



WESTERN AND CENTRAL AFRICA

# SIERRA LEONE

# World Bank Group COUNTRY CLIMATE AND DEVELOPMENT REPORT

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# **Abbreviations**

AfDB	African Development Bank
APR	Awareness, Preparedness, and Resilience
ARC	African Risk Capacity
BAU	Business As Usual
CAT DDO	Catastrophe Deferred Drawdown Option
CC-MFMod	Climate Change Macro-Fiscal Model
CCDR	Country Climate and Development Report
CCE	climate change and the environment
CFU	Climate Finance Unit
CIF	Climate Investment Funds
CLRA	Customary Land Rights Act
CLSG	Côte d'Ivoire-Liberia-Sierra Leone-Guinea
CMA	Community Management Association
C-PIMA	Climate-Public Investment Management Assessment
CRW	Crisis Response Window
CSA	Climate-Smart Agriculture
DRFS	Disaster Risk Financing Strategy
DRM	Disaster Risk Management
EDSA	Electricity Distribution and Supply Authority
EIB	European Investment Bank
EPA-SI	Environmental Protection Agency – Sierra Leone
FAO	Food and Agriculture Organization
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
HEPPR	Health Emergency Prevention Prenaredness and Response
HEO	Heavy Fuel Oil
ICT	Information and Communication Technology
IC7M	Integrated Coastal Zone Management Plans
	International Development Association
IFC	International Einance Corporation
IFMIS	Integrated Financial Management Information System
IME	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
	Independent Power Producer
IRP	Integrated Resource Plan
	Illegal Unreported and Unregulated
IVS	Inland Valley Swamps
LECEDS	Low Emissions Climate Resilient Development Strategy
I PG	liquified netroleum gas
	Land-Use Change and Forestry
MAES	Ministry of Agriculture and Food Security
MCC	Millennium Challenge Corporation
MECC	Ministry of Environment and Climate Change
MELOO	Microfinance Institution
MEMod	Macro Fiscal Model
MEMD	Ministry of Fisheries and Marine Resources
	Ministry of Lande Housing and Country Planning
	Marine Protected Area
	Mianue Flutevieu Alea Miaro Small and Modium Enterprises
MINDO	Medium-Term National Development Plan

NAMA	Nationally Appropriate Mitigation Actions
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NAT	National Agricultural Transformation
NBS	Nature-based Solutions
NCCAP	National Climate Change Action Plan
NCCP	National Climate Change Policy
NCCPF	National Climate Change Policy Framework
NCCS	National Climate Change Strategy
NCCSAP	National Climate Change Strategy and Action Plan
NCCSC	National Climate Change Steering Committee
NCS	National Steering Committee
NDC	Nationally Determined Contribution
NDMA	National Disaster Management Agency
NGO	Nongovernmental Organization
NPAA	National Protected Areas Authority
NSADP	National Sustainable Agriculture Development Program
NSO	National Statistical Office
NWRMA	National Water Resource Management Agency
PFM	Public Financial Management
PM2.5	Particulate Matter 2.5 microns or less
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
PV	Photovoltaic
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SDG	Sustainable Development Goal
SLCF	Sierra Leone Climate Fund
SL-MET	Sierra Leone Meteorological Agency
SLRE	Sierra Leone River Estuary
SMEs	Small, and Medium Enterprises
SSA	Sub-Saharan Africa
SSP	Shared Socioeconomic Pathway
STAT	Scientific and Technical Advisory Taskforce
WAPNP	Western Area Peninsular National Park
WHO	World Health Organization

# **Executive Summary**

## **Executive Summary**

The **Sierra Leone Country Climate and Development Report (CCDR)** analyzes Sierra Leone's socioeconomic development prospects in the context of climate change. It provides an overview of the climate and development risks facing Sierra Leone, models scenarios of select climate effects and adaptation, and proposes strategies to enhance resilience, steer the economy toward inclusive, low-carbon growth, and finance climate actions.

The consequences of a warming planet are gradual yet relentless. What begins as a series of hotter days evolves into extreme seasons and years. Every increment of warming will result in exponentially escalating hazards worldwide, but the severity of impacts will be unevenly distributed and hit countries like Sierra Leone the hardest.

Sierra Leone has already faced challenges in achieving meaningful economic development since the end of its civil war. The economy has at least shifted away from agricultural dominance, with agriculture's (including forestry and fisheries) share of gross domestic product (GDP) declining to 30 percent and that of services and industry increasing to 42 percent and 26 percent, respectively, in 2023. Agriculture, which suffers from low productivity levels, employs almost half of the population. Most labor movements out of agriculture are absorbed by the services sector, particularly in informal trade and tourism, rather than into higher-productivity industries. Weak human development, poor infrastructure and services, low capital accumulation, and economic volatility have further constrained income growth, leaving over half of the population in poverty. While the country could reach lower-middle-income status by 2032 through an ambitious reform program, it must identify ways to sustain stable and inclusive growth under a changing climate.

Climate change has already redefined weather and climate extremes in the country. The Intergovernmental Panel on Climate Change (IPCC) ranks Sierra Leone among the 15 worst-affected economies with significant declines in GDP per capita due to climate effects between 1991 and 2010. Regardless of global emission trends, increases in temperatures are projected through the end of the century and beyond. Sierra Leone's annual average temperature could rise to 28°C (from its baseline of 26.5°C) by 2050 under the most pessimistic climate scenario. Warmer temperatures, which are very closely tied to precipitation patterns and sea levels, raise the risk of erratic rainfall, severe flooding, and degraded land. While future rainfall trends are uncertain, Sierra Leone already experiences some of the highest annual precipitation levels in the world, averaging 2,653.4 mm. Both prolonged dry spells and intensified heavy rainfall events are projected in future climate scenarios.

# Without action, climate change could slow the economy, regardless of future climate and growth outlooks.

The CCDR discusses and estimates potential economic impacts from select climate-related effects such as heat stress, shifts in rain patterns, erosion, disease prevalence, and flooding.<sup>1</sup> The estimates presented

<sup>&</sup>lt;sup>1</sup> Of the many potential climate-driven impact channels, this report models only seven. The estimates of GDP impacts are therefore not comprehensive. The seven impact channels considered are labor productivity from heat stress, human health shocks to labor supply, rainfed-related crop shocks, erosion-related crop shocks, urban fooding, coastal flooding and sealevel rise, and damages and maintenance to roads and bridges. Several important impact channels—such as biodiversity loss, migration, or conflict—are not included due to limited data or methodological constraints. Even within the modeled channels, there is uncertainty related to emissions and climate projections, adaptive responses, and sectoral sensitivities. These estimates should be interpreted with caution, as indicative rather than predictive. Annex 2 provides information on the climate scenarios, and Annex 4 provides a description of the modeling used, including limitations of the model.

here are not comprehensive and subject to large variations which depend on underlying assumptions about the projected structure of the economy and expected climate conditions and should be interpreted as indicative rather than predictive. Two climate and economic growth scenarios are considered—dry/hot or wet/warm<sup>2</sup> and baseline or aspirational,<sup>3</sup> respectively.

Sierra Leone's GDP losses could range from 9 percent to 10 percent by 2050, depending on underlying growth patterns and different climate scenarios (ES Figure 1). A more aspirational economic scenario, which assumes faster structural transformation and higher growth, reduces climate change impacts only slightly, by less than a percentage point compared to baseline growth, underscoring that development alone cannot avert climate damage without targeted measures. Both climate scenarios, hot/dry and wet/warm, are expected to have a similar impact because both excessively dry and wet conditions are expected to be detrimental for agriculture. Estimated GDP losses of 9–10 percent of GDP, though indicative, are relatively high compared to similar analyses in CCDRs in other countries.

#### If no adaptive and resilience measures are taken, labor and crop productivity will decline, accounting for the most economic damage from climate change. Losses from capital stock damage are also substantial.

Heat stress is expected to reduce labor productivity significantly as rising temperatures are projected under all climate scenarios, with the most severe economic impact in the hot/dry scenario. Most of the country has limited access to electricity and workers have little protection from extreme heat. Agricultural workers are especially vulnerable to heat stress as they work predominantly outdoors. While service and industry jobs have been growing over the last decade, many workers still spend long hours outdoors or in poorly ventilated environments with little to no cooling.

Agricultural activity also reduces under all climate scenarios. Essentially, there is no preferred climate scenario for Sierra Leone's crop production—whether it becomes hotter and drier or warmer and wetter. Under a dry/hot climate scenario, lower rainfall and higher temperatures will reduce water availability (for both irrigated and rain-fed crops) and yields of crops that are sensitive to extreme heat, such as rice, cassava, and staple vegetables. In the other climate scenario, a wetter and warmer future would make crops less vulnerable to heat, but heavier rainfall would still lower crop yields through the risk of soil erosion and flooding.

The country's reliance on agriculture weighs on its resilience toward climate change. If the economy diversifies away from low-value-added farming activities toward activities higher on the value chain such as agro-processing or other industrial activities and services, it can reduce the country's exposure to climate-related impacts. This requires policies that help create stable macroeconomic conditions, support the development of a dynamic private sector and strengthen human capital to meet the growing needs of the economy and eventually help create jobs for Sierra Leone's large workforce.

Economic losses from damages to capital stocks, such as roads, bridges, and other infrastructure, are expected from increased maintenance costs and their location in high-risk flood zones. Between 1985 and

<sup>&</sup>lt;sup>2</sup> The dry/hot scenario examines the 10th percentile of mean precipitation changes according to various projections based on the Shared Socioeconomic Pathways (SSP) and combines SSP3-7.0 for sea-level rise and urban flooding projections. The wet/warm scenario examines the 90th percentile of mean precipitation changes and the 10th percentile of mean temperature changes and combines SSP3-7.0 for sea-level rise and SSP2-4.5 for urban flooding projections. Large natural disasters (low probability, high impact) are not considered in this analysis.

<sup>&</sup>lt;sup>3</sup> The baseline scenario is based on recent growth performance. Real GDP is projected to grow at an average annual rate of 4.3 percent over 2025–50. The aspirational scenario is based on higher growth than recent performance. It assumes more rapid structural transformation as well as ambitious reforms across all factors of production (labor, capital, and productivity). In this scenario, real GDP is projected to grow at an average annual rate of 6.6 percent during 2025–50.

2015, urban settlements grew by 143.5 percent, while areas exposed to pluvial flooding increased by 172.3 percent. In Freetown, land exposed to sea-level rise expanded from none in 1985 to 1.1 km<sup>2</sup> in 2015, with projections indicating 3.5 km<sup>2</sup> of at-risk settlements by 2050. Beyond the risk of catastrophic damage, roads and bridges face chronic repair costs, as extreme precipitation, flooding, and heat degrades surfaces and foundations that disrupt transport, commerce, and labor productivity.

#### Poverty and inequality will get worse under Sierra Leone's changing climate.

The poorest are expected to be disproportionately affected by climate change. Assuming baseline growth performance, the effects of climate change under the dry/hot and wet/warm scenarios can increase the poverty rate between 2 and 7 percentage points more than the baseline in urban and rural areas, pushing a total of nearly 600,000 additional people into poverty by 2050. Income inequality is projected to increase drastically, driven by a widening gap between workers in agriculture compared to other sectors, as the economic contribution of agriculture decreases with climate effects. In rural areas, agricultural laborers, who already have some of the country's highest poverty rates, will face extreme heat and erratic rainfall, which reduce crop yields, lower incomes, and make outdoor work increasingly difficult. Declining productivity also drives up food prices, further worsening food insecurity—already a crisis, with 80 percent of Sierra Leoneans failing to meet daily caloric requirements.

The poorest households will also bear the brunt of climate disasters, as many informal settlements are concentrated in high-risk areas, including flood-prone coastal zones and degrading forested hillsides. These communities are also the least equipped to cope with environmental hazards, with limited access to basic infrastructure such as clean water, sanitation, transport, electricity, and health services.

It is important to note that this analysis offers only a partial insight into the economic and poverty damages of climate change. Damages do not consider potential positive effects from future development interventions that intrinsically support adaptation and resilience, and adverse effects are not comprehensive, as they are based on a limited number of impact channels due to data availability challenges. Nevertheless, the analysis underscores the urgency of implementing targeted climate actions to mitigate projected impacts.

# Priority climate investments should focus on developing green energy and sustainable cities, promoting climate-smart agricultural and natural resource productivity, and strengthening social resilience to climate change.

To illustrate the benefits of climate adaptation, the CCDR estimated that scaling even a few adaptation interventions could reduce the loss in GDP to around 2–4 percent by 2050, assuming baseline growth. ES Figure 1 compares the effects of climate change on GDP by 2050 with and without targeted adaptation and resilience measures by impact channel, climate scenario, and growth scenario. Adaptation interventions include public investments in infrastructure (such as reservoirs, weather-resistant roads, and air conditioning) and some behavioral changes (such as new construction at higher elevations but rather planting of new types of crops). These interventions are not intended to be definitive solutions but rather provide general pathways that could be targeted, offering perspective on the transformative impact of strategic adaptation. Investment needs are significant, and hence it will be important to crowd-in the private sector to bridge the finances.

The report builds on these implications and outlines three main pathways to climate resilience in Sierra Leone, describing climate actions that are synonymous with the country's development goals. Most respond to climate adaptation needs, but many can also support low-carbon growth. Specific actions are summarized in ES Table 1 and detailed in the main report.

1. Developing green energy and sustainable cities. With the growth of the service and industry sectors, Sierra Leone has also been rapidly urbanizing, with the percentage of the population living in urban areas expected to surpass 50 percent by 2050. However, the livability challenges in urban areas, including the capital city, Freetown, present a vivid illustration of climate vulnerabilities and barriers to effective structural transformation of the economy. For example, Freetown's growing population density is driven by increasing land scarcity and a continuous influx of rural migrants seeking better services and employment opportunities amid diminishing productivity in the agriculture and natural resource sectors. Consequently, more and more settlements are encroaching on protected forest hillsides or low-lying coastlines. Increasing erosion and intense rainfall have also reduced slope stability and compounded the risks of landslides and flash floods. A lack of resilient infrastructure, such as paved roads, safe water supply and sanitation, drainage systems, and fortified buildings, increases damage and deaths from climate-related disasters. The 2017 Freetown Mudslide, which killed at least 1,141 people and had economic costs of around US\$35 million, serves as a poignant reminder of these vulnerabilities.

The development of resilient infrastructure in growing towns and remote rural areas alike is central for fostering more balanced development. While infrastructure vulnerabilities are highly visible in urban settings, they reflect broader infrastructural issues that span the entire country. The high migration from rural areas to cities, driven by the lack of services, jobs, and market integration in rural locales, underscores the need for better urban planning and developing reliable water and sanitation, drainage, energy, and transport systems that consider climate risks and bridge the urban-rural divide.

Sustainable energy development, for example, will be essential for increasing infrastructure resilience and has significant opportunities for low-carbon growth. Currently, a little over a third of the population has access to electricity, with a wide rural/urban divide and a heavy reliance on polluting heavy fuel oils for power and solid fuels for cooking. The lack of electricity, especially, limits the adaptation interventions such as scaling cooling and clean cooking solutions. Expanding energy imports and unlocking Sierra Leone's hydropower and renewable potential represent the least-cost pathway for scaling electricity access, far more affordable than the current trajectory, which relies heavily on expensive, fuel-based generation to meet rising demand. Sierra Leone can achieve substantial savings and reduce emissions, moving toward universal electricity access through grid electrification, mini-grids, and stand-alone solar systems. This energy transition not only aims to meet the country's energy demands but also catalyzes broader infrastructural advancements, including enhanced water resource management, cleaner transport options, and telecommunication and the digitalization of services for improved data management and coordination. Such integrated development efforts are essential for Sierra Leone's pursuit of sustainable, resilient infrastructure that supports growing service and industry sectors.

2. **Promoting climate-smart agricultural and natural resource productivity.** Overall, Sierra Leone will find it more challenging to depend on agriculture and natural resources for future growth and poverty reduction due to profound changes in agroecological and climatic conditions across the country. Agriculture, forestry, and fisheries, which make up roughly one-third of Sierra Leone's economy, expose the country to numerous climate threats. Climate change will worsen the agriculture sector's already low productivity. Farmers are not well-connected to markets, rely predominantly on rain-fed crops, and have limited access to new technologies and financing. Agricultural workers are also projected to suffer significant productivity losses from the increasing risk of heat stress due to climate change. Poverty rates are also already stagnant and highest in rural areas, reflecting the limited welfare gains of the agriculture sector. Communities living in poverty depend heavily on natural resources for sustenance, including fuelwood, shelter, and food and water security, leaving them more exposed to climate-related disruptions. The swift expansion of mining and quarrying, the main drivers of industrial growth in the economy, has also caused environmental degradation, reducing natural climate resilience and biodiversity.

As these challenges intensify, agriculture and natural resource sectors must be a priority for adaptation and sustainable management efforts to protect food security, rural livelihoods, and economic stability. Even as the economy diversifies, parallel investments in climate-smart agriculture (CSA), food systems, forestry and land management, coastal zones, and mining are needed to better safeguard agriculture and fishery production, ecosystem services, and the well-being of communities reliant on these environments while reducing resource overexploitation. These actions are central not only for adaptation but also have dual benefits for mitigation. For example, the country's dense forests and wetlands serve as significant carbon sinks, thereby minimizing emissions. The growing mining sector also presents opportunities to expand electrification, particularly as mining operations transition away from high-emission, self-generated diesel power.

In the agricultural and food systems, the policy, regulatory, and institutional framework needs to be strengthened, such as by updating the *Feed Salone* initiative and National Sustainable Agriculture Development Program (NSADP) to be more responsive to climate challenges and developing strategies for expanding sustainable fishery management. Investing in advanced weather forecasting and early warning systems, and expanding insurance schemes, alongside climate-smart technologies like heat-tolerant crop varieties, precision agriculture, efficient irrigation, inland valley swamps (IVS), and rainwater harvesting, will help the sector adapt. Forestry and other land uses require comprehensive inventory and community-centered management, incorporating agroforestry and reforestation to prevent degradation. For coastal zones, enforcing key regulations, modernizing fisheries with improved equipment, climate-smart landing sites, and cold storage facilities, and co-managing mangroves with Community Management Associations (CMAs) will enhance conservation and benefits while promoting alternative livelihoods that can provide sustainable economic opportunities.

3. Strengthening social resilience. Social resilience to climate change refers to the ability of people to adapt to and thrive in the face of environmental uncertainties and shocks. Strengthening this resilience is a cross-cutting priority for any future climate or growth scenario in Sierra Leone. It involves not just addressing the immediate aftershocks of climate events on lives and livelihoods but also investing in the long-term development of human capital or skills, knowledge, health, and social protection that enable individuals to prepare and respond to climate challenges. Investment in human capital plays a transformative role in reducing dependence on natural capital and shifting toward a more diversified and inclusive economy that attracts higher-skilled and greener jobs.

For example, Sierra Leoneans currently have limited ways to prevent and manage climate-sensitive health risks. Human and animal habitats are projected to overlap more in West Africa with temperature and rapid land-use changes, giving rise to opportunities for spillover events of zoonotic pathogens. Rising temperatures and shifts in precipitation patterns are also likely to change the distribution of mosquitoes and waterborne pathogens and heighten risks for undernutrition and heat stress. Improving health infrastructure, surveillance and response systems, and health workforce capacities will be imperative for managing the projected rise of climate-sensitive diseases and public health emergencies.

With over 40 percent of the population being school-age, human capital development is at risk for a considerable segment of the population due to the disruptions that climate change can cause to education access and attainment. Improving school resilience against climate hazards and integrating climate awareness into curricula can make future generations more capable of addressing climate challenges. Access to adaptive social protection systems will also be vital for building resilience among the most vulnerable groups against climate-related crises and evolving climate scenarios. Given that women and girls disproportionately feel the impacts of climate change, gender-sensitive programming is essential to ensure that social resilience efforts address their specific challenges, promoting equity and effectiveness

in climate adaptation strategies. Locally led climate adaptation—in which local councils, chiefdoms, and communities have stronger decision-making power in planning, implementing, and monitoring climate actions—can also play a role in increasing the uptake of climate interventions.



ES Figure 1. Impact on GDP with and without targeted adaptation and resilience measures between 2025 and 2050, by climate and growth scenario (as percentage of baseline GDP)

Source: World Bank staff estimations using Macro-Fiscal Model (MFMod) and Industrial Economics, Incorporated (IEc)

ES Figure 2. Impact on poverty rates with and without targeted adaptation and resilience measures between 2025 and 2050, by climate scenarios for rural and urban areas (deviations from the baseline, in percentage points)



Source: World Bank staff estimations using Macro-Fiscal Model (MFMod) and Industrial Economics, Incorporated (IEc)

# Climate resilience investments will need to be predicated by stronger instructions and mobilization of climate finance.

Sierra Leone's implementation of its Nationally Determined Contributions (NDCs), which are currently being updated, involves substantial financial requirements; as per the government, this is estimated at around US\$2.76 billion by 2030, with an average annual climate finance flow of US\$276 million or roughly 6 percent of annual GDP. The country may need to develop a more realistic costing as it embarks on the next update to the NDCs, separating the development costing from the incremental cost required for climate adaptation and mitigation actions. Sierra Leone has very limited fiscal space in its budget and has been at high risk of debt distress for several years. Meeting these additional financing needs will be challenging. The country could potentially utilize diverse funding sources, including exploring additional domestic taxes, attracting green private sector investments, and gaining international support through avenues such as carbon credits and multilateral development banks. Yet, the effectiveness of these strategies hinges on bolstering national institutions and policy frameworks to design and implement viable green projects, leveraging key assets like political will, high-carbon habitats, and community participation in forestry initiatives. Restoring and maintaining macro-stability—low and stable inflation and currency, along with sustainable debt levels—will be key in ensuring continued access to domestic and international finance.

Despite Sierra Leone's efforts, financial limitations and structural constraints pose significant challenges. In addition to the tight fiscal space, limited market access and a dearth of climate financing options for lowincome nations hinder the country's ability to secure necessary investments. Moreover, obstacles such as data deficiencies, technical shortcomings, and the absence of a comprehensive climate finance policy impede progress. While the establishment of the Climate Finance Unit (CFU) signals progress, substantial capacity-building efforts are imperative to overcome resource constraints and enhance expertise.

The establishment of the Sierra Leone Climate Fund (SLCF) stands as an important initiative to support both mitigation and adaptation efforts. However, deficiencies in national strategies, policies, and legal frameworks for climate finance, alongside weaknesses in green public financial management (PFM) practices, present significant hurdles. To address these challenges, Sierra Leone must prioritize the development of a comprehensive climate finance policy and mobilization plan. Strengthening global and regional engagements, ensuring debt sustainability, and leveraging technical assistance from international bodies like the International Monetary Fund (IMF) and the World Bank are essential steps toward realizing the country's climate finance objectives and fulfilling its NDC commitments. Additionally, enhancing institutional capacities, policy coherence, and regulatory frameworks are vital for advancing climate actions and attracting green investments to bolster the nation's resilience and sustainability efforts.

# Sierra Leone must grapple with the unjust impacts of climate change, but climate action has transformative potential to cultivate inclusive growth and development.

Sierra Leone has endured complex trials in the last few decades, including efforts to restore peace after a brutal civil war, catastrophic public health emergencies, and historic price volatility of its main commodities like iron ore. Yet, the climate crisis is a unique and persistent challenge. Sierra Leone emits less than 0.02 percent of the global share of anthropogenic greenhouse gases (GHGs). However, its position as one of the smallest emitters is contrasted by its being among the countries most vulnerable to climate change. At the same time, unmanaged growth could further degrade the environment, intensifying future climate impacts. Climate action must be integrated within Sierra Leone's development strategies in ways that tackle the intertwined challenges of increasing both growth and climate resilience together.

