companies, and civil society that they be extracted and processed with Environmental, Social, and Governance (ESG) and climate considerations in mind. A climate-smart and net-zero national strategy for mining and processing is a critical element in the G5’s economic transition. While the countries have significant artisanal and small-scale mining (ASM) operations, these are mostly for gold and, if not properly regulated, can cause water contamination and deforestation (Annex, 2.1.9).

1.3.3 Natural Capital, Environmental Degradation, and Impacts on Agriculture and Water

The World Bank’s Changing Wealth of Nations recognizes natural capital as important to a country’s wealth. Growth was mostly positive in other wealth categories in the G5, as produced capital and human capital increased in all countries (Annex, 2.1.2), suggesting that some of the growth of these wealth categories may have been at the expense of forest ecosystem wealth. On a per capita basis too, produced capital grew significantly in all G5 countries except for Niger, and per capita human capital also increased, albeit by a smaller amount, except in Mauritania and Niger (Figure 1.5). The significance of these trends lies in the fact that with climate change these forest ecosystems services will be needed more for adaptation; but the degradation of forests and their ability to provide these services does not bode well. The pressure on forest resources is likely to continue as climate-induced agricultural yield decreases and the high population growth rate lead to an increased demand for cropland, thus further decreasing forests’ ability to contribute to adaptation and resilience.

The G5 Sahel is one of most environmentally degraded regions in the world. About 80 percent of farmland is depleted, and the countries are in ecological deficit, which is not sustainable. This degradation is increasing, with about 60 percent being caused by human activity, such as household use of wood and charcoal for cooking, and the other 40 percent by climate change. Significant past droughts have meant that some G5 Sahel countries experienced a 47 percent increase in sandy areas in their important savannah habitats,³⁹ for example.

Figure 1.5 Change in per capita asset value of forest ecosystems services compared with changes in per capita total wealth, produced capital, and human capital (1995-2018)



Source: *Changing Wealth of Nations (CWON) 2021*. World Bank.

39 <https://eros.usgs.gov/westafrica/land-cover/land-use-and-land-cover-trends-west-africa>

Even if global warming is limited to a less than 1.5°C increase, climate change is expected to impact agriculture, for example reducing maize, millet, and sorghum yields.⁴⁰ Increased heat stress as a result of this warming may lead to crop failures for crops that are less resilient, such as cotton, which fails at temperatures over 35°C.⁴¹ Since these crops are economically important, with sorghum production alone contributing as much as 5.4 percent of GDP in Niger, reduced productivity means significant economic losses. Climate change also threatens pastoral systems, lowering productivity, damaging reproduction, and causing biodiversity losses. Losses of milk could be as high as 17 percent by 2100.

Fishing, meanwhile, already suffers from overfishing and habitat degradation, and climate change introduces new threats, such as increased temperatures, more variable rainfall, and more severe weather events.

The challenges are particularly great for women, who provide 70 percent of the labor in the food economy, a sector heavily influenced by climatic change.⁴² The increased risk to their livelihoods means a greater risk of food insecurity and malnutrition. Anemia due to malnutrition in pregnant women further increases the risk of stunting in their children later on with deleterious effects on their children's future productivity, thereby trapping families in a vicious cycle of poverty and vulnerability.

Water continues to be a significant limiting factor for development in a region that is one of the most water-stressed in the world (Table 1.3). In Burkina Faso, Chad, and Niger, less than half of the population has access to basic drinking water. Surface water across the region is limited and often seasonal, making groundwater a primary source of water for many people. While groundwater potentially represents a large untapped potential, the lack of data and monitoring of aquifers could lead to overuse of key aquifers that could provide reliable decentralized water supply. Furthermore, shallow groundwater can become contaminated because of poor sanitation and lack of treatment facilities. In Chad, for example, only 3.6 percent of the rural population and 40 percent of the urban population have access to basic sanitation services, raising the risks of waterborne diseases.

In addition, the region's water supply is unevenly distributed and crosses national boundaries, creating management challenges and potential conflicts. Increased use of irrigation, which now is used on less than 1 percent of cultivated land (Table 1.4), could increase crop yields, but at the cost of increasing competition for scarce water.

Climate change will make these problems worse. Climate projections for the Sahel are not conclusive and differ depending on climate models.⁴³ However, there is some agreement that, due to population growth, per capita water availability for the Sahel will decline (by 76 percent in the IPCC's RCP 2.6 scenario and by 77 percent for RCP 6.0 by 2080, relative to year 2000). The expected decline comes in the context of a slightly increasing overall water availability predicted under RCP 2.6 and a decreasing water availability under RCP 6.0 in the Global Change Analysis Model (GCAM)⁴⁴ (

40 United Nations High Commissioner for Refugees and Potsdam Institute for Climate Research (PIK). 2021. Climate Risk Profile: Sahel. Available at: <https://www.unhcr.org/61a49df44.pdf>.

41 Holmes, S., Brooks, N., Daoust, G., Osborne, R., Griffith, H., Waterson, A., Fox, C., Buonomo, E., and Jones, R. (2022) Climate risk report for the Sahel region. Met Office, ODI, FCDO. <https://www.metoffice.gov.uk/services/government/international-development/sahel-climate-risk-report>

42 Pepper, A. (2019), "Integrating gender analysis into food & nutrition security early warning systems in West Africa", *West African Papers*, No. 24, OECD Publishing, Paris, <https://doi.org/10.1787/abd5f499-en>.

43 Hulme, M. (2000). Climate perspective on Sahelian desiccation: 1973-1998. *Global Environmental Change*, 11(1), 19-29. Nicholson, 2013. *The West African Sahel: A Review of Recent Studies on the Rainfall Regime and its Interannual Variability*, ISRN Meteorology, 4.

44 The Global Change Assessment Model (GCAM) is a state-of-the-art integrated assessment model (IAM) designed to explore interactions among critical sectors of the economy, the human and physical systems, and to support policy-relevant decisions (Edmonds and Reilly 1985, Wise et al. 2009, Clarke et al. 2014). As a leading IAM, GCAM has contributed significantly to advance the scientific understanding of climate change as the IAM selected by the Intergovernmental Panel on Climate Change (IPCC) to model the representative concentration pathway (RCP) 4.5 (Thomson et al. 2011). GCAM is freely available as a community model and can be obtained through a widely used software repository (<https://github.com/JGCRI/gcam-core>).

Figure 1.6). The per capita decline, therefore, is not primarily driven by climate change, but rather by socioeconomic factors, such as increased agricultural production needs and increased water use (Figure 1.6).⁴⁵ A 2016 World Bank study estimated that the Sahel's annual GDP could drop by between 0.82 percent and 11.7 percent by 2050 because of climate-related water scarcity.⁴⁶

Table 1.3 Key water sector indicators for G5 Sahel countries

	Total renewable water resource (km ³)	Renewable water resources per capita (m ³ /pp/year)	Level of water stress *	Access to basic drinking water services (%)	Access to basic sanitation services (%)	Annual freshwater withdrawal, domestic (%)	Annual freshwater withdrawal, industry (%)	Annual freshwater withdrawal, agriculture (%)
Burkina Faso	12.5	651	7.81	47	22	46	3	51
Chad	43	999	4.29	46	12	12	12	76
Mali	100	3,241	8	83	45	2	0	98
Mauritania	11.4	93	13.25	72	50	7	2	91
Niger	33.7	162	7.45	47	16	10	2	88

*Freshwater withdrawal as a proportion of available freshwater resources

Source: World Bank Water Global Practice; Access to drinking water/sanitation services 2020 data from WHO (World Health Organization) and UNICEF (United Nations Children's Fund) Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP).

Table 1.4 Selected irrigation indicators for G5 Sahel countries

	Cultivated area (1,000 ha)	Area equipped for irrigation (1,000 ha)	Actual irrigated area (1,000 ha)	Cultivated area equipped for irrigation (%)	Irrigation potential (1,000 ha)	Irrigation potential developed (%)
Burkina Faso	6,100	54	46	0.9	165	33
Chad	5,238	30	26	0.6	335	9
Mali	6,561	371	176	5.7	566	66
Mauritania	411	45	23	11	250	18
Niger	17,818	102	88	0.6	270	38

Source: World Bank Water Global Practice

45 Climate risk profile: Sahel. UNHCR. PIK. Available at: <https://www.unhcr.org/61a49df44.pdf>.

46 World Bank. 2016. "High and Dry: Climate Change, Water, and the Economy." World Bank, Washington, DC. License: Creative Commons Attribution CC BY 3.0 IGO.

Figure 1.6 Water availability in the Sahel in 2020 and 2100 under climate scenarios RCP 2.6 and RCP 6.0 (GCAM)

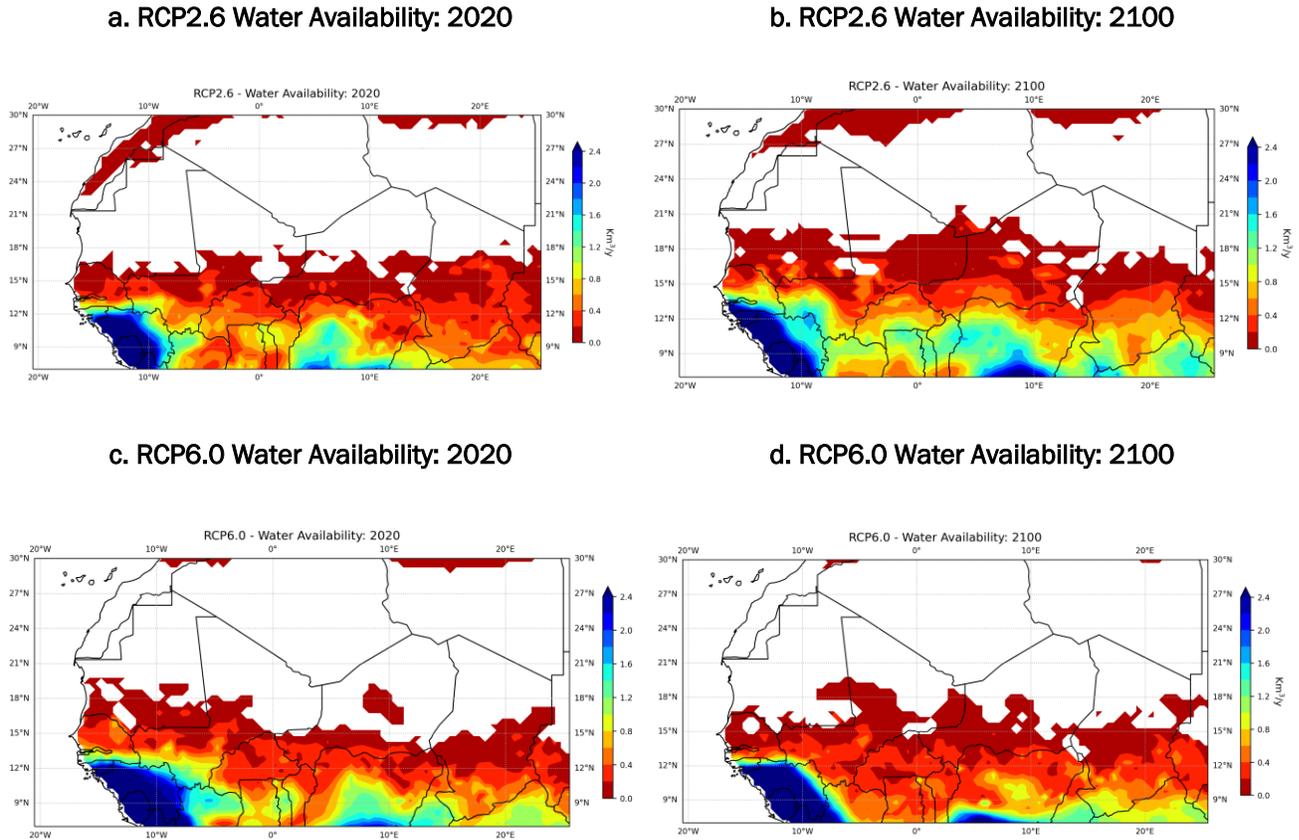
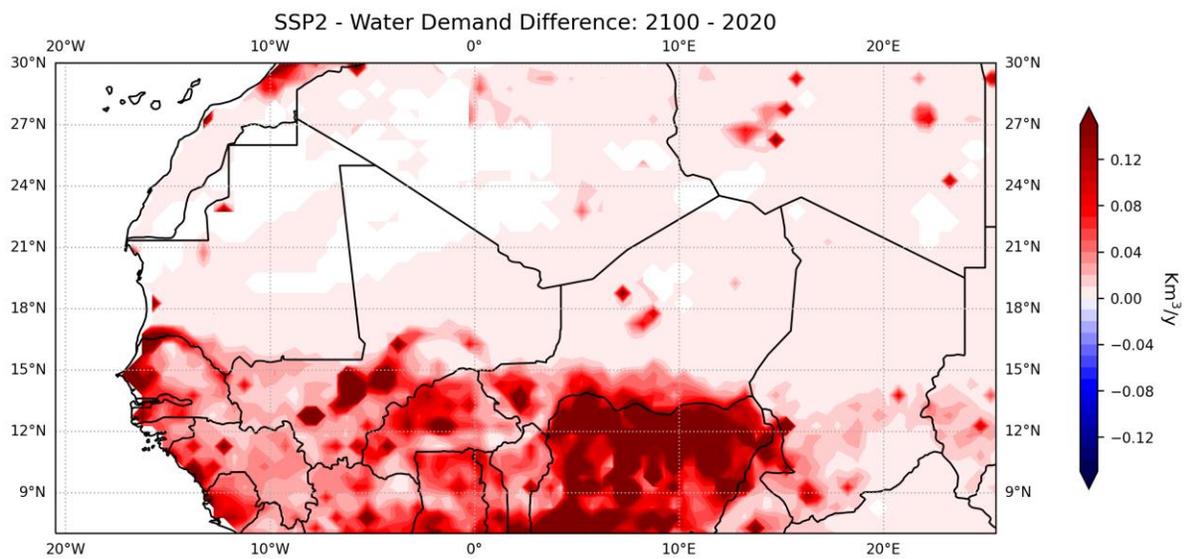


Figure 1.7 Difference in water demand in the Sahel between 2020 and 2100 (GCAM)



Note: Figure is based on agricultural and urban water demand and excludes demand from energy (hydropower).

1.3.4 Poor Infrastructure and Connectivity

The G5 Sahel countries suffer from some of the poorest infrastructure and connectivity in the world. Internet access in the Sahel is severely limited. Increasing access to digital connectivity in the Sahel will not only boost the economy but also provide employment prospects to the more than 1.4 million young people who enter the job market every year.

Forty percent of firms in the region identify transportation as a major constraint to their businesses. Transport networks are especially critical in agriculture since they enable connections to markets and food distribution. However, only one-third of rural people (and only 19 percent in Niger) now have access to all-weather roads (Table 1.5). Poor roads and high transport costs also make it difficult for the four landlocked Sahel countries to move goods to and from ports, and to deliver health, education, and social services in all countries.

Meanwhile, exponential growth of motorization and emissions from the transport sector is happening in a context where cities have failed to develop adequate public transport systems. As demand for urban transportation has grown, urban areas have become clogged with minibuses, shared taxis, commercial 2- and 3-wheelers, and other informal modes of transport. The 2- and 3-wheelers dominate in many Sahelian cities, as internal combustion engine (ICE) 2- and 3-wheelers account for 60 to 75 percent of all urban transport. In Ouagadougou and Bamako alone, 2- and 3-wheelers contribute to more than 50 percent of total CO₂ vehicle emissions and 60-75 percent of harmful air pollutants emitted by vehicles. In the medium to long term, transitioning to electric mobility (eMobility) would curb GHG emissions, especially when done in combination with a transition to renewable energy.

A transition to eMobility is still at an incipient stage in Sahelian countries. The number of existing electric vehicles is still negligible in Sahelian cities. However, the eMobility transition is likely to begin in the next few years in the Sahel, driven by the influx of electric vehicles from more developed economies and by lower electric vehicle costs. Electricity production levels currently are not sufficient to absorb a rapid eMobility transition, however, under existing energy conditions; if 70 percent of the current 2- and 3-wheeler fleet was converted to electric, it would consume 19.5 percent of the total electricity production in Mali and 82 percent in Burkina Faso.⁴⁷ This shows that cities in the Sahel are not prepared for a big-bang transition to electric vehicles. Instead, the eMobility transition needs to happen gradually, and requires a sustained effort to increase energy production, enhance the reliability of the grid, and green the energy supply.

Transport systems are extremely vulnerable to climate impacts. In 2019, floods and other natural hazards that disrupted transportation in Burkina Faso cost firms US\$92 million, equal to 1.1 percent of the country's GDP.⁴⁸ Future climate change will increase maintenance costs on the existing road network by 60 percent to 160 percent by 2050, a World Bank-led study estimates.⁴⁹

47 Arroyo-Arroyo F. and Vesin V. Pathways to Electric Mobility in the Sahel: Two and Three-Wheelers in Bamako and Ouagadougou. 2021

48 Hallegatte, S., Rentschler, J., and Rozenberg, J. 2019. Lifelines: The Resilient Infrastructure Opportunity. Sustainable Infrastructure Series. Washington, DC: World Bank. doi:10.1596/978-1-4648-1430-3. License: Creative Commons Attribution CC BY 3.0 IGO

49 2016. "Africa Climate Business Plan: Towards Resilient, Low-Carbon Transport (Consultation Draft – April 2016)." World Bank, Washington, DC. License: Creative Commons Attribution CC BY 3.0 IGO.

Table 1.5 Key transport sector indicators for G5 Sahel countries

	Firms identifying transportation as a major constraint (%)	Quality of transport infrastructure		Rural accessibility		Domestic integration		International integration		
		Quality of roads Rank: X out of Index: [1 = worst to 7 = best]	Quality of railroad Rank: X out of Index: [1 = worst to 7 = best]	Rural population with access to a primary road in 2 kms (%)	Rural population with access to any kind of road in 2 kms (%)	Population with access to a city of >50k inhabitants in less than 1 hour (%)	Population with access to the capital in less than 1 hour (%)	Average time to nearest land border crossing (hrs)	Average time to nearest port (hours)	Average time to nearest airport (hours)
Burkina Faso	40.3	131	93	27	52	33	19	5.12		3.84
		2.57	1.83							
Chad	25.1	135	N.A.	12	30	11	10	18.9		13.6
		2.47	N.A.							
Mali	51	89	88	22	57	40	23	7.97		9.21
		3.49	2.13							
Mauritania	46	124	91	38	54	34	30.2	13.24	11.37	11.7
		2.73	2.09							
Niger	19.6	N.A.	N.A.	19	40	31	7	5.22		4.54
		N.A.	N.A.							
Sahel median	40	128	91	27	52	33	19	7.97	11.37	9.21
		2.65	2.09							

1.3.5 Government Finance and Debt Constraints

The G5 Sahel countries do not issue international sovereign debt or raise significant external market-based financing, and only Burkina Faso, Mali, and Niger are at moderate risk of debt distress (Table 1.1) and have international credit ratings, which are all non-investment grade. Most government external debt is from concessional sources or semi-concessional development lenders. However, some commercial financing has come through for various purposes, such as for mining. Chad and Mauritania have a high risk of external debt distress (Table 1.1), and Chad, Mauritania, and Niger have limits for non-concessional external borrowing under World Bank and IMF programs. All countries are classified as IDA and benefitted from the Debt Service Suspension Initiative in 2021. Burkina Faso, Chad, Mali, and Niger peg their currencies to the Euro. The Sahel country governments also raise funds domestically and in their respective regional financial markets (West African Economic and Monetary Union (WAEMU) and Central African Economic and Monetary Community (CEMAC)).⁵⁰

This already challenging financing landscape faces increasing headwinds, including political instability in Burkina Faso, Chad, and Mali. There is a debt restructuring in Chad under the G20 Common Framework and Mauritania has embarked on debt restructuring with bilateral partners (Kuwait, Saudi Arabia, and China) to reduce its external risk rating.⁵¹ However, there are several positive factors to build on, including the relatively low inflation environment in the region,⁵² the stable currency (pegged to the Euro),

⁵⁰ Mali has been suspended access to the WAEMU regional market (UMOA-Titres) since January 2022 due to sanctions imposed by ECOWAS.

⁵¹ For Mauritania, an agreement was announced with Saudi Arabia on April 17, 2022, converting a US\$300 million deposit into a concessional loan that will be repaid over a period of 20 years, with a grace period of 8 years and an interest rate of 1 percent.

⁵² However, the region has seen much higher inflation since 2021 due to rising global commodity (especially food and energy) prices and higher inflation from the Eurozone as well as domestic supply-side factors.

the regional financial markets to enable a wider investor base, and the track record of domestic and regional level debt issuances by the Sahel governments. Between 2019 and 2021, public debt increased by 12-13 percentage points of GDP in Burkina Faso, Mali, and Niger, while stabilizing at an unsustainable level of 52 percent of GDP in Chad.⁵³

Grants represent an important source of financing in the G5 Sahel countries, with contributions ranging from 1-2 percent of GDP in Chad, Burkina Faso, Mali, and Mauritania, to 7 percent of GDP in Niger in 2021. In addition, the region already relies heavily on concessional loans as the main external financing source, representing 70-90 percent of the external debt portfolio of the five countries.

1.3.6 Business Environment

Private sector investment is crucial for exploiting the Sahel region's abundant renewable energy and mineral resources, and for developing vital communications and transportation infrastructure and manufacturing.

However, the enabling environment for the sector is weak, with several legal and regulatory bottlenecks. Collateral registries have yet to be computerized, for example, and land registration processes are typically lengthy and cumbersome. An inadequate judiciary system causes long delays and high costs for resolving commercial disputes. For example, according to the World Justice Project's⁵⁴ ranking on the rule of law, Burkina Faso's overall score is 0.5 out of 1, ranking it 75 out of 139 countries, Niger's rank is 111, and Mauritania's is 133. This low performance is due to poor access to civil justice, corruption, lack of an open government, the absence of regulatory enforcement, and low-quality criminal justice. Another indicator, the Property Rights Index,⁵⁵ shows G5 countries rank low on measures of property rights protection, the ease of registering property, and access to loans. For businesses, the proliferation of small taxes, license costs, and other fees raise transaction costs and increase delays (Annex, 2.1.6-7).

1.3.7 Financial Sector

The financial sector in the G5 Sahel countries is dominated by the banking industry. It is profitable, with Return on Equity (ROE) and Return on Assets (ROA) ratios of 14.6 percent and 1.3 percent respectively in 2019. However, the loan portfolio remains highly concentrated. Fifty percent of the loan portfolio is linked to the 50 largest borrowers in the WAEMU region. Climate shocks could have sizeable impacts on the banking industry, especially on non-performing loans (NPLs) and liquidity ratios. Without greater protections from climate risks, banks could be a source of systemic risk that could be transmitted into the real economy.

The financial sectors in the G5 Sahel countries are not prepared for climate change. Currently, there are low levels of diversification. And with the exception of a few banks (namely foreign banks or banking groups), most domestic institutions have yet to include climate change-related risks in their internal risk management processes. That includes the regional authorities (such as the Banque Centrale des États de l'Afrique de l'Ouest (BCEAO) and the Commission Bancaire-UEMOA), which lack a regulatory framework for assessing these risks.⁵⁶

As a result, the whole financial sector is vulnerable to external shocks, including climate change. Problems in the sector then can have ripple effects throughout the economy. In the short term, those effects can include business disruptions, loss of assets, and property damage for industries, businesses, and farmers. Over the longer term, insurers will face increases in underwriting risks, leading to lower insurance coverage in some regions and lower asset values.

53 Debt declined by 5 percentage points of GDP in Mauritania due to debt restructuring.

54 <https://worldjusticeproject.org/rule-of-law-index/country/2021/>

55 <https://www.internationalpropertyrightsindex.org/>

56 BCEAO (Forthcoming). Climate Physical Risks in the WAEMU Banking Sector. A Qualitative Analysis.

More extreme droughts, floods, heatwaves, and other climate change impacts will therefore put tremendous pressure on the financial sector as it exists today. The number of non-performing loans (NPLs) in key sectors like agriculture is likely to rise because borrowers will be less able to repay, and banks will have trouble recovering the full value of loans in the event of defaults. The financial sector also will be negatively affected indirectly if climate change impacts reduce GDP, increase government debt or inflation, or raise interest and exchange rates.

1.3.8 Institutions, Governance, and Citizen Engagement

The G5 Sahel countries are held back by limited institutional capabilities and governance, impeding their development efforts, social contract, and climate change response.⁵⁷ Public resource mobilization, management, and service delivery remain incomplete and uneven in a context of limited transparency and accountability for performance. In the context of climate change, strategic planning and coordination, climate-smart public investment management, public procurement, and public asset management are at early stages. Because of these administrative hold ups, corruption, lack of inclusiveness, and poor resource redistribution, many citizens have little confidence in their governments.⁵⁸ Public policies often ignore and fail to represent marginalized and vulnerable populations. As a result, many people feel aggrieved and abandoned by the State.

The causes and consequences of climate change are intertwined with patterns of inequality, exclusion, and social cohesion issues. While climate change impacts all levels of society, those living in poverty are likely to be impacted the most. At the same time, the effectiveness of policies and measures aimed at addressing these negative impacts and managing the potentially adverse social consequences of climate policy depend on the participation and collaboration of these vulnerable groups. Sound understandings of the role of social intermediaries and the power dynamics at the local level are vital.

Institutional challenges likely amplify negative effects of climate change and reduce the impact of climate policies, exacerbating conflict and fragility. It is important to build capacity and inclusive institutional processes that support local climate action in a conflict-sensitive manner and promote social cohesion. Local communities bring unique perspectives, skills, and knowledge, and should be engaged as partners in resilience-building rather than being regarded merely as beneficiaries. Thus, there is a need to build the awareness and capacities of communities, local institutions, and social intermediaries⁵⁹ to deploy locally-led climate resilience and climate-smart local development.

As the section on conflicts has described, these institutional and governance failures are key drivers of rebellions, coups, and other violent actions, and help to galvanize the formation of non-state actors like self-defense militias. They also undermine countries' ability to tackle climate change. For more information, see Annex, 2.1.4.

1.3.9 Migration and Forced Displacement

In the Sahel countries, the deadly combination of persistent conflicts, high population growth, land degradation, natural resource competition, and natural disasters has already triggered mass movements of people. The violence that began in Mali in 2012, for example, has led to the displacement of more than 4 million people. Millions more have been forced to flee from floods just during the last few years. In

57 G5 Sahel countries' display a relatively low average score of 3.04 on the 2019 CPIA Public Sector Management and Institutions cluster.

58 Sahel Alliance. Governance. <https://www.alliance-sahel.org/en/fields/governance/> <https://www.alliance-sahel.org/en/fields/governance/>

59 World Bank's (2019) "Strengthening Citizen Engagement Capacities of Social Intermediaries in Mali and Niger" study found that as the state's penetration across the countries' territories is weak, non-state actors such as traditional chiefs, religious authorities, and civil society organizations etc. become important social intermediaries playing a significant role in impacting relations between state and citizens and therefore social accountability.

addition, millions of people are moving each year from rural areas to cities in search of economic opportunities or to escape conflicts, such as insurgencies or the tensions between farmers and herders.