#### ES Table 1. Summary of Priority Climate Actions

食 DEVELOPING GREEN ENERGY AND SUSTAINABLE CITIES 种种	PROMOTING CLIMATE-SMART AGRICULTURAL AND NATURAL RESOURCE PRODUCTIVITY	STRENGTHENING SOCIAL RESILIENCE
<ul> <li>Energy transition Short-term</li> <li>Achieve universal electricity access through increased grid electrification, mini-grids, and stand-alone solar systems.</li> <li>Take an integrated and cross-sectoral approach to creating an enabling environment that supports the development of the clean cooking market</li> <li>Medium-to-long-term</li> <li>Develop the country's hydro and other renewable potential and expand energy imports to attain energy security unlock</li> </ul>	<ul> <li>Agriculture and food systems         Short-term         <ul> <li>Strengthen the policy, regulatory, and institutional framework, such as by aligning climate in <i>Feed Salone</i> and NSADP and developing policies/strategies on irrigation, fisheries, digital governance, and private sector investment</li> <li>Introduce climate-smart technologies and management practices</li> <li>Medium-to-long-term</li> <li>Invest in weather forecasting, early warning systems, and insurance access for farmers, fishers and traders</li> </ul> </li> </ul>	<ul> <li>Population health Short-term</li> <li>Integrate and operationalize health interventions into climate policy planning and financing and vice versa</li> <li>Medium-to-long-term</li> <li>Strengthen the climate resilience of health care technologies and infrastructure.</li> <li>Manage the environmental determinants of health and strengthen health emergency prevention, preparedness, and response (HEPPR) capacities</li> </ul>
<ul> <li>Imports to attain energy security, untock tremendous savings, and reduce emissions from the sector</li> <li>Urban planning and infrastructure</li> <li>Short-term</li> <li>Promote urban planning that reduces built-up areas exposed to climate risk, such as by improving land-use zoning and data, building codes, capacity building, and inter-agency coordination</li> <li>Build a digital foundation for climate and development planning by collecting and standardizing data digitally and accounting for digitalization needs in energy planning</li> <li>Integrate climate risks into transport sector planning, development, and management</li> <li>Medium-to-long-term</li> <li>Expand and safeguard basic services and infrastructure (WASH disaster response)</li> </ul>	<ul> <li>Forestry, wetlands, mining, and other land-uses Short-term</li> <li>Improve understanding of forestry and other land uses</li> <li>Implement governance reforms across all land- use sectors</li> <li>Develop key regulations and strengthen the institutional framework for enforcing conservation measures and accessing benefits</li> <li>Ensure that extraction follows sustainable land- use and resource management practices</li> <li>Medium-to-long-term</li> <li>Promote sustainable mining technologies and practices and reduce mining reliance on diesel</li> <li>Invest in community-centered sustainable forest landscape management and restoration (for example, agroforestry, watershed protection, mendrove restoration poet mining load</li> </ul>	<ul> <li>Short-term</li> <li>Reduce the climate vulnerability of schools.</li> <li>Strengthen teacher training and resources for climate change education</li> <li>Social protection and inclusion</li> <li>Short-term</li> <li>Create fiscal space and increase domestic funding for shock-responsive social protection programming</li> <li>Support locally led climate action, bolster women's climate resilience, and increase transparency and accountability for green policies</li> <li>Medium-to-long-term</li> <li>Expand social protection program coverage to households in disaster-prone areas and in extreme poverty</li> </ul>
<ul> <li>digitalization) to ensure they are resilient and inclusive in the face of projected increases in climate risks</li> <li>Support low-carbon modes of transport</li> </ul>	<ul> <li>rehabilitation, and sustainable mining practices)</li> <li>Strengthen co-management of mangroves with CMAs</li> <li>Promote alternative livelihoods and improve the productivity of converted areas</li> <li>NABLING CLIMATE FINANCE &amp; GOVERNANCE</li> </ul>	CE 🏦

#### Short-term

- Develop a comprehensive national climate finance policy and strategy to mobilize green funding and address institutional gaps
- Incorporate green PFM instruments and adopt regulations for climate expenditure tagging to prioritize and track climate spending within Sierra Leone's financial systems
- Establish the SLCF to support both mitigation and adaptation activities, providing avenues for domestic, international, and private climate finance, and prepare to leverage carbon markets through robust valuation systems and clear regulatory frameworks

#### Medium-to-long-term

- Ensure macro-stability and debt sustainability to create favorable fiscal space and facilitate public financing for climate initiatives, enabling continued access to external grants and concessional loans
- Support the adoption and implementation of Disaster Risk Financing Strategies (DRFS), including enhanced expenditure tracking and the establishment of a National Disaster Management Fund, to strengthen disaster resilience
- Prepare to leverage carbon markets, through investments in institutions, the legal framework, and technical infrastructure to better manage its natural assets

## **Chapter 1. Development in a Changing Climate**

#### **Key Points**

- Sierra Leone faces complex development challenges, including pervasive poverty, limited fiscal space, and overreliance on natural resources for growth. These challenges leave it highly vulnerable to climate change, which in turn is likely to intensify problems further, creating a vicious cycle of vulnerability and hardship. An integrated approach that addresses both development and climate priorities is essential to promote growth and poverty reduction.
- Climate change is projected to raise temperatures, make rainfall patterns more erratic, and increase sea-level rise in Sierra Leone. These changes increase the risk and severity of future crises and threaten gains in poverty reduction in Sierra Leone through their compounding impacts on infrastructure, agricultural production and natural resources, and human development.
- Sierra Leone contributes less than 0.02 percent of the global share of anthropogenic greenhouse gas (GHG) emissions. It should, therefore, focus on adapting to the effects of global climate change rather than mitigating emissions. Still, investment in green energy, human capital, and sustainable natural wealth management can promote Sierra Leone's low-carbon growth while supporting broader development and adaptation goals.

This chapter reveals the interdependent relationship between development and climate challenges, showing how they often influence each other. The first section describes Sierra Leone's economic growth, progress in poverty reduction, and national development vision. The second section outlines the risks posed by climate change, by reporting projections of climate shifts and hazards, highlighting the sectors that are most vulnerable to such effects. The third section assesses the country's GHG emissions to identify opportunities for low-carbon growth.

#### **1.1 Development context**

Since it gained independence in 1961, Sierra Leone has experienced periods of robust growth interrupted by frequent crises that have required reactive recovery efforts. The economy's volatility reflects civil conflict and wars, military interventions, the 2014 Ebola outbreaks, natural disasters, and various international and domestic shocks, including the fluctuating prices of iron ore, energy, and food, and deterioration in trade. Before the COVID-19 pandemic, Sierra Leone was one of the fastest-growing economies in Africa, growing at an average annual rate of nearly 5 percent between 2016 and 2019. At the height of the pandemic, in 2020, the economy contracted by 2 percent (Figure 1.1).

Sierra Leone faces fiscal constraints and the urgent need to improve living standards for its rapidly expanding population. About 40 percent of its 8.6 million people are under the age of 15, and the population is growing at an annual rate of 2.2 percent. With a gross national income (GNI) per capita of US\$600 (Atlas method) in 2022, the country's per capita income is less than a third of the average for Sub-Saharan Africa (SSA) (World Bank 2024a). Although gross domestic product (GDP) is projected to increase by 3–4 percent per year in the short term, inflation, depreciating exchange rates, and risks of a debt crisis constrict Sierra Leone's fiscal space, necessitating careful prioritization in development strategies (World Bank 2023a).



Figure 1.1. Annual GDP growth and sectoral shares of GDP in Sierra Leone, 2018–2023

Source: World Bank staff, based on data from World Development Indicators 2025.

The economic dependence on agriculture, forestry, and fisheries has been declining over the years, with the rise of service and industry sectors. Within a land area of just over 71,000 km<sup>2</sup>, Sierra Leone possesses a diverse range of natural landscapes, including productive coastlines, mineral-rich cliffs, and dense forests. On average, the agriculture, forestry, and fishing sectors contributed to about a third of GDP in the last decade (World Bank 2024b). These sectors contributed to post-crisis recovery and significantly reduced poverty. Agriculture employs over 40 percent of the population, but the sector suffers from low productivity levels, limiting gains in household welfare. Despite its growing prominence, the mining sector has not produced steady growth or job creation, and it leaves the economy exposed to international price volatility.

More than half of Sierra Leone's population lives in poverty, making it among the poorest countries in SSA. The official poverty rate is 57 percent (26 percent based on the international poverty line of US\$2.15 per day), with 13 percent living in extreme poverty, according to the most recent data in 2018 (World Bank 2022). Poverty fell by about 6 percentage points between 2011 and 2018. The bulk of this progress was in urban areas, mostly around Freetown. Population growth outpaced the rate of poverty reduction, however, leading to an increase of nearly 1 million people living in poverty by 2018. The Gini coefficient, a measure of inequality, also increased (from 0.33 to 0.37) during this period, likely because of the widening gap between rural and urban areas. The North province has the highest rate of poverty (77 percent) and the Greater Freetown area the lowest rate (23 percent) (World Bank 2022). Poverty may have increased by 2 percentage points in 2020 as a result of the impact of COVID-19 on household welfare, particularly in urban centers (World Bank 2022).

**Poverty in rural areas, where 57 percent of the population lives, remains pervasive.** The rural poverty rate stands at 74 percent, more than twice the urban rate of 35 percent. The rate of extreme poverty remained constant at the national level but soared from 9 percent to 13 percent between 2011 and 2018 in rural

areas (World Bank 2022). The vast majority of rural households work in agriculture. They consume an average of 30–40 percent of their total output, an indication of low crop yields and widespread food insecurity (World Bank 2022). Lack of access to infrastructure, markets, and productive agricultural inputs has translated into low returns and growth in rural real incomes and worsening extreme poverty and inequality.

Poverty has declined more rapidly in cities, but they are extremely dense and becoming less and less livable. Population growth (especially from rural migration) has put pressure on Sierra Leone's urban economy and living standards. Migration reflects less a pull toward opportunities in industry than a push away from the lack of rural services and agricultural growth. Most former rural residents transition from low-productivity agricultural jobs to service jobs in urban settings. The absence of adequate industrialization is concerning, as it sets a ceiling on future poverty reduction. Freetown, despite its relatively high service coverage, cannot absorb the population growth it is experiencing. Secondary cities urgently require infrastructural investments, not only to manage the country's rapid urbanization sustainably but also to provide better, well-integrated market access to agricultural households, connecting them more effectively to the broader economy.

Sierra Leone's inadequate infrastructure serves as a significant barrier to inclusive growth and poverty reduction. Electricity coverage is low (36 percent nationwide) (World Bank 2023b). Only 55 percent of the population has access to basic drinking water services (54 percent in rural areas and 80 percent in urban areas), and nearly 22 percent lack access to basic sanitation (14 percent in rural areas and 35 percent in urban areas) (WHO/UNICEF 2023). Transport quality and connectivity are poor. Less than 10 percent of the country's 11,400 km of roads are paved, and only about 53 percent of the population (28 percent in rural areas) lives within 5 km of a primary or trunk road (World Bank 2022).

Sierra Leone has some of the worst human development outcomes in the world. It ranked 181st of 195 countries and territories on the Human Development Index (HDI), which considers life expectancy, years of schooling, and income per capita (UNDP 2022). About 11 percent of children born in 2021 in Sierra Leone will not survive past their fifth birthday, placing the country in the lowest quartile of the global distribution (World Bank 2023b). About a quarter of children under five are stunted, a marker of chronic undernourishment that reduces physical and cognitive potential (Stats SL and ICF 2020). Children entering school can expect to complete an average of 9.6 years of schooling by the time they turn 18; this figure drops to 4.6 years after adjusting for the quality of learning (World Bank 2023c). There are a few major gender differences across most human development outcomes, although, on average, women have fewer years of education and lower labor market participation rates than men (World Bank 2023c). Sierra Leone's poor performance on human development outcomes reduces the country's human capital. Children born in Sierra Leone today are just 37 percent as productive as they would have been had they had quality education and good health by the time they entered the workforce. As a result, GDP per capita is just over a third of what it could be (World Bank 2023a).

Amid these challenges, Sierra Leone has ambitious plans that emphasize a people-centric approach to sustainable development. Its goal is to achieve middle-income status by 2039. The recently reelected administration intends to facilitate this transition by prioritizing human capital in its latest national development plan, investing in health, education, and other sectors and services that bolster people's ability to reach their full potential. In addition to human capital, the plan aims to diversify the economy, improve governance, and strengthen its competitiveness and infrastructure (GoSL 2019). In pursuit of these development goals, the next section will delve into how climate change adds further complexity and risks that will shape Sierra Leone's path forward.

#### **1.2 Projected physical changes and development risks from climate change**

This section examines projected changes in temperature and rainfall in Sierra Leone based on the Shared Socioeconomic Pathways (SSPs) developed by the Intergovernmental Panel on Climate Change (IPCC). It also estimates sea-level rise, erosion, and flooding from other datasets and scientific literature.<sup>4</sup> These projections form the basis for identifying risks to Sierra Leone's ecosystems, economy, and population, which inform the choice of priority sectors and adaptation strategies discussed (in the macroeconomic and poverty impact of climate change in Chapter 3 and sectoral pathways in Chapter 4).

Climate change has already redefined weather and climate extremes across the world, including in West Africa. Average global temperatures of the Earth's land and oceans, which are very closely tied to overall climate conditions and impacts, were about 1.1°C higher in 2011–20 than they were in pre-industrial times (1850–1900). Since the mid-1970s, average annual and seasonal temperatures in West Africa have risen 1°C–3°C. This increase has manifested itself in higher extreme temperatures, extended heatwaves, changing rainfall, rising sea levels, and more flooding in the last few decades (IPCC 2022, 2023).

Sierra Leone is projected to experience increases in annual temperature and days of extreme heat across all SSPs. Between 1991 and 2020, its monthly temperatures averaged 25.2°C-28.5°C, with an annual average of 26.5°C. Under the most optimistic emissions scenario (SSP1-1.9), average annual temperatures are expected to increase but stabilize at around 27°C through the end of the century. Under the most pessimistic scenario (SSP5-8.5), average temperatures increase to 28°C in the near-term (2040–59) and to 30°C in the long-term (2080–99) (Figure 1.2, Panel A). These upward-trending averages are made up of more and more days of extreme heat. On average, there could be an additional 44 (optimistic scenario) to 85 days (pessimistic scenario) with a heat index above 35°C per year by mid-century and 38 (optimistic scenario) to 288 additional hot days (pessimistic scenario) by the end of the century (Figure 1.2, Panel B). The northern and eastern provinces of the country can expect the most drastic increases in extreme heat.

<sup>&</sup>lt;sup>4</sup> The IPCC imagines five SSPs, each defined by policies related to global emissions. SSP1-1.9 represents the "sustainability pathway," a best-case situation in which Paris Agreement targets are met by 2050 and global warming is kept to around 1.5 °C by 2100. SSP1-2.6 assumes a next-best-case situation, in which emissions are cut sharply but not in time to reach net-zero by 2050 and warming stabilizes around 1.8 °C by 2100. SSP2-4.5 represents the "middle of the road" scenario, in which emissions remain around current levels, with some progress, development and income grow unevenly, and warming rises to 2.7 °C by 2100. SSP3-7.0 represents the "regional rivalry" scenario, in which emissions roughly double from current levels by 2100, countries become more self-interested, and temperatures rise to 3.6 °C by 2100. SSP5-8.5 is the "fossil-fueled development pathway," in which emissions levels roughly double by 2050 and warming reaches 4.4 °C or higher.

Figure 1.2. Projected changes in temperature in Sierra Leone, 2020–2100, by SSP





Panel B: Change in number of hot days per year, 2040–59 and 2080–99



Source: World Bank staff, based on data from the Coupled Model Inter-Comparison Project Phase 6 (CMIP6) dataset, retrieved from the World Bank Climate Change Knowledge Portal. <a href="https://climateknowledgeportal.worldbank.org">https://climateknowledgeportal.worldbank.org</a> Note: Estimates represent the median (50th percentile) of mean annual projections of temperature and under five SSPs developed by the IPCC with respect to 1995–2014 historical data. Shaded bands in Panel A display the 10th–90th percentile ranges.

The effects of climate change on the direction and magnitude of rainfall changes are unclear (Figure 1.3, Panel A), although some climate scenarios project more wet days (days that receive more than 20 mm of rain) and extended periods of dry days (Figure 1.3, Panels B and C). Between 1991 and 2020, Sierra Leone's average precipitation ranged from 6.8 mm in its driest month to 612.7 mm in its wettest, with a total annual average of 2,653.4 mm, making Sierra Leone one of the wettest countries in the world. Rainfall is heaviest along the coast; it declines toward the northeast, where vegetation is primarily woodland savannah rather than tropical forest. Whether Sierra Leone will have a wetter or drier future remains unclear, and variability across climate models, seasons, and regions is wide. This uncertainty likely stems from the lack of reliable rainfall data and the complex relationship between the West African monsoon and climate.

Compared with baseline data for 1995–2014, Sierra Leone may have more rainfall across all regions of the country (mostly increasing in the wet season and decreasing in the dry season) under the most optimistic climate scenario in both the near and long term. It is also projected to have a slightly higher frequency of severe wet days. However, under the most pessimistic climate scenario, rainfall declines are

expected throughout the country and year, with a decrease in the number of wet days. Under most climate scenarios, the duration of dry spells (the maximum number of consecutive days with less than 1 mm of rain) is projected to increase.



Figure 1.3. Projected changes in precipitation and number of wet days in Sierra Leone, 2020–11, by SSP

Panel A: Precipitation

Panel B: Change in number of wet days per year, 2040–59 and 2080–99

Panel C: Change in duration of dry spells, 2040– 59 and 2080–99



Source: World Bank staff simulations, based on data from the Coupled Model Inter-Comparison Project Phase 6 (CMIP6) dataset, retrieved from the World Bank Climate Change Knowledge Portal. <a href="https://climateknowledgeportal.worldbank.org">https://climateknowledgeportal.worldbank.org</a> Note: Estimates represent the median (50th percentile) of mean annual projections of precipitation under five SSPs developed by the IPCC with respect to 1995–2014 historical data. Shaded bands in Panel A display the 10th–90th percentile ranges.

Sea-level rise, storm surge, and erosion are significant concerns for Sierra Leone. No national sea-level monitoring or sea-level rise projections are available, but the global mean sea level is projected to rise by 0.63–1.32 m by 2100 under the most pessimistic scenario. With much of Sierra Leone's low-lying coastline

being below 10 m in elevation, over 2 million Sierra Leoneans are projected to be affected by sea-level rise. Many of Sierra Leone's smaller islands have experienced severe inundation in recent years. From 2040 onward, storm surges of 0.5–0.6 m are expected to occur along the coast. About a third of the country's 460 km coastline is significantly developed and at risk of erosion (World Bank 2023d). Environmental degradation from human activity, such as sand mining, deforestation, and settlement encroachment, combined with increased frequency of heavy rainfall, is compounding sea-level rise, storm surges, and erosion.

Climate change is expected to continue through the end of the 21st century and beyond. Every increment of warming will result in exponentially escalating hazards worldwide. The severity of impacts will be unevenly distributed, influenced by factors such as natural and built environments, demography, and adaptive capacity. West Africa is projected to be one of the world's hardest-hit regions because of the compounding impacts on infrastructure, agricultural production and natural resources, and human capital.

**Climate change is already contributing to the many challenges Sierra Leone faces.** Impacts of climate change caused GDP per capita to decline by an estimated 15–20 percent between 1991 and 2010, placing Sierra Leone among the top 15 worst-affected countries in Africa (IPCC 2022). Sierra Leone's Vulnerability Index<sup>5</sup> is estimated at 0.56, placing it among the world's 40 most vulnerable countries to climate change (University of Notre Dame 2023).

**Frequent climate-related disasters have had some of the most immediate and long-lasting costs on people and the economy.** Over the past 25 years, Sierra Leone has experienced more than 300 disaster events. The country's exposure to recurrent flooding, landslides, droughts, and wildfires continues to pose the greatest risks, significantly disrupting economic and social functions and imposing high public and private costs for rehabilitation. On average, Sierra Leone suffers annual losses of about US\$7.72 million (0.2 percent of 2019 GDP) from flooding alone. The combined annual average loss to buildings from flooding in Freetown, Makeni, and Bo is estimated at US\$2.8 million. The 2017 Freetown Mudslide killed at least 1,141 people; its economic impact is estimated at around US\$35 million (about 0.8 percent of 2016 GDP). The annual national cost of responding to overall disasters and epidemics is estimated at US\$9.09–US\$16.9 million (World Bank 2023d).

**Climate change will make it more difficult to provide reliable services and infrastructure**. Densely populated areas with unplanned growth face increased risks. The 2017 Freetown Mudslide, for example, illustrates the catastrophic consequences of haphazard urban planning that neglects climate and environmental risks. With increasing land scarcity, the uncontrolled expansion of housing into protected forested hillsides, coupled with factors such as increased erosion and intense rainfall, reduces slope stability and raises the risk of landslides and flooding. Insufficient drainage systems exacerbate the impacts of heavy rainfall, resulting in flash floods that inundate roads, bridges, and homes, particularly in low-lying areas. In rural areas, increased heavy rainfall, heat, and erosion lead to the deterioration of unpaved road networks and disrupt decentralized water and sanitation systems, compelling rural households to endure the burdensome task of searching for reliable water sources, as more rudimentary systems in rural areas falter more easily under climatic stress.

Climate change will affect crop yields, damage land, and complicate decisions about land use. The resilience of Sierra Leone's agricultural and natural resource sectors to past shocks has been variable, with ongoing challenges related to low productivity and limited growth. In 2022, 80 percent of households were

<sup>&</sup>lt;sup>5</sup> An index from 0 to 1 that considers vulnerabilities arising from deficiencies in food, water, health, ecosystem services, human habitat, and infrastructure.

unable to meet their basic food and nutrition needs, with the average caloric and protein consumption per capita declining and below the average for the Africa region (World Bank 2023a). The government's vision for rural development relies heavily on leveraging agriculture, agro-processing, fisheries, tourism, and mining (GoSL 2019), all of which are potentially affected by climate change. For example, the vast majority of agriculture is rain-fed, exposing crops to climate shocks. Warmer temperatures and erratic precipitation patterns can disturb growing seasons, prolong wildfire seasons, promote the proliferation of pests and disease, and alter ecosystems, all of which reduce crop yields and livestock health. Coastal areas face added threats of salinity intrusion, extreme weather events, and ocean acidification, which disrupt agriculture and fishing activities. Mountainous regions deal with land degradation and shifting vegetation zones. The mining and forestry sectors also face climate pressures. As climate effects become more acute, operations may require increased scrutiny of their environmental impacts to ensure the long-term sustainability of landscapes.

Climate change reduces human capital by changing the burden of disease, disrupting education, and exacerbating social exclusion, especially of vulnerable groups. West Africa is at high risk for emerging zoonotic pathogens, as human and animal habitats increasingly overlap, a trend that is expected to increase with climate change and urbanization. The 2014–16 outbreaks of Ebola, a zoonotic virus that originates primarily from fruit bats or nonhuman primates, were estimated to have caused 4,000 deaths in Sierra Leone alone. The climate will also make Sierra Leone more hospitable to already persistent diseases and health risks, including malaria and diarrheal diseases, as well as undernutrition. With more events of extreme heat, morbidity from cardiorespiratory diseases, poor mental health, and adverse pregnancy and birth outcomes are also expected to increase (Watts et al. 2021). Climate change will weaken human capital in the very short run by making it harder to pursue education, as flooding and extreme heat force schools to close, reduce students' concentration, and raise the risk of disease outbreaks. The chronic effects of climate change can also limit education and economic opportunities, as children and adults spend more time searching for water, fuelwood, and food; caring for the sick; and tending to agricultural land. These effects may be especially great among vulnerable groups, such as rural and poorer households and women and girls.

While this section presented an overview of the major climate risks to various sectors of Sierra Leone, Chapter 4 goes into deep-dive analyses of impacts and provides recommendations for actions, which are primarily centered around adaptation.

# **1.3 GHG** emissions in Sierra Leone: Risks and opportunities for low-carbon growth

Sierra Leone emits a mere 0.02 percent of global GHGs, making it the world's 143rd largest emitter out of 193 countries (Climate Watch 2025). Emissions intensity per GDP has declined in Sierra Leone, as its economy has grown. Changes in land-use change and forestry (LUCF) are the leading contributors to emissions in Sierra Leone, followed by agriculture, waste, energy, and industry (Figure 1.4).

The agriculture sector has experienced a significant and sustained increase in emissions, emerging as the leading emitter over the past decade. The main drivers of emissions in the sector include rice cultivation and enteric fermentation from livestock, which results in the emission of the largest volume of methane, a potent GHG that has significant warming effects in the short term compared with other gases. Agriculture needs to adapt to climate change if the sector is to remain resilient and promote low-carbon growth. As the climate reduces productivity and degrades land, unsustainable farming practices and farmland expansion may intensify, increasing emissions and exacerbating the negative feedback loop of limited climate resilience and high food insecurity. Sierra Leone's growing urban population increasingly relies on food

imports, as smallholders struggle to meet their own sufficiency needs, compounded by a lack of access to finance, updated technologies, transport, and advisory services. Modernizing the agriculture sector is imperative. It requires enhanced market integration, sustainable natural resource management, and advancements in farming technologies and post-harvest and distribution logistics to achieve adaptation targets and promote green growth.



Panel A: Emissions by sector



Panel B: Emissions intensity as share of GDP



Source: World Bank staff, based on data from Climate Watch (2024).

Note: MtCO<sub>2</sub>e = million metric tons of carbon dioxide equivalent. Climate Watch estimations differ from Sierra Leone's national greenhouse accounting reported to the United Nations Framework Convention on Climate Change (UNFCCC) because of differences in methodology and sources of data. For example, emissions data from LUCF vary based on different forestry definitions and assumptions about carbon sequestration. Energy emissions data from Carbon Watch are estimated using data from the International Energy Agency and the US Environmental Protection Agency; Sierra Leone's national accounting uses data from various federal agencies and ministries. Apart from the level of magnitude, Climate Watch data and Sierra Leone's national inventory report similar trends in leading sector emitters. Climate Watch data are not meant

to replace Sierra Leone's national accounting but rather aim to complement national estimates by providing more updated data and using a consistent methodology that allows comparison across countries and years.



Figure 1.5. Loss of tree cover in Sierra Leone, 2001–22

Source: World Bank staff, based on data from Global Forest Watch (2025).

*Note:* Tree cover is defined as areas with over 30 percent tree canopy. It includes land used predominantly for agricultural purposes based on satellite imagery. The methodology for measuring tree loss and coverage changed starting in 2013. There were improvements in satellite data and changes to the algorithm for understanding tree loss. These changes have implications for West and Central Africa, particularly on the resolution of detectable tree cover loss, and may explain large differences in data trends. Global Forest Watch particularly advises caution on interpreting upticks in deforestation in 2013, which may align with the incorporation of improved satellite data.<sup>6</sup>

Emissions are highly sensitive to LUCF activity in Sierra Leone because of its dense coverage of forests and wetlands. These ecosystems, particularly mature ones, can absorb and store large amounts of carbon in their biomass and transfer the carbon to the soil. According to some experts, Sierra Leone can be considered a carbon sink because its landscape allows it to sequester more carbon than it emits. Rising rates of deforestation and land degradation are threatening this vital ecoservice. Between 2014 and 2024, an average of 162,000 ha of tree cover a year were lost (Figure 1.5). This loss not only increases emissions by releasing carbon and reducing absorption potential, but it also makes the country more vulnerable to the effects of climate change. For example, mangrove forests are a key natural defense against severe flooding and storm surges. Rapid population growth and logging and mining are threatening forests, underscoring the need to balance economic growth and job creation against forest and wetland management to ensure sustainable and low-carbon development.

Strengthening waste management systems would reduce emissions and promote environmental health. Waste is the third leading contributor of emissions in Sierra Leone. Freetown produces about 0.5 kg of waste per person per day, leading to approximately 219,000 metric tons a year (Ngegba and Bertin 2020) Solid waste disposal in dumpsites, which is increasing with urbanization, is the second leading contributor to methane emissions (after agriculture). Over 40 percent of urban waste remains uncollected. It is disposed of at unauthorized sites, burned, or buried, with adverse effects on public health, air quality, and ecosystem damage. Plastic waste pollution poses a significant threat to coastal and marine environments. Improper disposal and inadequate waste management infrastructure contribute to the accumulation of plastic debris along the coastline and in the sea, which is a public health hazard, as well as affect the fisheries and other productive areas. Poor waste management practices also contribute to urban flooding, by blocking drainage systems. Sustainable waste management strategies, such as methane recovery and

<sup>&</sup>lt;sup>6</sup> https://www.globalforestwatch.org/blog/data/tree-cover-loss-satellite-data-trend-analysis/

recycling, could cut GHG emissions, decrease disposal costs, mitigate urban flooding and health costs, and open up new economic opportunities.

The region's excellent hydro and solar potential could foster sustainable energy security. Just 36 percent of Sierra Leone's population has access to electricity, and over 90 percent use solid fuel sources, such as charcoal and firewood, for their cooking and heating needs (Stat SL and ICF 2020). The population relies on a mix of grid, off-grid solar systems, and liquid fuel-based power generators. The seasonality of hydropower generation (which currently has limited storage capacity) compounds the sector's financial strains, with the government shouldering substantial subsidies. Developing hydro potential and increasing imports would significantly reduce costs and emissions. The integration of hydro and solar generation, alongside improvements in sector governance and regulatory frameworks, is vital for sustainable growth and decarbonization efforts, underscoring the need for robust private sector involvement to overcome financial and operational challenges.

In addition to the major drivers of emissions, Sierra Leone also has opportunities for mitigation and lowcarbon growth in other sectors. The transport sector, for example, can reduce emissions through improved road networks and public transport, and the improvement of fuel efficiency standards. Enhancing energy efficiency in buildings and adopting green construction practices offer additional pathways for reducing emissions. Industrial processes can also find opportunities for energy efficiency measures, pollution management, and the adoption of cleaner technologies and renewable energy sources. An integrated approach, combining policy support, technological investment, and capacity building, with collaborative efforts from the government, private sector, and international partners, is essential for realizing these opportunities.

## Chapter 2. Climate Commitments and Enabling Environment

#### **Key Points**

- Sierra Leone's climate commitments include ambitious mitigation and adaptation targets, including a 10 percent reduction in GHG emissions and a 50 percent reduction in its vulnerability to adverse impacts of climate change by 2030.
- Meeting Sierra Leone's climate targets requires substantial capacity building and new sources of financing. The climate commitments identified in Sierra Leone's Nationally Determined Contribution (NDC) will cost around US\$2.7 billion by 2030. The country needs to build readiness and implement robust institutional structures to mobilize and manage climate and carbon financing.
- Weak institutions and coordination remain persistent challenges. Sierra Leone strives to establish an institutional structure that will allow it to implement its climate agenda.
- Sierra Leone's current legal and regulatory frameworks do not fully reflect the commitments outlined in the country's NDC.

#### 2.1 Climate change commitments

Policy makers are striving to respond to the challenges posed by climate change while addressing the country's pressing needs for economic development. Sierra Leone ratified the Paris Agreement on climate change in 2016. Five years later, it adopted the National Climate Change Policy (NCCP), which aims to ensure a climate-resilient and climate-compatible economy while achieving sustainable development through equitable low-carbon economic growth, and updated its NDC, which presents the country's plan for climate adaptation and mitigation commitments. While this chapter examines the 2021 NDC (latest available), it should be noted that the NDCs are currently being updated by the government.

Sierra Leone's climate commitments include ambitious targets for reducing GHG emissions to tackle climate change (Table 2.1). The updated 2021 NDC outlines short- and long-term goals for mitigation by aiming to reduce CO<sub>2</sub> emission levels by 5 percent by 2025, 10 percent by 2030, and 25 percent by 2050, compared with the business-as-usual scenario (UNFCCC 2021a). It plans to achieve these goals through a transformational shift toward a low-emission development pathway realized by promoting innovation and technology transfer in priority sectors (such as energy, waste management, transport, and agriculture) and implementing forestry REDD+ (Reducing Emissions from Deforestation and Forest Degradation). Private sector engagement in innovation and technology transfer is also envisioned to support economic growth by creating new markets and jobs as well as reducing GHG emissions.

Policy or strategy	Focus and objective
National Climate Change Strategy and Action Plan (NCCSAP) 2015	The NCCSAP consists of the Low Emission and Climate Resilient Development Strategy (LECRDS) and the National Climate Change Action Plan (NCCAP).

Table 2.1.	Climate relevant	t policies and	l strategies of	Sierra Leone
	•			

Policy or strategy	Focus and objective
Nationally Appropriate Mitigation Actions (NAMA) 2020	NAMA provided guidance on the implementation of mitigation measures in Sierra Leone, focusing on energy, transport and infrastructure, agriculture and forestry, industry, buildings, and waste management sectors.
National Climate Change Policy (NCCP) 2021	The NCCP seeks to ensure a climate-resilient and climate-compatible economy while achieving sustainable development through equitable low- carbon economic growth.
National Adaptation Plan (NAP) 2021	The NAP aims to reduce Sierra Leone's vulnerability to climate change by half by 2030, through increased risk awareness, improvements in rule compliance, increased institutional capacity, and an integrated gender-responsive approach to adaptation in development policies and programs across sectors and scales.
Updated Nationally Determined Contributions (NDC) 2021	The last NDC presents Sierra Leone's mitigation and adaptation options in reducing GHG emissions by 5 percent by 2025, 10 percent by 2030, and 25 percent by 2050 and reducing the country's vulnerability to climate change by half by 2030, in line with the NAP. A new version is being updated.

Sierra Leone also aims to build resilience by adapting to the adverse impacts of climate change. Its updated NDC targets a 50 percent reduction in vulnerability to climate change by 2030, which it plans to achieve by enhancing the country's adaptive capacity and strengthening resilience (UNFCCC 2021a). The NDC's climate change adaptation target is aligned with the NAP, adopted in 2021, which aims to build adaptive capacity to reduce climate change vulnerability and facilitate the integration of climate adaptation into relevant policies, programs, and activities. The NAP focuses on five priority sectors (agriculture and food security, water resources and energy, coastal zone management, the environment, and disaster management) and two cross-cutting priorities (gender equality and social inclusion and hard and soft infrastructure) (UNFCCC 2021b). As indicated in the NAP, Sierra Leone's adaptation targets will be achieved through increased risk awareness, improved rule compliance, enhanced institutional capacity, and an integrated gender-responsive approach to adaptation in development policies and programs across all sectors and levels.

**Meeting the NDC targets will require new financing of around US\$2.764 billion** (UNFCCC 2021b), an average of US\$276 million a year. Inflows of climate finance to Sierra Leone were only about US\$115 million in 2020, US\$118 million in 2021, and US\$164 million in 2022 (AfDB 2023a; Climate Policy Initiative 2022), revealing a massive financing gap. Mobilizing adequate private and public financing—particularly international climate funding and other innovative financing instruments for nature-based climate solutions—will be critical.

Alignment of the NDC and NAP targets with the national development plan is essential for implementing climate change commitments. However, the country's overarching planning instrument, the Medium-Term National Development Plan (MTNDP) 2024–2030, is not yet clearly aligned with the strategies outlined in

the NDC and the NAP. Integrating climate change commitments into national planning and decision-making is needed to achieve climate change targets. In this regard, the Environmental Protection Agency – Sierra Leone (EPA-SL) has taken an encouraging step by preparing centralized guidelines for mainstreaming climate change adaptation and mitigation into the development planning process. These guidelines will support the creation of climate-aware public strategies across all government levels and lay the foundation for improved centralized guidance on climate-sensitive public investment management (IMF 2024).

Proactive strategies are also needed to manage potential trade-offs between economic and environmental targets. If not managed in a way that fosters synergies between economic and environmental goals, the climate targets in the NDC may entail economic and social trade-offs. The opportunity costs associated with competing uses of available resources and additional costs of investments for environmental protection and conservation will have to be managed. Building local technical capacities and knowledge to manage a just and inclusive transition and development can reduce trade-offs and maximize development outcomes. Given its development level, Sierra Leone could exploit latecomer advantages in green technologies and could turn climate challenges into opportunities by undertaking a more green, resilient, and inclusive development pathway.

#### 2.2 Institutional readiness for climate action

Many of the policy targets identified in both the NDC and the NAP are grounded in Sierra Leone's NCCASP and MTNDP 2019–2023. The NCCSAP comprises the National Climate Change Action Plan (NCCAP) and the National Climate Change Strategy (NCCS). Other key frameworks and plans include the National Climate Change Policy Framework (NCCPF) of 2012 and the National Communications to the NCCS and the National Adaptation Programme of Action (NAPA).

The NCCAP, the updated NDC, and the NAP outline Sierra Leone's institutional frameworks for climate action. The NCCP identifies the Ministry of Environment and Climate Change (MECC), the Sierra Leone Meteorological Agency (SL-MET), the EPA-SL, and the Ministry of Energy as playing leading roles in the climate change agenda. MECC, established in 2020, oversees the EPA-SL, SL-MET, the Forestry Division, and the National Protected Areas Authority (NPAA). The Ministry of Agriculture and the Ministry of Land are also included in the governing structures of some of these institutions. The governing body of the NPAA includes representatives from the ministries of agriculture, land, finance, local government and rural development, fisheries, and mines and a representative from Njala University. MECC provides overall governance and coordination of the implementation of Sierra Leone's NDC agenda, with technical support from the EPA-SL and SL-MET; relevant line ministries, departments, and agencies contribute to sectoral policy reforms, resource mobilization, capacity building and technology transfer, and other actions in the process. The establishment of the MECC in 2019 has facilitated coordination of the institutions it oversees; its minister holds monthly meetings at which participants provide updates on their activities. There is a need to institutionalize this kind of coordination effort and mainstream it to help the government go from ad hoc initiatives to a systemic approach.

The government is striving to put suitable institutional structures in place for implementation of its plans for climate and development. It established the National Climate Change Steering Committee (NCCSC), which encompasses all relevant sectors and actors. It became functional only in 2022, with the passage of the EPA Act. It has no regional counterpart, making it difficult to extend its roles to lower levels of government. The government also established NDC coordination committees at the national and regional levels, along with coordination platforms to ensure delivery of the country's NDC commitments. The creation of the NCCSC and NDC committees is in line with the EPA Act, which underscores the need for the establishment of multilateral structures, committees, and coordination platforms to enhance

implementation of the country's climate targets and the international climate agreements to which the country is party. The government also developed a plan to establish a national adaptation committee; the committee has not yet been established.

Institution, year of establishment	Mandate/goal
Ministry of Environment and Climate Change (MECC), 2019	Improve institutional coordination of bodies and agencies responsible for environmental management and climate change.
National Disaster Management Agency, 2020	Enhance preparedness and provide timely intervention in response to disasters, including disasters related to extreme weather events.
Regional climate change committees, 2020	Coordinate climate action at the regional level, in support of national-level coordination.
Institutional framework for the NAP, 2021	Provide an institutional framework for the NAP, through the establishment of the Parliamentary Committee, the Inter-ministerial Committee, the National Steering Committee (NSC), the Scientific and Technical Advisory Taskforce (STAT), and three consultative groups.
Amendment of EPA Act (2008), 2022	Coordinate all actions relating to climate change to enhance consistency in policies, laws, and their implementation; establish the Directorate of Climate Change as a National Climate Change Secretariat and focal point for all climate actions.
Climate Finance Unit (CFU) under the Ministry of Finance, 2023	Strengthen coordination and support the mobilization of climate finance to promote sustainable and resilient economic development.
Presidential Initiative on Climate Change, Renewable Energy, and Food Security, 2023	Elevate the climate change agenda by coordinating actions to address critical issues concerning climate change, renewable energy, and food security, representing the country in climate-related forums, and bolstering cooperation with international partners.

Table 2.2. Institutional arrangements for implementing climate action in Sierra Leone

The 2021 NAP includes a multilevel coordination mechanism to implement climate policy targets and plans. It proposes institutional coordination mechanisms, namely the Parliamentary and Inter-ministerial Committee, the NSC, the STAT, and three consultative groups. The Parliamentary Committee provides high-level political and legislative support. The Inter-ministerial Committee, co-chaired by the MECC and the Ministry of Finance, coordinates policy oversight, coordination, and resource mobilization. The Parliamentary Committee, chaired by the chair of the Environment Committee in the House of Parliament, offers legislative support, monitoring and evaluation, policy advocacy, and public outreach functions. The two committees jointly oversee the NSC, which is chaired by the EPA-SL and includes other departments and agencies from the priority sectors. It provides day-to-day leadership and operational drive for NAP implementation. The STAT provides technical support and advice to the NSC and consultative groups,

including the Private Sector Consultative Group; the Local Council, Communities, and Civil Society Consultative Group; and the Development Partner Consultative Group. These frameworks involve overlapping institutions and are often project and program specific rather than permanent, government-owned platforms for guiding national climate action.

Weak coordination remains a persistent challenge. Despite national polices and a legal framework establishing institutions and coordination arrangements, implementation is still weak. Strengthening national and regional coordination is critical if Sierra Leone is to meet its climate change and development targets. In this context, it is essential to establish clear roles and responsibilities among various ministries and agencies for implementing climate change commitments and mobilizing climate finance. Under the revised EPA Act of 2022, EPA-SL, currently operating under the MECC, coordinates all aspects relating to climate change to enhance consistency in policies, laws, and their implementation. The amendment gives EPA-SL the statutory backing to enhance the level of coordination required to implement climate change commitments. There is also limited clarity on how provinces or districts coordinate climate action.

#### 2.3 Legal frameworks for the implementation of climate commitments

Sierra Leone's existing legal framework addresses the sustainable use of its natural resources in the face of climate change while ensuring economic development. Its 2015 land policy aims to curtail an unsustainable land tenure system and move toward a clearer, more effective, and just land tenure system that addresses social and public demands while promoting national development. It recognizes that land-use planning is essential to the sustainable utilization and management of land and land-based resources (GoSL 2015). Enactment of the Customary Lands Rights Act (CLRA) and the Lands Commission Act in 2022 gave legal effect to policy objectives of the lands policy and established a legal framework that can better address some of the challenges climate change poses.

The 2015 NCCSAP recommended the establishment of a dedicated Climate Change Act to direct climate actions, yet it has not materialized. Such legislation, if enacted, would confer further legitimacy upon climate goals, ensure accountability in implementing climate commitments, and promote adherence to relevant legal frameworks. The adoption of a climate change framework law would additionally furnish a holistic approach to climate adaptation and mitigation efforts in Sierra Leone.

Robust sectoral laws and integration of climate change considerations into these laws can also help Sierra Leone implement its climate policy. No legislation addresses the impacts of climate change on the agricultural sector. However, the National Sustainable Agriculture Development Program (NSADP) 2010–2030 emphasizes the need to increase productivity (through intensification and diversification) and promote commercial farming (through private sector participation), and it recommends the development of a comprehensive policy on climate change and the use of carbon credits to encourage reforestation and afforestation. It notes that climate change will affect the agricultural sector and recommends the formulation of a new forest policy and legislation based on the principle of sustainable forest management as a part of private sector promotion. The LECRDS, adopted in 2015, recommends a comprehensive review of existing laws and their modification to make them responsive to climate change; the review has not yet been conducted.

Sierra Leone lacks a policy or legislation on sustainable or climate-smart agriculture, although some programs and plans include climate-resilient approaches. The National Agricultural Transformation (NAT) 2019–2023 emphasizes addressing issues of low productivity, poverty among smallholders, and food insecurity and highlights the need to mainstream natural resource management issues that are linked to climate change. The NAT articulates a strategy to increase forest cover and maintain existing forests by strengthening policies and the institutional frameworks for integrated protection and management of

biodiversity through cooperation with local communities and other sectors. However, the climate change agenda is not included in sectoral legislation. For instance, neither the National Fertilizer Regulatory Agency Act 2017 nor the Seed Certification Agency Act 2017 integrates climate change, and neither includes climate change incentives for imports of bio-fertilizers or the setting of lower fees for the testing and certification of climate-resistant seed varieties. In 2020, the assessment of the existing climate-smart agriculture (CSA) approaches by the European Union-funded project Boosting Agriculture and Food Security indicated extremely limited adoption of CSA practices by smallholder farmers in Sierra Leone. The main driving factors for low adoption of CSA include limited knowledge, risks of pest and diseases, and perception of high labor requirement of some technologies. A guidance note on CSA insued in 2021 summarizes the recommendations for addressing key challenges for the adoption of CSA in Sierra Leone.<sup>7</sup>

The CLRA, enacted in 2022, aims to ensure cooperation with communities for integrated protection and management of Sierra Leone's land, forests, and biodiversity. In line with the pillar of the NAT 2019–2023 on mainstream natural resource management and its strategy to increase forest cover, the CLRA enshrines the participation of chiefdom authorities and communities in the protection and conservation of forests by allowing the adoption and enforcement of customary rules and practices for the protection of ecologically sensitive areas and co-management of these areas by chiefdom authorities and responsible government agencies. The CLRA also allows the government to implement alternatives to cushion communities if their use of natural resources is restricted in furtherance of conservation objectives. Further, the CLRA enables communities to secure their customary land tenure, which is crucial for long-term adaptation and mitigation measures. Reforestation and afforestation are more likely when landholders have secure tenure, and carbon finance mechanisms depend on secure tenure and clear land and forest ownership information to ensure fair benefit-sharing arrangements.

In the forestry sector, the Forestry Act of 1988 provides the legal foundation for the efficient management of forests, conservation, and the sustainable utilization of forest resources. It recommends the compilation of a national forest inventory and national forest management plans to inform the management of forest resources to provide the optimum combination of economic, social, and environmental benefits. The act is outdated, however, and poorly aligned with current trends in forest management and associated challenges. A new law is needed that responds to emerging realities, including the alarming rate of logging and increasing deforestation, and provides a clear definition of forests, as the Forestry Act and the Forestry Policy lack clarity on what constitutes forests.

**Sierra Leone's legal and regulatory framework does not fully capture its NDC commitments**. Most legal frameworks were enacted before the advent of the NDC and do not directly reflect the NDC commitments. The Forestry Act 1988, the 1990 Forest Regulations, and the NPAA Act of 2012 provide a framework for sustainable exploitation of forest resources and the conservation of national protected areas. They provide foundations for REDD+ initiatives and the reforestation/restoration of degraded areas. Effective enforcement would help address illegal logging, unsustainable exploitation, and encroachments into protected areas, which contribute to the loss of forest cover. Weak enforcement of laws hampers the ability to deliver on Sierra Leone's commitments.

<sup>&</sup>lt;sup>7</sup> Detailed recommendations are provided in the Climate Smart Agriculture (CSA) Guidance Note (<u>https://bafs.org.sl/wp-content/uploads/2021/06/CSA\_Guidance\_Note\_06\_2021.pdf</u>)

#### 2.4 Effective management of public resources and domestic financing for climate action

While attracting more international funding is important, strengthening the mobilization and utilization of domestic resources for climate actions is imperative. The effectiveness and efficiency of public assets, financial resources, and investment management are crucial for ensuring targeted resource allocation for climate interventions, as well as enhancing transparency and oversight. Properly managing public assets ensures resources are allocated efficiently, reducing waste and maximizing the impact of investments. The MTNDP 2019-2023 emphasized the need to improve public financial management (PFM) in Sierra Leone by focusing on the need to enhance revenue generation, fiscal risk mitigation, public debt management, procurement processes, and public asset management. Despite adequate PFM laws, enforcement faces political challenges, with issues like budget reallocations and unreliable budgeting persisting. The MoF (2021) assessment of Public Expenditure and Finance Accountability (PEFA) highlighted these and other problems, such as weak public investment management and insufficient executive action on audit recommendations. Sierra Leone's PFM systems have strengths in resource allocation frameworks but suffer from inefficiencies in service delivery due to unreliable expenditure allocations and cash shortages. Ongoing PFM reforms aim to improve spending efficiency and budget risk management. The country must use its domestic resources more effectively, ensuring scarce public funds are not wasted on investments that climate change could render ineffective. In addition, effective domestic financing mobilizes local resources to support climate initiatives, reducing reliance on international funding and ensuring sustainability. Together, these practices enable the implementation of climate policies, the development of resilient infrastructure, and the achievement of national climate goals, fostering economic stability and environmental sustainability.

Sierra Leone also faces substantial challenges in the design and effectiveness of public investment management, leading to inefficiency. The 2020 assessment of public investment management reveals that, despite a 60 percent increase in public capital stock from 2008 to 2018, there was no corresponding increase in public infrastructure outputs due to inefficient public investment (IMF 2020). This is due to weak institutional capacity to enforce proper appraisal, lack of clear prioritization and selection criteria, circumvention of appraisal requirements, and weaknesses in procurement, funding, and project oversight. Consequently, Sierra Leone has an efficiency gap of 48 percent in public investments, as measured by physical outputs, which is larger than the average for SSA countries (IMF 2020).

Sierra Leone has recently made progress in public investment management, but significant gaps remain. The introduction of the Pre-Investment Guidance Manual in 2022, along with enhancements in procurement and project oversight mechanisms, is a welcome step forward. However, major gaps still cause significant project cost overruns, undermining budget credibility. The lack of a unified project database and clear project selection criteria, along with ongoing challenges in managing multi-year contracts, annual capital budgeting, and effective commitment controls, have led to cost overruns in the capital budget, particularly in the roads sector, amounting to around 1.5 percent of GDP from 2021 to 2023 (IMF 2024). Addressing these persisting public investment challenges is a prerequisite for effective climate-sensitive public investment management. A comprehensive review and rationalization of public investments, particularly focusing on high-impact sectors like roads, is needed. The development of clear and transparent criteria for project prioritization and selection and the establishment of a central database to manage and monitor public investments are also key steps that need to be taken. Additionally, strengthening commitment controls and enhancing project oversight are essential to ensure that investments align with available resources and strategic objectives.

Sierra Leone performs moderately well in climate-aware policy planning, but significant gaps remain due to weaknesses in the public investment management process. According to the IMF (2024) assessment, while the country has established a climate-aware policy framework through its NDC and NAP, public investments, development plans, and sectoral policies and regulations are not fully aligned with its climate commitments. Coordination among climate investment entities is suboptimal, despite improved oversight frameworks for state-owned enterprises. Existing project appraisal guidelines and the public-private partnership framework lack adequate climate-related provisions. Additionally, budgeting and portfolio management do not sufficiently account for climate considerations. In this regard, it is important to strengthen sustainability analysis in project appraisals to include climate assessments, and to clarify and strengthen climate-related roles and capabilities within the public investment management process, particularly among the Ministry of Planning and Economic Development, Ministry of Finance, MECC, and the EPA-SL, through targeted training and a review of legal mandates.

Climate budget tagging is also required to help the government identify, measure, and monitor climaterelevant public expenditures to support resource mobilization for climate action. This process involves defining climate-related expenditures based on objectives or policy references and delineating the coverage across sectors and budget categories. Currently, climate-related public investment spending is not clearly identified in the budget and related documents in Sierra Leone (IMF 2024). The government plans to implement climate budget tagging starting in FY2025, using the Integrated Financial Management Information System (IFMIS) to identify and track climate-sensitive expenditures, including investments. This will involve creating budget output codes or binary flags in the IFMIS to facilitate the tagging of recurrent and investment expenditures related to climate change adaptation and mitigation.

The role of the private sector in financing climate actions in Sierra Leone also needs to be strengthened. AfDB (2023b) estimated that the private sector has the potential to contribute 25–75 percent of the country's climate financing needs, given recent trends in global private climate finance flows. Engaging the private sector brings additional financial resources and expertise, fostering efficiency and innovation in climate initiatives such as renewable energy and sustainable agriculture. To enhance private sector resource mobilization, Sierra Leone must improve technical capacity in climate project structuring and establish an incentive-based regulatory and institutional framework. Multilateral banks and development finance institutions can support these efforts. Despite strong political commitment, gaps in governance coordination hinder the effective mobilization of private sector climate finance. A detailed discussion on mobilizing domestic and private sector resources for climate action is presented in Chapter 5.

#### 2.5 Early warning systems

The NDC and the NAP identify concrete actions to strengthen early warning systems as one of the priorities for adaptation to climate change (Sierra Leone NAP 2021; Sierra Leone NDC 2021). The identified actions include the following:

- Building a system for early warning and disaster preparedness
- Strengthening the national meteorological services
- Building capacity for monitoring climate systems and communicating information about weather and climate
- Developing an understanding of climate-related hazards, vulnerability, and risks
- Promoting climate-related research, modeling, and prediction of weather and climate events.
Implementation of about 85 percent of the above actions is conditional on external funding; the remaining 15 percent will be undertaken unconditionally, using domestic resources (Sierra Leone NDC 2021).

The transformation of the National Meteorological Department into SL-MET, under the Sierra Leone Meteorological Agency Act, is envisioned to enhance the national capacity to provide early warning services. Improved weather, climate, and hydrological information, known collectively as hydromet, is important in informing climate-resilient development in Sierra Leone.<sup>8</sup> The SL-MET website provides real-time climate and hydromet data, including information for disaster management and early warning systems. In 2021, the government reviewed its 2006 disaster management policy, to align it with Sierra Leone's NDC. The new policy's objectives include improving the identification, assessment, monitoring, and early warning of risks. A National Disaster Preparedness Response and Recovery Plan was developed. In addition, some efforts through collaboration between the government and development partners, including the World Bank Group, were undertaken to strengthen disaster management operations in Sierra Leone. For instance, the World Bank project Resilient Urban Sierra Leone Project (P168608, US\$56.73 million) is supporting infrastructure and capacity-building interventions for the National Disaster Management Agency to improve integrated urban management, service delivery, and disaster emergency management in Sierra Leone.

Information must be granular to be useful; generalized warnings of a major hydromet event are of limited value. Weak technical capabilities and digital infrastructure continue to constrain the collection of such information and the provision of effective early warning services. Early warning and monitoring functions, infrastructure, equipment, and human resources all need improvement. Sierra Leone lacks digital infrastructure and systems, particularly for the data hosting, storage, back-up, and real-time access required to operationalize early warning systems. The low capacity of hydromet service providers; the lack of monitoring equipment and technology; and the dearth of administrative and human resources and specialist technical personnel for analyzing and forecasting granular hazardous weather and related events limit the quality and accuracy of meteorological and hydrological information and services. Lack of Internet connectivity and digital infrastructure also constrain SL-MET and allied institutions' efforts to provide early warning data.

<sup>&</sup>lt;sup>8</sup> Hydromet (hydrology + meteorology) is a science that deals with atmospheric, weather, water, and climate phenomena Hydromet services provide real-time weather, water, early warning, and climate information and data (https://www.worldbank.org/en/region/afr/brief/hydromet-in-africa)

# **Chapter 3. The Macroeconomic and Poverty Impacts of Climate Change and the Benefits and Costs of Adaptation**

#### **Key Points**

- Without adaptation, climate change could reduce potential GDP in Sierra Leone by range of 9–10 percent by 2050. Such declines would push nearly 600,000 additional people into poverty by 2050.
- Climate change will affect the economy mainly through changes to labor productivity from heat stress, reduced crop yields and agricultural productivity due to changes in rainfall patterns and soil erosion, the increased costs of repair and renewal of capital (caused by flooding from sealevel rise and extreme tide levels), and impacts on human health with the greater prevalence of diseases.
- Adaptation and resilience interventions could reduce GDP losses to less than 2 percent by 2050 in both the baseline and aspirational growth scenarios. The benefits well outweigh the estimated costs of these select interventions.
- Tight fiscal space, lack of access to market financing, and the limited climate financing available for low-income countries constrain Sierra Leone's ability to finance needed investments.