These movements of people disrupt communities, harm local economies, and put tremendous stress on locations that house refugee camps or receive large numbers of migrants or displaced people, especially secondary cities, where displaced populations are among the most vulnerable urban dwellers. Migration can be both a cause and an effect of worsening environmental conditions.

Climate change will make this challenge even more daunting by adding an increasingly potent driver of migration. A recent study⁶⁰ estimated that a 1 °C rise in temperature will increase the chances of conflict, and thus migration, by 54 percent in areas with both farmers and herders. Climate change is also likely to fuel migrations from the G5 Sahel countries to Togo, Benin, and other countries to the south. And by 2050, West Africa could see as many as 32 million internal climate migrants (just over 4 percent of the total population).⁶¹ In many of these migrations, women are more likely to be left behind because they often do not own any means of transportation or cannot afford to move. Moreover, when men migrate to urban areas, women become de facto heads of household and are left with the responsibility of ensuring that agricultural activities continue. Solving these problems requires a change in roles and responsibilities within the household and may challenge traditional gender roles within the village. If structures and norms outside the home exclude women from participation in traditionally male roles and spaces, women may be unable to connect to the critical resources or information required to respond to a changing climate.⁶²

1.4 Climate Change Risk and Impacts in the Sahel Region

The Sahel is one of the most climate vulnerable regions in the world and recent publications show the concerning extent of this.^{63, 64} In summary, climate change means that temperatures in the region are increasing, and by the 2050s the annual temperature will have increased by around 1.5-4 °C, compared with the pre-industrial past. The exact amount of this warming depends on the level of global greenhouse gas emissions.⁶⁵ The number of days with temperatures above 35 °C, considered the wet-bulb global temperature upper survivable limit for human beings, will also soar to more than 40 per year by 2050. A consequence of these temperatures will be heat-induced stress and mortality, and the heat will affect the vulnerable, outdoor laborers, and poverty-affected populations the most.

Precipitation is harder to predict, but most models indicate an increase in rainfall variability as well as unpredictable timing, leading to more erratic patterns of precipitation. Already, communities across the region are being threatened by frequent – and often more severe – droughts and floods. Since 2000, an average of 248,000 people per year⁶⁶ have been affected by floods that have damaged homes, roads, and other infrastructure and assets, and disrupted services.⁶⁷ Droughts have been even more harmful. More than 20 million people (90 percent of those affected by natural disasters) suffered through food insecurity or economic hardship between 2016 and 2020. Moreover, in addition to cutting crop yields,

60 Eberle, Ulrich et al. (2020). Heat and Hate, Climate Security and Farmer-Herder Conflicts in Africa (ESOC Working Paper No. 22). Empirical Studies of Conflict Project.

61 World Bank. (2021) Groundswell Report on “Acting on internal migration”.

62 McOmber, C. (2020), "Women and climate change in the Sahel", West African Papers, No. 27, OECD Publishing, Paris. <https://doi.org/10.1787/e31c77ad-en>

63 Holmes, S., Brooks, N., Daoust, G., Osborne, R., Griffith, H., Waterson, A., Fox, C., Buonomo, E., and Jones, R. (2022) Climate risk report for the Sahel region. Met Office, ODI, FCDO. <https://www.metoffice.gov.uk/services/government/international-development/sahel-climate-risk-report>

64 United Nations High Commission for Refugees and Potsdam Institute for Climate Research (PIK).2021. Climate Risk Profile: Sahel. Available at: <https://www.unhcr.org/61a49df44.pdf>.

65 IPCC AR6 Atlas, 2021

66 EM-DAT, CRED / UC Louvain, Brussels, Belgium – www.emdat.be

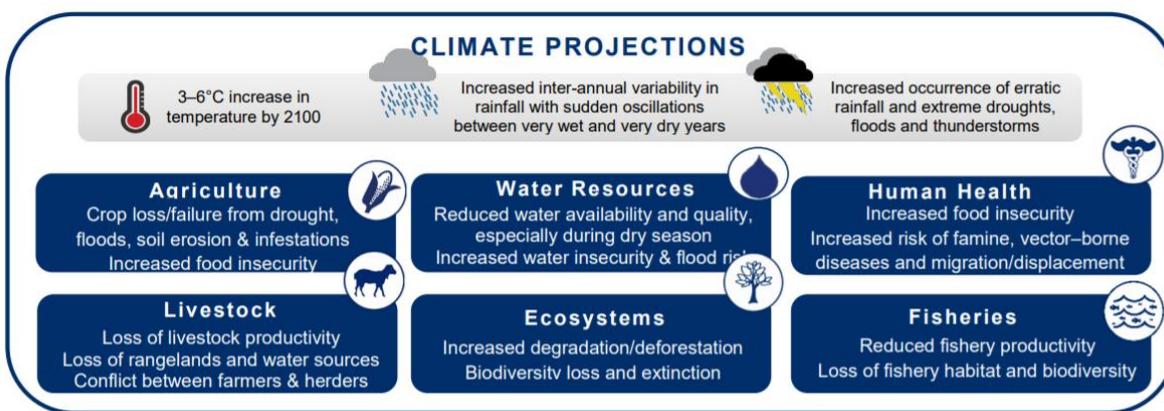
67 Floods are expected to shave off 5-14 percent of GDP in West Africa countries in the coming decade, given low levels of hard infrastructure and weak management capacity. (Source: World Resources Institute, Global Flood Risk: Affected GDP in 2030 due to climate and socioeconomic changes)

droughts have killed up to 20 percent of the trees in the region.⁶⁸ The region is particularly susceptible to land degradation and desertification. Indeed, the Sahel has been identified as being one of the world's tipping points if the global average surface temperature rises by 3 °C above pre-industrial levels.⁶⁹

In Mauritania, the only G5 country with a coastal area, sea levels will rise by 0.3 m by 2050 and erosion and coastal flooding will continue to happen, impacting infrastructure. Coastal fisheries will likely be negatively affected as warming impacts ocean upwellings, changing nutrient patterns and oxygen levels.

The G5 countries are subject to climate risks impacting a variety of resources. As mentioned previously, water resources availability, quality, and infrastructure will be negatively impacted, leading to more social marginalization, impacts on the poor for health, and transboundary tensions (Figure 1.8). Impacts on agriculture, pastoralism, and coastal fisheries have been described above but there will also be impacts on inland fisheries and aquaculture. Increased temperatures, changes in water oxygen levels, and infrastructure needed to cope with climate changes are likely to impact inland fisheries, a significant source of protein for many. Changes in temperature and rainfall will have impacts on the ecology of the countries and their biodiversity. The extinction risk for some species is high, even at a warming level of 1.5 °C; in Burkina Faso, global warming of 3 °C is projected to reduce the area of suitable habitat for the shea tree by 14 percent.⁷⁰

Figure 1.8 Climate projections and related impacts in West Africa Sahel



Source: *Climate Risk Profile: West Africa Sahel, Regional Fact Sheet, USAID, 2017.*

Even though climate modeling and predicting exact impacts are complex, the impacts caused by adopting adaptation measures are even more complex to predict and will need to be carefully considered. For example, building new infrastructure for irrigation or for water retention may help local inhabitants but may affect others downstream; agriculture adaptation strategies may impact the environment; and diversifying economic opportunities such as mining may put additional pressure on water resources.

68 <https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii/>

69 Hoegh-Guldberg, O., D. Jacob, M. Taylor, M. Bindi, S. Brown, I. Camilloni, A. Diedhiou, R. Djalante, K.L. Ebi, F. Engelbrecht, J.Guiot, Y. Hijioka, S. Mehrotra, A. Payne, S.I. Seneviratne, A. Thomas, R. Warren, and G. Zhou, 2018: Impacts of 1.5 °C Global Warming on Natural and Human Systems. In: Global Warming of 1.5 °C. An IPCC Special Report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skeea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I.Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.

70 Dimobe, K., Ouédraogo, A., Ouédraogo, K. and Goetze, D. 2020. https://www.researchgate.net/publication/342502307_Climate_change_reduces_the_distribution_area_of_the_shea_tree_Vitellaria_parda_adoxa_CF_Gaertn_in_Burkina_Faso

As this chapter has already described, the impacts of climate change also have socioeconomic consequences. They threaten livelihoods and productivity, harm health and nutrition, and contribute to violence and conflicts. To cope, households may push more children into early marriages, leading to increased fertility and other negative consequences. Those include increased stunting of children, malnutrition for women and children, lower educational attainment, lower productivity, and additional strains on already overstretched safety nets and institutional capacities. Moreover, the burdens from climate change fall disproportionately on the poor and most vulnerable – women, children, youth, ethnic minorities, nomadic groups, displaced people and migrants, and people with disabilities (including casualties of conflict) – preventing them from accessing the resources and technologies they need to cope with extreme weather events and adapt to climate change. In addition, the poor and vulnerable are the least able to mobilize the finance needed for adaptation measures.

These climate change impacts have been predicted to push an additional 43 million people in Sub-Saharan Africa into poverty by 2030 in the absence of good development,⁷¹ exacerbating the impacts from the COVID-19 pandemic. In Burkina Faso, Mali, and Niger alone, an estimated 20 million people live in areas affected by conflict, and 2.4 million people are in need of food assistance.⁷² Moreover, impacts like drought often force marginalized groups into a variety of negative coping strategies, such as accelerated destruction of trees for fuel, that perpetuate and deepen the cycle of poverty, fragility, and vulnerability. Even relatively small shocks can deplete savings, food stocks, and other assets, hindering the accumulation capacity of households and making it even harder to get out of poverty and to cope with weather and climate change impacts.

Not only is there a high level of uncertainty in climate models' projections of physical climate impacts, it is also difficult to estimate the economic and social impacts of these changes. Chapter 3 presents the results of new impact channel modeling using the latest climate models and country-specific biophysical models that was commissioned for this CCDR to improve estimates of economic damages (including heat stress and impact on agriculture) for the G5 Sahel countries. Beyond the threat of climate change, the Sahel oil- and gas-producing countries (Chad, Mauritania, and Niger) face macro-fiscal risks from a global transition to a low-carbon economy, which is also examined in Chapter 3.

71 Rozenberg, J. and Hallegatte, S. 2015. The Impacts of Climate Change on Poverty in 2030 and the Potential from Rapid, Inclusive, and Climate-Informed Development. Policy Research Working Paper; No. 7483. World Bank, Washington, DC. © World Bank. <https://openknowledge.worldbank.org/handle/10986/23447> License: CC BY 3.0 IGO.

72 World Food Programme 2022. Central Sahel Emergency Dashboard. June 2022. World Food Programme.

2 Climate Commitments, Policies, and Capacities

This chapter is designed to build on the background information given in Chapter 1 by describing the ambition and capacities of the G5 Sahel countries to reduce their greenhouse gas emissions and bolster their resilience to the threats posed by climate change. It also identifies key barriers that must be overcome to make progress towards both climate and development goals.

2.1 Climate Change Commitments

All the G5 Sahel countries submitted Nationally Determined Contributions (NDCs) under the Paris Agreement and updated those NDCs at the COP26 meeting in Glasgow in 2021 (Table 2.1).

The commitments in all five countries cover energy, agriculture, and land use and forestry. All but Niger also cover waste. Burkina Faso's and Chad's commitments include transport, while Burkina Faso and Mauritania also cover industry. Mauritania has made a conditional commitment to reach carbon neutrality if the country receives substantial support from external sources. Burkina Faso also estimates that its proposed adaptation measures will cut emissions, potentially delivering another 31 percent reduction by 2030.

Table 2.1 Summary of mitigation commitments in Sahel NDCs by 2030

Country	Unconditional GHG reduction compared to BAU baseline	Conditional GHG reduction compared to BAU baseline	Total GHG emissions including LULUCF (absolute in Mt CO ₂ eq and % of global GHG emissions) ⁷³
Burkina Faso	20%	29%	55 (0.11%)
Chad	0.5%	19%	105 (0.22%)
Mali	--	31% for energy, 25% agriculture, 39% land use & forestry, 31% waste.	44 (0.09%)
Mauritania	11%	92% (net-zero)	13 (0.03%)
Niger	13% for AFOLU, 11% for energy	23% for AFOLU, 45% for energy	46 (0.1%)

Though the G5 Sahel countries combined contribute less than 1 percent of global GHG emissions, all five countries have pledged to achieve net-zero emissions by 2050. In addition, at COP26, Burkina Faso, Chad, Mali, and Niger pledged to work together, along with more than 100 other countries, to halt and reverse forest loss and land degradation by 2030. They also pledged to achieve development and rural transformations that are both sustainable and inclusive, bringing benefits to all groups and communities. In addition, Burkina Faso and Mali pledged to reduce global methane emissions by at least 30 percent from 2020 levels by 2030, while Mauritania joined more than 40 countries that agreed to phase out coal power.

Adaptation is a top priority in all five countries' NDCs. Their adaptation plans cover a wide range of areas, including agriculture and livestock; conservation of ecosystems, biodiversity and forests; water and sanitation; energy and infrastructure; gender and social protection; land use planning; health; education; and fisheries and aquaculture. Mauritania and Chad have linked their NDC adaptation goals to the development of their National Adaptation Programs. In addition, Niger has prioritized adaptation actions that also reduce carbon emissions and increase carbon sequestration.

⁷³ World Bank DataBank, Country Climate and Development Report.

2.2 Financing Climate Commitments

The CCDR uses the data published by countries in their NDCs, although it is expected that NDC data will be refined by the G5 countries as they embark on future reporting. The costs of implementing the adaptation and mitigation NDC commitments in the G5 countries are high (Table 2.2). The estimated total cost of NDC adaptation investments, to be financed by both public and external sources by 2030, is US\$33 billion, about 44 percent of their combined 2021 GDP. The projected costs vary across countries, ranging from US\$2.8 billion for Burkina Faso to US\$10.6 billion for Mauritania. Estimates of the total financing needed to meet all mitigation commitments under the current NDCs range from US\$1.3 billion in Burkina Faso to US\$34.3 billion in Mauritania. For the G5, the total mitigation finance gap is close to US\$50 billion. However, the G5 could start by investing in systems that would help them achieve and verify NDC mitigation ambitions.

Table 2.2 Estimates of investments needed for mitigation and adaption based on G5 NDCs

Sahel Country	Est. Mitigation NDC Investment (US\$ bn by 2030)	Est. Adaptation NDC Investment (US\$ bn by 2030)	Total NDC Investment Est. (US\$ bn by 2030)	Average annual NDC Investment as % of 2021 GDP	Average annual NDC Investment as % of 2021 total capex
Burkina Faso	1.34	2.79	4.12	2.2	31.6
Chad	6.70	5.00	11.70	12.2	181.4
Mali	4.34	8.00	12.34	7.4	110.7
Mauritania	34.26	10.63	44.88	54.2	704.2
Niger	3.17	6.74	9.91	7.7	61.1
Total	49.80	33.16	82.96	N.A	N.A

Although NDC reporting is managed by ministries in charge of environment or climate, it is important that the ministries in charge of budgeting and planning become more involved in NDC implementation, reporting, and refining of data.

As part of the CCDR, a set of growth and development scenarios for the G5 Sahel countries was developed to analyze the economic and poverty impacts of climate-related shocks, and the fiscal and financial capacity to adapt (Chapter 3). Under all growth scenarios, the NDC needs of each of the G5 are above the country's means. Annual adaptation costs will on average account for 4.6 percent of a country's GDP under the medium-growth scenario (Table 2.3) and 4.3 percent under a higher-growth scenario.⁷⁴ Furthermore, for the medium-growth scenario, NDC adaptation investments (if financed through public resources) would absorb between 69 percent of annual tax revenues (Mauritania) to 8 percent in Burkina Faso (Table 2.3). Even under the higher-growth scenario, with higher national budgets,⁷⁵ the NDC adaptation investments would still absorb large shares of annual tax revenues,⁷⁶ ranging on average from 18 percent of public investments in Niger to 116 percent of public investments in Mauritania between 2023 and 2030.

⁷⁴ Medium-growth and higher-growth scenarios are described in Chapter 3.

⁷⁵ Compared to the medium-growth scenario given the larger size of the economies and strengthened domestic revenue mobilization. Public revenues expected to stabilize by 2030 at around 16-17 percent of GDP in Burkina Faso, Mali, and Mauritania, 14 percent in Niger, and 10 percent in Chad in the higher-growth scenario.

⁷⁶ Higher-growth scenario: Mauritania (~64 percent), Chad (~42 percent), Niger (~27 percent) or Mali (~22 percent).

Table 2.3 Example of NDC adaptation financing needs for the G5 Sahel countries*Based on a medium-growth scenario, as a percentage of GDP*

	2023	2024	2025	2026	2027	2028	2029	2030	Average
Burkina Faso	1.6	1.5	1.4	1.3	1.2	1.1	1.0	0.9	1.2
Chad	4.7	4.5	4.2	3.8	3.6	3.3	3.0	2.8	3.7
Mali	4.6	4.3	3.9	3.6	3.3	3.0	2.7	2.5	3.5
Mauritania	13.2	12.3	11.3	10.3	9.4	8.6	7.8	7.2	10.0
Niger	4.9	4.3	3.9	3.6	3.3	3.0	2.7	2.5	3.5

Based on a medium-growth scenario, as a percentage of tax revenues

	2023	2024	2025	2026	2027	2028	2029	2030	Average
Burkina Faso	10.8	9.8	9.0	8.2	7.5	6.8	6.2	5.7	8.0
Chad	59.4	53.1	49.8	46.8	44.0	41.3	38.8	36.4	46.2
Mali	30.6	28.3	26.3	24.5	22.8	21.3	19.8	18.4	24.0
Mauritania	89.1	81.0	75.7	70.7	66.0	61.6	57.5	53.7	69.4
Niger	41.9	34.1	31.7	29.4	27.2	25.3	23.4	21.7	29.4

Source: G5 Sahel Country NDCs, G5 Sahel CC-MFMOD, World Bank Staff analysis

As the G5 Sahel countries have noted in their NDCs, their current financial situation increases the need for external grants and new concessional borrowing and private sector financing to meet their conditional adaptation commitments. Necessary investments include grants to strengthen adaptation for the most vulnerable and more support for the private sector, which has limited ability to invest in adaptation in both the low- and medium-growth scenarios. Although significant finance is needed for adaptation, this often coincides with development needs.

2.3 NDCs are Often Linked to Development Plans

Most of the Sahel countries see close connections between their climate plans and their development policies. For example, Mauritania's NDC is intended to guide the implementation of the country's climate policy alongside its strategic development vision for the period 2016-2030, which also incorporates the UN Agenda 2030 and the African Union's Agenda 2063. Niger has included adaptation actions in its existing strategic frameworks, such as the Economic and Social Development Plan (2012-2015 and 2016-2020).⁷⁷ Chad's NDC is aligned with key objectives of the country's "2030 vision of Chad": improving living conditions, reducing social inequalities, and preserving natural resources.⁷⁸ Mali is integrating climate change into its policies and planning processes, notably in the implementation of sector strategies and Mali Vision 2040, the Strategic Framework for Economic Recovery and Sustainable Development, its National Environmental Protection Policy, and since 2011, in the National Policy on Climate Change.

⁷⁷ Niger's Economic and Social Development Plan flows from the Sustainable Development and Inclusive Growth Strategy - Niger 2035; the 3N Initiative (Nigeriens Feed Nigeriens); the National Policy on Climate Change; the Strategic Framework for Sustainable Land Management; and the National Strategy and Plan of Action for Climate Change and Variability. Other documents include reference to climate action including the National Strategy and Action Plan for Disaster Risk Reduction and the Environment and Sustainable Development Policy.

⁷⁸ Other frameworks that will facilitate the implementation of this vision include: the National Investment Plan for the rural sector in Chad (2016-2022), the National Strategy to Combat Climate Change (2017), the National Environment Policy (2017), and the Master Plan for the Development of Renewable Energies in Chad (2018).

All five Sahel countries recognize the need for capacity building to achieve their NDCs. There are significant gaps in the collection and processing of data needed to report and implement climate policies and measures, for example. Filling those gaps will require establishing effective measuring, reporting, and verification systems. Most Sahel countries also see the need to mobilize significant resources for climate finance. Possible steps include improving the regulatory environment for private sector investment, strengthening national financial systems, and developing innovative financing options, such as new tax revenues. It will also be necessary to transfer knowledge and technology in areas such as the design of bankable projects and the understanding of donors' rules and procedures; the economic and financial evaluation of adaptation projects; the NDC implementation process; environmental and social impact assessments; and land use planning.

2.4 Existing Policies and Institutions for Resilience and Risk Management

2.4.1 Disaster and Climate Risk Management

The G5 Sahel countries face significant challenges in their policies to address disaster risk management (DRM), disaster risk finance (DRF), and disaster risk reduction (DRR). These are mainly due to challenges related to coordination, financing and capacities for implementation. Burkina Faso has a national platform responsible for the coordination of emergency response and recovery in the country after a disaster, and a separate agency to address climate change impacts; however, there is little coordination or functional relationship between them. In Chad, policy documents may acknowledge or reference natural disasters and climate change, but often only as a challenge or constraint, and mainstreaming climate resilience and mitigation is often lacking in sectoral policies and plans.

Mali has developed a National Strategy for Disaster Risk Reduction aimed at strengthening institutional mechanisms for DRM and DRR and boosting financing for DRR; however, the country has struggled with implementation. In contrast, Mauritania does not have a legal or formal framework for DRR, and its DRM institutions and laws focus mainly on emergency management, especially in food crisis situations. In 2009, Mauritania developed a DRM strategy with support from the UNDP, but it has yet to incorporate other DRR programs that have been approved.

Niger has developed a DRM framework that spreads DRM functions among various institutions. However, the country does not have a DRM law. As a result, institutional mandates often overlap and actions are frequently limited by human and financial resources. Niger and Burkina Faso are implementing a disaster risk finance diagnostic to assess the economic and fiscal impact of disasters. It takes stock of existing risk finance instruments and the legal and institutional framework governing DRF, reviews relevant aspects of insurance markets, and identifies potential funding gaps following disasters. This DRF diagnostic is the foundation for a future DRF strategy.

The Sahel countries' environmental and social impact assessment regulations do not adequately cover climate and disaster risks, climate resilience, or the social dimensions of climate change. They sometimes touch upon specific disasters and risks related to pollution and nuisance issues. However, there are no requirements to consider climate and (natural) disaster risks as well as climate resilience in environmental impact assessments. In addition, in some cases (such as in Mauritania), the legal frameworks do not include either social impact assessments or strategic environmental assessments. It means that the overall systems in the region for climate and disaster risk assessment and climate resilience are inoperative and therefore very inefficient. This is a critical issue in countries that are among the world's most vulnerable to climate change. Moreover, even if this regulatory vacuum did not exist, the G5 countries lack the financial and technical capacities to implement such regulations.

Similarly, the countries' technical and data capabilities for predicting future climate impacts are scarce and limited. However, some advances have been made on early warning systems. Chad warns people of coming droughts and other potential climate-related natural disasters, helping to guide planting periods and reduce food insecurity. Mauritania is part of a regional program to better predict droughts, also to improve food security. At the regional level, countries have agreed to collaborate more closely on

hydrological and meteorological (hydro-met) policies and capacity development. Stronger regional cooperation is promoted by the Climate Commission for the Sahel Region and others. Recently, ECOWAS published a climate strategy to strengthen coordination on climate action for its member countries.⁷⁹

2.4.2 Urban Planning and Land Governance

Urban planning has yet to be significantly integrated with climate change considerations in the Sahel countries. Burkina Faso has a National Housing and Urban Development Policy, which requires urban and rural municipalities to develop urban planning tools, including land use plans. The policy does not explicitly highlight the issue of DRR; however, there are several policies aiming to increase urban resilience to the impacts of climate change.

Chad has no official climate action or disaster risk plans for its largest city, N'Djamena. While construction standards do take some climate risks into account (such as in permits for protected areas, rules on water and sanitation, and fire codes), implementing the standards has been difficult due to uncontrolled migration and the self-construction of homes that do not always follow regulations. Since 2017, Niger has had a legal framework guiding the urbanization process that puts areas highly exposed to flooding off-limits to construction – or “non edificant”. Cities also have Municipal Development Plans to guide infrastructure investments over a period of 5 years. However, these policies have been difficult to enforce given limited resources, resulting in uncontrolled urban growth in highly exposed areas.

Another set of challenges arise from legal uncertainties surrounding land ownership and governance. Many landowners do not have titles or deeds for their properties, making it more difficult to tax properties, enforce property rights, or settle land disputes. The Niger Government, for example, has been working to revise land tenure rules and laws since 1986, but has not yet succeeded in creating clear property rights and increasing land tenure security. Across the region, certain groups of people, especially women, displaced persons, and migrants, have particularly limited access to land.

2.4.3 Water Management

The G5 Sahel countries have made some progress in water management. Niger adopted its Integrated Water Resource Management (IWRM) program in May 2017, in compliance with the Niger River Basin Sustainable Development Action Plan. It aims to support the systematic and climate-informed planning of all water-related activities and investments at the municipal level. A similar action was taken by the Government of Mali, through its National Program for IWRM 2019-30, to implement the National Water Policy. Burkina Faso also has a National Program for IWRM in its National Water Strategy and has adopted an updated action plan for 2021-25. At the regional level, the Niger River Basin Organization presented a Climate Resilience Investment Plan at COP21 in Paris and has succeeded in partially funding the US\$3.1 billion plan. Similarly, the Senegal River Basin Organization is updating its Master Plan to better consider changing climate and socioeconomic conditions.

2.4.4 Financial and Social Protection Mechanisms for Climate Risks

A number of financial protection mechanisms can reduce the economic toll of natural disasters on households, farmers, and businesses. These mechanisms include scalable safety nets and risk transfer instruments such as insurance or national disaster funds.

However, only a few countries in the region have strengthened their financial responses to natural disasters (mostly droughts). The financing mechanisms that do exist (both government-led and donor-funded) are not consistently funded, nor do countries currently have coherent DRF strategies to manage the financial impacts of natural disasters. Here is a summary of some of the financing in each country:

79 ECOWAS Regional Climate Strategy, <https://ecowas.int/?p=54976>

- Mali has established a dedicated fund within the national budget to address both climate change adaptation and mitigation. Only a small portion (about US\$84,000) of this National Agricultural Support Fund is set aside for responding to disasters.
- Mauritania addresses disasters with a budget reserve, budgetary advances, a Natural Disaster Fund, and the National Humanitarian Action Fund. However, these instruments suffer from implementation issues and are rarely used. For example, the budget reserve is not dedicated for post-disaster responses, allowing its resources to be allocated to other activities.
- Burkina Faso and Mauritania have each established a national Environmental Intervention Fund to mobilize additional national financing, as well as additional external funds. Those funds can be used for responding to natural and industrial catastrophes, for the sustainable management of natural resources, for mitigating and adapting to climate change, and for combatting environmental degradation.
- Burkina Faso's *Fonds National de Solidarité* uses an annual budget of about US\$750,000 to help disadvantaged individuals and groups, groups in difficulty, and victims of natural disasters and humanitarian crises. The fund is financed through the national budget.
- Chad has developed a Special Environmental Fund, paid for with specific environmental taxes.
- Niger has investment plans and strategies (such as the National Climate Change Adaptation Strategy and Plan and the National Adaptation Plan) for coping with extreme weather events and helping vulnerable communities adapt to climate variability and change. The country also operates a large central relief fund financed by donors (about US\$15 million annually) used to improve food security.