This chapter discusses the impact of climate change on Sierra Leone's economy under different climate scenarios. It provides quantitative estimates of the economic impact of climate change through various channels under selected climate and growth scenarios. It reports the results of micro-simulations conducted to assess the poverty and distributional impacts and analyzes the investment costs and economic benefits of selected climate adaptation actions. The analysis uses revised National Accounts data from 2024 (Box 3.1)

#### Box 3.1. GDP rebasing

The Government has revised the National Accounts using 2018 as the new base year and incorporating new GDP measurement methodologies. The structure of the economy changed substantially since the previous base year (2006), and GDP measuring methodologies have evolved. The National Statistical Office (NSO) included all available statistical information (census, surveys, and administrative records), including surveys specifically designed for the rebasing. In line with the NAS, the NSO included activities not captured by the previous GDP or that were captured differently.

As a result of the rebasing of the National Accounts, the size and structure of the economy have significantly changed. The base year (2018) nominal GDP attained around NLe 50.7 billion (US\$6.4 billion), around 56.4 percent up from NLe 32.4 billion (US\$4.1 billion) measured with the previous base. Furthermore, the structure of the economy has shifted away from agricultural dominance to a service and agriculture-driven economy. The new national accounts revealed a decrease in the agricultural sector's share of the economy, whereas both industry and services have seen considerable expansion. For example, because of the rebasing, the agricultural sector's share to the economy decreased from 50.5 percent to 35 percent in 2018. Meanwhile, industry and services experienced respective increases of 17.5 percent (from 8.7 percent) and 44 percent (from 37 percent) in the same year.

Source: Sierra Leone authorities.

# 3.1 Vulnerability to climate change: Impact channels

Sierra Leone has not grown rapidly enough to achieve meaningful development outcomes. From a very low point following the civil war, it has lost ground relative to other economies. In 2002, coming out of the civil war, Sierra Leone had the 27th lowest per capita GDP in the world; it now has the 11th lowest level. Despite a rich natural resource endowment (minerals and fertile land), a growing share of the working-age population, and relative political stability since the end of the civil war, growth has been slow.

Structural transformation has been limited; employment is concentrated in agriculture, followed by mining, both of which are volatile, leaving Sierra Leone vulnerable to abrupt changes in climate. The typical changes expected in a country's sectoral employment patterns as it develops have been limited in Sierra Leone. A large majority of the workforce still works in agriculture and connected sectors, more so than in peer countries. Labor movement out of agriculture has been absorbed almost entirely by the services sector, especially in informal trade and tourism. Agriculture is one of the dominant sectors of the economy; on average, it has accounted for less than half of the total output, more than half of the employment, and less than half of the total growth in the last two decades.

Sierra Leone is one of the world's most vulnerable countries to climate change. With its diverse topography, it faces geographical vulnerabilities that amplify the impacts of climate change. The coastal regions, encompassing the capital, Freetown, are on the frontline of climate threats, grappling with rising sea levels and intensified storm events. Floods, droughts, extreme heat, and epidemic events occur frequently, affecting a significant and growing share of the population and economic activities. The country's economic reliance on agriculture makes it particularly vulnerable to changes in temperature and rainfall.

An ambitious and wide-ranging reform program is urgently needed to sustain high growth over the coming decade. To achieve its appropriately ambitious development goals, including reaching lower-middle-income status and progressing beyond that, Sierra Leone will need to find a way to sustain faster growth while ensuring that it is much less volatile than in the past. While it will be creditable if Sierra Leone were to cross the lower-middle-income threshold by 2032 by pursuing an ambitious reform program, this would still mean its lower-income level in 2032 would be much lower than those of aspirational peers such as Lao PDR and Côte d'Ivoire in 2023. Its limited structural transformation, macroeconomic instability, low productivity, constrained capital accumulation, and weak human capital development highlight the need for policy makers in Sierra Leone to be even more far-sighted and ambitious. In particular, there is a need to look for ways to sustain rapid and consistent growth beyond the attainment of lower-middle-income status in the coming years.

Some of the climate-driven impact channels that can affect Sierra Leone's growth trajectory are outlined below. Potential interventions to adapt to these changes are also discussed in later sections of this chapter.

# Human capital

## Effect of heat stress on labor productivity

Higher temperatures will increase heat stress and reduce the productivity of outdoor labor, especially given the large reliance on agriculture and outdoor work. Sierra Leone's agriculture, industry, and services sectors made up 43 percent, 12 percent, and 45 percent of total employment in 2021, respectively (ILO 2021). Structural transformation has been limited, and economic activity is still concentrated in agriculture, followed by mining, which drives large parts of the volatility in the economy. The agriculture sector is consistently more severely affected than other sectors due to a higher proportion of workers performing high physical activity tasks, coupled with higher outdoor temperature exposure.

#### Effect of heat stress on health

Climate change will affect human health and reduce labor productivity—by increasing the incidence of and deaths from vector-borne diseases such as malaria and dengue, heat-related diseases, and waterborne infectious diseases that cause acute diarrhea, all of which will reduce the labor supply. For example, the 2017 floods and landslides resulted in waterborne disease outbreaks. Malaria contributes most significantly to deaths among all communicable diseases (IHME 2021). Improvements in water sources, sanitation, and hygiene have not achieved targeted reductions, despite substantial domestic government investment; the risk of diarrheal disease remains high. Heat stress can reduce labor productivity through increased illness and death from malaria, dengue, diarrhea, and heat-related respiratory and cardiovascular disease. Climate change also affects health through pathways such as increased food insecurity, worsening air quality, and mental health stressors—see the Climate and Health Vulnerability Assessment for a comprehensive overview (World Bank 2024f).

## Agricultural productivity

**Crop and livestock production are expected to experience a variety of impacts from climate change.** Temperature increases are likely to reduce the suitability and productivity of crops. Changes in precipitation patterns can result in reduced water resources available for agricultural users and impact erosion levels, which in turn affect soil fertility. Rain-fed agricultural productivity is central to food security in Sierra Leone. The major food crops produced in Sierra Leone are paddy rice and cassava. Rice cultivation employs most of the rural population, and yet local demand still requires over US\$240 million of imported rice annually. Increased instances of rising temperatures, unpredictable rainfall, and severe storm events have resulted in disruptions to stable food production, especially through more frequent droughts. The crop-wise impact of climate change is discussed in more detail in Chapter 4.

## Rain-fed crop yields

Crop productivity is affected by the availability of irrigation (for irrigated crops) and rainfall (for both rainfed and irrigated crops) as well as heat stress from higher temperatures.

Changes in rainfall patterns, increasing evaporative (water) demands, and extreme heat will affect rain-fed crop yields. The major food crops produced in Sierra Leone are paddy rice and cassava, followed by maize, sorghum, sweet potatoes, oil palm, vegetables, fruits, cocoa, sugarcane, and groundnuts. Together, these crops account for 97 percent of crop production revenues, 94 percent of harvested area, and 98 percent of crop tonnage in the country. Climate change is expected to reduce yields for all rain-fed crops included in the dry/hot future. A wet/warm future is also expected to result largely in yield losses, although some crops (such as sugarcane) may experience small production gains, as heat-related effects are likely to be more detrimental to yields than water-related effects, particularly for rice, cassava, and vegetables, as also discussed in the next chapter. Increasing water storage and the use of heat-tolerant varieties can reduce the water and heat effects, respectively. The increased frequency of higher temperatures, unpredictable rainfall, and severe storm events has already disrupted stable food production, especially through more frequent droughts.

## Soil erosion

Soil erosion can adversely affect plant and animal life, diminish the efficacy of reservoir storage and hydropower production (through sedimentation), and reduce agricultural production (by removing valuable nutrients from the topsoil). Soil erosion and degradation resulting from climate change are already reducing farmland productivity and land fertility and damaging infrastructure supporting agriculture in Sierra Leone. Dispersion and erosion indices of soils used in cultivating cassava, plantain, maize, and guava are above

the minimum thresholds of 15.0 and 10.0, respectively, indicating high erodibility and the need for specialized soil and water conservation practices (such as agroforestry and rotational grazing) to prevent further degradation. If not replenished by fertilizers, soil loss can reduce the nutrients available to crops by eroding the topsoil. Although topsoil is generated naturally, natural generation is slow. Under climate scenarios that project increases in precipitation, erosion tends to worsen more in the eastern part of the country, where erosion is already a major concern. Under drier scenarios, the eastern part of the country, particularly the northeast, is projected to benefit from reduced erosion risk. This implies that there is more uncertainty about erosion risk in the parts of the country with the highest baseline erosion rates.

#### **Capital stock**

**Climate change is likely to affect infrastructure and the services provided by it in various ways,** including by increasing the frequency and magnitude of extreme events that damage assets and by increasing deterioration caused by heat and precipitation levels.

Climate change is projected to significantly increase the risk and intensity of floods in Sierra Leone, as precipitation increases and becomes more severe in some parts of the country. Floods will damage or destroy houses and other properties, agricultural land, and transport infrastructure. Pluvial flooding and flash floods are significant risks for all Sierra Leone's urban settlements, with flooding the second-most frequently occurring natural hazard in the country after epidemics (World Bank Group 2023). This flooding results from high-intensity rainfall in low-lying locations with a lack of infiltration potential, insufficient drainage, and decreased vegetation cover. Urban areas in Sierra Leone grew by 143.5 percent from 1985 to 2015, and pluvial flooding exposure areas grew by 172.3 percent. Projected increases in the frequency and severity of storm events will exacerbate the impacts of urban flooding.

**Rising sea levels and temporary flooding from extreme tidal levels threaten infrastructure and land in lowlying coastal zones.** Increased coastal flooding and sea-level rise from climate change are likely in Sierra Leone, as a result of the increased frequency and severity of intense rainfall, tropical storms, and tidal surges. A quarter of the country's urban population living in coastal and low-elevation areas is vulnerable to flooding (World Bank Group 2023). By 2040, Sierra Leone is expected to experience storm surges of 0.5–0.6 m. Areas of Freetown that are exposed to sea-level rise have increased from none in 1985 to 1.1 km<sup>2</sup> in 2015. By 2050, 3.5 km<sup>2</sup> of Freetown settlements are predicted to be exposed to sea-level rise; by 2100, the entire coast of Freetown will likely be affected, with impacts on public infrastructure and services, businesses, historical sites, and tourism. Even if urban areas remained at 2015 levels, 1.5 km<sup>2</sup> of settlements would be vulnerable by 2100.

Changes in precipitation, temperature, and flooding can damage roads and bridges, increasing maintenance costs, causing delays for passengers, and reducing labor productivity. Temperature affects only paved roads, precipitation affects both paved and unpaved roads, and flooding affects all kinds of roads and bridges. Impacts are generally higher under the wet/warm scenario than the dry/hot scenario, because extreme precipitation and flooding cause the greatest damage to roads and bridges. For roads, the analysis examines the impacts of climate change on repair and maintenance costs. For bridges, the estimates of vulnerability are based on a comparison between current and future return periods for flooding at the location of a bridge. In addition to the repair and maintenance costs estimated for roads and bridges, the analysis estimates the delay costs of damaged roads requiring repair and maintenance, which affect labor productivity.

# 3.2 Estimates of the macroeconomic impact of climate change

This section details the economic estimates of the potential impact of climate change in Sierra Leone under business-as-usual assumptions and under an aspirational economic trajectory. The following section will identify some adaptation interventions to contain this impact.

The macro-modeling reported in this chapter analyzes the economic and poverty impacts of climate change and adaptation policies. A country-specific Climate Change Macro-Fiscal Model (CC-MFMod)<sup>9</sup> was developed to quantify the macroeconomic effects of different climate, growth, and policy scenarios. The chapter examines two growth scenarios, thirteen climate scenarios (though much of the analysis focuses on two combined dry/hot and wet/warm scenarios),<sup>10</sup> and seven channels through which climate change could affect Sierra Leone. These selected channels and scenarios capture a range of possible climate stressors on the economy (infrastructure, productivity, labor supply, and sectoral output) but are not exhaustive.

This analysis examines two growth scenarios. The baseline scenario is based on recent growth performance (Figure 3.1). Real GDP is projected to grow at an average annual rate of 4.3 percent over 2025–50. The high-growth scenario is aspirational. It assumes more rapid structural transformation as well as ambitious reforms across all factors of production (labor, capital, and productivity). Under this scenario, Sierra Leone could become a lower-middle-income country by 2032 if it (a) increases total factor productivity in the non-resource sector by 1 percent a year through 2032 and 2 percent after 2032 and (b) raises total investment as a share of GDP to 25 percent by 2031—achieving an average annual GDP growth of 6.6 percent during 2025–2050.



#### Figure 3.1. Projected GDP per capita under the baseline and aspirational growth scenarios, 2024–50

Source: World Bank staff estimations.

<sup>&</sup>lt;sup>9</sup> See Annex 4 for a description on the CC-MFMod.

<sup>&</sup>lt;sup>10</sup> The analysis reports the results of two climate scenarios that combine results of eleven other scenarios examined. The combined dry/hot scenario examines the 10th percentile of mean precipitation changes according to various projections based on the SSPs and combines SSP3-7.0 for sea-level rise and urban flooding projections. The combined wet/warm scenario examines the 90th percentile of mean precipitation changes and 10th percentile of mean temperature changes and combines SSP3-7.0 for sea-level rise and SSP2-4.5 for urban flooding projections. Large natural disasters (low probability, high impact) are not considered in this analysis. See Annex 2 for the climate scenarios examined.

## Impact channels

This report examines seven (of the many) channels of impact (Table 3.1). It estimated the effect of shocks based on changes in climate variables in 2021–50 relative to the baseline (1995–2020). It then inputs these shocks into Sierra Leone's CC-MFMod, which is built from the 2018-based National Income Account (see Box 3.1). Given the caveats presented in Box 3.2, all figures in this section should be interpreted with caution.

#### Box 3.2. Caveats regarding estimates of economic loss or damage

- **Missing channels.** Of the many potential impact channels, this report models only seven. The estimates of GDP impacts are therefore not comprehensive. Some important channels are difficult to model. For example, climate change may affect nutrition and educational attainment, with lifelong consequences for health, learning, productivity, and earnings. Even within a channel, some pathways cannot be captured. Under the hotter and wetter climate scenarios, for example, the livestock yield channel captures the increase in food and water availability but does not reflect the possibility that the prevalence of livestock disease could increase, reducing 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 (such as water), the possibility of ecosystem collapse, or the acceleration of climate-induced outmigration. These risks are not unlikely, especially after 2050, if global emissions do not drop rapidly. Their realization would make the total GDP and poverty impacts much larger than estimated in this report.
- Failure to fully capture the positive effect of inclusive development on mitigating the impacts of climate change. The modeling captures only the positive effect of the shrinking of the agriculture sector in the higher-growth scenarios. It does not account for the possibility that 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, insurance, and strong social protection) might enable households and firms to reduce the impacts of climate shocks. Higher GDP and income could reduce vulnerabilities in several ways, including through (a) investment in inputs and irrigation, which would allow richer farmers to buffer the negative effects of climate change on agricultural yields; (b) better access to improved water and sanitation, which could reduce the impact of higher temperatures on waterborne disease and diarrhea; and (c) the allocation of more resources for mechanization of agriculture, which could reduce the physical intensity of labor, reducing the impact of higher temperatures on GDP losses.

Table 3.1 Potential effects of climate change on human capital, agricultural and natural resources, and infrastructure and services

		Sector	Labor	Labor	
Channel	Description	productivity	productivity	supply	Capital
Human capital					
Labor	Shock to labor productivity from daily heat stress experienced by both indoor and outdoor workers; incorporates occupation- specific work ability curves from the International Labour Organization.		$\checkmark$		
Human health	Shock to labor supply from changes in the incidence of and mortality associated with			$\checkmark$	

		Sector	Labor	Labor	
Channel	Description	productivity	productivity	supply	Capital
	vector-borne, waterborne, and temperature-				
	related diseases.				
Agriculture and	natural resources				
Rain-fed crops	Shock to crop revenues through changes in	$\checkmark$			
	yields. Estimates are based on Food and				
	Agriculture Organization (FAO) crop-specific				
	yield response functions to rainfall				
	availability and heat stress.				
Erosion	Shock to crops from topsoil erosion and	$\checkmark$			
	flooding. Impacts on erosion are estimated				
	from changes in rainfall.				
Infrastructure a	nd services				
Urban	Shock to capital in selected cities from peak				$\checkmark$
flooding	precipitation events that result in pluvial				
	flooding. Estimates are based on a study of				
	Monrovia.				
Coastal	Shock to coastal areas, including around		$\checkmark$		$\checkmark$
flooding, sea-	Freetown, from changes in mean sea level				
level rise, and	and extreme tide levels, using a bathtub				
extreme tide	approach.				
levels					
Roads and	Shock to capital from damage to and the				$\checkmark$
bridges	need for maintenance of roads and bridges				
	modeled through the IPSS model. Also				
	considers the effects of road disruption on				
	labor supply.				

## Projected impacts of climate change without adaptation policies or investments

Climate change will affect Sierra Leone through changes to labor productivity from heat stress, lower crop yields from shifts in rain patterns and land erosion, effects on human health, and the increased costs of repair and renewal of capital caused by flooding (urban and coastal) and rising sea levels.<sup>11</sup> The largest impact on the economy stems from its effects on labor productivity and agriculture. Assuming baseline growth, a dry or lower-precipitation shock (hot/dry) to the economy is expected to reduce GDP by 10.1. percent by 2050, while a warmer and higher precipitation shock (wet/warm) is expected to reduce GDP by 9.8 percent (Figure 3.2), largely driven by the impact of heat on labor productivity. Agriculture, which makes up roughly one-third of Sierra Leone's economy, exposes the country to numerous climate threats. Rainfall-related output losses could erase the second most economic gains under both wet/warm and hot/dry scenarios, potentially leading to GDP losses of up to 2.4–3.8 percent by 2050 in the baseline scenario. The

<sup>&</sup>lt;sup>11</sup> The combined effects from each of the impact channels are introduced as shocks into the CC-MFMod for each of the projection years, to assess the impacts of climate change on GDP and other macroeconomic aggregates in 2021–50. The shocks were smoothed as inputs without loss of generality. As the size of the impacts depends on the size and structure of the economy, the shocks are introduced and run for each of the two growth scenarios. The combined impacts of the channels are more than the sum of the individual channels because of the multiplicative effect of shocks.

other two significant impact channels are coastal flooding (projected to reduce GDP by 0.8 percent by 2050) and urban flooding (projected to reduce GDP by 0.5–0.6 percent by 2050) under the baseline scenario. The aspirational scenario reduces climate impacts only slightly, between 9.5 percent and 9.6 percent under the different climate scenarios (Figure 3.2).

# Figure 3.2. Projected effect of climate change on GDP level in 2050 without adaptation, by channel of impact, climate scenario, and growth baseline

Panel A: Baseline scenario GDP impacts in 2050 by damage channels (% GDP)







Source: World Bank staff estimations using Macro-Fiscal Model (MFMod) and Industrial Economics, Incorporated (IEc).

The cost of climate inaction is high. Without any adaptation, GDP losses could reach 4 percent of baseline GDP as early as 2030 and accelerate to 10 percent of GDP by 2050 (Table 3.2). Despite similar GDP losses by 2050 under the two climate scenarios, the interim period shows a different picture where the climate impact under wet/warm is much less pronounced (in 2030, GDP loss is less than half compared to hot/dry and about 30 percent less by 2040) and only accelerates strongly in the last decade of 2040–2050 due to erosion.

	Combined Wet/Warm				C	Combined Hot/Dry		
	2020	2030	2040	2050	2020	2030	2040	2050
	BAU			AU				
			Deviatior	n from Bas	eline Level	(Percent	)	
Impact Channels (% of real GDP)								
Total	0.0	-2.0	-5.4	-9.8	0.0	-4.3	-7.3	-10.1
Agriculture								
o/w Crop Production (Rain-fed)	0.0	-0.3	-1.1	-2.4	0.0	-1.5	-2.7	-3.8
o/w Crop Production (Erosion)	0.0	-0.2	-1.1	-2.3	0.0	-0.3	0.1	0.4
Infrastructure								
o/w Roads and Bridges	0.0	0.0	0.0	-0.2	0.0	-0.1	-0.1	-0.1

Table 3.2. Impact of climate change on real GDP, by channel, under the combined wet/warm and hot/dry scenarios, 2030–50, under baseline growth, without adaptation

	Combined Wet/Warm				(	Combine	d Hot/Dr	y
	2020	2030	2040	2050	2020	2030	2040	2050
				E	BAU			
Deviation from Baseline Level (Percent			(Percent	.)				
o/w Sea-level Rising and Coastal Flooding	0.0	-0.1	-0.4	-0.8	0.0	-0.1	-0.4	-0.8
o/w Urban Flooding	0.0	-0.1	-0.3	-0.5	0.0	-0.1	-0.3	-0.6
Labor								
o/w Labor Heat Stress	0.0	-1.2	-2.1	-3.2	0.0	-2.0	-3.5	-4.8
o/w Human Health	0.0	-0.2	-0.3	-0.5	0.0	-0.2	-0.4	-0.5

Source: World Bank staff estimations using MFMod and Industrial Economics, Incorporated (IEc). Note: BAU = Business As Usual; o/w = Of which.

# 3.3 Poverty impact of climate change shocks without adaptation

**Climate change has the potential to significantly slow the pace of poverty reduction in Sierra Leone.** Considering the effect of climate change in the economic growth, it can limit the pace of poverty reduction. The adverse impacts of climate change are likely to disrupt key sectors, such as agriculture, which will further exacerbate vulnerabilities for already marginalized populations. Under two future climate scenarios—hot/dry and wet/warm—projections indicate that by 2050, the upper bound poverty headcount ratio in the hot-dry scenario will increase by 4.2-4.3 percentage points compared to the baseline scenario. This increase would result in an additional roughly 600,000 people (583,845 – 596,711 people) falling into poverty.

## Figure 3.3. Poverty impacts at national level.



Source: World Bank staff estimates.

All climate scenarios result in increased inequality in the long run, with the combined hot/dry scenario leading to the largest increase by 2040 and the combined wet/warm by 2050. Income inequality, measured by the Gini coefficient, is projected to rise by 0.25 percentage points relative to the baseline in the hot/dry

scenario by 2040 and by around 0.45 percentage points by 2050 under the wet/warm scenario. These high levels of inequality, compared to the baseline scenario, are driven by a growing gap between workers in agriculture and those in other sectors, especially given the expected substantial decrease in value added by the primary sector. Additionally, per capita consumption for the bottom three deciles is expected to decrease by 10–11 percent with respect to the baseline scenario by 2050 in both the combined wet/warm and hot/dry scenarios.

In rural areas, where the majority of the population lives in poverty, an increase in poverty levels is expected under all the scenarios, while urban areas are expected to be less severely impacted by climate change. The rise in poverty is particularly pronounced in rural areas, with a potential increase of between 6.5–6.9 percentage points (Figure 3.4) relative to the baseline by 2050, compared to an increment of about 1.5 percentage points for total urban areas under the different climate scenarios.





Source: World Bank staff estimates.

Poverty levels are expected to remain relatively high in some interior districts of the country, even when considering climate change shocks, while coastal areas will be affected considerably (Figure 3.5). Spatially, the gap in the poverty headcount between the coastal regions (Kambia, Porto Loko, Bonthe, Moyamba, and the Western area) and the rest of the country is projected to increase slightly from 27.7 percentage points in 2030 to 29.1 percentage points in 2050 under the baseline scenario. However, this gap will be higher under the wet/warm climate change scenario, meaning 1.6 percentage points additionally by 2050. For example, in Port Loko district, climate change can undermine around 11.7 percentage points in poverty reduction by 2050 under the hot-dry scenario and nearly 12 percentage points under the wet/warm scenario by the same year. Other districts such as Kambia or Bonthe are expected to be severely affected, particularly under the wet-warm scenario by 2050.





Source: World Bank staff estimates.

# 3.4 Benefits and costs of selected adaptation interventions

This report examines seven channels of impact: heat stress, crop erosion, rain-fed crops, urban flooding, roads and bridges, sea-level rise and coastal flooding, and effects on human health. Adaptation actions selected include a realistic balance between adaptation costs and residual impacts.

Adaptation interventions can significantly mitigate damage and losses, with benefits outweighing costs. Selected adaptation interventions include investments in infrastructure (such as reservoirs, weather resistant roads, and air conditioning) and some behavioral changes (such as new construction at higher elevations and the planting of new types of crops) and are estimated to cost cumulatively about 5–6 percent of 2024 GDP (real terms) (see Table 3.3). The benefits of these adaptation interventions outweigh the costs (Figure 3.8, Panel B). Adoption of all adaptation interventions can reduce the impact on GDP by 6–8 percent. While the costs of interventions are largely front-loaded, with more than half of the costs to be incurred before 2030 (especially on the construction of roads, bridges, and reservoirs), the benefits are expected to accrue over time and start to exceed the annual costs after 2035.

Adaptation is easier under the wet/warm scenario than under the hot/dry scenario. In the dry/hot climate scenario, the adaptation and resilience actions could reduce GDP deviations to less than 4 percent by 2050 in both the baseline and aspirational scenarios. In the wet/warm climate scenario, GDP deviations are less than 2 percent in the baseline scenario. The largest gains come from the use of air conditioning for the indoor workforce, as the economic structure shifts toward greater formal employment in services, and manufacturing and agriculture become less labor-intensive. The next largest gains are from investments in water storage capacities and adopting heat-resistant crops (Figure 3.8, Panel A).

With adaptation, poverty and inequality are expected to increase in the hot/dry scenario, albeit at a slower pace compared to a no-adaptation or resilience scenario (Figure 3.6). Poverty is projected to rise by about 2 percentage points in 2040 and by 1 percentage point in 2050 in the hot/dry scenario with adaptation compared to the baseline. Under the wet/warm scenario, however, only the Gini coefficient is expected to decline relative to the baseline scenario. Despite efforts to mitigate the impacts of climate change, the slow

recovery of key sectors, such as agriculture, will continue to contribute to growing disparities. Vulnerable populations, especially in rural and remote areas, will struggle to adapt due to limited resources and infrastructure. These trends highlight the need for targeted interventions to support the most vulnerable communities and foster resilience.

	Adaptation and resilience		
Channel	measure	Cost	
Reduction in heat stress	<ul> <li>Invest in air conditioner for the indoor workforce.</li> <li>Mechanize agriculture, shifting unskilled agricultural workers to jobs that are less vulnerable to heat stress.</li> </ul>	A cumulative cost of current US\$250 million by 2050.	
Reduced soil erosion	Reduce tillage and use of crop residue as mulch.	No additional cost required.	
More water for rain-fed crops	<ul> <li>Add medium-size reservoirs to store excess rainfall for irrigation, so that irrigated area accounts for up to 20 percent of rain-fed rice, sugarcane, and vegetables by 2050.</li> <li>Increase share of heat- tolerant varieties for selected crops (that is, cassava, sweet potatoes, vegetables, and tropical fruits) to 25 percent.</li> </ul>	A cumulative cost of current US\$241 million is required for 2023–50.	
Protection against some urban flooding	<ul> <li>Build new infrastructure outside the historical 20- year floodplain, at the urbanization rate of the capital city.</li> <li>Floodproof the first meter of existing structures with the highest annual expected damage under the worst-case climate scenario by 2050.</li> </ul>	A cumulative additional adaptation investment equals 0.15 percent of total capital stock. In total, the adaptation interventions presented here are estimated to cost about US\$12.4 million in 2017 international dollars total in the period from 2025 to 2050.	
Protection of roads and bridges	Build new road     infrastructure to resist     higher temperature and     precipitation as well a 50-     year flooding event, with     work conducted once     existing infrastructure	Total investment of US\$717 million under the hot/dry scenario (3.3 percent of baseline GDP) and of US\$1,021 million under the wet/warm scenario (3.8 percent of baseline GDP) over 2022–50.	

Table 3.3. Estimated costs and benefits of selected adaptation interventions

	Adaptation and resilience			
Channel	measure	Cost		
	reaches the end of its life			
	or needs rehabilitation			
	after damage has occurred.			
Mitigation of sea-level rise and	Build new infrastructure at	No additional cost required.		
coastal hooding	a higher elevation, above			
	the projected sea-level			
	change by 2050, to protect			
	from extreme tidal events.			

Source: World Bank staff estimations using MFMod and Industrial Economics, Incorporated (IEc).

Table 3.5. Projected effect of climate change on GDP level by 2050, baseline scenario, with adaptatior	۱
(100% public)	

	Combined Wet/Warm				Combined Hot/Dry			y
	2020	2030	2040	2050	2020	2030	2040	2050
				E	BAU			
		C	Deviation	from Base	eline Level (	Percent)	*	
Impact Channels (% of real GDP)								
Total	0.0	-0.6	-1.5	-1.9	0.0	-2.8	-3.7	-3.7
	Agriculture							
o/w Crop Production (Rain-fed)	0.0	0.6	0.6	0.3	0.0	-0.6	-0.9	-1.0
o/w Crop Production (Erosion)	0.0	-0.1	-0.3	0.3	0.0	-0.2	0.4	1.2
Infrastructure								
o/w Roads and Bridges	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.1
o/w Sea-level Rising and Coastal Flooding	0.0	-0.1	-0.3	-0.5	0.0	-0.1	-0.3	-0.5
o/w Urban Flooding	0.0	-0.1	-0.1	-0.1	0.0	-0.1	-0.2	-0.1
	Labor							
o/w Labor Heat Stress	0.0	-0.8	-1.1	-1.5	0.0	-1.6	-2.4	-2.9
o/w Human Health	0.0	-0.2	-0.3	-0.5	0.0	-0.2	-0.4	-0.5

Source: World Bank staff estimations using MFMod and Industrial Economics, Incorporated (IEc). Note: BAU = Business As Usual; o/w = Of which.



Figure 3.6. Projected effect of climate change on poverty and inequality with adaptation

Source: World Bank staff estimations and Industrial Economics, Incorporated (IEc).

Figure 3.7. Projected effect of climate change on poverty with and without adaptation by rural, urban



Source: World Bank staff estimations and Industrial Economics, Incorporated (IEc).



Figure 3.8. Annual capital expense (% GDP) and benefits of adaptation intervention, by channel under baseline growth

Source: World Bank staff estimations using MFMod and Industrial Economics, Incorporated (IEc).

# **Chapter 4. Sectoral Pathways to Climate Resilience**

#### **Key Points**

- The development of green energy and climate-resilient infrastructure in growing towns and remote rural areas alike is critical for fostering more balanced development and reducing poverty nationwide.
- Climate change is profoundly altering agroecological and climatic conditions in Sierra Leone, resulting in varied impacts across different climatic zones and other land uses and coastal zones. By developing resilience in agriculture and natural resources productivity, which integrates nature-based solutions (NBS) and social and governance dimensions, the country can enhance its adaptation capacity to absorb and rebound from climate disruptions.
- Strengthening social resilience involves not just addressing the immediate aftershocks of climate events on lives and livelihoods but also investing in the long-term development of human capital or skills, knowledge, health, and social protection that enable individuals to prepare and respond to climate challenges.

This chapter presents three priority pathways that Sierra Leone can take to become more resilient to the impacts of climate change: (a) developing green energy and resilient infrastructure, (b) promoting CSA and natural resource productivity, and (c) strengthening social resilience (table 4.1). In examining the implications of various climate and growth scenarios (Chapter 3), the Country Climate and Development Report (CCDR) found that none of the projected climate conditions or structural adjustments to the economy would favor Sierra Leone's development in the absence of adaptation. Regardless of the growth trajectories that the country takes or global emission patterns of the future, Sierra Leone will have to adapt to the effects of climate change to avoid a smaller economy, potentially pushing more people into poverty by mid-century. The selected pathways described in this chapter identify the areas that need the most urgent climate action for Sierra Leone to meet its development goals. The pathways are informed by the CCDR's modeling results and further analyses of climate risks and opportunities across various sectors and present recommendations for climate action that are synonymous with development priorities.

Sectoral pathway	Area of analysis			
Developing green energy and sustainable cities	Energy transition			
	Urban planning and infrastructure			
Promoting climate-smart agriculture and natural	Agriculture and food systems			
resource productivity	Forestry, mining, and other land uses			
	Coastal wetlands			
Strengthening social resilience	Population health			
	Education			
	Social protection and inclusion			

# 4.1 Developing green energy and sustainable communities

#### **Energy transition**

Sierra Leone's energy transition must simultaneously capture energy security, equity, and sustainability in its climate and development strategies. Many firms already identify inadequate electricity supply as a major factor that disrupts production and drives up costs. Rising temperatures and changing weather patterns increase energy demand across sectors and provoke power shortages, making energy insecurity an increasing risk that threatens the country's plans for a more diversified and productive economy. At the same time, scaling energy access will be central to raising living standards and adapting to climate change effects. The CCDR modeling indicates that substantial economic damages and poverty can be averted through energy-intensive adaptation interventions, such as cooling solutions, agricultural mechanization, and water storage, to reduce projected heat stress and shocks to crop yields. However, meeting increasing energy demands while averting future damage to the environment will require Sierra Leone to identify more opportunities for developing green energy infrastructure.

Limited access to electricity significantly increases community vulnerability to climate change. Currently, only 36 percent of the population has access to electricity, with a stark rural-urban divide: 44 percent of the urban population is connected to the grid, compared to just 1.3 percent of the rural population (Khan and Khoo 2024). This limited access hampers essential services such as healthcare, education, water supply, and connectivity and digitalization. Additionally, increasing household demand for energy contributes to the degradation of ecosystems as families turn to natural resources for fuel. Only one in ten Sierra Leoneans has access to clean cooking, with 95 percent of rural households using firewood and 67 percent of urban households relying on charcoal (Khan and Khoo 2024). The total cost of limited access to clean cooking in Sierra Leone is estimated at US\$4.7 billion per year, driven by negative impacts on health, gender equality, and the environment.

Even if the country is to scale energy access, Sierra Leone's energy supply is largely dependent on expensive liquid fuel-based power and already does not meet peak demands. The country has three main sources of power: (1) the Bumbuna hydropower plant, which generates 5 MW in the dry season and 50 MW in the wet season; (2) the Karpowership, an independent power producer (IPP) liquid fuel-based generation plant (heavy fuel oil - HFO) that produces 20 MW in the wet season and 60 MW in the dry season; and (3) the Côte d'Ivoire-Liberia-Sierra Leone-Guinea (CLSG) regional transmission line, which has an initial power purchase agreement (PPA) of 10 MW and transmission service agreement (TSA) of 27 MW. The total available generation capacity across sources is about 80 MW in the wet season and about 75 MW or less in the dry season. The peak demand of current users is already above 80 MW, and the distribution utility, the Electricity Distribution and Supply Authority (EDSA), estimates that unsuppressed demand in Freetown was 105 MW in 2022, resulting in no reserve margin. EDSA has high losses and weak collections and is unable to pay for its power purchases or meet current demand. Since 2021, it has struggled to pay for power purchases from Karpowership, resulting in the government subsidizing expenses. The fiscal stress increased after the Ukraine crisis and the subsequent oil price rise, with the government estimating that it would have to provide US\$36 million in 2023 in electricity subsidies to the sector.

The government plans to tap into the country's large hydro and solar potential to meet increasing demand and transition away from expensive and polluting HFO. The grid electricity coverage is about 21 percent, of which 20.5 percent is from the national grid, mostly in Freetown, and 0.6 percent from mini-grids. The country has approximately 100 mini-grids, the majority of which are solar and battery storage systems. About 3 percent of these mini-grids are mini hydro systems, and 15 percent are diesel based. The 1996 Power Sector Master Plan identified 27 potential hydropower sites with a total capacity of 1,513 MW. The

Integrated Resource Plan (IRP) developed in 2020 also identified hydro as an important means to meet demand.<sup>12</sup> The main hydropower sites proposed are an expansion of Bumbuna I and the development of Bumbuna II and Bekongor. The IRP also identifies solar generation (around 140 MW) and imports from CLSG as the key sources for replacing all grid-connected fossil fuel-based generation by 2025. Sierra Leone is also developing a publicly funded 40 MW solar project and has connected CLSG, which has the potential to substantially increase imports.

# Recommendations

Sierra Leone will need to navigate its energy transition and overcome challenges that will be exacerbated by climate, such as rising energy demand, inequitable electricity supply, and reliance on expensive liquid fuels. Sierra Leone must implement targeted strategies that can enhance energy security, equity, and sustainability. The country can prioritize the following recommendations to guide its energy transition.

- (1) Develop the country's hydro and other renewable potential and expand energy imports to attain energy security, unlock tremendous savings, and reduce emissions from the sector.
- (2) Achieve universal electricity access through increased grid electrification, mini-grids, and standalone solar systems.
- (3) Take an integrated and cross-sectoral approach to creating an enabling environment that supports the development of the clean cooking market.
- 1. Develop the country's hydro and other renewable potential and expand energy imports to attain energy security, unlock tremendous savings, and reduce emissions from the sector.

Untapped hydropower potential could be a game-changer for the country by helping it achieve reliable energy security (Figure 4.1). If Sierra Leone can develop its tremendous hydro potential or increase imports, it stands to save 19 percent to 51 percent, respectively, in investments and operations costs over the next two decades (Figure 4.2). A status quo generation expansion leaves the sector with just 40 MW of solar (under implementation) and 50 MW of additional hydro (Bumbuna I expansion planned by Millennium Challenge Corporation (MCC)) with the rest of the demand met through emergency thermal similar to the existing Karpowership. The capital and fuel costs of this approach would reach nearly US\$4.5 billion by 2040.

Expanding imports from CLSG would cost 51 percent less (US\$2.2 billion). Expanding hydro resources would be even cheaper, at just 19 percent of the cost of the status quo, and could potentially lead to exports, depending on demand and development. Sierra Leone's current annual GHG emissions from power generation are relatively low (0.6 mtCO<sub>2</sub>), given the size of the system. If it chooses to use HFO to meet its demand, annual GHG emissions could more than quadruple to 2.5mtCO<sub>2</sub> by 2040. In both the higher-import and higher-hydropower scenarios, Sierra Leone could eliminate grid-connected fuel-based generation, reducing annual emissions to just 1.6 mtCO<sub>2</sub> in the former scenario and just 0.5 mtCO<sub>2</sub> in the latter scenario.

**Moreover, hydro-based generation in Sierra Leone is likely to be only moderately sensitive to climate change** (Figure 4.3). Considering that hydropower relies on consistent water availability, changes in precipitation patterns and water flow due to climate change can affect its reliability. For planning purposes, five hydroenergy scenarios were defined. In all but the worst-case scenarios (which project power reductions of 15– 25 percent), the potential impacts of climate change on hydropower generation are either insignificant or

<sup>&</sup>lt;sup>12</sup> The IRP developed for the MCC in 2020 forecasts demand at 640 MW by 2040 under the base scenario.

slightly positive. This presents a justifiable case for Sierra Leone to explore the significant potential for additional hydro-energy generation with relatively low GHG emissions.





#### Figure 4.2. Cost of status quo, expansion of imports, and expansion of hydro power in Sierra Leone



Figure 4.3 Potential impacts of climate change on hydropower generation in Sierra Leone in 2030 and 2050

Panel A: 2030







# 2. Achieve universal electricity access through increased grid electrification, mini-grids, and stand-alone solar systems.

The IRP is proposed using least-cost electrification options to achieve universal access by 2030. Combining the results from the World Bank's generation planning (Electricity Planning Model- EPM) and the results from two least-cost electrification models, including the National Online Electrification (NODE) Platform, it is seen that for 65 percent of the population, grid electrification will be the cheapest way to provide access to electricity. Stand-alone solar systems will be the most affordable form of electricity for nearly 430,000 households, typically rural households. Some 850–1,400 communities can be connected to mini-grids powered by solar photovoltaic (PV) and (in some cases) back-up diesel to get electricity. To achieve universal access, Sierra Leone will require about 210 MW of additional generation capacity (mostly renewable or imports) including 11–20 MW (solar PV, battery, and back-up diesel) from mini-grids and about 17 MW from stand-alone solar systems.

The country will need to seek private capital to achieve universal access to electricity by 2030, which will require investments of US\$830 million–US\$1 billion. This is a conservative estimate as it does not include the increased need for air conditioning to adapt to the impact of higher temperatures on labor productivity (as discussed in Chapter 3) This means that Sierra Leone faces a massive task in raising over US\$118–

US\$142 million a year to meet its goal of universal access to electricity by 2030. Given that the public sector has very limited funds and development partners can provide only limited support, Sierra Leone will need to attract the private sector to reach its Sustainable Development Goal (SDG) 7 targets.

Improving sector governance, especially at the distribution utility, and enhancing the capacity of the sector regulator, Sierra Leone Electricity and Water Regulatory Commission can give confidence to the private sector. Private capital will not be willing to take the off-taker risk presented by the poor operational and financial performance of EDSA and the sector. An integrated approach to planning is critical if the necessary transmission and distribution infrastructure investments are to be made and the sector is to become sustainable and provide least-cost expansion of generation (hydro and solar). Although the focus is on putting in place the institutional and policy framework to unlock the sector's potential, it is imperative that the government aligns its regulatory framework for more competitive and robust private sector led power infrastructure.

Energy planning for achieving universal access should also estimate digitization investment needs, which cuts across many climate resilience interventions. Recent policy developments emphasize a whole-of-government approach to digitalization for enhancing climate resilience. The National Innovation and Digital Strategy (NIDS) and the National Information and Communication Technology (ICT) Policy reflect the government's vision for leveraging digital technologies to improve environmental sustainability, climate-smart agricultural practices, and early warning systems. The government's Enterprise Architecture Framework and the NCCSAP indicate the government's intention to leverage technology for disaster risk reduction and climate resilience. In the short term, energy generation and distribution infrastructure should be assessed to target efforts and investments needed to increase access to electricity. In the long term, (a) develop an energy roadmap that takes account of the government's goals and objectives of digitalization as well as climate impact, to help transition Sierra Leone through various stages to becoming energy efficient; (b) align efforts by and the goals of the public and private sectors (a strong public-private partnership can help accelerate the move toward digitalization); and (c) establish greener national data centers, by consolidating server infrastructure across institutions.

# 3. Take an integrated and cross-sectoral approach to create an enabling environment that supports clean cooking market development.

Sierra Leone's 2021 SDG7 Cleaner Cooking Energy Compact sets out to achieve universal access to affordable, reliable, and modern energy services. The main target is to increase the use of liquified petroleum gas (LPG) to an adoption rate of 25 percent as an alternative to wood fuel and to ensure that all households have access to energy-saving cooking solutions. To achieve these targets, a total investment of around US\$60 million is needed each year, including US\$22 million from the public sector, US\$1.4 million by the private sector to install downstream infrastructure for the functioning of modern energy cooking markets, and US\$21 million by households themselves. The estimated benefits of achieving the clean cooking targets, however, are 23 times higher than the estimated total investments and 65 times higher than the amount of public financing.

- In the short term, (a) develop a national strategy for clean cooking and action plan to achieve policy targets; (b) formalize cooking energy demand into national energy planning; and (c) adopt regulations and standards promoting market development for clean cooking solutions.
- In the long term, (a) scale up public and private financing for clean cooking; (b) deploy sustainable national programs for clean cooking; and (c) expand data collection efforts and monitor progress.

#### Urban planning, transport, and infrastructure

Sierra Leone's rapid urbanization amidst high poverty and climate vulnerability highlights the need for integrated strategies to manage sustainable urban growth and disaster risk. In 2022, about 44 percent of the population was living in urban areas; the figure is projected to surpass 50 percent by 2050 (World Bank 2023c). About 30 percent of the population lives in the six largest urban centers: Freetown, Bo, Kenema, Koidu, Makeni, and Port Loko (World Bank 2023c). Poverty is declining more rapidly in urban areas than in rural areas, but the increasing density of cities is making them less and less livable (World Bank 2022). This demographic shift, fueled largely by rural migration, is putting pressure on urban economies and reducing living standards. Urban growth has been largely unplanned, resulting in widespread informality, wide socioeconomic and spatial inequalities, limited access to essential services and transport, and the proliferation of informal settlements.

These urban trends significantly heighten climate and disaster risks. Cities are increasingly developing into high-risk zones that are exposed to flooding, landslides, and sea-level rise. Urban expansion has led to a marked increase in built-up areas that extend city borders, increasing their vulnerability to flooding, landslides, and sea-level rise as green zones shrink and rainfall becomes more erratic. Most of the direct risks are felt by the urban poor, over 60 percent of whom are estimated to live in informal settlements, with more than a quarter residing in low-elevation and coastal zones and an increasing number settling on mountain slopes (World Bank 2023c). Between 1985 and 2015, urban neighborhoods exposed to sealevel rise grew from 0 to 1.1 km<sup>2</sup>, and built-up areas exposed to flash floods increased by 172 percent to 33 km<sup>2</sup>. Freetown has the most built-up areas exposed to flash flooding.

Sierra Leone's rapid urbanization also places increasing pressure on its transport infrastructure, which is already vulnerable to climate and disaster risks. As cities expand and populations grow, demand for mobility is rising, yet the transport network remains underdeveloped, poorly maintained, and lacking climate resilience. About 90 percent of passenger and goods transport relies on roads, but much of the network is in poor condition, lacks all-season accessibility, and is unsafe. About 40 percent of primary roads are paved, most of which are in good or better condition. Almost all secondary and feeder roads are unpaved, with 57 percent in fair or poor condition. The number of bridges, which are essential for ensuring connectivity across the country's varied river basins, is small. Urban areas, particularly Freetown, are seeing a surge in informal and unregulated transport services, such as used minibuses imported from abroad, which contribute to pollution, congestion, and road safety hazards. Limited investment in sustainable and efficient public transit options has resulted in increasing reliance on private vehicles and informal transport, exacerbating emissions and traffic bottlenecks. Meanwhile, inadequate road drainage and poor maintenance make urban transport highly vulnerable to flooding, disrupting mobility and limiting access to markets, jobs, and essential services. Connectivity challenges also extend beyond cities, as rural communities depend on roads and water transport that are frequently impassable during the rainy season. Without improved transport planning that accounts for urban expansion and climate risks, cities will continue to face worsening congestion, pollution, and disruptions that threaten economic productivity and quality of life. Moreover, the CCDR modeling found that the damage and deterioration of infrastructure and services (which are concentrated in urban centers) through climate effects and events could result in GDP losses of 1.5-2.4 percent by 2050 (see Section 3.2). Much of this potential damage is due to their location in highrisk zones.

Adaptation efforts are limited primarily to constructing climate-resilient roads, especially in rural areas, with little attention given to broader transport sector resilience, such as operations and management against seasonal climate hazards. This oversight could increase the indirect costs associated with disruptions,

which could affect sectors such as agriculture and urban services. Despite the potential of water and rail transport to efficiently move goods in a country with extensive river basins and significant mineral exports, policies disproportionately favor road transport. A more balanced approach is needed to fully operationalize Sierra Leone's climate-resilient and low-carbon ambitions for its transport sector, address gaps in sector operations, and expand the scope of adaptation measures beyond infrastructure.

The absence of a comprehensive urban and transport planning policy framework has driven some of the climate and disaster risks. Legislation for planning (the Town and Country Planning Act of 1946) and development control (the Freetown Improvement Act of 1960 and the Greater Freetown zoning rules of 1969) are outdated and lack provisions for enforcement. Regulatory tools to manage the built environment, such as land-use plans at the national, regional, or local level, are nonexistent. For Freetown, the last official land-use plans, known as Area Planning Schemes, were adopted in 1948; subsequent proposals for the adoption of a city-wide master plan or national urban plans failed (MLHCP 2014). The Freetown Structure Plan for 2013–2028, drafted in 2014, is in a protracted approval process and limits the possibility for the Freetown City Council to drive the processes of change. Further gaps in land administration and management passively encourage land hoarding, land grabbing, deforestation in restoration areas, and urban sprawl into environmentally risky areas in cities.

The Local Government Act 2004 devolved land-use planning and development control functions to local councils that lack capacity. They lack the needed technical staff (such as engineers and planners), dedicated enforcement bodies to ensure compliance, adequate provisions for public participation in planning processes, and building standards provisions that meet contemporary building design requirements. In addition, they typically rely on national allocations, which have been dwindling and are insufficient to support needed large-scale investments; on average, local councils collect only about US\$150,000 a year, a tiny fraction of what is needed to finance climate investment [MLHCP 2014]. Own-source revenue-generating systems at the local level are outdated and weak, and tax compliance by residents who do not see the need to pay for inadequate provision of services is low. As a result of these problems, the central government took over many of these functions. The Ministry of Lands, Housing, and Country Planning (MLHCP) issues building permits across the country, leaving local councils with no control over development. Their inability to perform development control functions leads to numerous unplanned developments and uncontrolled expansion of urban areas into ecologically unfriendly terrains.

The challenges extend beyond urban and transport planning to basic infrastructure, particularly water and sanitation. Weak water and sanitation service delivery makes it difficult for Sierra Leone to mitigate the impacts of seasonal fluctuations, flooding, and population growth. Water and sanitation service levels are deficient across the country, with nearly 90 percent lacking access to safely managed water<sup>13</sup> and about 75 percent of the population lacking access to basic sanitation services<sup>14</sup> (WHO/UNICEF 2023).

While urban populations generally have better access, water utilities struggle to provide water reliably, especially during the dry months. The water supply infrastructure does not meet demand from population growth in cities like Freetown, leading to water rationing. The Guma Valley Dam, which was built in the 1960s to serve 500,000 people in Freetown, now serves 1.2 million people. Nonrevenue water in Freetown is estimated at 58 percent, mainly from exposed service connections, referred to as 'spaghetti connections' (Guma Valley Water Company [GVWC] - Business and Investment Plan 2019–2023). A 2016 water point mapping study carried out for the National Water Resources Management Agency (NWRMA)–Strategic

<sup>&</sup>lt;sup>13</sup> Drinking water from an improved water source that is located on premises, available when needed, and free from fecal and priority chemical contaminants.

 $<sup>^{\</sup>rm 14}$  Use of improved sanitation facilities that are not shared with other households.

Development Plan 2019–2023 found that 37 percent of all water points were nonfunctional, and 51 percent provided water only seasonally (Government of Sierra Leone 2019). Just 45 percent of urban residents are able to access water for at least one day in a week without disruption.

**Sanitation and solid waste management issues are similarly dire.** In Freetown, an estimated 336,440 m<sup>3</sup> of fecal sludge is generated annually, of which just 21 percent reaches and is treated at the one fecal sludge treatment plant, located in Kingtom. The remaining 78 percent is improperly managed, either buried on-site following manual emptying without transportation to an appropriate facility or discharged into water bodies untreated. Across all urban areas in Sierra Leone, nonexistent drainage systems, insufficient maintenance, and frequent blockages from solid waste, along with poorly constructed infrastructure, significantly contribute to the risk of flooding, landslides, and water- and vector-borne diseases.

Other environmental health challenges, such as poor air quality and extreme heat exposure will worsen with climate change and unplanned urban growth. Emissions from vehicles, factories, and domestic burning are reducing air quality, as evidenced by rising levels of fine particulate matter (PM2.5). The cities of Bo, Kenema, Koidu, Makeni, Port Loko, Freetown, and Bonthe had an average PM2.5 count of  $35-40 \mu g/m^3$  in 2019—seven to eight times the World Health Organization (WHO) recommended threshold of 5  $\mu g/m^3$ . The spatial distribution of heat mirrors the layout of older and newer urban settlements, with higher surface temperatures in the high  $40^\circ$ C range found in densely built-up areas, reflecting heat island effects (World Bank 2023c).

Limited digitalization further constrains urban planning, service delivery, and disaster risk management (DRM). Effective climate adaptation and disaster response rely on timely, high-quality data, yet Sierra Leone's digital infrastructure remains weak, undermining planning and response efforts. Local councils lack capacity to assess climate risk data and there is poor coordination among relevant agencies and early warning systems. The NDMA, for example, receives data from other organizations, such as the African Union, but is not able to share data easily with partners due to weak digital infrastructure. SL-MET is not adequately equipped to provide reliable, user-friendly climate information, further limiting preparedness. Weak digital systems also hinder land-use planning, infrastructure mapping, and hazard monitoring, contributing to unregulated urban expansion and heightened climate risks.

## Recommendations

**Unplanned urban expansion and inadequate infrastructure have increased climate vulnerability.** Integrating adaptation and low-carbon growth principles into urban infrastructure, water supply systems, and transportation networks is essential for building resilient and sustainable cities that can thrive in the face of climate change while minimizing their carbon footprint. Sierra Leone should focus on the following key actions to improve its infrastructure resilience:

- (1) Promote urban planning that reduces built-up areas exposed to climate risk and promote digitalization for improved climate and development planning.
- (2) Integrate climate risks into transport sector planning and management and support low-carbon modes of transport.
- (3) Expand and safeguard basic services and infrastructure to ensure they are resilient and inclusive in the face of projected increases in climate risks.