The potential for agricultural insurance to improve resilience is largely untapped. There are a few operating agricultural insurance schemes, such as the Assurance Récolte au Sahel initiatives in Burkina Faso and Mali. In addition, Burkina Faso launched a National Agriculture Insurance Pilot Program in 2020. However, none of these initiatives have reached scale yet. And while conventional insurance may be available in other countries, it is available only to the largest and most sophisticated producers, and only for the protection of large farm assets like machinery and infrastructure from common perils such as fire and theft. As a result, the overwhelming majority of agricultural holdings have no insurance protection against climate hazards. However, a feasibility study on using index-based drought risk insurance for pastoralists in the Sahel (Senegal, Mali, Burkina, and Niger) will be finished in 2022.

Another step forward has been the purchase of coverage by the five Sahel countries from the regional insurer African Risk Capacity (ARC). The insurance only covers emergency relief efforts, however, which are a fraction of the total direct economic losses, and participation by countries has been inconsistent across the years (Table 2.4).

Table 2.4 Agricultural risk finance

Country	Agricultural season						Maximum cover 2019/20 (US\$ million)	Payout (US\$ million)
	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20		
Burkina Faso			x	x	x			
Chad						x	1.2	
Mali		x	x	x		x	15.0	
Niger	x	x	x			x	5.3	3.5 (2015)

Source: F.Lung; C.Stefan; R.Iturriz. 2021. *Agriculture risk finance in West Africa a study commissioned by World Bank.*

At the household level, there are typically few resources to draw on in the event of a shock. Households' coping strategies, such as reduced food consumption or reduced access to education and health care, can harm their long-term productivity and economic prospects. In hard times, for example, poor people are often forced to sell livestock or deplete any savings they might have. They may also be forced to eat less (with less nutritious food) and cut back on health care and educating their children. All these strategies will dim families' prospects – sometimes with negative consequences for subsequent generations as well.

To address these problems and build resilience, Sahel countries have developed Adaptive Social Protection (ASP) systems. Through the provision of regular cash transfers and services to the poorest and most vulnerable households, adaptive social protection directly supports their capacity to prepare for, cope with, and adapt to climate-related shocks. ASP systems include multi-year cash transfer programs with productive inclusion measures that have proved effective in promoting more productive and resilient livelihoods. These empower beneficiaries to diversify their assets and livelihoods and reduce their exposure and vulnerability to shocks. Niger automatically dispenses cash immediately after a drought; for example, the Government used satellite data to identify drought-affected areas and provide 15,000 households with cash transfers.

Box 2.1 Stress testing social protection systems

A Stress Test Tool has been developed by the World Bank to assess the adaptiveness of social protection systems to respond to climate shocks. The adaptiveness depends on how well a country is doing on each of the building blocks of a social protection system (details in Annex, 2.1.15). The G5 Sahel are generally nascent in their progress in establishing building blocks of social protection systems and shock-responsive functions. Niger, Mauritania, and Mali relied on ASP systems to protect poor and vulnerable households from the economic impact of the COVID-19 crisis. The stress test assessment also highlighted areas which need further work and funding, such as increasing coverage of social protection programs and social registries, strengthening grievance and redress mechanisms, and improving coordination between social protection and emergency or disaster management actors.

Preliminary results of the G5 Sahel (and Senegal) stress test

	Latent	Nascent	Emerging	Established	Advanced
Gov leadership and Inst. arrangements		Burkina Chad Mali Mauritania Niger	Senegal		
Finance	Chad Senegal	Burkina Mali	Mauritania Niger		
Data and Information		Burkina Chad Mali Niger	Mauritania Senegal		
Programs and delivery systems		Burkina Chad Mali Niger	Mauritania Senegal		

2.4.5 Barriers to Action on Climate Resilience

The barriers to action on climate resilience and disaster risk management and reduction include:

- Literacy and the ability to adapt or mitigate climate shocks. Education, awareness, and skills are key to comprehend actions and consequences and have the ability to mitigate adverse shocks. Yet in the G5 Sahel, only 12 percent of children are enrolled in school and can read and comprehend an age-appropriate passage by the end of primary school. In every G5 country, fewer than 50 percent of adult females are literate, compared with 59 percent in Sub-Saharan Africa.
- Inadequate finances and budgets. In Chad, for example, the national annual budget for the environment (including climate change) is only 0.8 percent of the total budget.
- No dedicated and specialized national entities for data collection and archiving. Scientific data are mainly produced during one-off collections for projects or programs, or information comes from development partners. The data then remain dispersed at the national level.
- Lack of cross-sectoral coordination and technical capacities. Ministries in charge of the environment have very limited power to promote climate or environment mainstreaming in national and sectoral policies.
- Challenges of establishing effective public weather services make it difficult to support local and national decision-making with climate information.
- Weaknesses in current environmental and climate regulations. The absence of climate issues in national regulations is striking given the level of vulnerabilities to climate change. However, Mauritania and Chad are updating their regulations to include climate change considerations.
- Failure to include climate change and green technologies in national strategies and plans. That's particularly a problem in sectors such as energy, water, sanitation (including waste management), agriculture, transport, health, and education.
- Lack of local engagement. It is difficult for local communities to participate in decisions about natural resource management, climate adaptation, or disaster risk management, making it hard to leverage local knowledge and build community ownership for climate-smart solutions.

2.5 Existing Policies for Decarbonization

In the G5 Sahel countries, commitments on decarbonization actions are primarily laid out through their NDCs. All five Sahel countries have low-carbon economic growth strategies with a strong focus on developing their renewable energy potentials, and all have specific renewable energy targets. Burkina Faso aims to double the share of renewable energy in its energy production mix by 2030. Chad intends to increase its renewable electricity supply from 0 to 750 GWh per year. Mali has a goal of reducing GHG emissions in its energy sector by 31 percent. Mauritania plans to increase renewable energy to 50 percent of the energy mix by 2030. Niger has a target of 30 percent of renewable energy by 2030.

In addition to setting these targets, governments in the Sahel are committed to improving energy access. Targets include doubling access in Burkina Faso by 2023, achieving universal access in Mali and Mauritania by 2030, and reaching 80 percent of the population in Niger by 2035. The World Bank Group works through IDA, IFC, and MIGA to support the Sahel countries. So far, about US\$2.5 billion has been mobilized by IDA, with a pipeline of about US\$1.4 billion.

All five countries also are updating their least-cost power development plans, with a goal of completing them in 2022. Capacity constraints remain, however. For example, Burkina Faso's Electricity Law of 2017 was intended to create a competitive wholesale electricity market. However, the country's Ministry of Energy does not have the planning capacity to implement the law cost-effectively. This has hampered efforts to import solar panels and develop grid-connected solar PV plants. In Mauritania, renewable energy has been developed mostly on an ad hoc basis, despite the country's potential for solar power. Similarly, private-financed solar projects in Mali have been bilateral and unsolicited, causing Mali to buy the generated electricity at high prices.

Countries have also often failed to properly consider lower-cost regional supply options, leading to continued reliance on high-cost oil-fired generation. For instance, Niger liberalized its power sector in the 2016 Electricity Act, which ended the state-owned company's monopoly. Although the new institutional framework opened the sector to Independent Power Producers (IPPs), a lack of short- and long-term planning has hampered the development of renewable energy projects.

Finally, resilience and climate risks are largely absent in sector planning, even though climate change will greatly affect power system assets and could harm the availability of hydropower resources.

As the result of these issues and others, energy tariffs are high in Sahel countries – yet still fall short of covering generation and operational costs. In Burkina Faso, the average 2018 electricity tariff of US\$0.22 per kilowatt-hour falls well short of covering fuel costs, making the utility reliant on fuel subsidies. In Mauritania, both the on-grid and off-grid markets in the country are subsidized and do not allow the state to recover operating costs, contributing to the utility's high deficits. In Mali, the utility required a subsidy of US\$120 million in 2021. The large subsidies for fossil fuels are one of the biggest limitations to renewable energy development, making renewable energy seem more expensive than it actually is.

Some Sahel countries are beginning to tackle these problems. Mauritania is currently working with the International Renewable Energy Agency (IRENA) to restructure subsidies to allow installations of renewable energy systems. It is also revising its electricity code to promote consumption and production of renewable energy. Other countries are providing incentives for low-carbon technologies, such as exemptions for VAT and custom duties on imports of renewable energy equipment in Burkina Faso, Mali, and Niger.

Another barrier to renewable energy development in the Sahel is the lack of an enabling environment for private sector participation. As a result, IPPs represent only 19 percent of installed capacity. Reasons include existing power purchase agreements dominated by fossil energy, inadequate regulatory frameworks, lack of proper planning, security concerns, and lack of affordable financing. Countries are updating their policy, legal, and regulatory frameworks to take into account new developments in the sector and attract private investments. For example, with IDA support, Mali is revising its national energy policy, strategy, and law.

Finally, the Sahel countries have yet to take full advantage of regional integration (Annex, 2.1.1), which can increase reliability, lower costs, and allow greater penetration of variable renewable energy. Once interconnectors in West Africa are built, the G5 Sahel could use their large solar resources to export solar energy.

2.6 Institutional and Financial Challenges to Achieving Socioeconomic Transitions and Adapting to Climate Change Impacts

With undiversified economies dominated by agriculture, Sahel countries face significant challenges in reallocating resources to respond and adapt to shocks. They also have limited fiscal resources for investing in adaptation. In addition, they lack strong and accountable public finance and investment management systems (PFM/PIM), along with public procurement systems, which are needed to effectively deploy the considerable climate finance now being mobilized.

Another constraint is the lack of data capabilities to perform quantitative climate risk assessments and portfolio exposures of the financial sector to climate change risks. That's why the West African Economic and Monetary Union (WAEMU) Financial Sector Assessment Program (FSAP), conducted jointly by the IMF and the WB, has begun to conduct a qualitative analysis of climate risks for the financial sector (Box 2.2).⁸⁰ And though the Central Bank of West African States (BCEAO) joined the international initiative

80 World Bank Group. Forthcoming. Climate Physical Risks in the WAEMU Banking Sector: A Qualitative Analysis.

Network for Greening the Financial System (NGFS), the incorporation of climate and environment risks into supervisory practices is not effective. Further important steps will be mainstreaming climate and environmental risks into all decisions and using green bonds to finance countries' NDCs.

Box 2.2 Main climate-related risk scenarios in the WAEMU banking sector

Climate-related impacts can pose significant financial risks. The WAEMU FSAP climate risk module focused on the risks from extreme catastrophe events that could affect the banking and financial sector by 2050. In one scenario – an extreme, prolonged regional drought – Mali, Niger, and Burkina Faso would be the most severely affected, with 12 percent of regional credit portfolio at risk. In a second scenario – a sustained heatwave – 9 percent of domestic credit in Burkina Faso and 3 percent of regional credit would be at risk. Finally, in an extreme regional flood scenario, Mali, Burkina, and Niger would be the most affected, with 0.2 percent of regional credit (and up to 1 percent in Niger) at risk.

3 The Macroeconomic and Poverty Impact of Climate Change

This Chapter first summarizes recent economic developments and reinforces the case for accelerating and sustaining growth in the Sahel in the context of climate change. It then presents new modeling that has been conducted for the CCDR for each of the G5 Sahel countries to estimate the economic impacts of climate change through different channels (rainfed crop and livestock yields, heat stress and human health impacts on labor productivity, inland flooding, and damage to roads and bridges) under selected climate scenarios and different growth scenarios. Then, micro-simulations are done to assess the poverty and distributional impacts. Finally, the chapter analyzes the investment costs and the economic benefits (in terms of reduced GDP losses) of selected climate adaptation actions.

3.1 Recent Growth and Poverty Developments and Challenges in the Sahel

The recent growth performance of the region has been weak and volatile due to a combination of the lack of structural transformation, political instability and insecurity, COVID-19, and climate-related shocks.

While real annual GDP growth during 2010-2019 averaged a robust 4.9 percent across the region,⁸¹ the Sahel countries saw lower growth or recessions in 2020-2021 with economic recovery in 2022 subject to significant downside risks. With some of the highest fertility and population growth rates in the world,⁸² annual GDP per capita growth has been limited – and in some years negative – and not sufficient to significantly reduce the high poverty rates. The international extreme poverty rate (US\$1.9 per day per capita, 2011 PPP) in 2021 is estimated to be 5.8 percent in Mauritania,⁸³ 17.6 percent in Mali, 30.8 percent in Burkina Faso, 37.8 percent in Chad, and 41.8 percent in Niger.

The challenge of sustaining economic growth in the context of climate change is currently illustrated with the sharp increase in food prices and food insecurity. In Niger, a drought in September 2021, combined with crop infestations and increasing insecurity, caused annual cereal production to drop by 38 percent, leading to a decline in per capita growth from 3.6 percent in 2020 to 1.4 percent in 2021 and leaving more than 2.5 million people in a situation of food insecurity. The Sahel region has been facing elevated food price inflation since 2021 caused by lower-than-expected domestic agricultural production linked to climatic events (droughts and floods) and rising insecurity, which has further disrupted domestic food production and regional food trade.⁸⁴ For example, in Burkina Faso, inflation reached 3.9 percent – a 10-year high – in 2021, fueled by food prices (which increased 14.7 percent, driven by an increase of 40 percent in sorghum and millet prices). Millions of people are at risk of or already experiencing food insecurity and the situation is projected to further deteriorate in 2022 across the region. Importing food in response to domestic production shocks is especially challenging given high global food prices, which have further risen due to the Russia-Ukraine war.

Climate change has made the existing growth and poverty reduction agenda even more urgent as the ability to adapt is a matter of income and development. The richer a country is, the more resources the government, firms, and households will have to invest in adaptation interventions and to cope with adverse climate-related shocks. The Sahel region, for example, has low levels of national safety net systems, except in Mauritania. A country that has undergone more structural transformation will be more resilient to climate shocks as agriculture production is more affected by droughts, floods, and extreme

81 6% Burkina Faso, 3.4% Chad, 4.4% Mali, 4.2% Mauritania, 6.2% Niger.

82 2.8% in Mauritania, 2.9% in Burkina Faso, 2.9% Mali, 3.3% in Chad, to 3.8% in Niger.

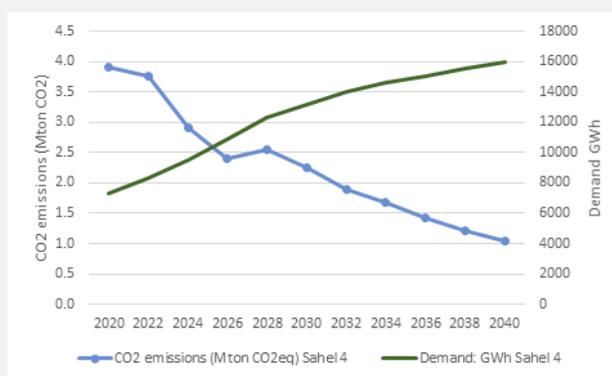
83 Mauritania has a lower middle-income poverty rate (US\$3.2, 2011 PPP) of 23.8 percent.

84 In Mali's case, the FAO projects that despite favorable weather conditions, rice production will decline by 15 percent in 2021 due to growing insecurity in rice producing regions, notably Mopti and Segou.

heat than other sectors. For the Sahel region, there is less concern that higher growth and development will increase emissions. In fact, there is an opportunity to reduce emissions in the energy sector while meeting increased demands of a larger economy (Box 3.1 below and Annex 2.1.1).

Box 3.1 Even under a high growth scenario, power sector emissions could follow a downward path

Even if Sahel countries' energy demand were to grow substantially faster as a result of high growth, emissions from the power sector in the region are likely to remain low. As Sahel countries are endowed with exceptional renewable energy resources, if they were to follow a least-cost development pathway to expand their power sectors, emissions could follow a downward path. Mauritania has one of the best onshore and offshore wind resources in the world, while Mali, Niger, and Chad also have excellent wind resources. All Sahel countries have an exceptional PV resource. In addition, increased regional integration will allow Sahel countries to benefit from the large hydropower resource of the Western part of the continent.



Source: World Bank analysis, National least cost development plans and WAPP Master plan. Note: Aggregated power demand forecast for Sahel 4 from is based on a medium-high to high growth scenarios.

3.2 Modeling the Impact of Climate Change on Growth and Poverty

3.2.1 Modeling Approach

The macro-modeling focuses on analyzing the economic and poverty impact of climate change and adaptation policies rather than modeling mitigation policies, because of the severity of the climate impacts on the region. The Sahel countries are among the most vulnerable in the world to climate change. Climate disasters, in particular floods, droughts, extreme heat, and epidemic events, occur frequently and affect a significant and growing share of the population and economic activities, in particular in the agriculture and livestock sectors. See Annex, Figure 1-3. To capture country-specific dynamics, each of the G5 Sahel countries were modeled separately but use a common modeling approach to allow comparisons and aggregations (Box 3.2).

Box 3.2 Summary of the common modeling approach taken for each of the G5 Sahel

1. **Macro-structural modeling was done for each of the G5 Sahel countries using a country-specific Climate Change Macro-Fiscal Model (CC-MFMod).** The CC-MFMod is the extended version of the MFMod – the macro-structural model already used to do core macro-modeling for each of the G5 countries. CC-MFMod was used to model the linkages between damages caused by climate change, climate adaptation, and macroeconomic aggregates. A CC-MFMod has been developed for each of the G5 Sahel countries to:
 - Model the three long-term growth scenarios (low, medium, and higher) to derive “baselines” up to 2050. The baselines assume no additional climate change impacts beyond what has already been

experienced up to 2020 and are used to compare with the outcomes from climate change-related shocks and policies.

- Model the impact of climate change-related shocks on the economy and macroeconomic aggregates (GDP, real sector, fiscal sector, external sector) in each of the growth scenarios up to 2050.
- Model selected adaptation measures in terms of reduced damages and increased investments.
- Model the impact of higher investments involved in decarbonizing the energy sector.

2. **Modeling to produce country-specific estimates of economic damages from climate change as inputs into the CC-MFMod.** The impact channels modeling used country-specific climate scenarios and biophysical effects to estimate economic damages. A set of six impact channels was selected based on relevance to the countries and feasibility. The modeling involved four stages: (i) selecting climate scenarios; (ii) collecting additional data required for the analyses; (iii) selecting and adapting a set of biophysical models for each of the six impact channels to the conditions of the G5 Sahel; and (iv) applying the 6 climate scenarios to the biophysical models for each impact channel to produce the set of annual shocks for the projection period 2021 to 2050 as inputs into each of the five CC-MFMods to produce “Climate change with no adaptation” scenarios.

Impact channels

#	Channel of Impact	Description of the economic shock
1	Rainfed crop yields	Agricultural productivity shocks. Impact on annual crop yields, based on crop yield responses to changes in temperature and precipitation.
2	Heat stress and labor productivity	Labor productivity shocks. Impact on labor productivity due to heat stress on outdoor work in the agriculture, industry, and service sectors.
3	Heat-related human health shocks	Health shocks on labor productivity. Impact on total labor productivity from health shocks due to temperature changes.
4	Livestock yields	Livestock productivity shocks. Impact due to heat stress on animals and reduced availability of pastures to graze due to temperature and precipitation changes.
5	Inland flooding	Capital damages due to precipitation changes, considering floodplains, design flood events, spatial distribution of capital, and run-off dynamics.
6	Roads and bridges	Capital damages to road and bridges infrastructure due to temperature and precipitation changes, and flooding effects across paved, gravel, and dirt roads.

3. **The poverty and distributional impacts of climate change-related shocks were assessed** by using the CC-MFMod outputs to do micro-simulations using the latest living standards or household data.
4. **Modeling of potential adaptation measures for selected impact channels.** Adaptation measures for three impact channels were modeled to assess benefits – in terms of reduced negative annual shocks – and costs in terms of annual capital expenditures (capex) and operating expenses (opex). These were then used as inputs into each of the five CC-MFMods to generate “Climate change with partial adaptation” results.

Adaptation Interventions

#	Channel of Impact	Description of the adaptation intervention
1	Rainfed crop yields	Expanded irrigation. Rehabilitation and construction of new irrigation for high-value crops and food crops to counter the impact of reduced water availability.
4	Livestock yields	Two interventions to compensate for the productivity losses of pastures: (i) Purchasing crop residues from in-country crop production to use as animal feed; and (2) Investment in establishing fodder banks.
6	Roads and bridges	Investments into climate resilient roads and bridges network.

The modeling has been undertaken with uncertainties about future climate outcomes, technologies, policies, and development paths. It quantifies results using a large set of assumptions in order to help assess the challenges and trade-offs. However, the answers are not definitive and specific numbers should be used cautiously. The key modeling caveats and limitations are summarized below. Together they are likely to result in an underestimation of the magnitude of economic losses from climate change.

Caveats for economic loss or damage estimates

- *Missing channels and pathways:* There are a large number of potential impact channels; however, for this report only six channels have been modeled, so estimates of GDP impacts are not comprehensive. Some important channels are difficult to model, for example, the impact of climate change on nutrition and educational attainment, which have life-long consequences for individuals' health, learning, productivity, and earnings. Moreover, as a regional report, some impact channels have not been included, such as sea level rise and storm surge which are only relevant to Mauritania. Even within a specific impact channel, while the modeling attempts to capture the main pathways in which climate stressors could have an impact, there are likely to be some pathways not captured. For example, under the hotter and wetter climate scenarios, the livestock yield channel captures better food and water availability but does not reflect the possibility that this climate scenario may increase the prevalence of livestock disease, which would negatively impact livestock yields.
- *Magnifying effects:* The macroeconomic modeling stops at 2050 and does not include potential magnifying factors in the region such as intensified conflicts over resources (for example, water), the possibility of ecosystem collapse, and the acceleration of climate-induced outmigration. The risks of these magnifying factors being realized are considerable, especially past 2050 if global emissions do not drop rapidly. They would make total GDP and poverty impacts much larger than what is estimated in this report.
- *Not fully capturing the positive effect of inclusive development on reducing the impacts of climate change:* The modeling only captures the positive effect from structural change with the agriculture sector becoming a smaller share of GDP in the higher-growth scenarios. It does not account for how higher incomes, better access to infrastructure (such as power for fans, improved water and sanitation, and improved access to health care) and financial support (such as access to finance and insurance, and strong social protection) will enable adaptation responses by households and firms to reduce the impacts of climate shocks.⁸⁵ The differences in the percentage of GDP losses between the growth scenarios in this report are therefore underestimated.
- *The no adaptation scenario assumes no significant adaptive measures are taken:* For example, the crop yield shock assumes that the crop mix in each country remains constant moving forward.

Caveats for poverty and inequality estimates

In addition to the above caveats on the estimates of GDP losses, which will flow through to the poverty and distributional analyses, the estimates of poverty and inequality impacts are likely to be lower bounds. They assume that all climate-related effects are translated into changes in economic output that vary across different sectors of the economy, which in turn affect household incomes depending on which sectors they are employed in. Additional distributional impacts across households due to other factors, such as household characteristics or geographic location, are not accounted for, which could lead to an underestimate of the (negative) distributional impacts.

In addition, there are substantial data limitations especially with regards to availability of country-specific sectoral data on adaptation measures (costs, benefits, and co-benefits) so that a comprehensive

⁸⁵ Ways in which higher GDP and income could reduce vulnerabilities include: (i) richer farmers that can invest in inputs and irrigation and thus lower reductions in agricultural yields; (ii) better access to improved water and sanitation, which reduce the impact of higher temperatures on waterborne disease and diarrhea; (iii) more resources for mechanization of agriculture, which reduce the physical intensity of labor and thus reduce the impact of higher temperatures on labor productivity.

assessment of the adaptation potential, the cost-benefit of the full range of adaptation interventions (such as those presented in Chapter 4), and the total financing for adaptation required for each country is not feasible for this report. Only a few selected adaptation interventions have been modeled.

3.2.2 Growth Scenarios

The modeling uses three growth and development baseline scenarios for each of the G5 Sahel countries to analyze: (i) the economic and poverty impact of climate-related shocks, as the relative and absolute size of the impact will depend on the structure and income level of the economy; and (ii) the fiscal capacity to adapt. Each scenario is categorized by the average annual growth in GDP per capita for the next 30 years (2021-2050) and by a set of assumptions on the components of growth, on the speed of structural transformation, and on the development narrative:

- **The low-growth scenario** is one of stagnation or a minimal increase in per capita income, which has been the experience of FCVs such as Haiti and Central African Republic. It is characterized by increased fragility, conflict, and violence, no structural transformation, and continued high population growth. Unless the current drivers of fragility are addressed, this could unfortunately become the most likely scenario in many of the Sahel countries.
- **The medium-growth scenario** is based on historical episodes of sustained growth performance in each country⁸⁶ – this is not necessarily a “trend” as recent growth performance has been weak and volatile. Sahel countries were able to double their per capita GNI (in constant 2017 US\$) from 1991 to 2020. Repeating that performance would roughly double their incomes again by 2050. Achieving this scenario would require increasing labor productivity and making some structural transformation from agriculture to industry and services.
- **The higher-growth scenario** is one where the growth rate is 50-100 percent higher than in the medium-growth scenario and would be more akin to the economic rise of former low-income countries such as Bangladesh or Vietnam. The scenario would require higher increases in labor productivity, larger structural transformation, and reduction in fragility and conflict. It would also require realizing the potential of the demographic dividend through lower population growth.

The medium- and higher-growth scenarios would need to be underpinned by strong policies and reforms and investments to address gender inequality, to strengthen human, physical and natural capital, and to improve the business environment. These actions are not easy to accomplish, so these growth trajectories should not be taken as a certain outcome for the Sahel. Annex Table 1-1 provides further details of the scenarios, and Annex, Figure 1-4 shows the GDP per capita in each of the scenarios.

The growth scenarios for Chad, Mauritania, and Niger could be affected by lower global oil prices because of the global transition to low-carbon energy sources. The baseline growth scenarios have been run using a set of baseline hydrocarbon prices which show a gradual decline in oil prices up to 2050.⁸⁷ Box 3.3 shows the impact of significantly lower global oil prices under a net-zero carbon scenario on Chad and Niger. Based on available data, the breakeven prices for Chad and Niger are lower than the lowest projected global oil and gas prices under the net-zero carbon scenario, so currently the risk of stranded assets is low. However, given the high uncertainty around oil and gas prices, it will be important for the countries to continue analyzing these risks as further information on production costs and prices become available. Even if assets are not stranded, lower global oil prices would have a negative impact on fiscal and current account balances and GDP. COVID-19 and the Russia-Ukraine war have highlighted how many other supply and demand drivers can affect hydrocarbon prices. Oil prices thus remain a key source of uncertainty and volatility for the Sahel oil producers. This analysis underlines the importance of

⁸⁶ Countries use different historical periods within the period 1990-2019, based on relevance for the country context.

⁸⁷ Baseline commodity price projections come from the World Bank’s Global Economic Prospects (<https://www.worldbank.org/en/research/commodity-markets>), while the net-zero price baseline comes from Network for Greening the Financial System (<https://www.ngfs.net/ngfs-scenarios-portal/>).

effective management of oil revenues and economic diversification (which is also critical for job creation) to reduce the countries' dependency on the oil and gas sector and volatile oil revenues.

Box 3.3 Impact of lower global oil prices under a decarbonization scenario on Sahel's oil producers

Among the G5 Sahel countries, Chad is currently the only net oil exporter while Niger and Mauritania are planning to reach this status by 2024 when current infrastructure projects will be completed. However, future oil revenues are highly uncertain. As countries implement their carbon emissions target commitments, oil is expected to be progressively replaced by lower carbon energy sources. Oil demand and prices might drop to a level that could make it unprofitable to produce (the so-called “shut down price”).

The macro-fiscal impact of lower global oil prices on Chad and Niger⁸⁸ is simulated under a net-zero carbon scenario derived from the International Energy Agency's (IEA) projections of future energy prices under its *Net Zero Emissions by 2050 Scenario*.⁸⁹ Based on currently available data, oil production levels for the Sahel countries are not expected to be affected as projected prices are above shut down prices. The lowest global oil price is projected at around US\$47 per barrel (bbl). For Chad, an oil price of US\$30 per bbl is necessary to maintain existing extraction rates. For Niger, an accurate assessment of the minimum price for production is difficult until oil production expands; however, Nigerien authorities currently estimate their unit cost of production at US\$17 per bbl, which is similar to onshore oilfields in neighboring Nigeria.

The main macro-fiscal impacts will be from lower oil revenues. Under the net-zero carbon scenario, it is estimated that Chad's fiscal revenues would be lower by 0.24 percentage points (pp) by 2030 compared to the baseline scenario. Assuming that expenditures are reduced to maintain fiscal sustainability, the fiscal balance would deteriorate by 0.07 pp. Chad's current account deficit would widen by a substantial 3.6 pp and Chad's GDP would drop by 3 percent. For Niger, fiscal revenues would be lower by 0.4-0.5 pp, the current account deficit would widen by around 1 pp, and the estimated GDP loss would be 1.5 percent (2.5 percent in 2050).

Average Global Oil Price (US\$ per x)	2021-2030	2031-2040	2041-2050
Baseline Scenario	76.6	69.7	83.5
Net-Zero Carbon Scenario	67.8	46.9	46.7
Chad – Net-Zero Carbon Scenario deviation from Baseline	2030	2040	2050
Real GDP (percent)	-3.00	-3.07	-3.07
Current Account Balance (percentage point of GDP)	-3.62	-0.73	0.52
Fiscal revenue (percentage point of GDP)	-0.24	-0.13	-0.09
Fiscal balance (percentage point of GDP)	-0.07	-0.04	-0.03
Niger – Net-Zero Carbon Scenario deviation from Baseline			
Real GDP (percent)	-1.5	-1.8	-2.5
Current Account Balance (percentage point of GDP)	-0.9	-0.9	-1.3
Fiscal revenue (percentage point of GDP)	-0.4	-0.4	-0.4
Fiscal balance (percentage point of GDP)	-0.5	-0.3	-0.1

Source: World Bank analysis. WB CC-MFMD

⁸⁸ The data for Mauritania was not available to conduct this analysis.

⁸⁹ This IEA scenario is designed to keep supply and demand in balance under an energy demand scenario consistent with achieving net-zero CO₂ emissions from energy and industrial processes by 2050. It implies a rapid decline in oil and natural gas demand, which means

3.2.3 Climate Scenarios

To model climate uncertainty, six climate scenarios were selected for each of the five countries. Three of them focus on emissions uncertainties, and three capture uncertainties across the climate models. The climate scenarios follow World Bank guidance⁹⁰ and were provided by the World Bank’s Climate Change Knowledge Portal (CCKP) for 29 General Circulation Models (GCMs) from the Coupled Model Intercomparison Project 6 (CMIP6) suite of IPCC model outputs. On the CCKP, each GCM has up to five combinations of Shared Socioeconomic Pathway (SSP) and Representative Concentration Pathway (RCP) emissions scenario runs.⁹¹ Annex Figure 1-1 shows significant variation in projected mean temperature and precipitation for Mali (there are similar observations for the other G5 Sahel countries) through 2100 from the CCKP. For this reason, it is important to select future climate scenarios that capture a wide range of climate conditions). The first three scenarios allow for comparisons across emissions scenarios, and the “dry, wet, and hot” scenarios capture the broad range of climate change effects across GCMs to assess the impacts on the economy and the performance of adaptation options.

Table 3.1 Climate scenarios modeled

Climate Scenario	Description
1. SSP3-7.0 Average - Pessimistic scenario	Ensemble average of SSP3-7.0 GCMs Higher temperature increases and larger precipitation changes compared to Intermediate and Optimistic Cases
2. SSP2-4.5 Average - Intermediate scenario	Ensemble average of SSP2-4.5 GCMs Higher temperature increases and larger precipitation changes compared to Optimistic Case but lower than Pessimistic Case
3. SSP1-1.9 Average - Optimistic scenario	Ensemble average of SSP1-1.9 GCMs: The lowest temperature increase among all the scenarios and smaller precipitation changes compared to Intermediate and Pessimistic Cases
4. Dry scenario	10th percentile of mean precipitation change across SSP3-7.0 and SSP5-8.5 GCMs The driest among all the scenarios (i.e., smallest (or decrease) precipitation changes)
5. Wet scenario	90th percentile of mean precipitation change across SSP3-7.0 and SSP5-8.5 GCMs The wettest among all the scenarios (i.e., largest (increase) precipitation changes)
6. Hot scenario	90th percentile of mean temperature change across SSP3-7.0 and SSP5-8.5 GCMs The highest temperature increase among all the scenarios

Figure 3.1 for each country shows the changes in average temperature and precipitation for the period 2041-2060 compared to observed values (1995 to 2020) for each of each of the GCM-SSP combinations. The temperature and precipitation changes for each of the six climate scenarios are highlighted in blue. Note that water availability depends not only on rainfall, but also on evaporation and thus on temperature.

All GCM-SSP combinations for all countries predict an increase in mean temperatures.

no fossil fuel exploration and no new oil and natural gas fields are needed beyond those already approved for development. No new coal mines or mine expansions are required either. Prices are increasingly set by the marginal operating costs of projects needed to meet demand, resulting in fossil fuel prices that are significantly lower than in recent years. The methodology and data are available in the report Net Zero by 2050: A Roadmap for the Global Energy Sector.

90 From February 3, 2022, titled Global scenarios for CCDR analyses

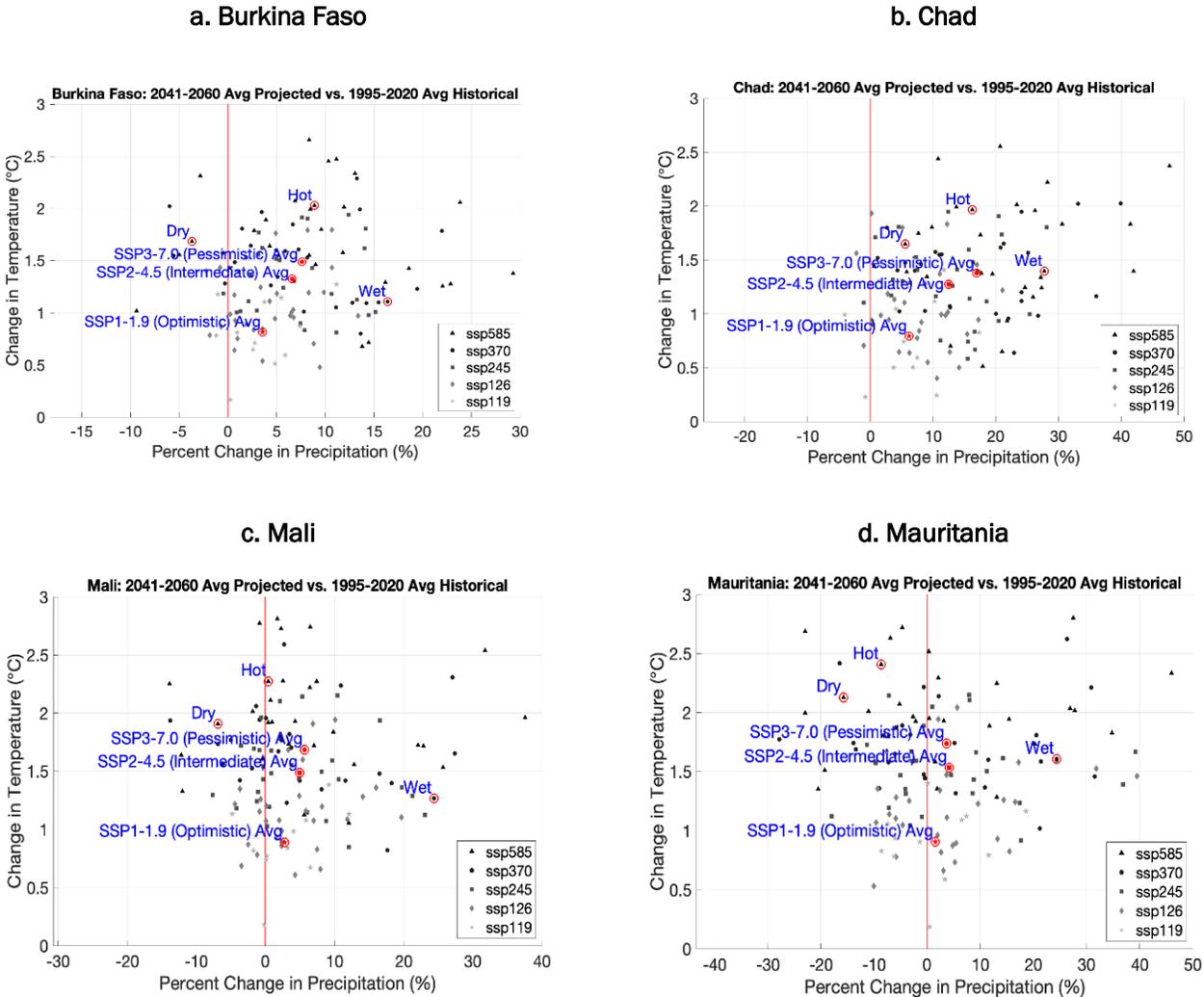
91 These include SSP 1-RCP 1.9 (1-1.9), 1-2.6, 2-4.5, 3-7.0, and 5-8.5. For each GCM-SSP combination, CCKP provided a modeled history from 1995 to 2014 (the baseline) and projections from 2015 to 2100, for monthly mean temperature and precipitation. CCKP also rectified each projection to a common 1x1 degree grid for the globe. Note that if there are data constraints, the CCDR may refer to two generations of CMIP due to data availability constraints. While long-term GHG emissions in the RCP8.5 are widely considered overly pessimistic, the CMIP5 climate change scenarios with RCP8.5 provide a useful (and not implausible) worst-case climate change scenario, which would be consistent with continued GHG emissions and high climate change sensitivity.

- Under the optimistic climate scenario, the increase is between 0.8 and 0.9 °C.
- Under the pessimistic climate scenario, the increase is between 1.4 and 1.7 °C.
- Under the hot scenario, the increase is between 2 and 2.4 °C.

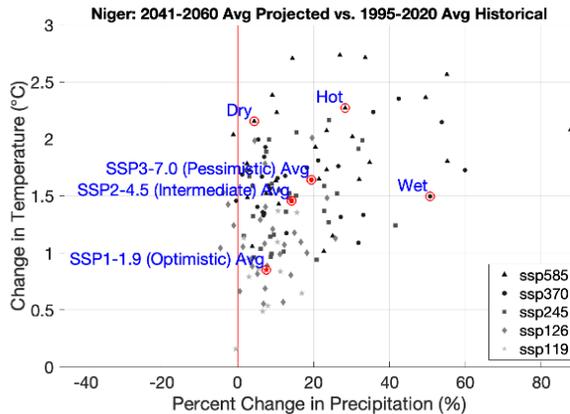
Most but not all GCM-SSP combinations predict an increase in precipitation. For Burkina Faso, Chad, and Niger, most GCM-SSP combinations predict an increase, while for Mali and Mauritania, a significant number of GCM-SSP combinations predict a decrease in precipitation. It is important to note that an increase in precipitation does not necessarily mean more water availability, since higher temperatures at the same time can cause higher evaporation.

- Under the wet scenario, the increase is 16 percent for Burkina Faso; 24-28 percent for Chad, Mali, and Mauritania; and 51 percent for Niger.
- Under the dry scenario, precipitation declines by 4-7 percent in Burkina Faso and Mali, and by 16 percent in Mauritania. Precipitation increases in Chad and Niger.
- All the other scenarios (except for hot in Mauritania) predict increases in precipitation.

Figure 3.1 Scatterplots of projected precipitation and temperature changes by SSP-GCM for G5 Sahel countries



e. Niger



3.2.4 Impact Channels Results

Below are summaries of the modeling results for each of the six impact channels. Table 1-2 in the Annex contains further details of the impact channels modeling.

Impact Channel 1: Rainfed crop yields Rainfed crop yields will be affected by changes in rainfall patterns, by increasing evaporative (water) demands, and by extreme heat as temperatures rise. Figure 1-6 in the Annex shows the crop yield shocks (expressed as percentage deviation from the baseline crop yield) for the period 2021 to 2050. Variations in projected precipitation is a bigger driver of uncertainty in future crop yields than variations in projected temperature, so the dry and wet climate scenarios are used to show the range of shocks. In the wet scenario, there is a positive crop yield shock in some years and a negative crop yield shock in others, with the deviations generally not far from the baseline. In the dry scenario (which is also hotter), there are generally negative crop yield shocks, with the magnitude increasing over time (as the dry scenario becomes dryer over time). *By 2050, the reduction in crop revenues from a dry or hot scenario is between 5 and 10 percent.*

Impact Channel 2: Heat and labor productivity Higher temperatures in the Sahel will lead to more heat stress, reducing the productivity of outdoor labor. Figures 1-8 to 1-10 in the Annex show the productivity shock (expressed as percentage deviation from the baseline labor productivity) for the period 2021 to 2050. The channel is only sensitive to temperature change, so the optimistic and the pessimistic climate scenarios are used to show the range of shocks. There are significant labor productivity losses under all scenarios, since all predict higher temperatures and more heat stress. The losses are higher for scenarios with higher temperatures. *The losses are highest in the agricultural sector (9 to 12 percent by 2050 under the pessimistic climate scenario) and lowest in the service sector, because agriculture involves more outdoor labor.*

Table 3.2 Labor productivity loss (%) from heat stress by 2050 (moving average)

SECTOR	Burkina Faso		Chad		Mali		Mauritania		Niger	
	SSP1-1.9	SSP3-7.0	SSP1-1.9	SSP3-7.0	SSP1-1.9	SSP3-7.0	SSP1-1.9	SSP3-7.0	SSP1-1.9	SSP3-7.0
CLIMATE SCENARIO										
Agriculture	-6%	-10%	-7%	-10%	-7%	-12%	-6%	-11%	-5%	-9%
Industry	-6%	-9%	-6%	-9%	-6%	-10%	-5%	-9%	-4%	-7%
Service	-3%	-4%	-2%	-4%	-2%	-4%	-2%	-4%	-3%	-5%

Impact Channel 3: Heat-related human health shocks In addition to causing direct labor productivity losses from heat stress, higher temperatures can indirectly reduce labor productivity through increased morbidity and mortality due to disease (malaria, dengue, diarrhea, and respiratory and cardiovascular heat-related diseases). Figure 1-11 in the Annex shows the heat-related human health shocks on labor productivity (expressed as percentage deviation from the baseline labor productivity) for the period 2021 to 2050. The channel is only sensitive to temperature change, so the optimistic and pessimistic climate scenarios are used to show the range of shocks. Productivity declines under all scenarios and the losses are higher for scenarios with higher temperatures. However, the losses are small compared to the direct labor productivity losses from heat stress because fewer laborers are affected by increased disease exposure. *By 2050, the impact on labor productivity for all countries is no more than 0.4 percent for the climate optimistic and less than 1 percent for the other scenarios.*

Impact Channel 4: Livestock yields Climate change will affect livestock yields and revenues because of reduced availability of pastures to graze and greater heat stress on animals from temperature and precipitation changes. Figure 1-12 in the Annex shows the livestock yield shocks (expressed as percentage deviation from the baseline livestock yield) for the period 2021 to 2050. Variations in projected precipitation is a bigger driver of uncertainty in future livestock yields than variations in projected temperature, so the dry and wet climate scenarios are used to show the range of shocks. In the wet scenario, there is a positive livestock yield shock in most years after 2030 when the improved productivity of pastures outweighs the negative impact of heat stress on animals. In the dry scenario (which is also hotter) there are generally negative livestock yield shocks, with the magnitude increasing over time (as the dry scenario becomes dryer over time). *By 2050, the reduction in livestock yields in the dry scenario ranges from 11 percent (Burkina Faso) to nearly 20 percent (Niger, Chad). However, in a wet scenario, yields are estimated to improve in all countries.*

Impact Channel 5: Inland flooding Flooding events damage infrastructure and physical capital which in turn negatively affects economic activities. Climate change may exacerbate flooding by increasing the intensity and duration of storm events. Figure 1-14 in the Annex shows the inland flooding shock (expressed as percentages of capital and agricultural land that are expected to be damaged each year) for the two emissions scenarios in the CMIP5 climate model ensemble: RCP4.5 and RCP8.5.⁹² Generally, flood damages are greater under the RCP8.5 (pessimistic) scenario than under the RCP4.5 (optimistic) scenario, since higher emissions are expected to cause greater climate variability. *By the 2050 period, annual damages to built-up infrastructure would be highest in Chad (0.9 percent) and Niger (0.5 percent) due to relatively high concentration of infrastructure in wide floodplains, and lowest in Burkina Faso (0.04 percent⁹³), under the RCP8.5 scenario.*

Impact Channel 6: Road and Bridges Changes in precipitation, temperature, and flooding can cause damages to roads and bridges, which in turn increase annual maintenance costs for roads and bridges and create delays for passengers. Delays translate to lost labor productivity. The modeling results show large increases in both maintenance costs and hours of travel delay. Impacts are generally higher under the wet scenario than the dry scenario because extreme precipitation and flooding cause the biggest damages to roads and bridges. *Compared to the baseline, average annual weather-driven repair costs over the 2021 to 2050 period would rise the most in Mali (US\$340M per yr), Niger (US\$240M per yr), and Chad (US\$220M per yr). The largest increases in passenger delay hours would occur in Niger, Mali, and Burkina Faso.*

⁹² CMIP5 is used for the flooding impact channel due to data availability constraints. While long-term GHG emissions in the RCP8.5 are considered overly pessimistic, the CMIP5 climate change scenarios with RCP8.5 provide a useful (and not implausible) high-warming scenario, which would be consistent with continued GHG emissions and high climate change sensitivity or positive feedback from the carbon cycle.

⁹³ Burkina Faso shocks are low because there is minimal infrastructure exposed to floods in this country.

Assessing the impact of the channels on the macroeconomic aggregates For each country, the annual effects from each of the six impact channels are introduced as “shocks”⁹⁴ into the CC-MFMOD for each of the projection years to assess the impacts of climate change on overall GDP and macroeconomic aggregates in the period 2021 to 2050. The shocks have been smoothed as inputs into CC-MFMOD without loss of generality.⁹⁵ As the size of the impacts will differ according to the size and structure of the economy, the “shocks” are introduced and run for each of the three growth baselines described above. The combined impacts of the six channels are more than the total of the individual channels as there is a multiplicative effect of shocks in the CC-MFMOD.⁹⁶ To show the range of impacts, the impacts under the wet and dry climate scenarios for the rainfed crop and livestock yields channels and the impacts under the optimistic (SSP1-1.9) and pessimistic (SSP3-7.0) climate scenarios for the heat-labor productivity, health-labor productivity, and roads and bridges channels are presented in the next section.⁹⁷

3.2.5 Macro Impacts of Climate Change Shocks with No Adaptation Policies and Investments⁹⁸

The impacts of channels on economic output vary significantly by sector, climate scenario, and country. Figure 3.2 shows the individual and combined impacts on total GDP (level) for each country in 10-year intervals for each of the low-, medium-, and high-growth baselines. The key patterns are the following:

- **Rainfed crop and livestock yields decline under the dry climate scenario but increase under the wet climate scenario in most countries.** The size of the impacts on GDP (whether positive or negative) depends – in addition to the size of the yield shock – on the country’s agriculture sector, namely the share of rainfed crops and livestock as a share of total agriculture value-added⁹⁹ and the share of agriculture in the economy.¹⁰⁰
- **The heat-labor productivity channel’s negative impact on GDP is large, especially in the hotter pessimistic climate scenario.** It is also larger in the agriculture and industry sectors, since they have higher shares of outdoor workers. Countries with a higher share of GDP in agriculture will therefore be more negatively affected than those with higher shares in industry and services.
- **The human health-labor productivity channel** has a larger impact in the climate pessimistic (hotter) scenario, but a relatively smaller negative impact on GDP overall, at less than 1 percent in all countries and scenarios.
- **Inland flooding** impacts on GDP are large in Chad and Niger, but small or negligible in other countries.
- **The roads and bridges channel** impacts are significantly larger in the wet climate scenario for all countries.

94 Shocks here are defined as economic impacts of climate change. These shocks are introduced as deviations from a reference point. In CC-MFMOD, these shocks are then mapped to the appropriate economic channels (e.g., heat on labor productivity, crop losses on agricultural value added and marginal costs of production).

95 A Hodrick Prescott (HP) filter is applied to smooth the inter-year variability in the “shocks” for CC-MFMOD. The HP filter is a standard way of smoothing through volatility in a time series by extracting the trend from any data with a cyclical component. An alternative to apply the filter on the output of the CC-MFMOD – which is appropriate for shocks with massive outliers – was considered; the results were very similar and did not alter in a material way.

96 The CC-MFMOD has several nonlinearities and the way the shocks enter is multiplicative. Given that some of the shocks affect TFP, we have both marginal cost and real impacts and they interact in the model also in a nonlinear way.

97 For the inland flooding channel, the results from RCP 8.5 are included in the dry and climate pessimistic set of results and those from RCP 4.5 are in the wet and climate optimistic ones.

98 The impacts have been calibrated on studies in which some adaptation is included. For instance, in crop modeling, farmers may not adjust the type of crops, but they at least adjust the planting and harvesting times. The challenge to define a pure “no adaptation” baseline is a common issue in the discipline. The models assume some autonomous adaptation by economic agents (e.g., changing agricultural practices), but no adaptation policies and investments.

99 Rainfed crops as a share of total agriculture value-add is 78% in Burkina Faso but only 16% in Mauritania.

100 Agriculture in 2021 as a share of GDP is 25% in Burkina Faso, 33% in Chad, 35% in Mali, 23% in Mauritania, 39% in Niger.

Under the wet and optimistic climate scenarios, the largest negative impacts come from the heat-labor productivity channel (with annual GDP losses ranging from -1.8 percent in Mauritania to -4.2 percent in Mali by 2050) and the roads and bridges channel (annual GDP losses ranging from -1.2 percent in Burkina Faso to -3.6 percent in Mali by 2050). In some countries, there are large positive impacts from the rainfed crops yield channel (Niger) and livestock yields channel (Chad, Mali, Mauritania, and Niger).

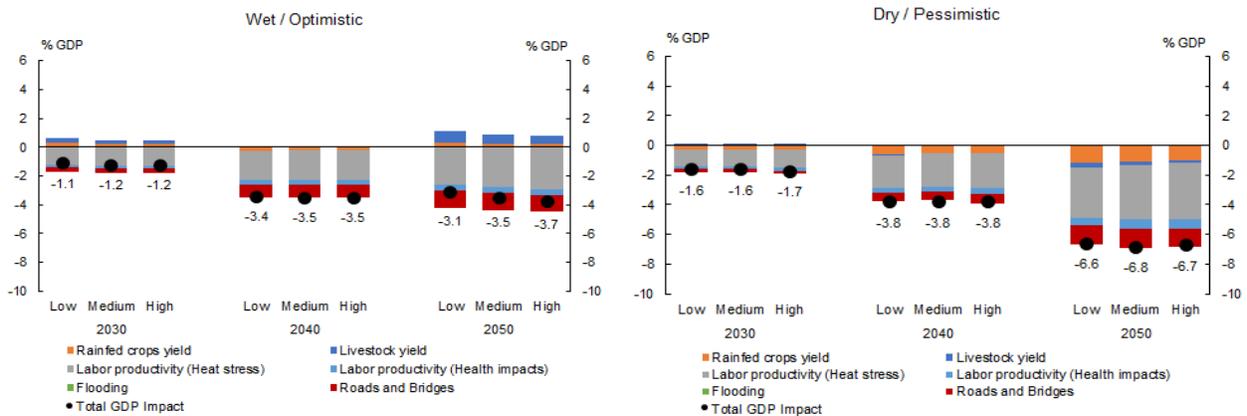
Under the dry and pessimistic climate scenarios, all channels produce negative impacts. The largest is from the heat-labor productivity channel (with annual GDP losses ranging from -2.8 percent in Mauritania to -6 percent in Mali by 2050). The second largest impact channel varies across countries – roads and bridges in Burkina Faso, livestock yields in Chad, Mali, and Mauritania, and rainfed crop yields in Niger.

An additional challenge for the agriculture sector and food security is that there is very large annual variability in the shocks to rainfed crop yields and livestock yields. In one year, the shock can be large and positive, while in the next year it can be large and negative. Even if across the total period the net impacts are small, the annual shocks matter; the volatility creates challenges for households in the agriculture sector and in the wider economy, and contributes to food insecurity in the Sahel.