# 1. Promote urban planning that reduces built-up areas exposed to climate risk and promote digitalization for improved climate and development planning.

**Mainstream national climate change goals in the urban development agenda.** Integrating national climate change and economic goals into the urban development agenda ensures that urbanization aligns with broader sustainability objectives. By prioritizing low-carbon development pathways, cities can mitigate climate risks while promoting economic prosperity and social equity. This will require strong institutions centrally, as well as empowering local councils and communities with the knowledge and skills to assess climate change risk and vulnerability, which is paramount for building resilience at the grassroots level. This involves providing comprehensive training programs that equip stakeholders with the tools to identify potential hazards and develop effective adaptation strategies tailored to their specific contexts.

**Build a digital foundation for climate and development planning.** The first priority would be to collect and standardize data digitally. In the short term, the Ministry of Communication, Technology and Innovation should ensure that the following: (a) standardize data formats during collection, to facilitate processing and analysis and generate insights for decision-making; (b) use digital technologies to gather data; and (c) use technologies to identify and monitor transport networks, land-use patterns, weather patterns, ecosystem health, and so on, to produce a clearer picture of climate impact. In the long term, establish a governance framework for data that is consistent with the government's Enterprise Architecture Framework<sup>15</sup>, to enhance interoperability and support a coordinated effort by all ministries, departments, and agencies in addressing climate.

Integrate climate resilience measures into spatial planning policies. The absence of national or urban-level land-use plans, a zoning strategy, a building code, and other key legislation for urban development has limited spatial planning practices that could reduce climate and disaster risk. Specific attention is needed to manage the urban sprawl in Freetown, especially encroaching into the Western Area Peninsular National Park (WAPNP) and its narrow chain of hills, which is a source of potable water for the city and has high landslide potential due to the wet conditions. While some local laws forbid illegal construction and/or construction in high-risk areas, strengthening the monitoring and enforcement of land-use regulations and construction standards is vital to reducing the number of households settling in high-risk areas. Development and building control systems must be strengthened to identify hazard zones and restrict development within mapped areas, including critical wetlands. For example, integrating climate and land data through a digital Land Management and Information System (LIS) enables the mapping and monitoring of hazard-prone areas. Strategies that emphasize urban regeneration and compact, mixed-use development should be devised to manage urban sprawl, reduce pressure on infrastructure, and promote sustainable urban growth.

Increase the capacity of urban and transport planners to prepare and implement risk-informed land-use and disaster response plans, including through increased digitalization. Urban planners need to be able to develop and execute land-use plans that are informed by risk assessments. Digitalization must be prioritized. This involves establishing a centralized data management platform on spatial climate change risks and hazards and developing a plan for disseminating and using the data. Local councils and communities should also be trained to assess climate change risk and vulnerability. A digital platform for building regulation systems can be developed to fast-track the issuance of building permits and certificates and track building construction at the city level. This digital approach enhances transparency and efficiency

<sup>&</sup>lt;sup>15</sup> This is a blueprint document which provides a high-level description of how to align organizations business strategy and objectives with its information technology infrastructure to enable interoperability and reduce ad hoc implementation of information systems.

in urban planning and development processes. Strengthening inter- and intra-agency coordination is also needed to address climate change hazards at the national, provincial, and local levels. Enhancing the capacity of key agencies such as SL-MET and the NWRMA is essential for providing accurate and granular weather, meteorological, and hydrological information. Access to timely and reliable data enables effective planning and response to hazardous weather events, thereby minimizing risks and protecting communities. The NDMA plays a pivotal role in coordinating emergency response and recovery efforts. Strengthening its capacity to implement timely emergency response and recovery plans ensures a coordinated and efficient response to disasters, thereby minimizing their impact on communities and infrastructure.

# 2. Integrate climate risks into transport sector planning and management and support low-carbon modes of transport.

Efforts should focus on investing in climate-resilient transport infrastructure and services while strengthening the knowledge base for informed decision-making. This includes developing climate and disaster risk data, hazard maps, and analytics to support transport sector planning and management, as well as building technical skills to integrate climate risk considerations into transport policies. Additionally, climate resilience measures should be incorporated into design and engineering standards for roads, bridges, ports, and ferries, ensuring that infrastructure is better equipped to withstand future climate impacts. Expanding the use of NBS in road and port design can further enhance resilience while providing environmental co-benefits. Overall, climate resilience should be fully integrated into the transport planning process, ensuring that infrastructure and services are designed to withstand evolving climate risks. This includes developing climate-resilient strategies across different transport networks and establishing a DRM system that incorporates early warning mechanisms and information services to support resilient mobility and connectivity. Furthermore, the adoption of climate-resilient construction codes should be institutionalized to guide the development of roads, bridges, ferries, and ports, reinforcing long-term sustainability and resilience in the transport sector.

As part of low-carbon development opportunities, priority should be given to fortifying public mass transit systems, such as bus rapid transit, to encourage sustainable urban mobility. Sierra Leone's NDCs and NAP aim to forge a low-carbon, resilient transport infrastructure to improve rural connectivity and urban mobility. Mitigation efforts include transitioning to clean alternative energy for mass transit, enhancing the water transport system, implementing vehicle emission testing and control, and promoting electric mobility, to reduce GHG emissions and dependency on conventional vehicles and fuel imports. They also propose developing a strategy to regulate the age of imported vehicles. Pilot initiatives for e-mobility in urban areas, encompassing electric cars, buses, bikes, and motorbikes, can be explored further to gauge their viability and effectiveness. Additionally, efforts to promote lower-emission freight by enhancing rail freight corridors and optimizing inland waterways for more efficient transport should be supported. Furthermore, there is a call to institutionalize climate-resilient construction codes governing roads, bridges, ferries, and ports infrastructure development to safeguard against future climate-related challenges. In the long term, more stringent emission and fuel standards for imported vehicles can be introduced. Tax incentives are being considered to stimulate the importation of low-emission vehicles. Concurrently, the development of emobility standards and financial incentives can aim to facilitate the widespread adoption of electric vehicles and associated infrastructure.

# 3. Expand and safeguard basic services and infrastructure to ensure they are resilient and inclusive in the face of projected increases in climate risks.

Critical infrastructure and assets must be climate-proofed or retrofitted to withstand future challenges. This involves delineating flood hazard lines and enforcing regulations to ensure that infrastructure is built and

maintained to be resilient to climate-related risks (particularly those in urban areas). Efforts to enhance flood resilience can also incorporate NBS that improve land infiltration during rainfall events and improve the condition of mangroves in coastal areas as a buffer and absorption of flood waters. These solutions not only help mitigate flooding but also contribute to ecosystem health and biodiversity. Furthermore, the integration of green infrastructure into open spaces is crucial for reducing urban vulnerability to climate change. Encouraging percolation during rainfall and mitigating urban heat islands through the strategic placement of vegetation can enhance the resilience of urban environments. This entails implementing NBS that prioritize the preservation and enhancement of green spaces.

Efforts to improve water and sanitation service delivery and enhance water management systems are pivotal for sustainable development and climate adaptation. One crucial aspect is improving the operational efficiency of water utilities, aiming to minimize losses and ensure equitable access to water and sanitation services. Investing across the water supply chain, from the source to household and institutional delivery, is essential for ensuring that populations and the economy are protected from health risks related to water and climate, as well as addressing water scarcity for multiple uses. By closely monitoring water resources factors, authorities can swiftly identify issues affecting water resources and take timely corrective actions to address deteriorating quality and dwindling quantities of water. In the case of Freetown, there is a dire need to maintain and protect the Western Area Peninsula catchment with watershed management initiatives and enforcement. Ensuring water security also includes upgrading wastewater treatment facilities to mitigate emissions from untreated waste and safeguard surface and groundwater from pollution.

**Diversifying water sources is another key strategy to ensure water availability, especially during extreme climatic conditions.** By tapping into a variety of surface and groundwater sources, communities can better withstand the impacts of climate variability. This will become a need as the climatic conditions in the northern part of the country shift toward more drier conditions most of the year as a result of climate change. Furthermore, improving climate-resilient water storage capacity is essential for mitigating the impacts of flooding and drought caused by seasonal variations in rainfall. By strategically enhancing storage infrastructure, communities can better manage water resources and reduce vulnerability to extreme weather events.

Additionally, improving solid waste management systems is essential for reducing GHG emissions and enhancing overall urban resilience. Efforts should focus on enhancing waste disposal practices and implementing recycling initiatives to minimize environmental impacts and improve stormwater management.

# 4.2 Promoting climate-smart agriculture and natural resource productivity

## Agriculture and food systems

Agriculture accounts for 30 percent of Sierra Leone's GDP and employs about half of its labor force (Stats SL 2024), mostly dependent on rain-fed and subsistence farming. Rice and cassava are staple foods of the country and yet 26 percent of people are food insecure. The sector's reliance on rain-fed farming and inadequate infrastructure leaves it vulnerable to climate change. Despite historical challenges, including civil war, Ebola, COVID-19, and the global food crisis intensified by the Ukraine conflict, the agricultural sector has shown resilience, growing at an average rate of 2.5 percent between 2019 and 2023 (Stats SL 2024). However, this growth has not been sufficient to significantly reduce poverty or food insecurity in rural areas.

Agriculture is crucial for inclusive development, poverty reduction, and food security. The country's small size and limited market exposure necessitate rapid productivity growth, competitiveness, and

diversification of the agricultural sector (World Bank 2022). Sierra Leone's global GHG emissions are minor, yet agriculture is the main source of these emissions as of 2021.

Climate change is affecting agricultural systems, including labor productivity, crop, livestock, and fishery production, in Sierra Leone. Changes in temperature and precipitation and the growing frequency of extreme weather events are disrupting growing conditions, leading to water stress, and reducing crop yields by interfering with flowering, fruiting, and grain development. These changes also alter disease and pest dynamics. Livestock experience heat stress and a decline in forage quality, with adverse consequences for their health, reproduction, and overall productivity. Climate variability also affects crop coverage and diversification. Some crops, such as cassava, sorghum, and maize, have shown a high capacity to adapt to climate change; growing conditions for them may improve because of climate change in some regions of Sierra Leone and in other countries (Egbebiyi et al. 2020).

The impacts of climate change on Sierra Leone's agroecological and climatic zones and major agricultural commodity systems are expected to persist and intensify (World Bank 2023b). The modeling presented in Chapter 3 is based on projected impacts of two climate scenarios (dry/hot and wet/warm) on crop productivity.

As expected, rain-fed crop production registers smaller and less steep declines under the wet/warm scenario than under the hot/dry one—that is, a 5 percent decline by 2050 under the wet/warm scenario (the light green line) versus an 8.5 percent decline under the hot/dry scenario (the dark green line) (Figure 4.4). After 2027, dry/hot conditions (the red line) lead to significantly larger production shocks than do wet/warm conditions (the blue line). By 2050, dry/hot conditions lead to a production shock of 10 percent compared to 7.5 percent under warm/wet conditions. Both scenarios include periods of improvement between 2037 and 2042, followed by steep deterioration thereafter.

As discussed in Chapter 3, labor is a major channel through which climate change affects agriculture—that is, through the agricultural workforce and thus economic output. Heat stress directly affects labor supply (working hours) by changing the allocation of time to labor beyond certain thresholds. Climate change also reduces performance during working hours (labor productivity) when workers are under heat stress. Both labor supply and labor productivity are projected to decrease under future climate change in Sierra Leone.

The simulations suggest that dry/hot conditions generate more severe crop production shocks than do wet/warm conditions—5.9 percent on average for dry/hot versus 3.22 percent on average for wet/warm. There are significant differences across crops (Figures 4.4, 4.5, and 4.6). At one extreme lie mangoes, cassava, and, to a lesser extent, plantains. These three crops are expected to register relatively large negative production shocks under both dry/hot conditions (10–16.5 percent) and wet/warm conditions (3.5–10.2 percent). At the other extreme lie groundnuts, the major cereals (rice, sorghum, maize), and sweet potatoes. These five crops are expected to realize relatively small negative production shocks under both scenarios (0–3 percent). Other crops show mixed outcomes across the two scenarios. Sugarcane is expected to experience a negative production shock of 7.5 percent in the dry/hot scenario but a positive production shock of 1 percent in the warm/wet scenario. Cocoa production is expected to fall by 6.5 percent in the dry/hot scenario but only 1 percent in the wet/warm scenario. Oil palm is expected to fall by 5.5 percent in the dry/hot scenario and by 2.5 percent in the wet/warm scenario.



Figure 4.4. Sector-level impacts of climate change in Sierra Leonean agriculture

Note: SSP1-1.9 mean = optimistic global mitigation; SSP3-7.0 mean = pessimistic global mitigation

**Extreme weather conditions jeopardize the safety of small-scale fishers, reduce their catches, and damage infrastructure.** Hurricanes and heavy rainfall disrupt fish movements and alter catch composition; they also harm coastal infrastructure and disrupt fishing activities. Salinization of freshwater bodies—caused by saltwater intrusion disrupts both fish populations and the livelihoods of fishing communities. Rising sea temperatures and ocean acidification threaten the country's coral reefs, posing severe risk to the coastal fisheries sector. These changes are affecting fish breeding and recovery of fish populations which are further compounded by unsustainable fishery practices.<sup>16</sup>

Source: World Bank simulations

<sup>&</sup>lt;sup>16</sup> The depletion of fish stocks has reached critical levels in recent times, primarily due to intensive industrial fishing practices and the proliferation of artisanal fishers spurred by population growth. This is additional to ecosystem changes taking place as a result of climate change. Fishers consistently report dwindling catches, sparking intensified competition for increasingly scarce resources. In a bid to safeguard their livelihoods, artisanal fishers, constituting 66 percent of the country's annual production, resort to unsustainable fishing methods, including the use of undersized-mesh nets, dynamite, and channel fishing, thus disrupting the natural reproductive cycle of fish stocks further compounded by habitat destruction. This crisis is exacerbated by the widespread availability of illegal fishing gear, lax enforcement of regulations, and pervasive economic hardship.



## Figure 4.5. Crop-specific production shocks in Sierra Leone under the dry/hot climate scenario

Source: World Bank simulations







**Overall, Sierra Leone will find it more challenging to depend on agriculture and its natural resources for future growth and poverty reduction**. As demonstrated, climate change is profoundly altering agroecological and climatic conditions across the country, which complicates decisions around land use and leaves the country more vulnerable to climate changes. The results from the CCDR's modeling (Chapter 3) showed that crop yields would decline in drier and hotter climate conditions (by increasing water demand and reducing the availability of water for irrigated and rain-fed crops) as well as in wetter and warmer conditions (by eroding soil and land fertility).

#### Recommendations

A comprehensive reorientation of all participants in the agricultural and food production sector toward agroecological and systemic approaches help adapt to the challenges of the changing climate. Adaptation to climate change require tailored strategies across crop, livestock, and fishery sectors. Evidence suggests

that agroecological, climate-conscious, and well-managed food systems are inherently nutrition-sensitive, gender-responsive, climate-smart, inclusive, and yielding low-cost, safe, and nutritious food with minimal harm to natural ecosystems. These elements collectively form essential components for building resilient and sustainable food systems and Sierra Leone should focus on the following key actions:

- (1) Strengthen the policy, regulatory, and institutional framework.
- (2) Invest in weather forecasting, early warning systems, and insurance.
- (3) Introduce climate-resilient and climate-smart technologies and management practices.

#### 1. Strengthen the policy, regulatory, and institutional framework on agriculture and fisheries

Recognizing agriculture and other food systems' vital contribution to Sierra Leone's socioeconomic structure, strengthening food system policies through a collaborative and inclusive approach is essential as part of the *Feed Salone* initiative and NSADP 2010–2030. This requires a comprehensive reassessment and modernization of current policies to meet the present and emerging challenges and prospects, especially to prepare for climate change impacts and other unpredictable factors. A multistakeholder approach that includes the private sector, civil society, and universities will ensure that policies are evidence-based, practical, and aligned with innovations that support climate and development goals.

In the agriculture sector, specifically, ensure the irrigation policy that is currently under development includes approaches to increase water storage and the use of heat-tolerant crop varieties to adapt to water and heat effects. Implementing water control structures such as small dams and weirs can regulate water levels during rainy seasons and store water for irrigation during dry periods. This approach enhances resilience by maximizing water utilization for agricultural purposes. To combat soil erosion resulting from agriculture and other land uses, gradually introduce specialized soil and water conservation approaches such as agroforestry and rotational grazing to prevent further degradation based on the location and crop types across all agroecological areas.

Fisheries sector (capture and culture), requires a coherent strategy and roadmap to prevent the piecemeal approaches that have historically undermined the sector's long-term viability and toward sustainability of previous and current investments. Adopting climate-resilient fishery management plans, particularly tailored to individual species, identified through comprehensive stock assessments will address the sector's growth demands and identify solutions to mitigate the impacts of climate risks and harmful human-induced alterations, especially illegal, unreported, and unregulated (IUU) fishing<sup>17</sup>. Development of a strong policy to reverse the unsustainable fishery sector can contribute to the economy and food security. Furthermore, there is potential to develop mariculture and aquaculture, alleviating the current intense pressure on wild fish stocks exacerbated by climate change.

Strengthening institutions, knowledge, and human resource capacity is key to boosting sector performance and sustainability. Stronger institutions with a strong knowledge base and institutional capacity can drive transformation toward market-driven, profitable, climate-smart, and sustainable agricultural systems and value chains. Digital tools and platforms for climate action, will enable the gathering and analysis of data for timely and informed decisions and to guide local planning and actions. Universities and research institutions, civil society, and private sector can play a crucial role in building technical expertise, advancing climate-smart innovations, and supporting the training of a skilled workforce for agriculture and fisheries.

<sup>&</sup>lt;sup>17</sup> According to the Financial Transparency Coalition, Sierra Loene's IUU fishing vessels is the second highest in the world during the period 2010–2022. <u>https://financialtransparency.org/wp-content/uploads/2022/10/FTC-fishy-Network-OCT-2022-Final.pdf</u>

Improved agricultural and fisheries regulations promote climate resilience that responds to the respective policy changes creating a conducive environment for farmers' prosperity, market efficiency, and a seamless food supply chain. Strict enforcement of regulations using digital platforms and citizen engagement to minimize negative tradeoffs of productivity growth including unabated IUU fishing, and environmental degradation will not only address the potential impacts of climate change but also safeguard economic activities of about 10 percent of the population that depends on fisheries. Furthermore, by creating an enabling environment for the private sector, climate-smart market and supply chain infrastructure can be developed.

## 2. Invest in weather forecasting, early warning systems, and insurance

Advanced weather forecasting, early warning systems, and agricultural insurance schemes reduce climateinduced loss and damage to agriculture and fisheries resources and assets. Allocating resources to accessible technologies, skilled workforce, and data analysis will improve the precision and dependability of weather forecasts. This empowers farmers, fishers, traders, and authorities with accurate and timely information, allowing them to make well-informed decisions regarding planting, irrigation, harvesting, fishing and marketing activities, encompassing storage, transportation, processing, and financial planning. Alongside improvements in weather prediction, it is equally important to deploy effective early warning systems with tools, such as sensors and communication networks, to identify and communicate warnings about imminent natural threats. The aim is to guarantee that at-risk farmers and fishers get prompt alerts, enabling them to take preemptive actions for evacuation, safeguarding resources, and minimizing potential damages. Integrating insurance mechanisms to reduce climate risk investment along the agri-food value chain can also be considered to further enhance resilience.

For the above systems to be effective, farmers/fishers need to be well-informed of the benefits of early warning systems and insurance to actively participate in building a culture of resilience and adaptive capacity. User-friendly digital platforms that deliver climate information, advisories, and best practices to farmers and traders through mobile phones and other communication channels will provide timely information. Furthermore, strengthening surveillance, control, and sensitization systems will prepare timely actions for emerging plant and animal diseases. The capacity building of SL-MET, NWRMA, and related agencies will provide granular and accurate hazardous weather, meteorological, and hydrological information and services. Early warning systems should be integral to emergency preparedness with the NDMA coordinating timely emergency response and recovery plans.

## 3. Introduce climate-resilient and climate-smart technologies and management practices

Due to increasingly unpredictable, frequent, and severe extreme weather conditions, enhance the productivity in key agricultural, and fisheries systems within sustainable limits. This can be achieved by adopting integrated approaches such as integrated land-use planning, agroforestry supporting a landscape approach to conservation by reconnecting forest fragments and acting as buffers (refer Box 4.1), conservation agriculture<sup>18</sup> practices through improved soil structure and stability, increased drainage, and

<sup>&</sup>lt;sup>18</sup> Conservation agriculture (CA) is based on the principles of minimum soil disturbance, crop rotations, and soil cover with crop residues. Reduced or zero-tillage practices have been shown to reduce soil loss and support agricultural productivity while also benefiting groundwater recharge, soil fertility, and pest and disease regulation (European Environment Agency 2021). Crop diversification strategies can include mixed cultivation, intercropping, and maintaining local genetic diversity of crops. These practices can improve yield stability during droughts and enhance biological control of pests through species interactions while improving biodiversity. The use of cover crops (grass or legumes in rotation between regular crops) can help alleviate drought stress by increasing water infiltration rates and soil moisture, improve soil quality, and reduce soil compaction and erosion risk.

water-holding capacity and actions that maximize environmental benefits while minimizing conflicts between agricultural growth and livelihood improvements.

**Investing in resilient and climate-smart technologies is essential for enhancing the adaptation of main sectors like agriculture against climate change.** Agriculture serves as a crucial source of self-employment for a substantial segment of the rural populace, with 75 percent engaged in subsistence farming. However, the sector faces hurdles in the form of restricted technological progress and deficiencies in institutional support and infrastructure. These obstacles disproportionately affect the rural impoverished, exacerbating natural resource depletion. Adopting sustainable practices, such as precision farming, water-saving techniques (efficient irrigation<sup>19</sup>, rainwater systems, and water management) and developing integrated farming systems, provisioning of good quality seeds and fertilizers can benefit small-scale farmers. Mariculture can alleviate pressure on overfished resources.

# Box 4.1 Considering interactions between agroforestry management and the landscape context in the design of cocoa agroforestry systems

Cocoa agroforests can provide an effective strategy to reduce the environmental impacts of forest fragmentation and support globally threatened biodiversity as they tend to maintain some of the biodiversity of the original forests. Cocoa agroforestry systems can also provide livelihoods for smallholder farmers as they can produce yields equivalent to monoculture and provide opportunities for producers to charge a premium from markets for environmentally sustainable and certified products. However, it is crucial to understand how cocoa might best be managed to meet both goals and inform landscape management.

Cocoa agroforestry around the Gola Rainforest National Park supports an important bird community, with the majority of records being of forest-dependent species, and over half being of biome-restricted species. Recent research suggests that forest bird species richness is associated with the interaction between canopy volume and proportion of forest in the surrounding landscape. Where forest cover is low in the landscape, low-intensity cocoa agroforestry can provide compensatory habitat for forest bird species, but when forest cover is high, cocoa that is more forest-like in structure may not lead to increased bird species richness, although it may benefit certain species. Thus, understanding the interacting effects of the landscape and on-farm habitat can provide important information on how changes in cocoa management may impact biodiversity.

**Inland valley swamps (IVS) present an opportunity for harnessing agricultural potential.** With a usage of 5 percent of the estimated 690,000 ha of IVS,<sup>20</sup> there is potential to increase up to 30 percent in the short to medium term for rice production combined with inland fisheries. Develop policy actions for sustainable use and maintenance of ecosystem services including realizing biodiversity co-benefits. To promote the efficient use of IVS, provide farmers with robust support from both the Ministry of Agriculture and Food Security (MAFS) and the Ministry of Fisheries and Marine Resources (MFMR) in partnership with the private sector. Strengthening the extension services and outreach units within both MAFS and MFMR will be needed for delivering effective extension services.

Diversifying production with climate-resilient crop varieties reduces the reliance on single crops, and shifting to large-scale managed farms as opposed to smallholder farming could reduce production losses. This requires participation and investments from the private sector, while ensuring farming communities

<sup>&</sup>lt;sup>19</sup> In 2023, FAO reported a concerning trend: despite ample arable land and water resources, irrigation techniques are utilized on a mere fraction—less than 0.05 percent—of the nation's cultivable land. Consequently, agricultural output across the country heavily relies on rainfall, perpetuating a predominantly rudimentary agricultural system with limited adoption of modern agricultural practices. Source: <u>https://openknowledge.fao.org/server/api/core/bitstreams/c2a318b1-e22c-44b9-96fc-309f3bfe8c80/content</u>

<sup>&</sup>lt;sup>20</sup> https://aquadocs.org/bitstream/handle/1834/39263/2018-01.pdf?sequence=1&isAllowed=y

are duly employed. Furthermore, put in place actions to address the growing challenges of pest- and disease-related losses in production and trade as a result of changing climate, diminishing agrobiodiversity, local crop varieties, and livestock breeds together with access to safety nets. Strengthening farmer and trader organizations can increase their engagement in energy-efficient climate-resilient agricultural technology development dissemination and market infrastructure expansion.

**Co-management of fisheries has been proven to be effective to foster fisheries community adaptation and resilience in Sierra Leone, with support from Community Management Associations (CMAs), and should be part of the fishery legislation.** This can lead to (a) more effective and sustainable management strategies tailored to the local fisheries-specific needs and conditions; (b) a stronger sense of ownership over resources and therefore self-monitored compliance of bylaws; (c) prevention and resolution of conflicts; (d) implementation of gear restrictions and setting of quotas to prevent overfishing; and (e) promotion of adaptive governance structures.

Build and upgrade fishery infrastructure, by modernizing the fishing port in Freetown, operationalize fishery assets in place, and create climate-smart landing sites, with processing and cold storage facilities, reducing post-harvest losses and adapting to climate change impacts. Attention is needed in securing financing for long-term operation and maintenance. This also requires participation of the private sector to crowdsource financing and to manage and sustain the facilities.

Adequate funding is needed for research and extension services, including necessary staff, materials, and equipment. Strengthening farmer/fisher and trader organizations, ensuring and protecting women's rights to essential resources and technologies, and encouraging private sector investment in climate-smart market, supply chain, and mechanization and agro-processing infrastructure are all vital steps toward a more sustainable and resilient agricultural sector. Additionally, farmers have expressed the need for dedicated budget support over grants to implement climate-smart resilience initiatives.

## Forestry, mining, and other land uses

The Upper Guinea ecosystem in Sierra Leone is a cornerstone of environmental and economic resilience. They are characterized by a mosaic of forest fragments in a matrix of production systems and provide ecosystem services that support agriculture, water generation, climate regulation, soil fertility, and nontimber forest products. Forests are also vital for livelihoods and serve as a safety net during times of stress.