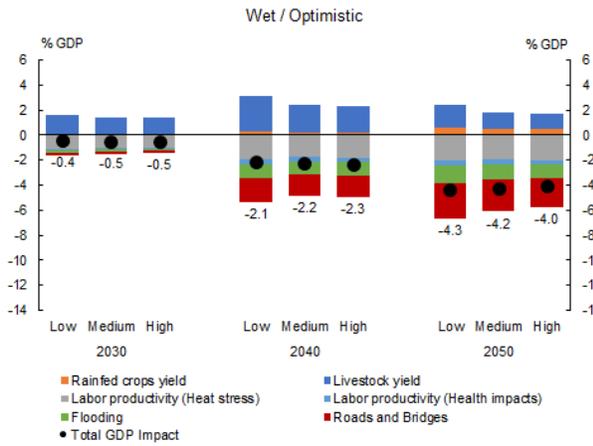
Figure 3.2 Annual GDP loss (% deviation from the baseline) from six impact channels, with no adaptation

a. BURKINA FASO, WET/OPTIMISTIC Climate Scenario

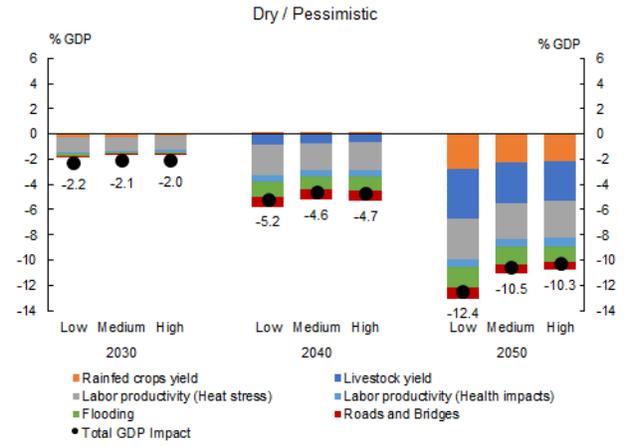
b. BURKINA FASO, DRY/PESSIMISTIC Climate Scenario



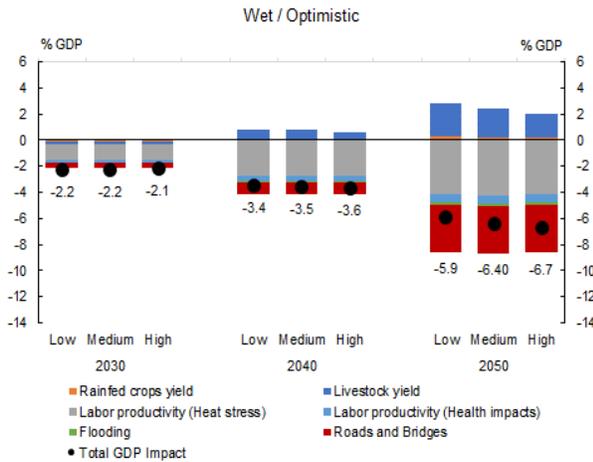
c. CHAD, WET/OPTIMISTIC Climate Scenario



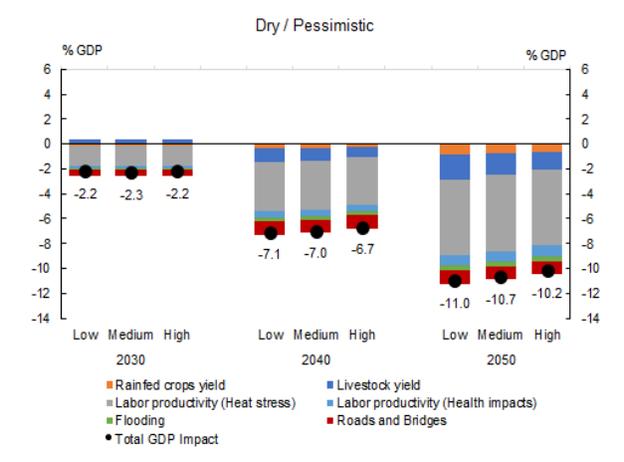
d. CHAD, DRY/PESSIMISTIC Climate Scenario



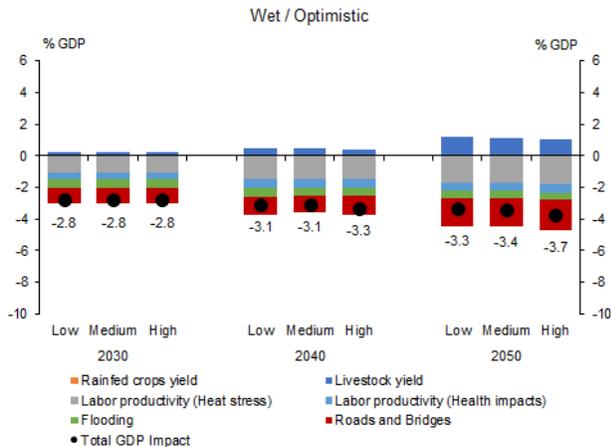
e. MALI, WET/OPTIMISTIC Climate Scenario



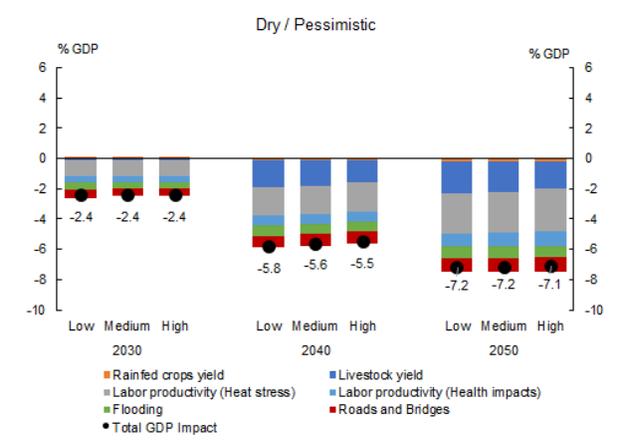
f. MALI, DRY/PESSIMISTIC Climate Scenario



g. MAURITANIA, WET/OPTIMISTIC Climate Scenario

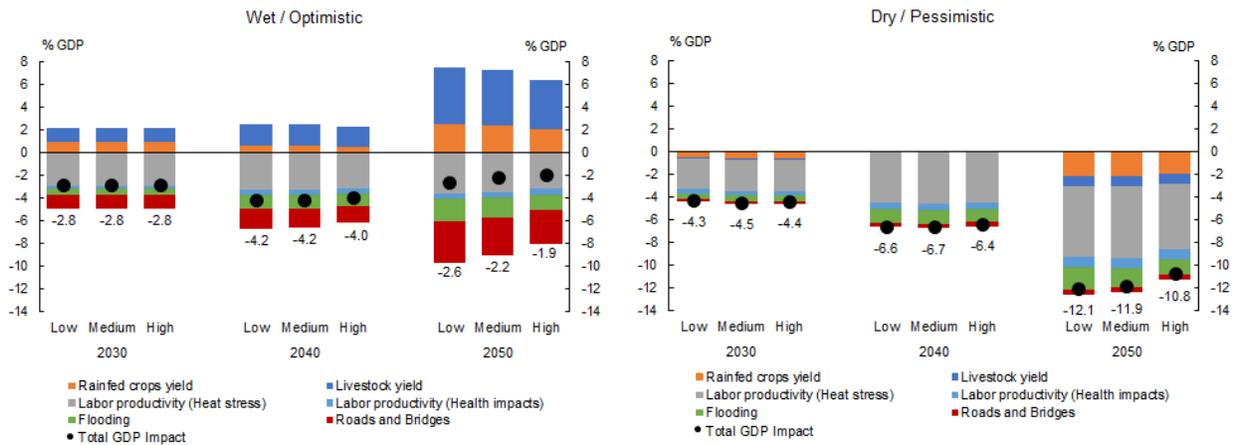


h. MAURITANIA, DRY/PESSIMISTIC Climate Scenario



i. NIGER, WET/OPTIMISTIC Climate Scenario

j. NIGER, DRY/PESSIMISTIC Climate Scenario



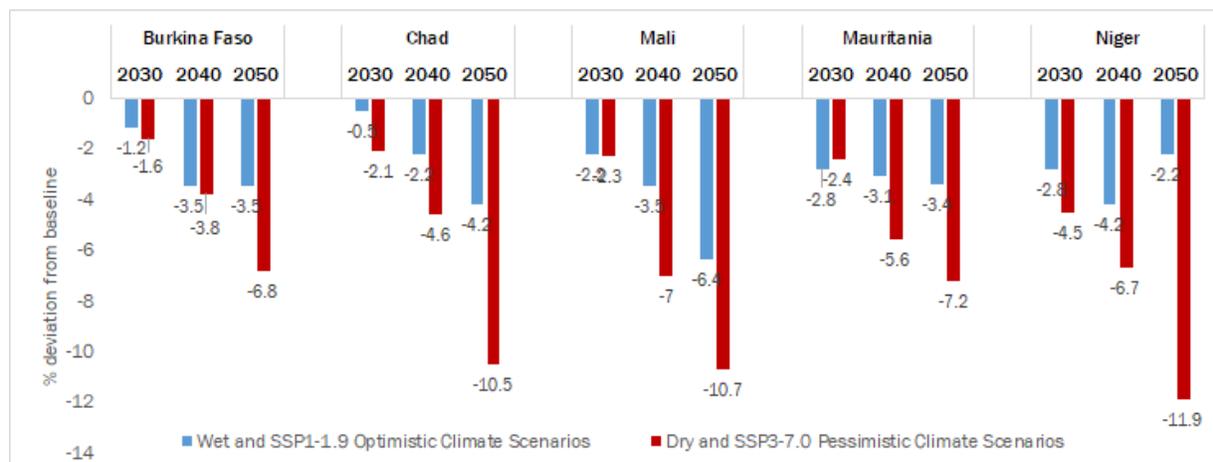
Source: IEC analysis for the World Bank, CC-MFMOD, May 2022.

Notes: The black dots and data labels refer to the Total GDP impact of the combined channels.

Looking at the combined effects of the six impact channels, climate change is expected to cause significant output losses for all the G5 Sahel countries. Figure 3.3 shows the economic losses as the percentage deviation from baseline GDP until 2050.¹⁰¹ The total negative impacts increase over time and are significantly higher under the dry and pessimistic climate scenarios compared to the wet and optimistic climate scenarios. In the wet and optimistic climate scenarios, rainfed crop and livestock yields often increase and the negative impacts of the other channels are smaller. By 2050, annual GDP compared to a medium-growth baseline would be reduced by between 2.2 percent (Niger) and 6.4 percent (Mali) under the wet and optimistic climate scenarios and by between 6.8 percent (Burkina Faso) and 11.9 percent (Niger) under the dry and pessimistic climate scenarios. That can be large enough to wipe out most or all annual growth in real GDP and real GDP per capita. As discussed earlier in the chapter, these estimates are likely to underestimate the economic losses from climate change because there are other impact channels not included, and also because they do not include the magnifying effects of climate-induced changes in ecosystems, increases in conflicts, and migration shifts.

101 A larger projection window suggests that losses increase linearly – with expected losses reaching concerning sizes.

Figure 3.3 Annual GDP losses (% deviation from the medium-growth baseline) from the combined impacts of six channels, with no adaptation¹⁰²



Source: CC-MFMOD

The annual GDP losses (relative to the baseline) are higher for the low-growth scenario compared to the medium- and higher-growth scenarios for Chad, Mali, and Niger,¹⁰³ especially in the dry and climate pessimistic scenarios.¹⁰⁴ In the low-growth scenario, there is little or no structural transformation, and the economy is dominated by the agriculture sector, which is subject to larger negative shocks. Under the medium- and higher-growth scenarios, the impacts are reduced as the economy shifts away from agriculture. This is one example of how growth and development can help make the economy more resilient. However, as discussed earlier in the chapter, the modeling does not fully capture all the positive effects of inclusive development on reducing vulnerability to climate change. The differences in annual GDP losses between the growth scenarios are therefore likely to be larger than what is shown in Figure 3.2.

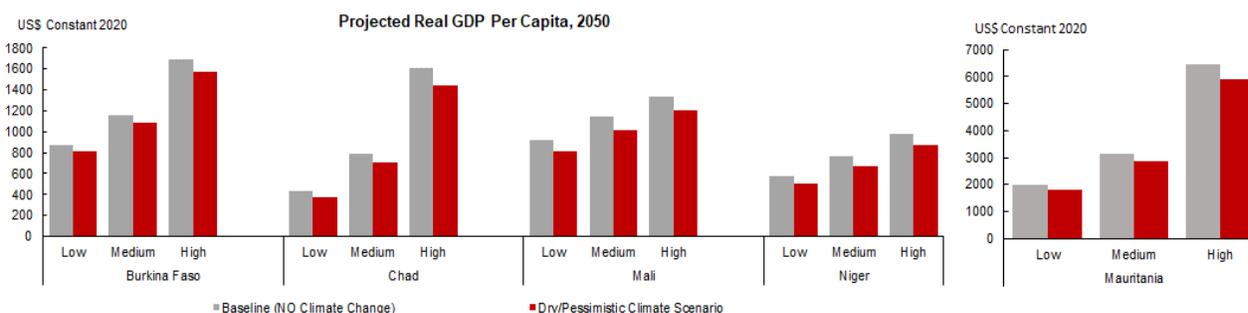
More important, annual GDP and annual GDP per capita after the losses from climate change-related shocks will be significantly higher for the higher-growth scenarios because the baseline (with no climate shocks) is much higher than in the lower-growth scenarios. Even with adaptation interventions, there will still be significant economic damages from climate-related shocks, since it is difficult to fully adapt. Figure 3.4 shows that for all countries, the projected GDP per capita by 2050 in the medium- and higher-growth scenarios with climate change shocks (shown for the dry and pessimistic climate scenarios as shocks are larger) and no adaptation will still be higher than in the low-growth scenario baseline with no climate shocks. This demonstrates the importance of strong underlying growth to “offset” these damages and to enable the increase in income per capita needed to reduce poverty in the Sahel region.

¹⁰² The challenge to define a pure “no adaptation” baseline is a common issue in macro-modeling. The results assume some autonomous adaptation by economic agents (e.g., changing agricultural practices), but no adaptation policies and investments.

¹⁰³ Annual GDP loss in percentage terms is more similar across growth scenarios for Burkina Faso and Mauritania as agriculture is already not their dominant sector – less than 25 percent of GDP.

¹⁰⁴ The absolute annual GDP losses are much larger for the higher growth scenarios as the economy is much larger. By 2050, total GDP in the medium-growth scenario is 1.5-2 times the GDP of the low-growth scenario, while total GDP in the high-growth scenario is 2-4 times the GDP of the low-growth scenario.

Figure 3.4 Projected real GDP per capita, 2050



Source: CC-MFMOD

3.2.6 Poverty Impact of Climate Change Shocks Without Adaptation

The poverty and distributional implications of different macroeconomic scenarios in each Sahel country were derived using simulations that leverage household survey data with the macro projections. The simulations produce the overall poverty and inequality trends for each country under different growth scenarios, as well as estimates of how aggregate changes in income will be distributed among population groups with different characteristics, such as location (urban and rural), age, and education level. More specifically, the results from the CC-MFMOD macro model are linked to a microsimulation model over the projection period. The macro projections are used as inputs to simulate changes in demographics, employment, labor productivity, and prices, using the latest available household survey data in each country, 2017 (Mauritania) and 2018-19 (for the other 4 countries). Annex 1-2 provides more details of the poverty analyses methodology.

With continued rapid population growth in the Sahel, the pace of economic growth will not be sufficient to significantly increase per capita income growth and materially reduce poverty even without the impacts of climate change. Under the baseline scenario of no climate change and medium growth, the poverty rate¹⁰⁵ in the region is expected to decline slightly, from 29 percent (2020) to 27 percent by 2050. Niger, Mauritania, Burkina Faso, and Mali will reduce poverty by 5.7, 3.9, 3.3, and 2.7 percentage points, respectively, by 2050, while poverty will increase in Chad by 6.5 percentage points.¹⁰⁶ Due to continued rapid population growth in the medium-growth scenario, the absolute number of poor in the Sahel region is projected to increase from 23.8 million in 2020 to 52.8 million in 2050. Even in the higher-growth scenario (which assumes lower population growth) without climate change, the number of poor is expected to remain slightly unchanged at 23.7 million, even as the poverty rate falls to 12 percent by 2050. Thus, the Sahel countries – with the exception of Mauritania which has a significantly higher income per capita and lower extreme poverty rate than the other countries¹⁰⁷ – will remain at risk of falling deeper into a “poverty trap” of low per capita income growth and high levels of poverty. The projected average annual real GDP growth of less than 5 percent in the medium-growth scenario will be insufficient to trigger a job and economic transformation in the region, and the growth elasticity of poverty will remain low without substantive efforts to reduce population growth.

With no adaptation, climate change will increase the poverty challenge in the Sahel. For the G5 countries and for all the growth and climate scenarios, economic losses from climate change impacts will increase

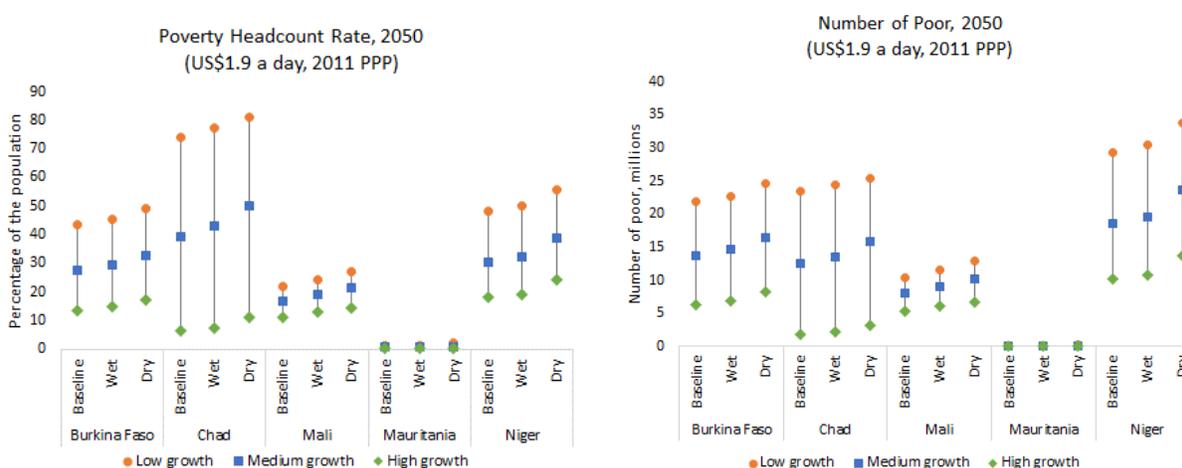
¹⁰⁵ Using the international poverty line of US\$1.90 a day in 2011 PPP.

¹⁰⁶ Under the baseline scenario of no climate change, the cross-country differences are mainly driven by differences in projected GDP per capita growth.

¹⁰⁷ Mauritania had an extreme poverty rate of less than 5 percent in 2020 and this is expected to fall to around 1 percent by 2030 under the growth baseline scenarios. A 3-percentage point decline over a decade is similar to other middle-income countries that have sustained growth at a slow-moderate rate.

poverty. By 2050, under the medium-growth and dry and pessimistic climate scenarios, the poverty rate will increase relative to the baseline by 0.2 percentage points in Mauritania, 4.7 percentage points in Mali, 5.3 percentage points in Burkina Faso, 8.6 percentage points in Niger, and 10.6 percentage points in Chad.¹⁰⁸ For the region as a whole, it is estimated that by 2050 there would be an increase in the poverty rate from 27 percent in the medium-growth baseline scenario to 29 percent in the wet and optimistic climate scenarios and to 34 percent in the dry and pessimistic climate scenarios. The number of poor relative to the baseline also increases in all countries under all scenarios, but is higher in the dry and pessimistic climate scenarios. By 2050, under the medium-growth and dry and pessimistic climate scenarios, the number of poor will increase relative to the baseline by 0.02 million in Mauritania, 2.21 million in Mali, 2.7 million in Burkina Faso, 3.34 million in Chad, and 5.23 million in Niger.

Figure 3.5 Poverty rates and number of poor by 2050, by growth and climate scenarios

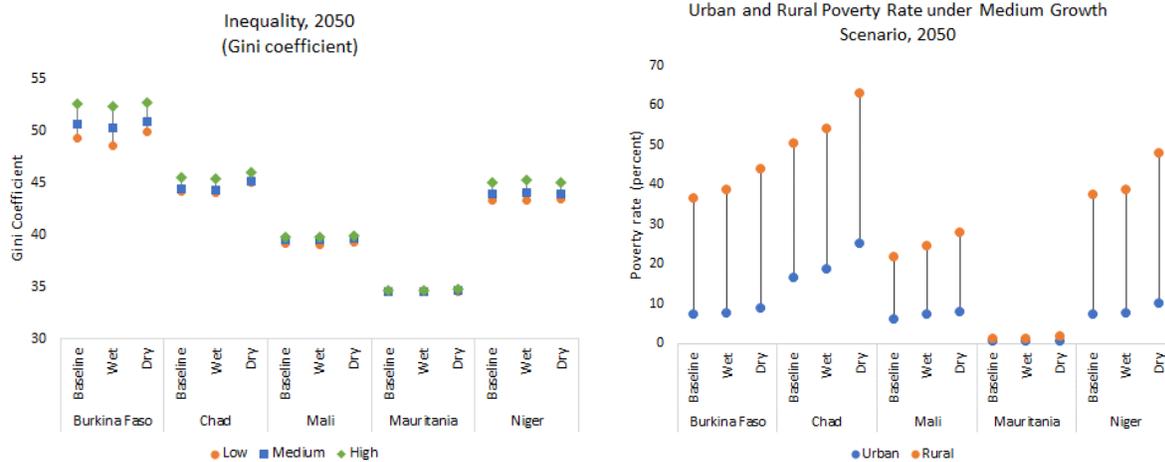


With no adaptation, climate change will increase inequality in the Sahel. Across the Sahel, inequality is among the web of complex factors that have generated an environment of fragility, conflict, and violence (FCV) that increasingly cuts across borders. With or without climate change, growth is not expected to benefit the poor very much, and the Gini coefficient (a measure of inequality) is expected to increase over time. This is because the poor are more exposed to shocks, such as natural disasters, insecurity, and health challenges, while also benefiting less from government redistributive efforts, which are small and not well-targeted. The impact of climate change on the Gini coefficient would be marginal in Mauritania and Mali. However, in Burkina Faso, Niger, and Chad, the dry and pessimistic climate scenarios lead to a greater increase in inequality while the wet and optimistic climate scenarios lead to a smaller increase in inequality relative to the baseline. Per capita consumption is expected to decline for the poorest decile compared to the richest decile for all the countries under the dry and pessimistic climate scenarios by 2050. The poorest are affected more under the dry and pessimistic climate scenarios because heat stress lowers the labor productivity of outdoor workers (who are generally in agriculture and poorer) and because of the high share of poor households in agriculture, which would see declines in rainfed crop and livestock yields. In addition, in the face of drought, the poor have less access to irrigation infrastructure and tend to rely on detrimental coping mechanisms such as selling livestock and other durable assets.

¹⁰⁸ Across the three growth scenarios, poverty levels are higher in Niger and Chad and the impact of the economic losses on poverty is higher in these two countries.

Climate change will lead to higher poverty impacts in rural areas. In all countries and all growth scenarios, the climate impacts on poverty are higher in rural areas than in urban ones. In addition, the gap between rural and urban increases over time towards 2050. In particular, the dry and pessimistic climate scenarios lead to larger impacts on rural communities working in agriculture for the reasons explained above.

Figure 3.6 Gini coefficient and urban/rural poverty rates in 2050, by growth and climate scenarios



In addition, moving from south to north, livelihoods tend to change from farming to livestock and small trading. Across subregions of countries, under the medium-growth and dry and pessimistic climate scenarios, the poverty impacts would be higher in Chad than in any other country. In addition, some of the most vulnerable border communities in Chad, Niger, and Mali would experience a higher increase in poverty, as shown in Figure 3.7 and Figure 3.8.

Given the spatial nature of the climate shocks and impacts and the socioeconomic interdependence of Sahel communities, a regional approach to welfare policies can help increase resilience and adaptation. There are many opportunities for welfare policies. First, existing national safety net programs could be strengthened and scaled up. Second, investments in more productive and conflict-sensitive land management and pastoral systems could be increased. Third, an effort to scale up the administration of human development programs would reduce the current devastating impacts on health, education, and human capital accumulation, thus strengthening the resilience and adaptive capacities of Sahelian communities.

Figure 3.7 Impact on poverty rates under the wet and optimistic climate scenarios

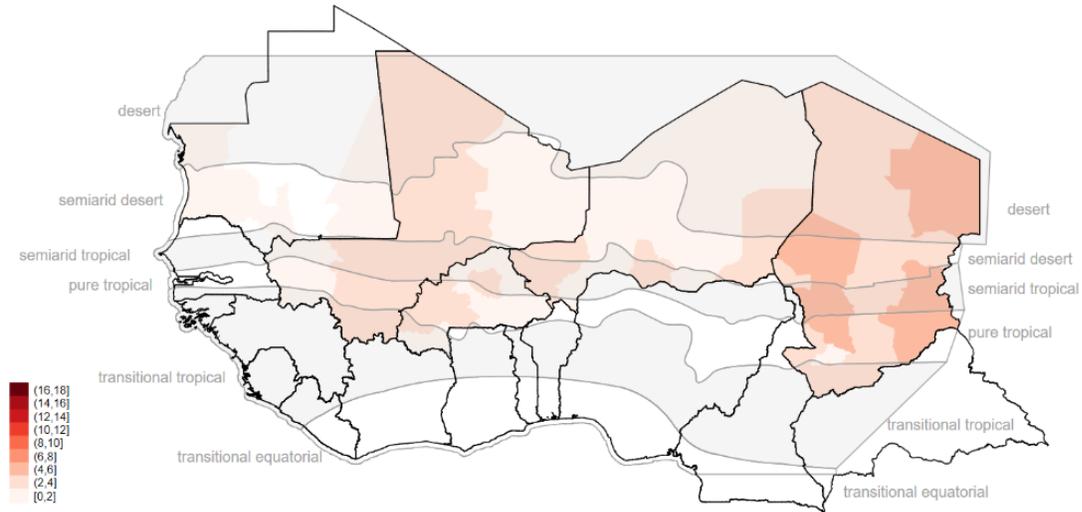
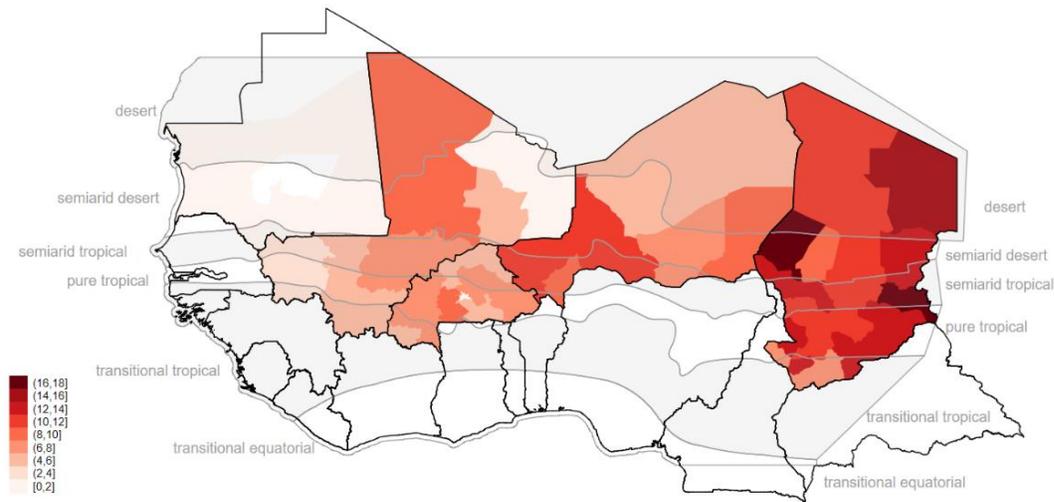


Figure 3.8 Impact on poverty rates under the dry and pessimistic climate scenarios



Note: Coloring of regions reflects difference in projected poverty rates for 2050 between the baseline scenario and the climate change scenario, under the assumption of medium growth. Climatic zones definitions from ECOWAS.