The Global Forest Resources Assessment of 2020 estimated Sierra Leone's forest cover to be 35.12 percent with 9.41 percent under protection and only 2.25 percent remaining as primary forests. Forest cover has significantly reduced (18.92 percent) between 1990 and 2020. Furthermore, the protected areas in the country face significant pressure. Research conducted by Malan et al. (2024) revealed that the average annual forest loss within protected areas was about 1 percent during 2013–2018, lower than the national average of just under 3 percent. There is considerable pressure on protected area buffer zones, with average deforestation rates of around 2.5 percent per year between 2013 and 2018. Similar trends were observed in neighboring Guinea and Liberia.

Climate change is expected to adversely affect forest resources and biodiversity in Sierra Leone, potentially leading to loss of species, increases in disease, and degradation of ecosystem services. The ecological zones are shifting due to rising temperatures and reduced rainfall, causing a loss of flora and fauna and decreased ecological productivity. Land cover changes include 60 percent tropical dry forest, 24 percent tropical very dry forest, and 12 percent subtropical moist forest, with a northward shift from tropical rainforest to tropical dry forest. Simultaneously, climate change poses threats by increasing the risk of

hazards like fires, water shortages in drier parts of the country, pests, and diseases, leading to the loss of both quantity and quality of forests.

Forest conversion for agriculture, slash-and-burn practices, and logging are driving forest loss. In 2022, land-use change, and forest activities were the second largest GHG emitters in the country (after agriculture) (Climate Watch 2025). Mining, livestock rearing, urbanization, and industrialization also contribute to forest loss. Challenges in forest management stem from outdated regulations, unclear institutional roles, and lack of resources and enforcement. Although the Forestry Act underwent amendments in 2022, it still does not address 21st century forest issues, because institutional mandates are unclear and human and financial resources are insufficient.

Mining activities have significantly altered land-use patterns and large-scale mining operations have converted fertile agricultural land and affected agricultural productivity (Wilson, Wilson, and Moise 2022). Beyond direct land degradation, mining activities have driven extensive deforestation, not only through excavation but also due to the expansion of settlements around mining sites, where communities rely on forest resources for farming, cooking fuel, and construction. Artisanal mining, which remains widespread and largely informal, has further exacerbated environmental damage, contributing to soil degradation, water pollution, and biodiversity loss, including in protected areas. Poor regulatory oversight, illicit operations, and weak enforcement have left many mining sites abandoned, scarred by open pits and degraded landscapes. Additionally, the mining industry is a notable contributor to climate change, accounting for an estimated 4–7 percent of global GHG emissions (McKinsey Sustainability 2020). In Sierra Leone, where mining is a key economic driver, balancing resource extraction with environmental sustainability remains a pressing challenge. Recognizing these risks, the government has introduced the Mines and Minerals Development Act of 2022 to promote responsible and sustainable mining practices. However, effective implementation will require stronger governance, environmental safeguards, and community engagement to mitigate the sector's long-term social and ecological impacts.

The Sierra Leone National Adaptation Plan 2021 and REDD+ Program of 2010 identify the broader directions the country should take to address forest sector climate adaptation needs and mitigation opportunities. While some financing has been secured by the government to demonstrate REDD+ Program actions, both domestic and foreign financial resources to the NAP have been inadequate to meet the targets resulting in interventions that were ad hoc. The first documented REDD+ Program pilot, at Gola Forest Reserve led to a reduction (though not a complete reversal) of deforestation in the REDD+ communities by approximately 1 percentage point (or 30 percent) compared to non-REDD+ communities (Malan et al 2023). Although the program decreased deforestation by around 929 ha per year in the buffer zone of the reserve and ~340,000 tCO<sub>2</sub> in avoided emissions per year, it did not eliminate pressure on the forests entirely, demonstrating the need for scaled-up investments to address the drivers of deforestation and forest degradation. Sierra Leone has already identified and mapped land degradation hotspots under the United Nations Convention to Combat Desertification (UNCCD) target setting toward land degradation neutrality. Investments in areas characterized by high restoration potential and high socioeconomic benefits in poverty areas offer opportunities to improve the conditions of the most vulnerable people and increase ecosystems' resilience.

## Recommendations

Like all other countries under Upper Guinean forests, there is an interconnectedness of forests with other land uses in Sierra Leone and securing long-term resilience to climate change and enhancing the productivity of the forestry sector require an integrated approach that combines ecological, economic, and social goals. Recognizing the interconnectedness of forests with other land uses, such as growing sectors in mining and quarrying, is vital. Short- to medium-term strategies include the following:
- (1) Improve the understanding of forestry and other land uses.
- (2) Implement governance reforms across all land use sectors.
- (3) Promote sustainable mining management and practices.
- (4) Invest in community-centered sustainable forest landscape management and restoration.

#### 1. Improve the understanding of forestry and other land uses

The inconsistent data on Sierra Leone's forest cover and changes underscore the need for a comprehensive national forest inventory for sustainable management of resilient forest landscapes. The ongoing forestry inventory and the setting up of the National Forest Monitoring System supported by the FAO for the NPAA necessitates detailed mapping and continuous monitoring to identify climate-induced impacts, formulation of adaptation strategies, and understanding the impacts of land use on carbon dynamics. Additionally, an assessment of forest capital accounting by the Forestry Division and NPAA will help identify financial inflows and outflows, informing adequate public financing for integrated forest landscape management, to increase their resilience to climate vulnerabilities.

#### 2. Implement governance reforms across all land-use sectors

Reform governance across all land-use sectors to overcome institutional barriers, promote sustainable landscape management within the forest mosaic, and develop effective policies and regulatory mechanisms to address complex institutional requirements and land-use challenges. This entails aligning land-related policies and legislation, eliminating existing overlaps and fostering incentives for coordination and collaboration within the forest-agriculture mosaic. Furthermore, eliminate discretionary powers that undermine the sustainable management of forest resources. Presently, laws intended to shield these vital resources paradoxically grant authority to permit activities they aim to prevent, resulting in a significant loss of forest cover. Therefore, revising legislation to remove such ambiguities is fundamental to ensure effective conservation and prevent further degradation of our forests.

The Forest Policy of 2010 and the Forestry Act of 1988 require updating to integrate all forestry elements across various forestry-related policies and legislation for coherence and consistency in achieving overarching sustainability and climate-resilience goals within the forest sector. Additionally, there is need to develop clarity related to carbon rights and establish mechanisms for benefit-sharing among different stakeholders. Currently, there is a notable absence of a legal framework to access carbon financing for forest landscapes, which is incongruent with the goals of a comprehensive carbon market policy including to identify potential implications and trade-offs associated with carbon trading. Furthermore, forest carbon governance will help to manage unauthorized trading activities that could jeopardize national resources, ensure equitable benefit-sharing, and align with international commitments such as the Paris Agreement and regional policies like the Economic Community of West African States (ECOWAS) Environment Policy (2008), the Forest Convergence Plan (2013), and the African Union Forest Management Framework (2020).

MAFS, with its significant land jurisdiction, and MLHCP should jointly introduce measures to enhance institutional coordination for land-use planning. This includes optimizing the use of limited climate and other financing through an inter-agency committee, promoting integrated planning and management, facilitating data sharing and information exchange, implementing joint projects and programs, and conducting joint monitoring and evaluation. Additionally, collaboration among Upper Guinea countries is vital, necessitating the creation and implementation of shared regulations to promote sustainable management of both national and transboundary natural resources, and to revitalize quickly deteriorating forest reserves.

Aligned with the Customary Land Rights Bill (CLRB) and National Land Commission Bill (NLCB) adopted in 2022, systematically register and demarcate customary land, strengthening land tenure and property rights. These are key steps to promote sustainable land management, reduce deforestation, mitigate land degradation, curb illegal land grabbing, and prevent further marginalization of poorer communities. This effort should be supported by the establishment of a digital land management and information system, integrating data on land ownership, land use, land management, and land value. Addressing norm-based socialization and limitations on women's rights to land and natural resources is also important, requiring the incorporation of gender perspectives in awareness creation and advocacy of laws and activities that protect women's rights to productive resources and assets.

#### 3. Promote sustainable mining management and practices

Ensuring that extraction follows sustainable land-use and resource management practices will be essential to balancing economic gains with long-term environmental sustainability and resilience. There is a need to enhance the governance within the mining sector to curtail illicit practices and reckless land allocations for extraction purposes. The mining sector in Sierra Leone, akin to its counterparts in neighboring nations, exerts notable environmental and climate change pressures, mainly through forest land conversion and surging illegal mining endeavors especially when agriculture no longer becomes a lucrative business. There is a need to implement the regulation linked to the Mines and Mineral Development Act of 2022, and adopt the regulation to implement the Environmental Protection Agency Act 2022. These provide the legal impetus to formalize and regulate artisanal mining, elevate production standards to mitigate deforestation and land degradation, implement mechanisms for mineral traceability and certification to foster ethical procurement and responsible supply chains. Furthermore, update the Environment Protection (Mines and Mineral) Regulation of 2013 to include emerging environmental management challenges of the sector.

Promoting sustainable mining technologies and practices will enhance the resilience of mining areas, support post-mining restoration, and reduce climate emissions. This requires enforcing stringent regulations on responsible mining, adopting eco-friendly techniques such as green mining, and strengthening monitoring mechanisms to ensure compliance. Empowering the EPA-SL to oversee environmental management will help mitigate ecosystem damage and improve climate resilience. There should be a shift away from self-generated diesel power toward cleaner energy sources in the mining sector to reduce the sector's environmental impact. Sierra Leone's Energy Transition and Green Growth Plan aims to do this by encouraging mining companies to connect to the national grid, but mining companies can also be encouraged to use renewable energy sources to reduce emissions. Timely reclamation, rehabilitation, and reforestation efforts must be integrated into broader landscape restoration plans, with mining concessions held accountable for necessary investments. A robust monitoring system will be essential to prevent backsliding and ensure the long-term success of restoration efforts.

#### 4. Invest in community-centered sustainable forest landscape management and restoration

Investing in resilient and sustainable landscape management involving forest communities is pivotal for tackling resource scarcity, environmental degradation, and climate change, while also promoting economic and social growth. Collaborative efforts among governments, communities, nongovernmental organizations (NGOs), businesses, and researchers can create sustainable, climate-resilient landscapes to enhance community resilience, create nature-positive economic opportunities and jobs and aid in carbon sequestration, aligning with NDCs and Sierra Leone's REDD+ Program.

Implement landscape restoration efforts customized to the unique characteristics of specific areas and the needs of local populations. Include policy options to empower communities as key stakeholders in these restoration initiatives and address tenure security and the rights of local communities, especially women.

Furthermore, expanding the protected area network and safeguarding forest remnants under the jurisdiction of local communities are necessary steps to mitigate the risk of future deforestation through community forestry programs with livelihood incentives. For detailed insights into the costs and benefits of forest restoration in Sierra Leone, refer to Box 4.2.

# Box 4.2 Implementing NBS for the protection and restoration of forested catchments through the Western Area Peninsula Water Fund

More than 90 percent of the Western Area Peninsula major river catchments, as well as the two reservoirs they feed, originate in the WAPNP. However, the region faces water supply challenges: the average daily output of Guma Valley Water Company (GVWC), which provides water supply services to the city of Freetown, is just over half of the estimated average daily demand.

In February 2024, the GoSL launched the Western Area Peninsula Water Fund, with US\$2 million initial investment into a US\$20 million initiative to facilitate investments in NBS for the protection and restoration of the WAPNP. The Water Fund aims to restore the watersheds within the WAPNP to supply the quantity and quality of water needed in the Greater Freetown Area while improving the livelihoods of the people in the watershed, conserving the area's biodiversity, and building resilience to climate change.

The Fund's Business Case assessed the economic value of priority ecosystem services under a BAU scenario and a conservation scenario, determining the potential benefits of the conservation scenario in relation to the costs of implementation. The estimated costs of strengthening the protection of the WAPNP's 17,000 ha were US\$170,000 annually. The cost of fencing the WAPNP's 90-km perimeter was estimated at an initial US\$855,000 in addition to US\$44,100 annually for inspection and maintenance. Together, these measures could decrease deforestation and prevent encroachment and illegal activities. Forest restoration was estimated to cost around US\$6 million, with active restoration (involving planting or seeding) of 1,489 ha at a cost of approximately US\$2,000/ha initially, plus six years of maintenance at a cost of US\$446,700. The business case also proposed agroforestry for the buffer zone around the WAPNP.

The conservation scenario was estimated to reduce the expected annual damage costs from flooding by US\$2.05 million, with a return on investment of US\$1.65 for every US\$1 invested in restoration activities. Identified benefits also included extending the life span of the Guma Reservoir by 60 percent and the Congo Reservoir by 67 percent, as well as additional revenue from tourism, estimated at US\$3.92 million annually by 2050. Overall, the Water Fund is projected to generate approximately US\$55 million in economic and social benefits over a 30-year period.

Source: World Bank's Background note on NBS opportunities in Sierra Leone, 2024.

#### **Coastal wetlands**

Sierra Leone's 530 km of coastal areas face significant threats from escalating coastal erosion, floods, and storm surges, which affect health, livelihoods, and key sectors (including fishing, tourism, and agriculture). The sea has encroached into the land by over 300 m in some places during the past four decades, and coastal flooding is already threatening vulnerable coastal populations inundating low lying wetlands and dry land, reducing fish availability, eroding shorelines, and leading to saltwater intrusion into estuaries, rivers, and groundwater aquifers. Particularly in vulnerable areas like Freetown and small islands, where settlements are susceptible to coastal hazards, mangroves act as natural barriers, offering protection against erosive forces and reducing the risk of damage to infrastructure and human lives. By 2050, projections made by the World Bank in 2018 suggest that the rising sea levels could result in building losses totaling US\$46.8 million, affecting approximately 1,881 structures. Recent research indicates a mean shoreline change rate of 2.9 m per year (World Bank 2018). For instance, communities such as Turtle Island and Conakridee, heavily reliant on fishing, are particularly vulnerable to beach erosion, rendering

them more susceptible to the impacts of climate change. These areas, along with numerous others along the coast, experience significantly higher tidal influences, particularly during the rainy season (July-August), known locally as Juxon spring tides, leading to severe flooding of infrastructure located in the high-tide zone. Human activities such as unplanned sand mining, land reclamation, and coastal infrastructure exacerbate these issues, posing serious threats to coastal areas. In locations such as Lakka and Hamilton, attempts at hard protection have proven unsuccessful.

Mangroves offer some defense against the sea by preventing erosion and serving as storm barriers. These are being cut down for firewood and construction. In 1987, 47 percent of the coastline was covered with mangroves, with a total area of 171,600 ha. A study by Mondal et al. (2018) estimates the total area at 152,575 ha, a decline of 11 percent; it concludes that mangrove cover in Sierra Leone declined by approximately 25 percent between 1990 and 2018, with significant variations among regions. For instance, there has been a notable decrease of 46 percent in the Scarcies River Estuary, primarily attributed to extensive land conversion for rice farming. Conversely, mangrove cover has slightly increased in Ywari Bay and the Sherbro River Estuary, and expanded in the Sierra Leone River Estuary (SLRE) due to reforestation initiatives. The local communities, reliant on mangrove resources, are suffering from lower fish catches, and decreased agricultural yields.

The lack of statutory bylaws for coastal zone management coupled with an inefficient national regulatory framework could further undermine management and conservation efforts. While the NPAA was established by the National Protected Area Authority and Conservation Trust Fund Act of 2012 (which only came into effect in 2022) with a mandate to manage all wetlands designated as protected areas including Ramsar sites, mangroves are not legally protected in Sierra Leone. The only regulations are through traditional restrictions or international treaties, which have not translated into local laws and regulations.

#### Recommendations

**Well-conserved mangrove resources can yield billions of dollars of benefits a year.** Funding to restore mangrove forests is money well spent, and every US\$1 spent on mangrove restoration yields US\$6.83–US\$10.50 in returns over the following 20 years, according to Su, Friess, and Gasparatos (2021) (the range reflects different discount rates), providing valuable ecosystem services including increasing the resilience of coastal areas from climate vulnerabilities. In addition, mangroves can store up to 10 times more carbon than terrestrial forests. In the short to medium term, Sierra Leone should implement the following strategies to develop incentives aimed at restoring and conserving these vital resources.

- (1) Develop key regulations and strengthen the institutional framework for enforcing conservation measures and accessing benefits such as blue carbon credits.
- (2) Strengthen co-management of mangroves with CMAs.
- (3) Promote alternative livelihoods and improve the productivity of converted areas.

# 1. Develop key regulations and strengthen the institutional framework for enforcing conservation measures and accessing benefits such as blue carbon credits

Prioritize updating and adopting the draft Wetlands Bill, accompanied by the development of statutory bylaws specifically tailored for the management of coastal zones. These regulations, once implemented and enforced rigorously, play a pivotal role in safeguarding mangrove ecosystems and ensuring their continued efficacy in mitigating the impacts of natural hazards such as storm surges, flooding, and sealevel rise.

Update and implement the Integrated Coastal Zone Management Plan (ICZM) enhancing resilience and effectively managing mangroves and other vital coastal ecosystems. Additionally, it is imperative to update the National Wetland Inventory and Strategic Plan with mapping and long-term monitoring protocols, the National Mangrove Restoration Action Plan, and the management plans for the SLRE and Mamunta-Mayossoh Wildlife Sanctuary. These updates should prioritize integrating climate actions and identifying new Marine Protected Areas (MPAs), while also developing necessary management plans to combat illegal activities such as logging, overfishing, and habitat conversion.

#### 2. Strengthen the co-management of mangroves with CMAs.

Take proactive measures to strengthen the effectiveness of CMAs, expanding upon the groundwork set by MFMR. This entails not only offering support to existing CMAs but also facilitating the establishment of new ones, ensuring comprehensive coverage of coastal regions. By providing CMAs with the necessary resources and guidance, they can effectively implement various wetland management plans tailored to the unique needs of their respective areas. Equip the CMAs with the knowledge, skills, and tools required to engage meaningfully in coastal governance, thereby amplifying their role as stewards of coastal resources.

**Develop collaborative programs with CMAs aimed at mangrove reforestation and restoration**. Focus on revitalizing degraded areas by employing native species and sustainable planting techniques, thereby boosting the resilience of coastal ecosystems. Moreover, there exists a promising avenue to capitalize on blue carbon opportunities, which can serve as a catalyst for securing additional resources to support reforestation and restoration endeavors.

#### 3. Promote alternative livelihoods and improve the productivity of converted areas.

Create incentives for coastal communities, particularly fishers and coastal farmers, to adopt improved environmentally friendly technologies for fish smoking and enhance benefits and production from existing rice fields. Additionally, provide support and investment in alternative livelihood options such as mariculture, ecotourism, and sustainable extraction of non-timber forest products for communities reliant on mangrove forests.

Wetland-dependent communities require financial capital, potentially through initiatives such as microfinancing, especially in the agricultural and fisheries sectors. This will enable farmers and fishers to explore alternative economic avenues and integrate agro-silviculture practices into their rice fields, thereby mitigating mangrove conversion. Consider the impacts of these initiatives on poverty levels, gender roles, and resource utilization patterns. By aligning conservation objectives with community interests and needs, these incentives can foster long-term sustainability and resilience in coastal ecosystems.

## 4.3 Strengthening social resilience

### **Population Health**

Sierra Leone faces a range of communicable and non-communicable diseases, many of which are sensitive to climate. Both its under-five mortality rate (101 deaths per 1,000 live births) and neonatal mortality rate (30 deaths per 1,000 live births) are higher than the average for SSA (UNIGME 2023). Malaria has been the leading cause of death in Sierra Leone among people of all ages for over 30 years. Diarrheal diseases and lower respiratory infections also are among the top causes of death for all ages and genders, and neonatal disorders and adverse birth outcomes are among the top causes of death among infants and women (IHME 2021). Undernutrition is also widespread, with 30 percent of children under five having stunted growth (Stats SL and ICF 2020).

Climate-related factors can increase health disparities within vulnerable groups and across geographic areas. Rising temperatures, shifts in precipitation patterns, and increases in extreme weather events are likely to change the distribution of vector-borne and waterborne pathogens and heighten risks for food insecurity. heat stress, and disruption of services. The risk of malaria transmission is projected to change, with some areas becoming less suitable as *Anopheles* mosquito species habitats and others becoming more suitable. For example, the Western Area is projected to be the most vulnerable to increased transmission risks, in the absence of preventative measures. The Eastern Province may see a sharp decline, as it becomes too warm for *Anopheles* mosquito survival. Due to its poor water and sanitation coverage, the entire country is at increased risk of waterborne diseases as hotter temperatures increase the replication of some waterborne pathogens, and extreme rainfall increases their spread. Toxic algae blooms are expected to increase in hotter coastal waters, raising the risk of contamination of shellfish and fish. Reductions in crop yields are also expected to limit food security. Heat-related morbidity and mortality have not been quantified in Sierra Leone, but the risk of heat stress is expected to rise throughout the country, particularly for agricultural workers and people living in urban areas (because of urban heat island effects). Heat-related morbidity may also be intensified by increasing air pollution of PM2.5.

Sierra Leone has made strides in improving its health information and surveillance system infrastructure as well as its approach to climate-heath governance, but gaps remain. In the aftermath of the Ebola outbreak, the country established an integrated disease surveillance and response system. The National Health Information System (NHIS) and the District Health Information System (DHIS) routinely collect data on climate-sensitive diseases. The National Public Health Agency generates weekly epidemiological reports and other materials on risk communication. Still, leadership and efficient reporting mechanisms are lacking, digitalization at health facilities is limited, climate/weather data and early warning systems are poorly integrated, and the systems are not maintained, reducing the effectiveness of information sharing and disease surveillance. In 2023, the Ministry of Health established a Climate Health Unit and is now in the process of developing a national climate and health action plan with a view to developing a full Health National Adaptation Plan.

The country's limited health workforce constrains the surge capacity needed to respond to increasing incidences of climate-sensitive diseases. Sierra Leone's health workforce has increased since the introduction of the National Free Healthcare Initiative, in 2010. However, the country still has only about 0.04 medical doctors and 0.74 nurses and midwives per 1,000 people—well below the WHO's minimum threshold for meeting universal healthcare coverage (WHO 2021). The geographic distribution of the health workforce is also skewed. Over 60 percent of the population is rural, but over 70 percent of the health workforce, particularly doctors and nurses, are in urban areas (MHS 2016). Labor conditions are poor, with about 48 percent of the workforce unsalaried. Many healthcare workers have limited training and skills. Allied health professionals, who are key to disease surveillance and reduction of climate-related disease risks, are also in dire shortage. In 2011, there were only 183 medical pathologists and laboratory scientists and 201 environmental and occupational health and hygiene professionals in the country. The Ministry of Health and the Ministry of Education, Science and Technology do not consider climate change in human resource planning or national training and capacity-building programs.

Healthcare facilities are unevenly distributed, infrastructure lacks resilience, and the essential medicines and laboratory services needed to manage climate and health risks are limited. Sierra Leone has 1.64 health facilities (hospitals and peripheral health units) per 10,000 people, but most are in urban areas. Accessing health facilities is also a problem, especially during rainy seasons, because roads are impassable, or health facilities are damaged. About 7 percent of healthcare facilities are in flood-prone areas, and many are at risk of being damaged from mudslides. Limited data are available on drug stocks and resource allocation for health facilities. In 2016, the country reported shortages of key medications,

with oral rehydration solutions and oxytocin injections available 75 percent of the time, magnesium sulfate 78 percent of the time, and zinc only 23 percent of the time (World Bank 2023e). Laboratory capabilities face challenges in testing (specimen transport, quality management, and regulatory standards). Although Sierra Leone has an estimated 1,200 laboratory facilities, only 13 percent of sampled labs could perform rapid diagnostics for malaria (Stats SL 2020). Extreme weather events such as flooding increase supply chain vulnerability, leading to frequent shortages of water, electricity, reagents, consumables, and equipment. The absence of standard operating procedures, accreditation, or registration licensing undermines quality control in these laboratories.

#### Recommendations

**Given the increasing climate-related health risks in Sierra Leone**, such as rising heat stress, more extreme weather events, and the prevalence of vector- and waterborne diseases, it is imperative to enhance the resilience of the health sector. The recommendations outlined below are drawn from the Climate and Health Vulnerability Assessment (CHVA) (World Bank 2024f), which offers more detailed analysis and findings. To address these challenges effectively, the following should be prioritized to protect population health.

- (1) Integrate and operationalize health interventions into climate policy planning and financing, including the development of a Climate Change and Health National Strategy and Action Plan.
- (2) Strengthen the climate resilience of healthcare technologies and infrastructure.
- (3) Manage the environmental determinants of health and strengthen HEPPR capacities.
- 1. Integrate and operationalize health interventions into climate policy planning and financing, including the development of a Climate Change and Health National Strategy and Action Plan.

Outline priority climate change-related risks, health sector adaptation options, and opportunities to work with non-health sectors in new rounds of NAPs and NDCs. Current discussions are too broad to guide concrete actions, necessitating a more focused approach. It is essential to formally link health sector needs within the National Secretariat for Climate Change Committee (NSCC) multistakeholder committee to enable the multisectoral approaches needed to mitigate climate-related health risks. Integrating health and climate data into early warning systems can directly support local health capacity planning and improve the health system's response to climate risks, such as vector-borne water-related diseases, food insecurity, and air quality. Developing a Climate Change and Health National Strategy and Action Plan, aligned with the NAP, and updating the National Health Sector Strategic Plan will facilitate implementation. Establishing a unit on climate change and health within the Ministry of Health could serve as a central coordinating mechanism for policy planning and budgeting, including the development of subnational adaptation plans on climate and health.

**Develop local strategies tailored to unique climate contexts and needs.** Local-level plans should build on and replicate successful efforts like the Transform Freetown Strategy. This includes appointing roles such as Africa's first Chief Heat Officer in Freetown and pursuing activities like urban greening, flood resilience, improved WASH systems, and nutrition interventions. These initiatives can guide other cities and localities in creating effective strategies to mitigate climate-related health risks while addressing their specific vulnerabilities. Additionally, engaging district-level community groups, especially youth and women's groups, and leadership structures can support dialogues and the development of climate and health programs.

Integrate climate-related health threats into health sector policy and workforce planning and medical training. This involves assessing the needs in the context of climate change, including the necessary skill

mixes and geographical distributions of personnel to meet expected health demands. Additionally, health sector policy makers and planners should be trained to use climate information to inform the design of health sector programs and policies. Designing a national curriculum that incorporates climate-related health threats and targeted capacity building on climate-sensitive diseases is crucial for preparing the health workforce to address these emerging challenges.