3.3 Modeling Adaptation to Climate Change – Selected Interventions

Serious adaptation interventions are warranted to reduce economic losses, but there are likely to be limits to adaptation. First, many impact channels do not have easy adaptation actions, and it is likely that climate impacts will exceed the adaptive capacity of countries, communities, and ecosystems. Second, even if it is technically possible to fully adapt (reducing the economic damages or losses to zero), it may not be desirable. It would be economically inefficient to fully adapt if the costs to do so outweigh the benefits, although distributional and ethical concerns should also play an important role in decision-making (Box 1-1 in the Annex).

The benefits (in terms of reduced GDP losses) and costs of high potential adaptation interventions for three of the impact channels, rainfed crop yields, livestock yields, and roads and bridges, have been analyzed. The interventions shown in Table 3.3 were selected on the basis of high potential benefits for the G5 Sahel region and feasibility to model. The analysis is not meant to be comprehensive or a prioritization of adaptation measures, as not all adaptation measures can be modeled because of the nature of the action and the lack of data on the investment costs, benefits, and co-benefits. For the heat stress and labor productivity channel, structural transformation – shifting from agriculture (predominantly outdoors work) to industry and service sectors – is a form of adaptation. The impact of structural transformation in reducing economic losses can be seen in the previous section by the lower (as a percentage of baseline) GDP losses in the higher-growth scenarios.

Table 3.3 Adaptation interventions modeled for three impact channels

Channel	Adaptation intervention	Benefits (Reduced Losses)	Costs ¹⁰⁹
Rainfed crop yields	Expanded irrigation: (1) rehabilitation of irrigation infrastructure for cash crops; and (2) construction of new shallow groundwater-based irrigation for smallholders for cash crops and food crops.	Increase water availability for rainfed crops that would be reduced as a result of changes in precipitation. Annex Figure 1-7 shows the rainfed crop yield shocks with adaptation.	US\$8,200 per ha for 243,000 ha of rehabilitation, and US\$4,700 for 1.8M ha of shallow groundwater-based smallholder irrigation in total for G5 Sahel. ¹¹⁰
Livestock yields	Two livestock feed measures: (i) purchasing crop residues from in-country crop production to use as feed; and (2) investment in establishing fodder banks.	To partially compensate for the reduced feed from pastures as a result of changes in temperature and precipitation. Annex Figure 1-13 shows the livestock yield shocks with adaptation.	US\$48-70 per ton of residue (depending on residue mix by country) and US\$10 per ton for fodder banks. Quantity varies according to scenario. ¹¹¹
Roads and bridges	Proactive adaptation requiring investments to make roads and bridges network climate resilient. Proactive measures vary depending on the road surface and stressor.	Roads and bridges will be less damaged by changes in temperature, precipitation, and flooding events. This will reduce the losses in capital stock and labor productivity from delays and lower future O&M costs.	For roads, new and rehabilitated construction costs range from US\$10,000 to US\$818,115 per km, and annual routine maintenance range from US\$750 to US\$5,698 per km. For bridges, rip rap deployment is US\$6,500 per pier lane and concrete strengthening is US\$323 per m ² .

New and rehabilitated irrigation for rainfed crops, improvements in livestock feed practices, and investments in climate-resilient road and bridges can significantly reduce economic losses from climate change. Figure 3.9 shows the GDP losses from climate change under the dry and pessimistic climate scenarios with no adaptation and with partial adaptation. The annual GDP losses for each of the three channels are significantly reduced as a result of adaptation interventions. Looking at the medium-growth scenario, the reduction in total GDP losses in 2050 (the difference between no adaptation and partial adaptation) ranges from about 2-3 percentage points of GDP in Burkina and Mauritania to 4 percentage points in Mali and Niger, and 5 percentage points in Chad. The modeling accounts for the opportunity cost of the adaptation capital investments by reducing public investments in other sectors under the assumption of tight fiscal constraints. If adaptation investments do not lead to a reduction in public investments in other sectors, the reduction in total GDP losses from adaptation would be significantly higher than what is presented. Annex Figures 1-15 to 1-19 show the GDP losses under the wet and optimistic climate scenarios with no adaptation and with partial adaptation. They also show significant reduction in GDP losses as a result of adaptation interventions. Annex Table 1-3 shows the key

¹⁰⁹ Adaptation costs will be based on unit cost estimates obtained from international and, where available, local sources.

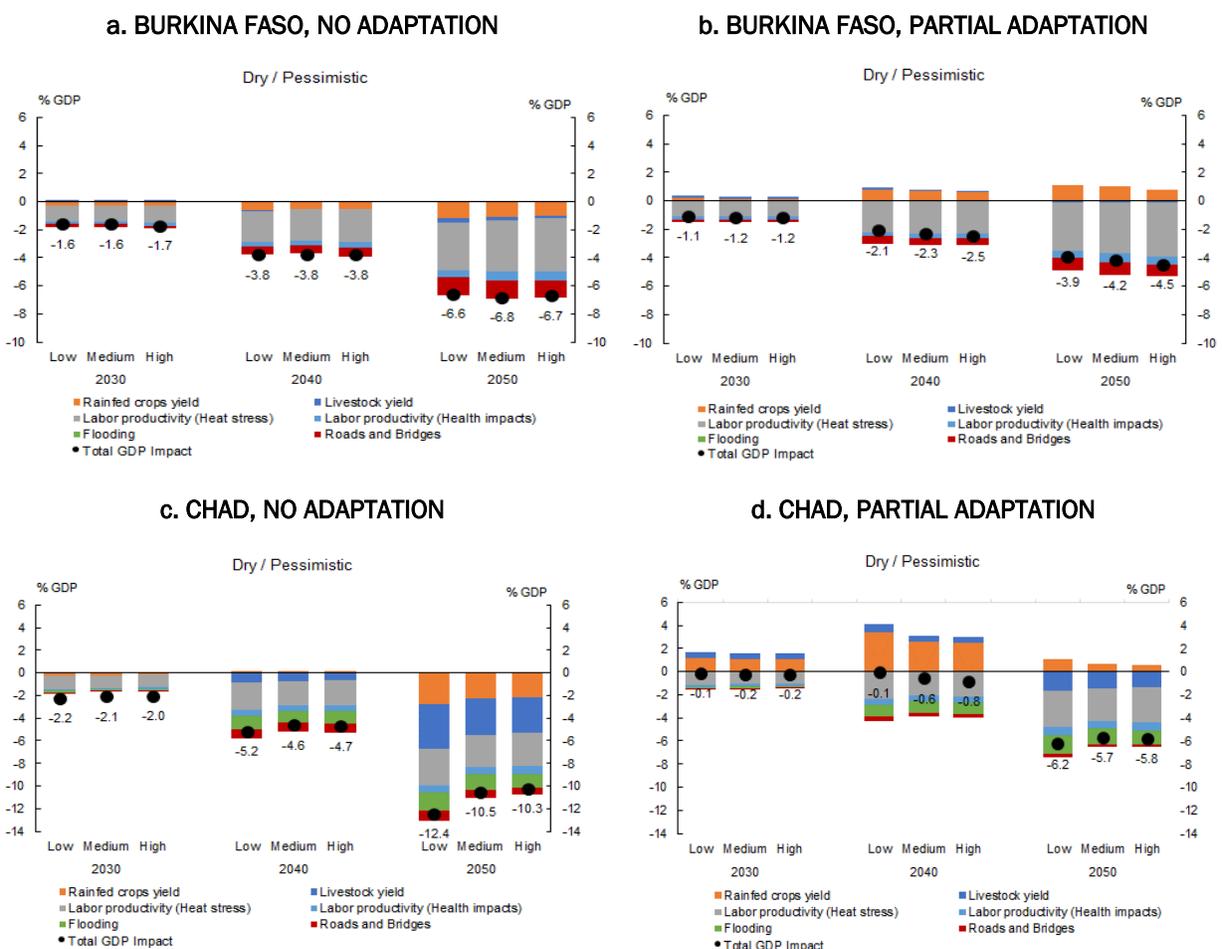
¹¹⁰ We assume irrigation is constructed in even increments between 2025 and 2039, such that CAPEX is evenly distributed over these years. We assume CAPEX starts again in 2045 when the irrigation systems need to be replaced or rehabilitated (after 20 years). OPEX costs are 2 percent of CAPEX. By 2039, total CAPEX and OPEX is now about \$900M per year across the five countries.

¹¹¹ For this channel we assumed the investments were aimed at closing the production gap caused specifically by climate change. As a result, more crop residues are purchased and fodder banks used in drier scenarios

macroeconomic and poverty indicators for each country under their medium-growth baseline scenario; with climate shocks and no adaptation scenario; and with climate shocks and partial adaptation scenario.

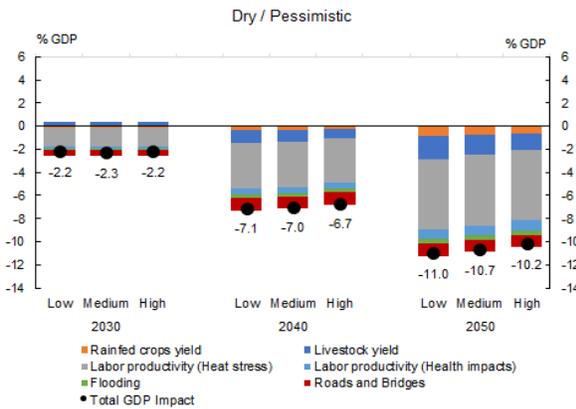
Some adaptations could bring about gains greater than the losses avoided. For the rainfed crop yields channel, adaptation through expanded irrigation leads to an improvement from the baseline economic output in all countries. Agricultural productivity in the Sahel is currently very low, partly due to water scarcity. Expanding the irrigation network already made development sense; climate change now increases the potential benefits. This example highlights how some adaptation interventions are likely to bring about gains that are larger than the losses avoided by addressing existing productivity gaps and infrastructure deficits in the Sahel countries.¹¹²

Figure 3.9 Annual GDP loss (% deviation from the baseline), dry and pessimistic climate scenario

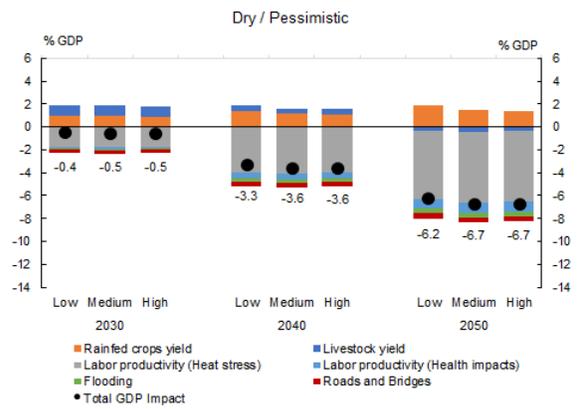


112 Adaptation interventions could produce benefits that exceed the cost of estimated damages if they provide protection against damages that are being incurred in the baseline – i.e., reducing damages from hurricanes that are occurring in the baseline scenario, not just the additional or more intense ones in the further climate change scenarios.

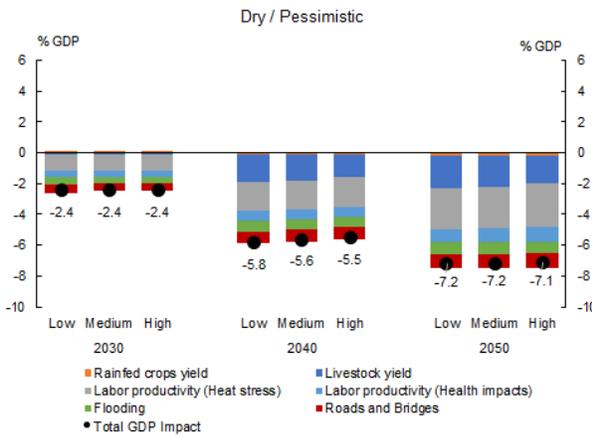
e. MALI, NO ADAPTATION



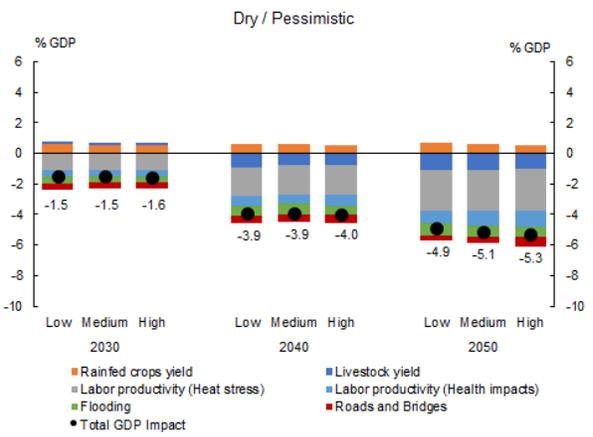
f. MALI, PARTIAL ADAPTATION



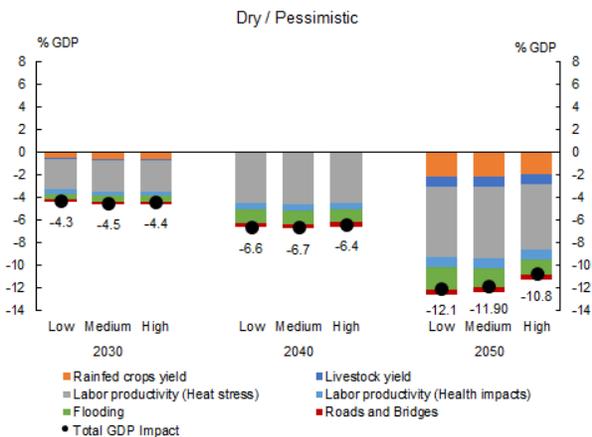
g. MAURITANIA, NO ADAPTATION



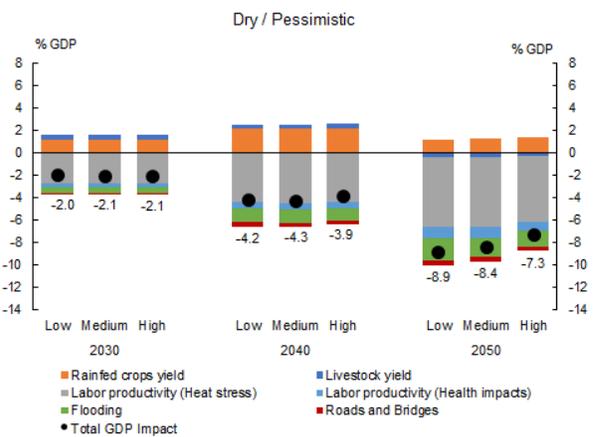
h. MAURITANIA, PARTIAL ADAPTATION



i. NIGER, NO ADAPTATION



j. NIGER, PARTIAL ADAPTATION



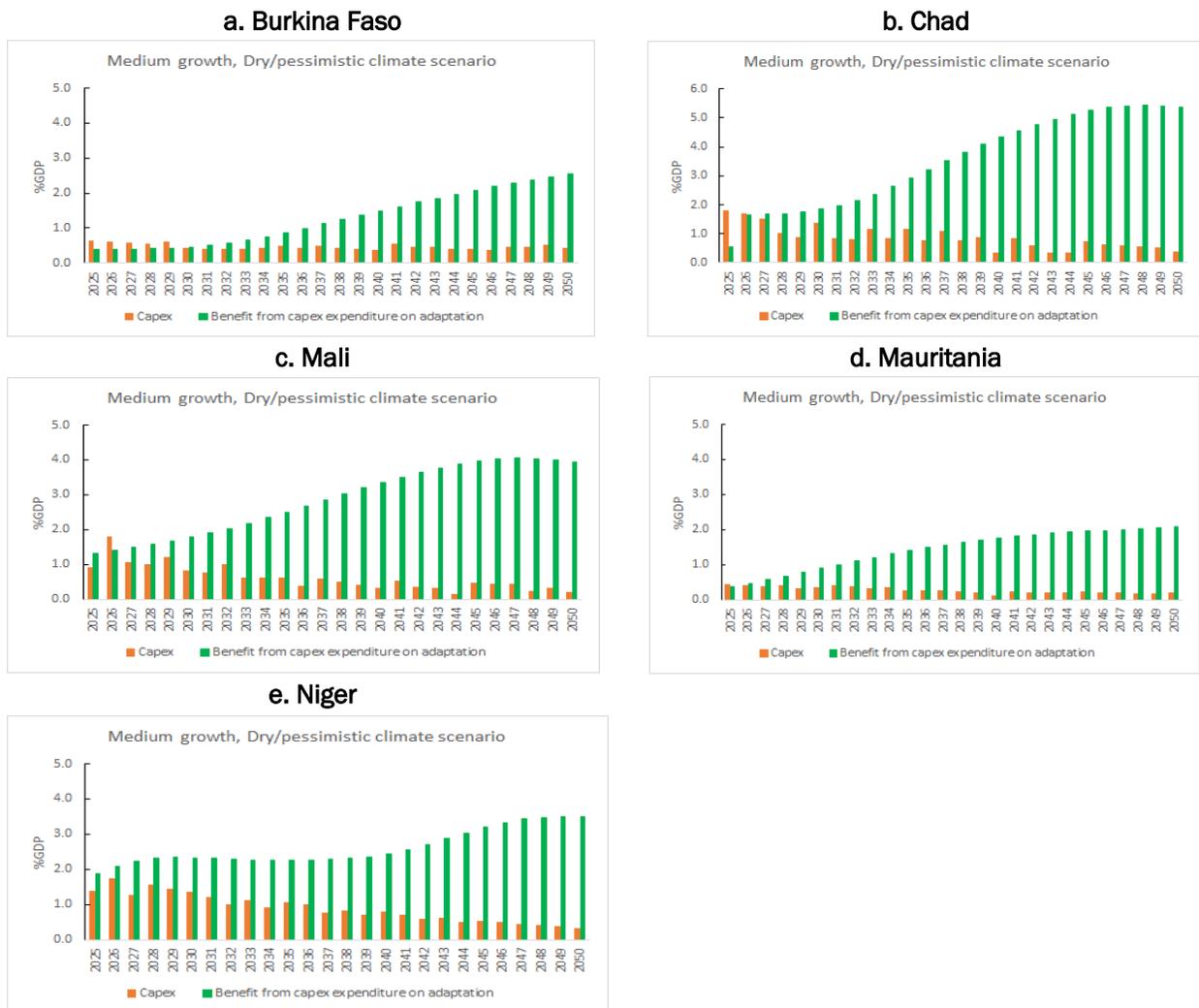
Source: IEC analysis for the World Bank, CC-MFMOD, May 2022.

Notes: The black dots and data labels refer to the Total GDP impact of the combined channels.

The interventions involve significant investments even if the benefits outweigh the costs. Figure 3.10 shows the annual benefits (the reduction in GDP losses between the no adaptation and the partial adaptation scenarios) and the annual investments of partial adaptation modeled over 2025-2050 as a

share of baseline GDP. There are two key observations. First, while the benefits generally outweigh the costs over the period, there is a large variance in the ratio of capital expenditures to benefits. Chad, Mali, Mauritania, and Niger show annual benefits exceeding annual costs from the beginning of the period, while Burkina Faso shows net benefits from 2030 onwards. The adaptation interventions modeled for the purpose of this report have been standardized with little customization for each country. Therefore, the large variation in these results should not be interpreted as showing real differences in the potential for adaptation, but rather highlights the need to customize adaptation interventions to ensure benefits are higher than the costs. Second, the investments required – especially in the earlier years¹¹³ – are significant compared to the countries’ economies and fiscal capacities and would require significant resource mobilization, including from the private sector (see 4 for further discussion).

Figure 3.10 Partial adaptation annual capex and benefits as a share of GDP



Source: CC-MFMOD. IEC.

113 Capex generally falling over time reflects several factors: (i) for roads and bridges as time goes on more and more of the assets are upgraded and armored to withstand climate so the damage costs become much lower. There are re-adaptation costs in those later years, but those costs are much lower than the initial adaptation. For example, if the size of the culvert and drainage is increased to better cope with flooding, then some of that earthwork would not need to be completed after the original adaptation investment.; (ii) learning and innovation reduce the relative costs of adaptation to avoid economic losses.

4 Selected Development and Climate Priorities

4.1 Introduction: Pathway Forward

The G5 Sahel face formidable challenges. As described earlier, Burkina Faso, Chad, Mali, Mauritania, and Niger are among the least developed nations in the world with high levels of political instability, conflict, and violence, and are particularly vulnerable to climate change. But with judicious investments and policies, they can become far more resilient to the impacts of climate change, while also diversifying their economies, raising incomes, and reversing environmental degradation. This chapter offers a pathway to making this potential a reality and enabling the G5 countries to reap the benefits of sustainable and inclusive development.

Imperative of the overall growth agenda

Climate change has made the overall development and growth agenda in the Sahel even more urgent. Sustainable growth is the best form of adaptation, and human capital is essential to achieve sustainable growth. A country that has made a greater structural transformation by shifting away from agriculture to industry and services will be less harmed by climate-related shocks. Moreover, as the analysis in Chapter 3 shows, strong underlying growth will be critical to “offset” the significant economic damages from climate-related shocks and enable an increase in income per capita to reduce poverty. Therefore, in addition to the specific recommendations in this chapter, addressing the constraints to conflict-sensitive growth, job creation, and economic transformation remains a priority in the context of climate change (Box 4.1).

Box 4.1 Growth and jobs policy agenda in the Sahel

With a young and rapidly growing population and workforce, the G5 Sahel economies have not been able to invest enough in human capital to match demographic growth. The lack of social, physical, and natural capital also does not help. Other constraints to growth and job creation are the lack of economic diversification and structural transformation and a difficult business environment (see Annex 2.2.1). As a result, few jobs offer decent incomes, and a high proportion of the young are unemployed, which in turn contributes to further fragility. IFC recently conducted Country Private Sector Diagnostics (CPSDs) in Burkina Faso and Mali, with another for Chad forthcoming. Policy recommendations in each emphasize improving digital infrastructure, while improving transport and logistics was highlighted as a priority in Burkina Faso and Mali. See Annex 2.1.7 for more policy recommendations.

Countries’ capacity to build human capital – improving learning and productivity – and accelerate the demographic transition depends on their ability to better realize the potential of their youth, including those who are most vulnerable. Currently, more than 14 million adolescent girls (80 percent of all girls 10-19 years old) are at risk of child marriage, teenage pregnancy, and early school dropout across the 10 countries in the Sahel. High adolescent fertility in the Sahel is accompanied by high maternal mortality and malnutrition, low levels of education and productivity, and low use of modern contraceptives. Thus, investing in the human capital of children, especially of girls, is essential. Furthermore, for human capital, a resilient growth trajectory will require resilient health and education facilities, preparedness of these for climate shocks, and early warning systems.

Five key areas to prioritize

The chapter provides recommendations, policies, and investments for making gains in five specific areas: Institutions, Climate Financing and Risk Mitigation, Energy, Landscapes, and Cities. These topics do not attempt to cover every sector or issue in these countries. Instead, they were carefully chosen because judicious policies and actions in each of these areas can rapidly stimulate sustainable economic growth over the next five years. They are cognizant of the need to have accompanying human development measures as well as a conflict-sensitive approach to ensure equitable development. They are divided into

categories: two that are cross-cutting, enabling factors (Institutions and Climate Financing and Risk Mitigation) and three that describe specific sectors (Energy, Landscapes, and Cities). The three sectors are highly exposed and vulnerable to climate change impacts and are in urgent need of reforms and investments. For each of the priority areas, a concerted effort on on-the-job training and skills development is needed, with particular attention given to women. Adoption of mobile technologies should be considered for every investment. The chapter also evaluates the World Bank's own ability to make a difference in the region with the existing institutions and delivery model.

Making progress in these areas will not be easy. There are huge development gaps in all G5 Sahel countries, and the cost of successfully adapting to climate change can seem overwhelming. However, as shown in Chapter 3 of this report and in many other studies, the costs of *inaction* are too high. Moreover, addressing climate change with both adaptation and mitigation is inextricably linked to – and one of the essential elements of – a comprehensive development strategy.

4.2 Five Priority Areas for Next Five Years

4.2.1 Two Priority Cross-Cutting Issues: Institutional Capacity and Climate Financing

At the core of climate action, the G5 Sahel countries must strengthen institutions and mobilize the necessary financial resources. Even with the best sectoral plans, the lack of institutional capacity in the G5 Sahel countries is the most critical barrier for action.

4.2.1.1 Institutional capacity and delivery model

The governance and accountability systems in the G5 Sahel countries need to be reinforced. A new social contract, involving a fundamental review and reimagining of stakeholder roles, is needed to overcome endemic political instability and channel the countries' young energy to more productive uses. In particular, the effectiveness of policies and measures to reduce climate change impacts depend on the participation and collaboration of the groups most vulnerable to those impacts.

Recommendations for institutional strengthening include:

- Build the institutional foundations that are essential for both development and effective climate action, especially planning and monitoring of budgetary processes, managing land governance, and strengthening social protection systems.
- Clarify the roles and responsibilities for climate action among the many government agencies, paying particular attention to *planning and finance* functions. Deploy public resources and civil servants beyond capital cities and move towards climate-smart investments, public procurement, and public asset management.
- Identify and support the specific areas of technical expertise needed in the key agencies for climate action, paying particular attention to program design skills and implementation capacities. Establish a centralized, open-access country-focused technology portal, and define a robust coordination mechanism across agencies, sectors, geographies, businesses, and populations, and build capacities to help inform strategic decision-making on climate-related financial risk management.
- At the local level, build inclusive institutional processes that support climate action in a conflict-sensitive manner and promote social cohesion and the inclusion of all groups, including marginalized ones.

The traditional World Bank portfolio delivery model must overcome significant technical, organizational, institutional, and regulatory challenges to help overburdened public sectors disburse aid faster. Given the urgency, governments might delegate oversight and leadership roles to capable stakeholders. The World Bank and Delivery Partners must also work more effectively at the local level and with the private sector, and do more to help governments and the private sector access, mobilize, and leverage new climate financing for the large-scale programs needed today.

4.2.1.2 Increasing Financing for Climate Action

The G5 Sahel countries need to mobilize additional finances from international, private, non-governmental, and national sources, while also making more effective use of their existing financial resources. The CCDR highlights how governments can mainstream climate considerations into existing budgeting and planning processes, and how the private sector may be increasingly mobilized (Annex, 2.1.5). Domestic public resources, even with expanded support from traditional donors, are not enough; climate finance and the private sector must provide significant new investment.

Using existing national resources – government and household – but more climate informed

As described in Chapter 1, the ability to finance climate investments from government borrowing is limited because of rising deficits and debts and increased defense spending to meet security challenges. More can be done, however, to ensure that existing spending takes managing climate impacts into account.

In addition, it is critical to enable small firms and households to adapt to climate change and to improve their resilience, using such financial protection mechanisms as scalable safety nets and risk transfer instruments like insurance or national disaster funds (see Chapter 2 and Annex 2.1.11 and 2.2.1-6).

Recommendations for actions that can be taken quickly – in the next three years – include:

- Strengthen the governments' financial resilience to natural disasters with pre-arranged risk retention, risk sharing, and risk transfer instruments that provide rapid, cost-efficient liquidity in the aftermath of climate shocks. These include social safety nets and disaster funds, insurance (agriculture and infrastructure), and contingency financing such as the Bank's catastrophe deferred drawdown option instrument (CAT-DDO).
- Explore the use of the IMF Special Drawing Rights and the Resilience and Sustainability Trust for climate action financing, including "debt-for-adaptation" swaps.
- Accelerate the roll-out of mobile money and Digital Financial Services (DFS).

Additional policies that could be implemented in the medium term (by 2030) include:

- Improve access to finance for resilience by leveraging digital financial services and using regional risk pooling solutions for social safety nets.
- Increase access to finance, including climate insurance and risk mitigation products, and support resilience of microfinance institutions particularly in conflict-affected areas, to ensure wide outreach in rural areas.
- Adopt systems for transparent monitoring of and decision-making for the national budget allocation for priority climate actions and strengthen anti-corruption initiatives.

Increasing private finance

With the geopolitical situation across the G5, the scope for increased concessional external loans is uncertain and climate investments would be difficult to fully finance without private sector involvement. In order to attract large-scale private finance under challenging conditions, the WBG (IDA, MIGA and IFC) and WB Treasury know-how and convening power should be leveraged. The greatest potential in the G5 Sahel is likely for renewable energy. The CCDR team has worked with WB Treasury to devise a potential loan structure, on concessional terms, that could advance projects in renewable energy (Box 4.2 and Annex, 2.1.5).

Recommendations to attract large-scale private sector project finance in the next three years include:

- Convene a private sector roundtable with investors, developers, governments, and donors to resolve barriers to climate investments, specifically around energy access, and establish a donor-funded technical assistance and capacity facility to help identify bankable projects.
- Develop a clear and transparent strategy to use limited concessional resources to leverage private capital through blended capital investments, and reach out to development partners on possible access to concessional funding under the Desert to Power initiative.

Recommendations for actions by 2030:

- Use green and sustainable bonds (by sovereigns or regional development banks) for new climate projects.
- Develop regional cooperation and a regional approach for risk financing.

Increasing climate finance

Although the benefits of the climate action measures proposed in the CCDD are typically much higher than the costs, the G5 countries have so far benefited little from climate adaptation and mitigation finance. Recommendations for increasing climate finance in the next three years include:

- Implement the commitments made in Glasgow by developed nations to double adaptation finance by 2025.
- Support countries in delivering on their NDCs by linking NDC commitments to WB policy and project finance, beyond climate co-benefits.
- Mobilize climate trust funds to mainstream climate considerations into existing decision-making in Ministries of Finance, Economy, or Budgeting.

Over the medium term (by 2030):

- Develop the capacity, regulations, and institutions to support the preparation of projects and programs that can access climate finance and benefit from revenues potentially available in carbon markets and leverage new private sector financing.
- Explore opportunities for mitigation finance, such as payments for emissions reductions, in renewable energy and transport.

4.2.2 Three Priority Sectors: Energy, Landscapes, and Cities

The following section describes three important sectors and how the suggested policies and investments can help the region address the problems and take advantage of the opportunities within each sector.

4.2.2.1 Energy

Only a third of the population in the G5 Sahel countries now has access to affordable, reliable electricity. Providing universal access can transform the countries, bringing economic growth, business opportunities, and health benefits from reduced pollution. Fortunately, there are abundant renewable energy resources in the region and technologies such as grid-scale solar are often the least-cost option, offering the G5 Sahel countries an opportunity to move away from a heavy reliance on expensive oil-fired generation, inefficient operations with high network losses, and weak sector finances due to poor collection rates.

In addition, providing modern energy cooking services for the 80 million people that do not have access can reduce both diseases from air pollution and deforestation.

Policy recommendations for renewable energy:

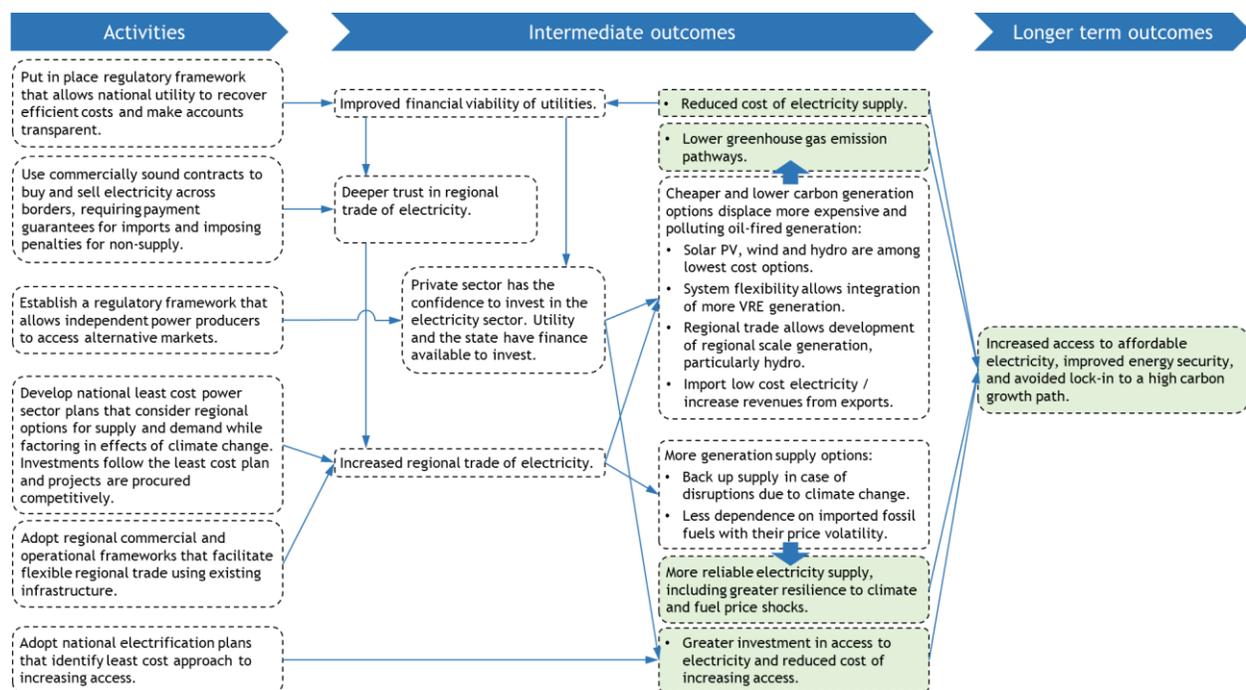
Policies and program actions that can be taken in the next three years to help the G5 Sahel countries achieve universal access to cheaper, more reliable, and more sustainable power include (see also Figure 4.1):

- Adopt national electrification plans that scale up the development of least-cost renewable energy projects and the transmission lines needed to deliver electricity equitably.
- Put in place institutional, legal, and regulatory frameworks that attract independent power producers to access markets.
- Strengthen governance mechanisms to improve the operational and financial performance of utilities and foster regional trade.

Over the medium term (by 2030), countries could:

- Develop business models to encourage the electrification of schools and health centers, and to attract long-term investment, including provisions for maintenance services, remote monitoring, and incentives to extend coverage to more remote areas.
- Deepen regional integration and develop cross-border plans and regulations to identify least-cost power generation and expand trade across borders, making it easier and cheaper to integrate large amounts of variable renewable electricity (VRE) in the electricity grid, as the WB has shown (see Annex, 2.1.1).
- Explore other technologies when using renewably-produced electricity, such as biogas or green hydrogen.

Figure 4.1 Summary of the policies and actions that can create a reliable, low-carbon power system with expanded access to electricity



Note: currently, Burkina Faso, Mali, and Mauritania are heavily reliant on imported liquid fuels for electricity generation. Niger imports most of its electricity needs from Nigeria, supported by local generation based on expensive diesel fuel and low-cost coal. Chad has a small power sector that relies heavily on locally refined liquid fuels.

Investment opportunities and needs for renewable energy:

Many of the utilities in the region are in a dire financial condition, restricting their abilities to invest in maintaining the grid, expanding access, and putting the countries' power sectors on a low-carbon growth path. As a result, private sector financing is urgently needed to complement the financial resources of the utilities and the state sector. National governments must therefore create an enabling environment for private sector participation in their power sectors. Putting utilities on a sound financial footing will free up resources for investment by the utilities and the state, while making them more attractive to private sector investors. Table 4.1 shows the investments needed for each country, while Box 4.2 describes actions that can be taken in the short and medium term.

Table 4.1 Estimated investment needs and new electricity connections required to reach universal access by 2030

Country	Investment (US\$ million)				Total new connections	Grid	Off-grid
	Grid	Mini-Grid	Standalone	Total			
Burkina Faso	1,247.5	2,363.1	923.7	4,534	4,488,898	47%	53%
Chad	413.6	4,232.6	602.1	5,248	3,983,813	16%	86%
Mali	1,880.0	325.6	422.3	2,628	3,770,000	78%	22%
Mauritania	430.7	99.0	87.5	617	839,658	73%	27%
Niger	1,674.7	2,765.1	797.5	5,237	6,106,268	52%	48%

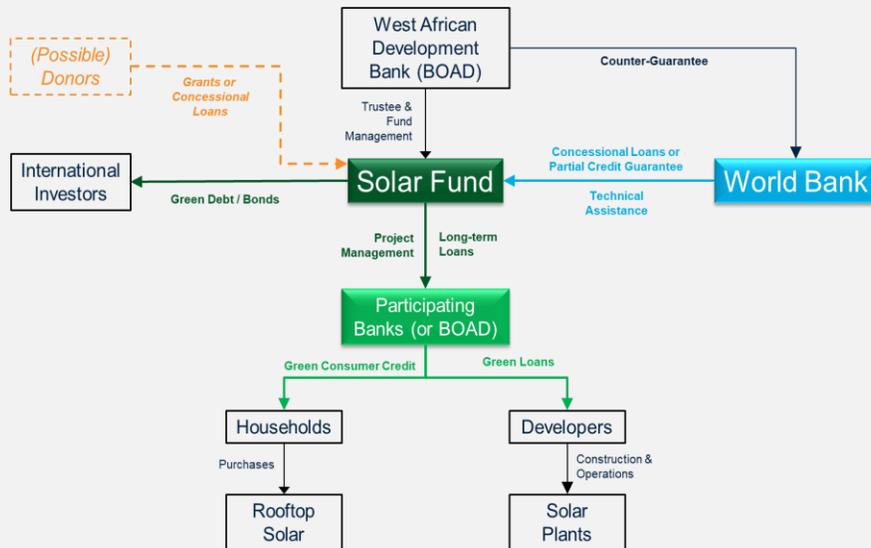
Source: Energy LEAP (2020)

Box 4.2 Increasing financing and private sector engagement in renewable energy

Taking full advantage of the enormous potential for renewable energy in the five Sahel countries and increasing access to electricity will require massive investments and significant private sector engagement in solar and wind power generation. The estimated investments needed to reach the goals in countries' NDCs range from US\$7 billion in Burkina Faso to US\$44.9 billion in Mauritania by 2030. In addition, financial solutions and policies are needed to reduce the risks for private sector developers of renewable energy projects.

The most significant potential source of financing is blended concessional lending from multiple donors or multilateral development banks, since one institution alone cannot provide the investments needed. Examples of such blended financing already exist, such as in the Great Green Wall (GGW) and Desert to Power initiatives. Moreover, several new financial institutions are expanding their activities to Africa, including the European Investment Bank (EIB) and the first Asian Infrastructure Investment Bank.

The Sahel countries also can raise public financing for specific renewable energy projects through financial instruments such as green, sustainable, and sustainability-linked (GSS) bonds. The combination of blended concessional finance with some public financing should then be sufficient to attract private capital into sectors with strong commercial potential, such as solar power (see Figure).



Another challenge is that private sector renewable energy developers also face considerable risks, such as market uncertainties, interest rates, climate change, and political instabilities. To reduce those risks, the Sahel countries could provide insurance for various liabilities, derivatives for weather events and financial risks, and guarantees. In addition, successful demonstration projects will be especially critical to increasing the amount of external private capital flowing into the region.

A practical next step is a deeper analysis, including consultations with investors, financiers, lawyers, developers, governments, and donors, to explore the challenges and opportunities of solar and wind power development in the Sahel.

Policy recommendations for clean cooking:

The clean cooking market is still nascent in most of the G5 countries (except for Mauritania). Major drivers of households' lack of access include the lack of alternative affordable solutions, low awareness, and unaffordability. It is therefore important to take an integrated approach by working across sectors, by tackling both supply and demand, and by creating an enabling environment for clean cooking market development.

Recommendations for short-term actions include:

- Include clean cooking in the Sahel region's climate agenda, scale up public and private financing for clean cooking, and leverage existing business models and clean energy businesses.
- In each country, make clean cooking part of national energy planning. The effort needs to be led by a designated institutional champion responsible for coordinating with key stakeholders, with accountability for achieving results.
- Develop and enforce regulations and standards that promote market development for clean cooking solutions, and provide targeted subsidies to low-income households.

Actions over the medium term (by 2030) include:

- Incentivize sustainable biomass for cooking through reforestation, which will also reduce deforestation.
- Leverage results-based financing (RBF) to create incentives for private-sector investment and deliver clean and efficient cooking solutions with pre-defined result levels and triggers for payment.
- Expand data collection efforts and monitor progress.

Investment opportunities and needs for clean cooking:

To achieve the clean cooking targets set out by the G5 Sahel countries, a total investment of around US\$493.1 million is needed each year, including US\$241.5 million for Burkina Faso, US\$36.3 million for Chad, US\$67 million for Mali, US\$113.4 million for Mauritania, and US\$34.9 million for Niger (Table 4.2). Specifically, it is estimated that approximately US\$145.3 million is needed from the public sector to fund awareness raising and technical assistance as well as providing subsidies to ensure that improved or modern cooking solutions can be afforded by the poorest. Another US\$20.9 million is needed from the private sector to install downstream infrastructure for the functioning of modern energy cooking markets, and the rest would come from households' direct contributions.

Table 4.2 Estimated investment needs by sector and household direct contributions to reach clean cooking targets in G5 Sahel countries by 2030

Country	Clean cooking targets	Annual investment (US\$ million)	Public	Private	Household
		Total			
Burkina Faso	Universal access in urban areas and 65% in rural areas 2030 LPG urban penetration of 68% by 2030. ¹¹⁴	241.5	97.0	13.0	131.5
Chad	Distribute 3,000,000 improved wood-burning stoves and 1,500,000 charcoal-burning stoves. ¹¹⁵	36.3	8.6	N/A	27.7
Mali	Universal access. ¹¹⁶	67.0	16.0	N/A	51.0
Mauritania	100% access to LPG in urban areas and 50% access to LPG in rural areas.	113.4	15.4	7.9	90.1
Niger	100% urban penetration of improved cookstoves (ICS) and 30% rural. Support to biogas and biofuels. ¹¹⁷	34.9	8.3	N/A	26.6
Total		493.1	145.3	20.9	326.9

The estimated benefits of achieving the clean cooking targets, however, are 20 times higher than the estimated total investments and 69 times higher than the amount of public financing. The majority of the benefits are due to avoided deaths and disabilities. In addition, the gender benefits are estimated at US\$3.15 billion per year, primarily because of the time women would save collecting fuel and cooking, and the climate benefits are estimated at US\$1.08 billion per year, due to reductions in greenhouse gas and black carbon emissions. Achieving the clean cooking targets also would contribute to the G5's climate adaptation by reducing reliance on charcoal and fuelwood, by providing vulnerable populations with alternative clean cooking solutions, and by aligning policies, data, institutions, behaviors, and finance for more green, resilient, and inclusive development.

The World Bank has analyzed a scenario for providing universal access to clean cooking in all Sahelian cities and increasing rural access to 100 percent Mali, 65 percent in Burkina Faso, 77 percent in Chad, 50 percent in Mauritania, and 30 percent Niger by 2030. Compared to business as usual, the results show that women would save 230 to 440 hours per year, labor hours lost to illness would drop from 42 million for Mauritania to 630 million for Burkina Faso by 2050, and the area of forests and shrublands

114 The Global LPG Partnership (2017).

<https://static1.squarespace.com/static/5633c4c2e4b05a5c7831fbb5/t/5acbc7d6562fa79982af9a6a/1523304406277/National+and+Regional+Targets+for+Clean+Cooking+Energy+Access+in+Africa+by+2030.pdf>.

115 Chad Nationally Determined Contributions (NDC), October 2021.

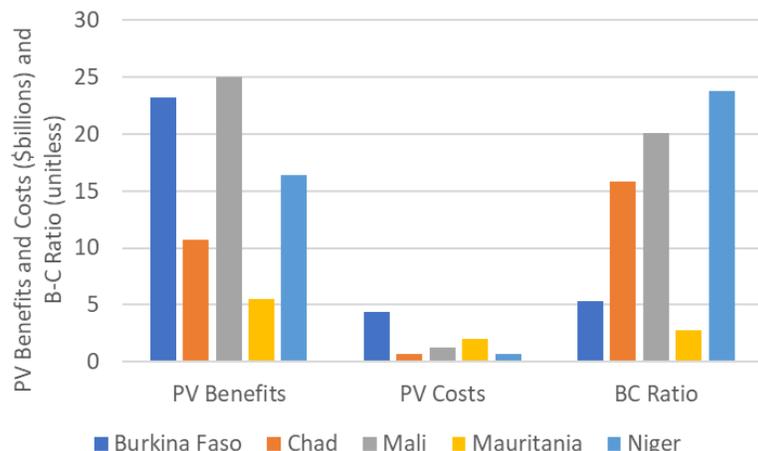
<https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Chad%20First/CDN%20ACTUALISEE%20DU%20TCHAD.pdf>

116 SEforALL Africa Hub (2021), Mali Country Overview, <https://www.se4all-africa.org/seforall-in-africa/country-data/mali>

117 SEforALL Network (2015), Niger Country Overview, <http://www.se4all.ecreee.org/content/niger>

would increase by 2 million hectares by 2050, bringing enhanced ecosystem services. Overall, the benefits far outweigh the costs (see Figure 4.2). Full details are in the Annex, 2.1.8.

Figure 4.2 Present value (PV) benefits and costs of clean cooking investment program and benefit-cost (B-C) ratio, 2023-2050 (discount rate of 3%)



4.2.2.2 Landscapes – the importance of connecting the environment, water, and agriculture

Climate change is adding to the threats facing the main natural capital components of landscapes: environment, water, and agriculture. Reversing these trends requires policies designed to accomplish five main goals: (i) promoting innovation, such as in the greater use of climate-smart agriculture; (ii) increasing the availability and access of natural capital (particularly for women); (iii) making systems more efficient and sustainable; (iv) boosting equity and inclusion, so that marginalized groups are not left behind; and (v) strengthening transparency and accountability. The Sahel is also at the edge of its adaptation capacity for some living organisms.¹¹⁸

Poorly managed natural capital is an ecological, social, and economic liability, because it drives biodiversity losses and reduces productivity. Over time, it also weakens resilience to extreme climate events and, ultimately, contributes to unsustainable livelihoods (characterized by food insecurity, intra- and inter-community conflicts over access to and use of shrinking natural resources, gender inequality, regional disparities, and population displacement). Poorly managed natural capital can have a negative impact on agriculture and water availability and quality.

Policies and investments for landscapes should bolster natural capital (the environment) and improve water retention (for domestic or agriculture use) and organic matter in soils for agriculture. Policy and investment needs for environment, water, and agriculture should be considered together and not in silos by development partners. In addition, social aspects should not be overlooked. Communities bring a wealth of local knowledge to the challenge of strengthening resilience. Particular attention to women and pastoralists is key; so is creating inclusive processes for local dialogue at the community level. Landscape interventions should also be considered alongside other development lending opportunities; for example, cash-for-work programs could be aligned with landscape restoration objectives.

A key recommendation for improved landscapes management is to support the professionalization of local communities and vulnerable groups, including initiating or continuing the formalization of the productive sectors (exploitation, processing, training, marketing, and trade) for these resources. The landscape approach means that some of the environment, water, and agriculture sections below overlap,

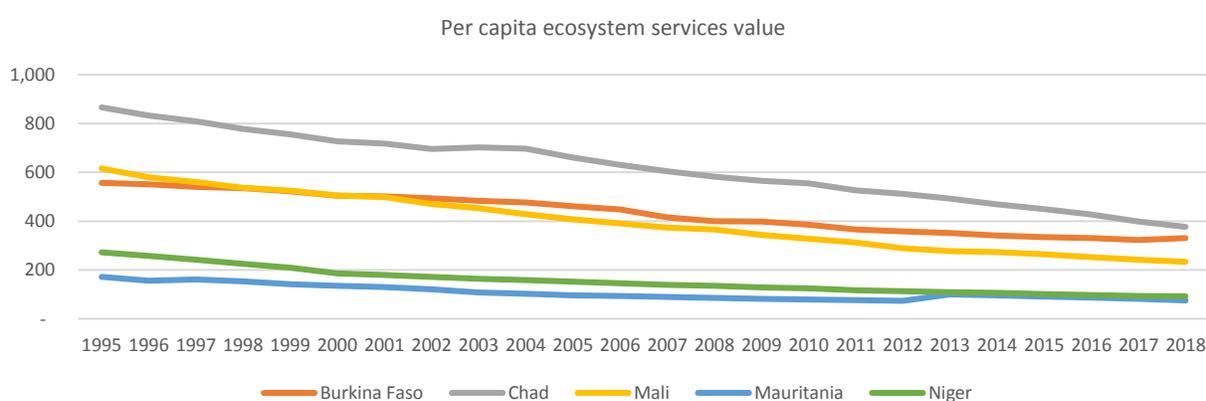
¹¹⁸ Ellison D. and Speranza C. 2020. From blue to green water and back again: Promoting tree, shrub and forest-based landscape resilience in the Sahel. *Science of the Total Environment* 739.

and some of the bullets listed in one section are relevant in others. All recommendations need to be ESG- and climate-informed, as well as conflict- and gender-sensitive.

4.2.2.3 Environment – The Fundamental Basis of Natural Capital

Natural capital provides humans with essential *provisioning services* (products such as food, freshwater, wood, fibers, and medicinal plants); *regulating services* (including surface water purification, carbon storage and sequestration, climate regulation, and protection from natural hazards); *cultural services* (including natural areas that are sacred sites and areas of importance for recreation and aesthetic enjoyment); and *supporting services* (including soil formation, nutrient cycling, and primary production). Healthy natural capital and forest ecosystems are also needed for adaptation, yet trends are moving in the wrong direction (Figure 4.3).

Figure 4.3 Per capita forest ecosystem service values (1995-2018) (in constant 2018 US\$)



Source: *Changing Wealth of Nations (CWON) 2021*. World Bank.

Policy recommendations for actions in next three years:

- Ahead of investments, map the mosaic of different land uses (agricultural, pastoral, forests, grasslands, and settlements) and identify the investments that would maximize natural capital and productive uses through an integrated landscape approach based on sustainable management of the land.
- Continue or initiate policy reforms and investments to scale up re-greening, including local land use participatory planning in the Great Green Wall Initiative (GGWI) countries.

Policy recommendations for actions in the medium term (by 2030):

- Ensure funding for universities or specialized regional research centers promoting education in landscape management with climate-change integrated, and ensure social inclusion of women and marginalized groups to promote better management of natural and land resources and prevent or reduce conflicts.
- Strengthen the key pillars of the landscape approach through: (i) *Participation*: involving local communities, especially marginalized groups like women; (ii) *Governance*: including clarity of land rights, access to funding, and integrating climate resilience; and (iii) *Sustainability*: empowerment and capacity building, addressing conflict-sensitive land interventions, and assuring resilience to climate impacts.

Investment opportunities in the next three years:

- Scale up investments in restoration, building on re-greening successes such as the Sahel and West Africa Program (SAWAP) and complementing large-scale ambitions such as the GGWI (Box 4.3 and Table 4.3).
- Develop or strengthen agroforestry value chains to enable farmers to benefit from both crop and tree products, as well as realizing other benefits from re-greening (shade provision, wind shelter, soil retention, and water retention).

Investment needs by 2030:

- Aggressively scale up sustainable land management practices to build land and livelihood resilience against climatic shocks, and to integrate the multiple ecosystem benefits (including carbon storage) of restoration.
- Redesign local economies to make them more productive areas focused on growing markets and exports. For these investments, adopt technology to map the mosaic of different land uses (such as agricultural, pastoral, forests, fishery, foraging, hunting) and identify the investments that would maximize both natural capital and productive uses, and align these with community expectations.
- Make grassroots investments aimed at enhancing people's lives by creating employment opportunities, building local capacity, and promoting dialogue, incorporating local aspirations into a landscape vision, capitalizing on local technical know-how and savvy, and reaffirming cultural identities.
- Invest in monitoring systems to assess and monitor natural resources, including activities and their impacts. This should be accompanied by a technical assistance program to build the professionalization of the community in managing their landscapes.

Table 4.3 Land restoration investments targeted for the G5 Sahel to 2030

	INDICATIVE ANALYSIS OF LAND RESTORATION NEEDS IN THE G5 SAHEL TO 2030			
	% area (indicative)	Surface area (ha)	Cost/ha ¹¹⁹	Total Cost (US\$ million)
Cropland	50	7,500,000	366	2,745
Grassland	20	3,000,000	366	1,098
Shrubland	10	1,500,000	204	306
Woodland	15	2,250,000	204	459
Forest	4	600,000	870	522
Wetlands	1	150,000	5877	881.5
		15,000,000		6,011.5
	INDICATIVE ANALYSIS OF TA IN THE G5 SAHEL TO 2030			
Technical assistance				480
TOTAL				6,491.5

119 Mirzabaev, A., Sacande, M., Motlagh, F., Shyrokaaya, A. and Martucci, A. 2022. Economic efficiency and targeting of the African Great Green Wall. Nature Sustainability, Vol. 5, 17-25.

Box 4.3 The Great Green Wall Initiative - Support from the World Bank

The Great Green Wall Initiative (GGWI) is an African-led coordinated effort across the Sahel-Saharan region to restore and sustainably manage land, water, and other natural resources, addressing both the damage to the natural environment and poverty. By 2030, the GGWI aims to restore 100 million hectares of degraded land, sequester 250 million tons of carbon, and create 10 million jobs in rural areas.

The initiative was created in 2007 under the auspices of the African Union. It includes 11 countries: Burkina Faso, Chad, Djibouti, Ethiopia, Eritrea, Mali, Mauritania, Niger, Nigeria, Senegal, and Sudan. Since 2007, the GGWI has evolved into a broader ecosystem management approach, aiming to build resilient landscapes, improve livelihoods, and boost economic opportunities for communities.

New commitments launched at the One Planet Summit helped to renew interest in achieving the GGWI goals. Numerous partners have pledged support, including the UNCCD, GCF and IFAD, AFD, and the Sahel Alliance. The World Bank committed to invest US\$5.6 billion between 2021 and 2025 in the 11 countries through 60 projects in a number of sectors (Agriculture, Environment, Energy, Jobs, Social protection, and Information Technology) that promote sustainable development.

4.2.2.4 Agriculture, Livestock, and Fisheries

The agriculture sector in the G5 needs a radical overhaul. In several of the G5 Sahel countries, it is by far the largest employer and not insignificant generator of GDP. However, productivity is low and the sector is highly vulnerable to climate change. The overhaul should achieve major sustained increases in productivity through expanded sustainable land management practices; enhanced availability and adoption of climate-resilient production technologies and practices in cropping, livestock, and fishing systems; expanded access to finance and financial risk management services; and effective preservation of agrobiodiversity. Interventions designed for and targeted to women farmers are particularly important.¹²⁰

Given the importance of livestock and fisheries in rural livelihoods and nutrition, it is vital to stabilize and expand the availability of, and the access to, sustainable feed and water. Improved livestock health is also crucial. In the fishing industry, overfishing and degradation of fish habitats must cease. Increased access to markets based on improved infrastructure and market information systems is critical to value chain development for expanded livelihoods. Efficient and effective research and extension systems are important, alongside effective disaster early warning, preparedness, and response systems.

Implementing improvements in agriculture, livestock, and fisheries is challenging, given both existing issues and the growing impacts of climate change. Rainfall is becoming increasingly erratic and poorly distributed, with extreme droughts and floods more widespread and frequent. Crop choices will need to respond to the shifts in land availability and suitability caused by climate change – and the impacts will vary among countries.¹²¹ Therefore, investments and policies in the agriculture sector need to react to changing conditions and are likely to vary based on location.

In general, the productivity in major cropping, livestock, and fishing systems is stagnant or falling due to lack of climate-resilient and climate-smart technologies and management practices, high pest-related production losses, declining soil fertility, and declining agrobiodiversity with the loss of local varieties and

120 In Mozambique, adding modules on “personal initiative training” that emphasize perseverance and problem-solving to traditional extension services led to increases in women’s investment in inputs, adoption of conservation farming practices (taught during the agricultural extension program), cultivation of cash crops, and creation of off-farm businesses (thus accelerating the process of structural transformation).

121 The State of the World’s Land and Water Resources for Food and Agriculture – Systems at breaking point. Synthesis report 2021. Rome. <https://doi.org/10.4060/cb7654en>

breeds. Food production deficits are leading to low stocks, high demand, and high prices. In addition, agricultural research and extension systems are poorly resourced. Trained veterinary and fishery personnel, materials, and equipment are lacking, leading to poor animal health and over-exploitation of fish stocks. Prices of agricultural inputs are high, and seed producers are reluctant to enter the market, limiting crop choices for farmers.

Rangelands and watering points, particularly important for pastoralism, are increasingly depleted, spurring irregular interaction, competition, and even conflict between pastoralists and farmers for land and water in remote areas. Farmer organizations are weak. Women have unequal access to productive resources and technologies. Within and across borders, trade is highly informal and opaque. Market and value chain infrastructure, organization, and information capacities are weak, leading to limited private sector investment.

Fisheries are also facing significant challenges. Lake Chad has lost more than 90 percent of its surface area due to increased water use, changing rainfall patterns, and rising temperatures, for example. That has reduced fisheries productivity and increased disputes over access to water, fisheries, and land ownership.¹²² Meanwhile, Mauritania's hugely important continental fisheries, among the richest fishing grounds in the world and accounting for 10 percent of the country's GDP and 50 percent of its export earnings,¹²³ are suffering from over-exploitation, with catches at 30-40 percent above the maximum sustainable yield.

One particularly effective strategy for improving productivity and resilience across the agriculture sector is improving and expanding irrigation. Less than 1 percent of the total cropland in the G5 Sahel countries (about 600,000 hectares) is equipped for irrigation – and in 40 percent of that area, irrigation systems have fallen into disrepair. Because irrigation can double yields compared with rainfed agriculture, a major rehabilitation and expansion can counter the crop yield losses expected from climate change impacts. Indeed, greater irrigation is crucial to expanding food production enough to meet the projected food needs of the growing population. An estimated US\$2 billion is needed to rehabilitate 243,000 hectares of both large- and small-scale irrigation systems, and more than US\$13 billion¹²⁴ is needed to expand irrigation to 1 million additional hectares. Developing irrigation from shallow alluvial groundwater would increase productive land by 3-4 million hectares.¹²⁵

To keep pace with the consequences of socioeconomic trends, the land area dedicated to crops would need to slightly increase through 2050, and agricultural production would need to increase significantly. Climate change, however, will both lower productivity and increase agricultural commodity prices, in part because of increased use of biomass for energy. These results highlight the need for an effective management system to plan for land use and to reduce the pressure on the land system from increased demand for bioenergy.

In response to the rising food prices and growing food insecurity in the region, it will be important to avoid putting in place food subsidies, price controls, and trade restrictions. These measures are fiscally unsustainable and can worsen the problem by hindering timely producer and supply responses to rising prices. Trade restrictions such as food export bans are hard to enforce in practice and are often counterproductive when trading partners retaliate with similar measures, driving up food import prices across the board. Instead, countries are encouraged to strengthen social safety nets to mitigate the impact of commodity price increases while addressing the underlying drivers of food insecurity, including removing barriers to regional food trade, increasing investments to make agricultural food production more resilient to climate shocks, and strengthening the food storage and logistics chain.

122 Climate Risk Profile: Sahel, UNHCR, PIK. Available at: <https://www.unhcr.org/61a49df44.pdf>.

123 Climate Change Profile West African Sahel © Ministry of Foreign Affairs of the Netherlands | April 2018

124 Based on the actual average investment costs of the PARIIS project

125 British Geological Survey Map

Policy recommendations for action for the next three years:

- Professionalize farmers, including smallholder and women farmers, and disseminate information and assistance to (i) adopt effective practices such as improved soil, water, and agronomic practices, (ii) increase the uptake of relevant irrigation technologies; (iii) improve crop selection (such as using drought-tolerant varieties); and (iv) mainstream the use of early warning system and hydro-meteorological information for enhanced productivity and resilience of farms.
- Reform land tenure policies, strengthen women's formal land rights, secure land titles and support inclusive land management and conflict resolution mechanisms at the local level as the basis for increased investment and productivity of croplands and pastoral lands.
- Liberalize fertilizer supply and promote efficient distribution by the private sector.

Policy recommendations for actions by 2030:

- Scale up adaptation programs, ranging from stronger strategic grain reserves and management systems for food crises to crop and livestock insurance schemes, effective food storage systems, and more robust extension and advisory services specialized in climate adaptation and resilience.
- Invest in sustainable land husbandry, animal nutrition, vaccines, and improved veterinary services, as well as sustainable fisheries practices for more resilient livestock and fisheries sectors.
- Develop and strengthen agroforestry value chains to enable farmers to benefit from crop and tree products and reap other benefits from re-greening.
- Expand efficient irrigation systems and water harvesting practices.

Investments that can be made in the next three years:

- Increase productivity and resilience for crop production and systems, for animal resources and production systems including pastoralism, and for nutrition-sensitive agriculture through sustainable, diversified, and integrated crop, livestock, and fish production systems. For many of these, the goal should be use by at least 60 percent of farmers (40 percent of them women). Weather and climate services, and early warning systems to deal with climate and other shocks, need to be put in place alongside strategic grain reserves and effective disaster risk management systems in farm communities to reduce food insecurity.
- Enhance professionalization of farmers and technology transfer by providing improved extension and advisory services with private involvement; by formalizing structures and service delivery; and by increasing adoption of digital technologies and contract farming.
- Factor in social conflict risks in agricultural investments and guarantee an equitable and accepted distribution of the resources created that is inclusive of pastoralist production modes.

Investment opportunities and needs by 2030:

- Improve trade and agricultural market systems, reduce post-harvest losses, and increase value addition and competitiveness of diversified agricultural commodities, for domestic, regional, and international markets.
- Build a strong demand-driven research sector for crop improvement and husbandry, animal resources and fisheries improvement, and soil and water management that develops and disseminates locally adapted inputs, technologies, and innovations to improve productivity and mitigate risks.
- Strengthen the enabling environment and responsive institutions for effective and efficient public and private sector services in the agriculture sector. Plans and strategies should include evidence-based regulatory frameworks, capacity building in climate-smart agriculture, and development of PPPs.

Table 4.4 Investments needed in agriculture and fisheries

INDICATIVE ANALYSIS OF INVESTMENT NEEDS FOR THE DEVELOPMENT OF THE AGRICULTURE AND FISHERIES SECTORS IN THE G5 SAHEL TO 2030	
	Total Cost (US\$ million)
1. Increase productivity and resilience through sustainable, diversified, and integrated crop, livestock, and fish production systems.	8,000
i) Crop production and systems	6,800
ii) Animal resources and production systems	1,000
iii) Nutrition-sensitive agriculture	50
iv) Weather and climate services, early warning, and response	150
2. Build a strong demand-driven research sector that develops and disseminates locally adapted inputs, technologies, and innovations to improve productivity and mitigate risks.	100
3. Enhance professionalization of farmers and technology transfer.	700
4. Improve trade, agricultural market systems, and increased value addition and competitiveness of diversified agricultural commodities, for domestic, regional, and international markets.	800
5. Strengthen the enabling environment and responsive institutions for effective and efficient public and private sector services in the agriculture sector.	100
TOTAL	9,700

4.2.2.5 Water Security

There is an urgent need to invest in diversifying water resources, increasing recharge and storage, and promoting the sustainable use of water to safeguard future consumption.

Policy recommendations (next three years):

- Develop better information and support for resilient water storage infrastructure planning and improved water resources management.
- Improve water productivity by strengthening water governance and formalize a policy framework for integrated water resources management (IWRM).

Policy recommendations (by 2030):

- Assess and rehabilitate, if necessary, the many existing hydraulic structures, including dams, hydro-agricultural infrastructure, and water supply systems.
- Adopt a multi-sectorial approach to watershed planning so that all stakeholders are onboard to allow for rapid economic and sustainable development.
- Diversify and make more resilient all possible water sources by: (i) leveraging both surface water and groundwater; (ii) developing multipurpose large- and medium-scale storage facilities alongside rainwater harvesting and storage at the local level; (iii) investing in nature-based solutions, such as forest and wetland restoration, to regulate flows and reduce floods; and (iv) coordinating extraction and use of water through integrated water resources management plans.

Investment opportunities and needs possible by 2030:

- Diversify water sources by mobilizing surface and groundwater resources and exploring non-conventional water resources. Use circular economy principles, such as wastewater reuse, demand management, and runoff capture.
- Develop multipurpose storage facilities that can significantly help increase regional energy access, improve flood and drought control, and secure access to water for different uses.

- Develop small-scale storage infrastructure and encourage water harvesting.
- Develop and implement adequate food storage systems to counter food insecurity and expand beyond subsistence living.
- Aggressively scale up current SLM practices to build land and livelihood resilience.

4.2.2.6 Rural Water Services, Quality, and Sanitation

In the G5 Sahel, 43.5 percent of the population, or more than 37.5 million people, lack access to basic drinking water services, while 74.6 percent lack access to basic sanitation services. In rural communities, these numbers rise to 56.2 percent and 84.8 percent respectively.¹²⁶ Almost 60 percent of the G5 Sahel rural population practice open defecation,¹²⁷ putting the region's water resources at increasing risk of contamination as climate change intensifies flooding. Increased access to safe and sustainable WASH services will improve the resilience of the Sahelian people to water scarcity. It will also reduce threats from waterborne diseases – such as cholera, schistosomiasis, and other diarrheal diseases – the incidences of which have been shown to increase due to heavier rainfall and higher temperatures.¹²⁸ Higher temperatures increase the concentration of algae and bacteria in water resources, while declines in water availability reduce water's pollutant dilution capacity.¹²⁹

The total investment required to achieve universal access to water supply and sanitation services in both rural and urban areas is substantial and is aggravated by the region's high rate of population growth. In addition to infrastructure investment, the World Bank should also seek to leverage results-based instruments to establish and operationalize key policy, institutional, and regulatory reforms required for improved sector performance, operational efficiency, and cost recovery. The goals are to maximize the use of the region's scarce water resources, increase resilience to climate-related threats, and make the sector more attractive to private financing.

Policy recommendations for actions in the next three years:

- Expand water, sanitation, and hygiene (WASH) investments equitably to significantly increase coverage, especially in high climate risk areas.
- Support sector institutions in developing action plans for establishing and operationalizing necessary policy, institutional, and regulatory reforms for improved sustainability.
- Support service providers in developing risk, resilience, and emergency response plans to secure long-term resilience to climate-related and other threats in the provision of water supply and sanitation services.¹³⁰
- Increase water quality monitoring to spot the increasing threats posed to water supplies from waterborne disease, droughts, and floods.
- Finance country-specific sector diagnostics that identify the most critical bottlenecks to improved sector performance and climate resilience.

¹²⁶ 2020 data from WHO (World Health Organization) and UNICEF (United Nations Children's Fund) Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP).

¹²⁷ 2020 data from WHO (World Health Organization) and UNICEF (United Nations Children's Fund) Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP).

¹²⁸ Levy K, Smith SM, Carlton EJ. Climate Change Impacts on Waterborne Diseases: Moving Toward Designing Interventions. *Curr Environ Health Rep.* 2018;5(2):272-282. doi:10.1007/s40572-018-0199-7

¹²⁹ Climate risk profile: Sahel. UNHCR. PIK. Available at: <https://www.unhcr.org/61a49df44.pdf>.

¹³⁰ Plan development should follow the approach outlined in the World Bank's Resilient Water Infrastructure Design Brief, *Building the Resilience of WSS Utilities to Climate Change and Other Threats: A Road Map*.

Policy recommendations for actions by 2030:

- Support health and educational institutions in delivering climate-informed trainings and capacity building to current and future water and sanitation professionals, including the development of young professionals' programs to facilitate the participation of youth and women.
- Provide safe and sustainable water and sanitation services, such as by using private water kiosks and vendors, and by avoiding depleting or contaminating water resources.

Investment opportunities and needs:

Given the lack of access to safe and sustainable WASH services in the region, the world's highest population growth rates, increasing urbanization, and the impacts of climate change, WASH investments are particularly critical to human capital and economic development. As the magnitude of required investments is substantial, G5 countries, as well as their development partners, will need to substantially increase their investments in the sector to address this gap in a timely manner. Table 4.5 presents the estimated investment required in the G5 Sahel to achieve universal access by 2030 (Annex, 2.1.2, for further details).

Investments that can be made in the next three years:

- Switch from diesel to renewable energy for water supply provision, where feasible.
- Promote circular economy solutions and closed-loop systems, especially producing energy from waste and improving inefficiencies in water and wastewater treatment plant operations.
- Upgrade latrines to improve sanitation and reduce GHG emissions.

Investments that can be made by 2030:

- Improve WASH infrastructure, including rehabilitation of existing infrastructure and constructing small-scale works.
- Improve development and funding of O&M mechanisms.
- Develop the full sanitation value chain, including containment, emptying, transport, treatment, and reuse, to prevent the spread of human waste.
- Incorporate resilient design in WASH infrastructure to ensure robustness to droughts and floods.
- Significantly increase investments that support poor and vulnerable rural communities, given that most sector funding is currently concentrated in urban areas.

Over the longer term, it may be necessary to build desalination plants in Mauritania as a last resort where potable surface water and groundwater are unavailable due to seawater intrusion.

Table 4.5 Estimated investment needs to achieve universal water supply and sanitation coverage by 2030, by target service level and year (in millions USD)

Target	Total (Urban and Rural WSS)		Urban			Rural		
	Total Investment	Avg. Annual Investment	Water	Sanitation	Total Urban	Water	Sanitation	Total Rural
Universal basic	9,102	1,011	1,096	1,611	2,706	4,594	1,801	6,395
Universal basic (with 50% of currently unserved safely managed)	15,703	1,745	2,788	2,351	5,140	8,249	2,315	10,563
Universal safely managed	22,304	2,478	4,481	3,092	7,573	11,903	2,828	14,731

4.2.2.7 Cities: Urbanization and Provision of Basic Services

As described in Chapter 1, cities in the Sahel are growing rapidly and uncontrollably, driven by migration from rural areas and natural increase. Since 1985, the built-up areas have doubled, mostly in the form of informal settlements, sometimes in risk-prone areas, due to lack of resources and planning capacities at the local level. The large populations in informal settlements face more frequent and intense floods yet have inadequate drainage and weak solid waste management (SWM) systems. Solid waste dumped in existing drains can trigger flash floods. Moreover, 23.5 percent of the urban population, highly concentrated in informal settlements, lack access to basic drinking water services, while 49.2 percent lack access to basic sanitation services,¹³¹ putting them at high risk of cholera and other waterborne diseases. Permeable poorly managed latrines, leaking septic tanks, and the open dumping of untreated fecal sludge by sanitation workers further aggravate this threat. Heavy rains have also directly affected water infrastructure across the region.¹³² Integrated solutions are needed to transform urban resilience and increase access to basic services, and to boost the urban population's quality of life. The policy and investment recommendations include three main interventions:

1. Manage climate risks through resilient urban planning and land use planning

In the next three years:

- Develop systems to collect data and perform risk assessments (such on water basin hydrology or climate risks of informal settlements).
- Create energy and climate plans to mainstream climate mitigation and adaptation into public policies, including strategies to control urban sprawl.
- Support climate champions in cities and hire staff with resilience expertise.

By 2030:

- Develop a public and green space policy that prevents future settlements in risk-prone areas.¹³³
- Preserve or add green spaces in informal settlements to reduce the impacts of heatwaves and floods while also capturing carbon and improving living conditions.
- Support service providers in developing risk, resilience, and emergency response plans to secure long-term resilience. This should include enhanced water quality monitoring.

2. Improve community resilience through increased basic services delivery in informal settlements

In the next three years:

- Add water kiosks and, where feasible, household connections to supply safe drinking water.
- Add water meters to encourage water conservation, reduce non-revenue water losses, and enable more efficient tariff schemes.
- Create jobs in waste collection and construction. Though often temporary, these jobs increase employment for youth, refugees, and migrants and can be life changers.

131 2020 data from WHO (World Health Organization) and UNICEF (United Nations Children's Fund) Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP).

132 For example, more than 700 wells in Niamey were damaged or destroyed after heavy rainfalls in 2020, putting the population at risk of cholera and other waterborne diseases. USAID Bureau for Humanitarian Assistance (BHA), "USAID's Response to Flooding in the Sahel." 2020, [Online]. Available: <https://storymaps.arcgis.com/stories/6b8ed21a7bca49268de26aecc21b456c>.

133 Lessons learnt from the Karachi Neighborhood Improvement project – public spaces are classified into three main categories: (i) streets and sidewalks; (ii) public open spaces like markets, parks, playgrounds, plazas, squares, urban forests, and waterfronts; and (iii) public buildings such as community centers and libraries.

By 2030:

- Reduce waste by preventing, reducing, reusing, recycling, composting, or recovering materials.
- Establish guarantee systems for local banks to finance waste collection by local private operators.

3. Invest in large-scale systematic informal settlements upgrading

In the next three years:

- Identify informal settlements with the highest climate risk or which present the highest economic potential through densification.
- Begin to improve public spaces, such as creating public plazas and green spaces and paving roads.
- Engage local urban communities to create a real-time feedback loop to sharpen the focus on areas and services. Participatory approaches, such as Urban Labs, are already showing encouraging results.¹³⁴

By 2030:

- Improve drainage systems and flood defenses (including nature-based solutions such as urban river restoration, erosion management, and greening of upstream and flood prone areas) to reduce flooding risks.
- Provide housing opportunities in parallel with limiting new informal settlements.
- Improve sanitation (see WASH section).

Investment needs:

Estimates based on similar investments in other African countries point to a need of US\$18.7 billion for a 5-year program and US\$8 billion for a 10-year program, not including the investments required to achieve universal water supply and sanitation coverage within urban communities.¹³⁵ Total estimated investments required to achieve universal access to water supply and sanitation services by 2030 within the G5 Sahel are shown in Table 4.5. The Annex (2.1.2) provides additional detail on the estimated investment needs, including under scenarios to achieve universal access between 2030 and 2050.

¹³⁴ Urban Labs, tested in Sahel by AFD in Ouagadougou, support communities in inventing and testing urban micro-projects with social, cultural, and environmental impact. An urban operator facilitates in partnership with local authorities identification and implementation of micro-projects, which may be temporary or eventually upscaled. Projects can promote better use of unoccupied space during land-use studies or construction such as urban improvements, development of new uses for renovated spaces (such as sports trail or playgrounds in restored river banks), etc.

¹³⁵ These numbers are indicative only and do not take into account specific local conditions, which are extremely important for estimating the costs. The estimates account only for certain investments and do not include the cost of policy development and capacity building and developing an information infrastructure. These estimates also do not account for economies of scale, which may bring some costs down. Investment estimates are driven by population growth rates and take into account a conservative 2% annual inflation.

Table 4.6 Indicative analysis of investment needs for resilient urbanization in the G5 Sahel

INDICATIVE ANALYSIS OF INVESTMENT NEEDS FOR RESILIENT URBANIZATION IN THE G5 SAHEL						
	5-year program			10-year program		
	Urban population targeted (# of people in urban areas)	Urban population targeted (% of total urban population)	Investment needed (US\$ Million)	Urban population targeted e (# of people in urban areas)	Urban population targeted (% of total urban population)	Investment needed (US\$ million)
Informal Settlements Upgrading	18,956,955	55	4,085.7	23,715,491	55%	5,643.3
Solid Waste Management	25,850,393	75	1,276.8	32,339,306	75%	1,763.6
Flood Management	22,403,674	65	2,535.4	28,027,398	65%	3,501.9
TOTAL INVESTMENT NEED			7,897.9			10,908.8

4.3 Potential Considerations for the Longer Term

Although this CCDR focuses on spurring growth in over the next three or seven years, development partners should also consider ideas for supporting growth in the longer term. Exploring manufacturing opportunities and services, including digital, would be valuable. In addition, two areas with especially large potential for sustainable and resilient growth are mining and transportation. Although these areas are suggested for attention in the longer term, analytical work and planning for these should be stepped up as soon as possible.

Mining

The Sahel region is rich in “climate action” minerals and metals, and Mali in particular is well positioned to become an important exporter. The G5 countries thus have opportunities to develop mining operations that are designed from the start to be climate-resilient, sustainable, and internationally competitive. That would mean using renewable energy whenever possible, enhancing energy efficiency, and minimizing environmental impacts. Taking advantage of these opportunities will require new legal and regulatory frameworks, increased geological capacities for assessing mineral deposits, greater access to finance and markets, and building new roads, railways, ports, and other essential infrastructure. Relevant policy actions in this area could focus on updating mining laws and codes to require lower carbon practices and circular economy approaches; building capacity to identify deposits and to update geological information; increasing private investment; providing the necessary supporting infrastructure; and mapping for quality and quantity of the climate action minerals.

Developing the mining sector should be treated with both urgency and caution. There are several pitfalls related to “rent seeking” and capacity constraints which will need to be addressed. Nevertheless, to achieve longer-term results it is important for the G5 countries to start initiating actions in this important sector.

Equally important, if skill sets can be updated and other sectors incentivized, such as manufacturing, green hydrogen development (in Mauritania), and green transport, these sectors too would provide growth and job opportunities.

Transportation

Sahelian countries are highly dependent on imports and on road transport for freight. However, poor roads increase transport inefficiencies, and an old, polluting truck fleet causes high emissions and contributes to overall high freight transport costs. The situation is expected to get worse as more extreme

weather events and other climate change impacts affect the transportation system. It is critical, therefore, to invest in road improvements, road maintenance, and emergency works, as well as in greener options such as rail and inland waterways. In addition, policy reforms are needed in areas such as customs, axle load control, truck registration, mandatory technical standards and inspections, driver training, insurance requirements, and access to the profession and to markets. Such reforms could cut the costs of transporting staple goods in West Africa by 50 percent within 10 years.¹³⁶

Passenger transport can be made greener and more resilient as well. With formal public transport systems almost nonexistent, internal combustion engine 2- and 3-wheelers now account for 60 to 75 percent of transport in Sahelian cities, contributing more than 50 percent of total CO₂ vehicle emissions and 60-75 percent of harmful air pollutants from vehicles in some cities. If nothing is done to change current private motorization trends, Sahelian cities will suffer from exponential increases in pollution, congestion, and traffic fatalities. There is an urgent need, therefore, to invest in quality public transport and safe walking infrastructure, and to transition to electric vehicles, such as battery-powered 2- and 3-wheelers. To maximize the benefits of the transition, countries need also to make their electricity supply greener and more reliable.

4.4 Next Steps

The CCDR process has been successful in uniting teams from several practices across the WBG. The Bank could build on that success by considering a pilot model in the Sahel that removes operational silos. This model should include a multidisciplinary team, including WB, IFC, and MIGA colleagues, and should have a laser focus on jobs and growth opportunities. In addition, climate know-how needs to be systematically brought into the range of Bank operations in the Sahel, and WB investments must give due consideration for each country's growth and for opportunities to de-risk private sector involvement.

So far, consultations with various groups have been limited – mostly with Government and Development Partners. When geopolitical circumstances allow, however, the plan is to undertake consultations relevant to implementation, including with civil society.

G5 Sahel data constraints have become apparent, especially as modeling work was undertaken. Partners are encouraged to join forces on data generation and sharing, as well as validation, to improve useable data sets, at regional, national, and household levels.

136 USAID. (2011). Regional Agricultural Transport and Trade Policy Study. West Africa Trade Hub Technical Report #41.

5 Conclusion

The G5 Sahel region is facing a fragile economic recovery and other multiple challenges: increased political instability, rising insecurity, uncontrolled urbanization, declining agricultural productivity, a food security crisis affecting millions of people, displacement of people, limited governance, poor public sector capabilities, insufficient institutions, and growing impacts from climate change. Climate change is raising the risks of social exclusion and migration, while regressing human development, and is leading to potentially devastating ecological and economic tipping points in the region. As a result, there is an urgent need to act now to accelerate both development and resilience to the impacts of climate change.

While the challenges are great, the opportunities are large as well. The G5 Sahel countries have untapped strengths and comparative advantages. They have a young and growing labor force. These countries have vast natural resources, including renewable energy resources. The potential for large-scale renewable energy projects is enormous and indispensable to unleashing green manufacturing and entrepreneurial opportunities, including energy exports to European and West African markets. The region is rich in mineral resources, including those needed for modern green technologies, and the countries' economies are close to European and Middle East markets. With judicious climate-smart investments and strengthened policies and institutions, the G5 countries can become far more resilient to the impacts of climate change and avoid locking in a carbon-intensive growth path. They can also diversify their economies, raise incomes, and reverse environmental degradation, while managing the potentially adverse social consequences of climate policy and making efforts to maximize the benefits of climate action for the poor.

To ensure that climate change does not reverse development gains, significant investments, new policies, and improved strategic planning with a focus on the social dimensions of climate change are required. However, the costs of *inaction* are far greater than the costs of taking action. Moving forward quickly now can help put the G5 Sahel countries on a path to a greener, more resilient, more prosperous, and more inclusive future.

In recent years, the World Bank Group has provided a record level of financial resources to the G5 Sahel countries as part of its institutional strategy to address fragility, conflict, and violence. It is also upgrading its delivery model to make it larger, faster, and more effective. However, the climate crisis and its growing impacts, combined with the post-COVID-19 economic recovery needs, the challenging debt situation of the G5 countries, and the effects of the war in Ukraine on global food, fertilizer and energy prices, require an even higher level of engagement.