#### 2. Strengthen the climate resilience of healthcare technologies and infrastructure.

Strengthen primary healthcare systems with improved adaptive capacity and revise public health program standard operating procedures to address climate risks. This should involve an assessment of the climate vulnerability of current health infrastructure, including current laboratory capacities to diagnose climate-related diseases. Standards for resilience and sustainability should be established for a minimum threshold for healthcare infrastructure to be considered climate resilient (for example, requirements embedded in building codes and permitting systems). Introduce sustainable cooling measures for healthcare facilities and labs, focusing on natural ventilation, renewable energy sources, and sustainable refrigerant technologies. In parallel, promoting the deployment of low-cost air quality sensor networks can help monitor harmful pollution levels, guiding risk communication and targeted mitigation measures.

Additionally, ensure sufficient stockpiles and delivery of essential medicines and innovations, such as the forthcoming malaria vaccines, to manage climate-sensitive diseases.

The health sector can also take steps to support resiliency and sustainability. Procurement of health supplies and technologies can incorporate on-site renewable energy sources and energy-efficient technologies such as PV cells, solar-powered machinery, vaccine chains, and water pumps. Additionally, developing regulations to support sustainable healthcare waste management, such as shifting away from medical waste incineration and promoting the recycling of non-hazardous waste at healthcare facilities, can have strong dual benefits of reducing infection risks and minimizing environmental damage.

#### 3. Manage the environmental determinants of health and strengthen health emergency capacities.

**Encourage non-health sectors to monitor and respond to climate-related health risks.** Build off a One Health framework<sup>21</sup> for the public health system to be resilient and prepared to face existing and future disease threats at the human-animal-environment interface. Identify service delivery gaps in managing environmental health determinants, such as drinking water, air quality, food systems, housing, transport, energy/clean cooking, and waste management. Support integrated surveillance systems and the delivery of environmental health interventions within community healthcare systems and community-led initiatives to raise household awareness of climate-related health risks, improve water and sanitation practices, improve uptake of clean cooking technologies, encourage CSA, and implement measures to prevent vector-borne diseases.

<sup>&</sup>lt;sup>21</sup> This Operational Framework provides a practical reference toward achieving that aim, with the following key objectives: (a) Provide operational guidance to directly address the need for targeted investments that prevent, prepare, detect, respond to, and recover from issues like diseases with endemic, emerging, and pandemic potential, including antimicrobial resistance; (b) Showcase opportunities for targeting disease threats upstream (prevention at the source, or via early detection and effective response) to help reduce the frequency and impact of emergencies the system has to react to; (c) Jointly yield long-term gains (and consider trade-offs) in human health, animal production, and environmental management, ultimately improving overall health of the planet and the lives, livelihoods, and well-being of people; (d) Outline activities and interventions with a starting point at the human-animal-environment interface, highlight proposed methods of institutional and technical implementation, and enable mechanisms of coordination and partnership to build more collaborative public health systems.

Enhance health emergency response contingency planning. Contingency planning for health sector deployment and response should be strengthened at national, provincial, district, and community levels in response to climate-related health shocks. This should include improving laboratory capabilities for testing and diagnosis of endemic, as well as novel and reemerging diseases. Conducting scenario-based simulation exercises with various ministries and subnational health workers will enhance planning and response capabilities for health emergencies that are outside the range of historical experience. These exercises will improve the ability of different agencies and health workers to manage unexpected health crises effectively, ensuring a more resilient and responsive healthcare system in the face of climate change, and can help prioritize climate-sensitive diseases and design contingency plans at various levels for acute climate shocks and long-term climate stressors.

#### **Education**

**Disruptions from extreme weather events significantly impede young children's human capital development.** Strengthening the education system's ability to withstand and adapt to these challenges is vital for maintaining continuous educational attainment and meeting the country's human capital potential. The government has made efforts to integrate climate resilience into education planning, notably through the implementation of the School Catchment Planning guidance, but more needs to be done to improve preparedness and response to climate disasters.

An analysis of the satellite imagery of water inundation completed for this report reveals that about 8–12 percent of schools were flooded at least once between September 2019 and September 2022, exposing as many as 372,000 children (11 percent of the student population) to flooding in schools. About 10 percent of all schools experienced at least two flooding events over this period, with at least 271 schools facing flooding of five days or more. Flooding was most prevalent across the western districts of Sierra Leone, with Kambia, Bonthe, the Western Area Urban, the Western Area Rural, Mayamba, Port Loko, and Pujehun accounting for 85 percent of all schools affected by flooding in this period. Flooding is most common along coastal areas and in river deltas and wetlands.

A mix of physical and social factors determines the vulnerability of schools to floods. The analysis found that a quarter of classrooms in flood-prone areas are either constructed with semi-solid materials or require significant repairs, increasing their susceptibility to flood damage. The lack of robust infrastructure, such as inadequate water and sanitation facilities, also increases vulnerability, particularly in the spread of waterborne diseases. Half of all schools in Sierra Leone lack water services, and 37 percent lack sanitation facilities (WHO/UNICEF 2023). Around 62 percent lack electricity, and 11 percent lack network connectivity, meaning they cannot receive or provide real-time information on extreme weather events. (Annual School Census 2022). Rural schools face greater social vulnerability than urban schools, because of limited access to support services during floods. Just 18 percent of flood-prone schools have a school feeding program, a proxy for social support services.

Bonthe is the most at-risk district in terms of vulnerability and exposure to flooding, followed by Kambia and the Western Area Urban. Freetown and the area around it also have a large number of at-risk schools. The disparity in vulnerability across districts highlights the need for tailored interventions to mitigate risks from diverse types of flooding (urban flash floods, coastal flooding). Primary schools are at greater risk than other schools due to the fact that they are more likely to be found in rural areas (than secondary schools) and are less likely to have good infrastructure and access to services

The 2018 curriculum reform of Sierra Leone's basic education system represents a first step in integrating climate change and environmental degradation topics into the curriculum. The change is intended to foster environmental awareness among students. Although climate change is not explicitly mentioned in the

syllabi, the basic education curriculum includes various topics related to climate change and the environment (CCE). Previously centered on exam preparation, the updated curriculum now dedicates significant instructional time to CCE-related subjects (about 17 percent in primary and 23 percent in junior-secondary levels). Key areas include sustainable energy, ecological conservation, and sustainable agricultural and agroforestry practices. This holistic approach embeds environmental sustainability in the educational foundation, equipping young learners with valuable green skills and knowledge for future challenges.

The new senior-secondary curriculum in Sierra Leone ambitiously broadens its focus to encompass an extensive range of subjects addressing CCE issues. Out of the 78 subjects offered, at least 10 are dedicated to CCE themes. They include four subjects that explicitly tackle CCE topics (climate change awareness, preparedness, and resilience (APR); environmental science; geography; and the environment) and subjects focusing on the environmental impact of industries like mining, fishing, and tourism. Four other subjects (integrated science, biology, agricultural science, and food security) implicitly incorporate CCE elements. The course on climate change APR presents the fundamental concepts of climate change, emphasizing strategies for mitigation and adaptation. Environmental science explores the relationship between humans and the environment, underscoring the importance of sustainable development. The curriculum of the food security course links the influence of climate change with food availability and pricing.

The significant progress made in integrating climate change into basic and secondary school curricula is yet to be fully adopted by teacher training institutions. Developing curricula is a foundational step in educating young people about climate change and environmental degradation. But the impact depends on the abilities and readiness of teachers and the availability of high-quality teaching and learning materials. Teacher training institutions—the institutions responsible for the pre-service education of prospective teachers—have not fully incorporated the new curricula, and most CCE subjects remain absent from these institutions' programs. This gap indicates a lack of preparedness in these institutions to equip teachers to implement the new curricula. In-service training for Sierra Leone's more than 37,000 active teachers also suffers from poor quality, lack of coordination, and insufficient regulation (World Bank 2023c). In-service teacher training programs tend to be isolated, ad hoc, and expensive, reaching only a limited number of teachers.

#### Recommendations

Sierra Leone should focus on the following key actions to build resilient human capital development:

- (1) Reduce the climate vulnerability of schools.
- (2) Strengthen teacher training and resources for climate change education
- 1. Reduce the climate vulnerability of schools.

**Strengthen climate resilience in educational infrastructure and resources.** Providing schools with climateresilient infrastructure and building materials is essential. This includes repairing existing buildings, improving water and sanitation facilities, and increasing access to reliable and resilient electricity generation. In parts of districts highly vulnerable to flooding, physical and social support should be provided to reduce hazard exposure, vulnerability, and risk. This support could encompass building climate-resilient infrastructure, offering social assistance, and ensuring the availability of remote learning materials in the event of school closures. Identifying low-risk schools near high-risk schools and equipping them to support learning activities for students from flooded schools is also critical.

Enhance emergency preparedness and response in the education sector. Maintaining school feeding programs during disruptions is crucial, particularly in poorer areas, to reduce vulnerability to flooding.

Increasing human resources, financing, and institutional capacity to establish new climate-resilient schools is essential. Schools at the greatest risk should be identified and prioritized, working with them to understand their physical and social vulnerabilities and identifying approaches to minimize disruptions from flooding. Applying the disaster risk reduction measures of the NDMA<sup>22</sup> will help reduce schooling disruptions from extreme floods.

#### 2. Strengthen teacher training and resources for climate change education.

Improve curricula on CCE, increase teachers' competencies and preparedness to use the curricula (by ensuring that the curricula are taught at teacher training institutions), and improve the availability of goodquality teaching and learning materials. Improve the quality of in-service training, which is poor, uncoordinated, and unregulated. Integrate green skills into educational and skills training curricula. Critical skills for green economic transformation include both hard and soft skills. Hard green skills are needed in sustainability, environmental health and safety, auditing, supply chain, finance, and risk analysis. Soft green skills are needed in management, communications, planning, customer service, innovation, operations, leadership, and research of CCE topics. These skills can be developed throughout one's lifetime, including through basic, tertiary, and technical education; reskilling on the job; and off-the-job training programs. A diagnostic study of Sierra Leone could help develop a green skills agenda.

#### Social protection and inclusion

Sierra Leone's high poverty rate and widespread multidimensional vulnerability limit the population's coping capacity in the face of climate change. In 2018, about three-quarters of the rural population and 20 percent of the urban population lived in poverty based on the national poverty line (World Bank 2022). omposite vulnerability (measured by an index made up of multiple socioeconomic indicators) is widespread (Figure 4.7).<sup>23</sup> Poverty is highest in the north and lowest in the west and south. The largest number of poor people live in the slums in the Western region, which includes Greater Freetown.

#### Figure 4.7. Indexes of composite vulnerability and poverty in Sierra Leone, 2015



Source: Risk and Vulnerability Analysis, Census 2015.

<sup>&</sup>lt;sup>22</sup> The NDMA has created a framework for disaster risk reduction (DRR) in Sierra Leone and is organized around a pillar system that includes coordination at the national government level between ministries, regional, district, and chiefdom structures created (Miles 2021). Disasters are then designated into three levels. Level one is for minor disasters, which require a response at the local level. Level two disasters exceed the capacities of the local level and require national support. Level three are the most serious and require major national assistance, international assistance, and can also require military support (Turay 2022).

<sup>&</sup>lt;sup>23</sup> From a 2022 vulnerability assessment conducted by the Red Cross Climate Center with financing from the Global Shield Financing Facility (GSFF), formerly the Global Risk Financing Facility (GRiF).

Note: Grey-colored chiefdoms represent locations with no data. All scores are normalized (1 indicates highest vulnerability, 0 lowest vulnerability).

Data collected from households located in disaster-prone areas reveal the extent of vulnerability in these areas. Between September 2022 and April 2023, the National Commission for Social Action (NaCSA) compiled a register of at-risk households based on data collated by the NDMA. Flooding was the most frequently reported hazard by households in these areas (cited by 57 percent of such households in the Western region and 21 percent living on hilly terrains, which also leaves them susceptible to landslides). Overall, 27 percent of households in disaster-prone areas have climate-sensitive livelihoods, such as agriculture, with households in the northern and eastern regions the most dependent on agriculture. Other sources of vulnerability include poor infrastructure; limited access to essential services such as healthcare, especially in rural areas; and high population densities. On average, only 16 percent of disaster-prone area households ever received a social protection benefit. This share varies widely, from 2 percent in the north to 32 percent in the east (Figure 4.8).







a. Disasters reported by type



b. Location of dwelling



The evolution of Sierra Leone's social protection system began in 2014, with the launch of various social assistance programs aimed at translating the National Social Protection Policy into action. The flagship unconditional cash transfer program, *Ep Fet Po*, provided income support to the extreme poor, with households receiving transfers every quarter. Several other social assistance programs were launched to

100

80

60 Percent address specific vulnerabilities.<sup>24</sup> In 2018, 19 percent of all households received some form of social assistance, according to the 2021 Social Protection Expenditure Review. At the time, the three largest social assistance programs were free medicines, in-kind transfers (noncontributory health services other than free medicines), and other in-kind transfers and cash transfers. *Ep Fet Po* coverage grew from 2,720 households in 2014 to well over 100,000 households by the end of 2022 (World Bank 2024e). New initiatives, such as the Productive Social Safety Nets and Youth Employment (PSSNYE) Project, support *Ep Fe Po* and attempt to link social assistance programming to disaster risk reduction through reforestation programs and data compilation to inform rapid action in response to climate shocks. However, data gaps in early warning systems for geographical targeting remain (see Section 4.1).

Reliance on external funding and the absence of a strategy or policy to manage the financial impacts of natural disasters highlight the need for a more sustainable financial framework. Most financing for social protection in Sierra Leone comes from donors. Social assistance programs supported exclusively by domestic sources (such as the social pension program) are inadequately funded. The only ex ante instrument available is the contingent budgetary reserve, which is earmarked for all budgetary contingencies, including disasters, and is normally insufficient to cover post-disaster response costs. The government relies heavily on ex post mechanisms, such as budget reallocations and international donor assistance for response and recovery. Local governments lack contingency funds for disasters and rely on budget reallocations. Their response to disasters is financed solely from their own sources of revenue.

The National Social Protection Policy (NSPP), which was revised in 2018 and launched in 2020, guides the implementation of social protection policy in Sierra Leone. It identifies three major groups of people—the chronically poor, the economically at risk, and the socially vulnerable—as in urgent need of social protection. The Agenda for Prosperity (A4P) 2012–2018 envisioned a sustainable future for all citizens, as expressed through a pledge to provide a social safety net for vulnerable citizens, among other goals. The National Social Protection Strategy (2022–2026) defines systems strengthening targets, including a single social registry, a grievance redress mechanism, and improved shock-responsive capacity. It is estimated that US\$293 million will need to be invested between 2023 and 2027 to progressively implement key programs. The Social Protection Bill was drafted in 2023 and is waiting for parliamentary approval. It will establish an independent authority to coordinate all social protection programs in the country. A robust national coordination mechanism for social protection is functioning regularly. It includes the National Social Protection Inter-Agency Forum (IAF), chaired by the Vice President and composed of ministers, and the Social Protection Technical Steering Committee (TSC), composed of technical directors from key sector ministries.

#### Recommendations

Sierra Leone should focus on the following key actions to address multidimensional vulnerabilities affecting the population:

- (1) Expand social protection program coverage to households in disaster-prone areas and all households in extreme poverty.
- (2) Create fiscal space and increase domestic funding for shock-responsive social protection programming.

<sup>&</sup>lt;sup>24</sup> These programs include noncontributory health initiatives (including the free healthcare initiative) to address high maternal and infant mortality rates and the reproductive and child health program, which aims to reduce the transmission of sexually transmitted diseases, including HIV; provision of study materials, school uniforms, school feeding, and fee waivers for examinations; and provision of other food and in-kind transfers.

- (3) Support locally led climate action, bolster women's climate resilience, increase transparency and accountability for green policies
- 1. Expand social protection program coverage to households in disaster-prone areas and all households in extreme poverty.

Analyze households in disaster-prone areas for eligibility for *Ep Fet Po* transfers. Assess the specific needs of women and girls in disasters and long-term adaptation to climate change. Explore the potential of preemptive cash transfers to eligible households in flood-prone areas, particularly in the disaster-prone areas of the Northern region. The large share of the population exposed to flood and landslide hazards, coastal erosion, and sea-level rise hazards is concentrated in the hilly, low-lying, and coastal areas of the Western Area and the northern and southern provinces of Sierra Leone. Much of Freetown is also in disaster-prone areas.

Improve data collection for identifying disaster-prone and vulnerable households that need social protection programs. Operationalize the social protection registry, to facilitate targeting and pre-shock needs assessments. Integrate the management information systems (MIS) for all social protection programs in the country by expanding the social protection registry. Invest in early warning systems for social protection. Continued investments by SL-MET and NWRMA are needed to facilitate implementation of forecast-based cash transfers ahead of a flood-based on data-driven forecasts of river levels.

# 2. Create fiscal space and increase domestic funding for shock-responsive social protection programming.

Undertake fiscal space analysis for social protection, in partnership with the Ministry of Finance, to identify room for further expenditures on social protection programs. Establish a stand-alone (off-budget) national contingency fund dedicated to post-disaster financing for disaster response and relief for level 1 and level 2 disasters, and cover disasters emanating from natural and man-made events (floods, landslides, fires, leakages, explosions, epidemic, and pandemic). Pass the social protection bill, which would create a national legal framework for social protection. Establish an independent social protection entity to coordinate all social protection programs in the country.

# 3. Support locally led climate action, bolster women's climate resilience, increase transparency and accountability for green policies

Supporting locally led climate action involves empowering lower levels of government such as local councils, chiefdoms, and communities to make decisions regarding planning, implementing, and monitoring climate interventions. These entities are at the forefront of climate impact and act as intermediaries between higher tiers of government, citizens, and civil society. Building the capacity of leaders on climate change increases climate awareness and informs local government planning and investments, while increasing the accountability of governance actors ensures resources target increased resilience among the poor and vulnerable.

Participatory climate risk assessments and local climate action plans help identify strategic areas for local investment to enhance resilience. At the district level, integrating climate change considerations into planning, budgeting, implementation, and decision-making is crucial. This locally led climate investment addresses regional climate risks, mitigates potential conflict drivers, and prioritizes community-centered action based on vulnerability assessments and social cohesion strengthening.

Supporting women's capacity for climate adaptation, particularly vulnerable women farmers, involves providing livelihood support, training on CSA, and increasing access and ownership of land. Incorporating women's land ownership, access, and management in climate change strategies optimizes agricultural

productivity while mitigating climate-related risks. Improving market connections for women's livelihoods and including renewable energy solutions in farming and processing practices are essential steps.

Increasing women's voice and agency in local natural resource management and decision-making processes ensures their perspectives are included. Developing gender-responsive policies and programs removes barriers to women's advancement. Addressing infrastructure deficits and underlying social and gender norms affecting women's economic opportunities and supporting investments in local climate-resilient social and economic programs prioritizes women's identified needs and frees their time for income-earning opportunities.

Ensuring DRM is inclusive and accessible to all, including people with disabilities, involves incorporating essential services related to maternal and reproductive healthcare and gender-based violence response into DRM. Collecting gender-based violence data post-disasters informs gender-sensitive DRM strategies, while involving women and people with disabilities in DRM decision-making bodies fosters a more resilient and effective framework for DRM. Improving accountability of climate change finance and action, increasing awareness, transparency, and participation around climate change finance and action, and meeting legal requirements for transparency, accountability, and participation in climate policy are essential steps in this process.

# **Chapter 5 Climate Financing**

#### **Key Points**

- Sierra Leone's 2021 NDC estimated a need of US\$2.8 billion by 2030. Actual climate finance inflows have been significantly lower, leaving a substantial financing gap.
- Sierra Leone has diverse financing options, including concessional loans, carbon markets, disaster risk instruments, and green lending, but unlocking them requires a strategy for stronger institutions, regulatory clarity, and project pipelines to attract and manage funds effectively

## 5.1 Climate financing needs and gaps

According to Sierra Leone's NDC target from 2021 estimates, the country will need about US\$2.8 billion by 2030 to meet its climate adaptation and mitigation needs.<sup>25</sup> The NDCs are currently being revised, but nevertheless, funding its 2021 NDC of US\$2.764 billion means that it will need an average climate finance flow of US\$276 million a year or roughly 6 percent of GDP. The forthcoming revisions of the NDC should address new priorities and funding gaps. Sierra Leone can tap its domestic budget (although its high risk of debt distress limits the room for budget finance); the private sector; and international sources, including carbon credits, multilateral development banks, and bilateral development finance institutions.

There is a substantial gap in the climate finance needed to fund actions for sustainable economic development in Sierra Leone. Funding reached about US\$115 million in 2020, US\$118 million in 2021, and US\$164 million in 2022 (AfDB 2023a; Climate Policy Initiative 2022). These figures represent 41 percent, 43 percent, and 59 percent of the NDC estimated annual needs of US\$276 million for climate finance, respectively.<sup>26</sup> About 80 percent of climate financing received in 2019/20 went to energy; agriculture, including forestry and other land uses; and cross-sectoral projects (Climate Policy Initiative 2022).

In addition, significant financial resources will be needed to reduce the risks from climate-related natural disasters. The simulated average annual cost of disaster response in Sierra Leone is US\$20 million, and the cost of very severe events (events with a 1 percent probability of occurring) could exceed US\$70 million. Based on the government's approach exemplified by disaster events in 2022, it appears that no more than US\$10 million could be mobilized through budget reallocation and the contingency budget reserve.<sup>27</sup>

Filling the overall gap requires mobilizing additional financing for Sierra Leone by leveraging public and private climate finance. Addressing the climate financing gap in Sierra Leone requires a multifaceted approach, leveraging domestic efforts and international support to achieve sustainable and resilient development. The country can target both international climate funding in the form of activity-based climate finance (loans, grants, equity, or guarantees) to cover up-front costs for green investments, and outcome-based finance (such as results-based climate finance and carbon markets).

<sup>&</sup>lt;sup>25</sup> The estimate of US\$3.47 billion by the African Development Bank (AfDB 2023a) includes US\$1.38 billion (40 percent) for mitigation and US\$2.09 billion (60 percent) for adaptation, including climate-related loss and damage. This estimate is much greater than the country's NDC estimates of US\$2.764 billion required for climate mitigation and adaptation by 2030.

<sup>&</sup>lt;sup>26</sup> These financing gaps become higher if we consider a US\$3.47 billion financing need estimated by AfDB (2022).

<sup>&</sup>lt;sup>27</sup> Disaster Risk Financing Strategy, World Bank analysis based on data from Ministry of Finance and UN OCHA Financial Tracking Service, <u>https://fts.unocha.org/</u>.

Sierra Leone needs to build its capacity to increase the participation of the private sector, including the domestic private sector, in climate financing. In 2022, only 12 percent of climate finance came from the private sector (AfDB 2023a). Private sector contributions must increase by a factor of at least 13 to cover Sierra Leone's total climate finance needs, assuming public contributions remain stable over the next few years (AfDB 2023a).

## 5.2 Mobilizing climate finance: options for Sierra Leone

#### **Concessional financing**

**Several types of concessional and semi-concessional funding are available**, including concessional financing by the International Development Association (IDA), which allows Sierra Leone to borrow at rates below 3 percent with maturities of up to 30 years. International climate funds, including the Green Climate Fund (GCF), the Climate Investment Funds (CIF), and the Global Environment Facility (GEF) have already provided financing for Sierra Leone and may continue to do so in the future.<sup>28</sup> New initiatives and the expansion of global and regional financial institutions' programs, such as the launch of the European Investment Bank (EIB) Global in January 2022, provide new opportunities to blend financing for climate actions. Integration of carbon markets with innovative financing tools, including green bonds and blended financing, could help Sierra Leone mobilize climate financing if the issues related to fiscal space and debt situation are properly addressed (AfDB 2023b).

#### Leveraging of carbon markets

Sierra Leone could leverage its natural resource to tap into global carbon markets. Sierra Leone's forests constitute about 39 percent of its land area and provide the important global public good services of carbon sinks and biodiversity conservation. It could use them to generate fiscal revenues by trading forest carbon and biodiversity conservation credits. Sierra Leone could also leverage its other natural assets, including agricultural assets, water resources, biodiversity, and solar endowment, to access climate finance—for example, by building on and scaling up its experience with the REDD+ program and other projects, including the Gola Rainforest and the Sierra Leone Safe Water projects, which generated about 1 million carbon credits that Sierra Leone issued on the voluntary carbon credit market between 2016 and 2021 (IMF 2022). The Miro Sustainable Plantation project, a collaborative agreement between the Dutch Green Business Group and the South Pole, expects to issue 128,000 credits of carbon offset audited and verified by the Verified Carbon Standard (IMF 2022).<sup>29</sup>

Strengthening Sierra Leone's capacity to create bankable projects for voluntary global carbon markets in the short and medium term could create foundations for the creation of compliance carbon market systems in the longer term. Potential projects that could generate credits include the Bumbuna Hydroelectric dam; the WAPNP and reforestation projects, including Freetown the Tree Town,<sup>30</sup> and the Ministry of Environment's plan to plant 5 million trees. While addressing Sierra Leone's vulnerability to climate change and development challenges, NBS also provide effective options for attracting climate finance. Annex 3 presents potential NBS as part of the climate priorities identified in the NDC and NAP.

<sup>&</sup>lt;sup>28</sup> GCF has provided over US\$75 million for projects in renewable energy, forestry, climate-resilient infrastructure in coastal areas, and enhancing climate information in Sierra Leone.

<sup>&</sup>lt;sup>29</sup> The U.S. International Development Finance Corporation (DFC) also announced the investment of US\$24 million in Miro Forestry Developments Limited to expand the company's sustainable forestry in Sierra Leone and Ghana

<sup>(</sup>https://www.dfc.gov/media/press-releases/dfc-invest-24-million-miro-expand-sustainable-forestry-and-create-new-jobs) <sup>30</sup> The Freetown reforestation initiative is geotagging each tree planted, helping it meet the transparency prerequisites needed to issue carbon credits.

Accelerating the implementation of concrete actions for carbon market readiness would help build the capacity for climate and carbon financing needed to exploit opportunities provided by the Paris Agreement. Articles 5, 6, and 9 of the Paris Agreement provide opportunities for climate and carbon financing through (a) provision of results-based payments for reducing deforestation and forest degradation to enhance carbon sinks, (b) voluntary cooperation in the implementation of emission reduction targets stipulated in countries' NDCs through international trading of carbon offsets, and (c) support for the flow of financial resources from developed to developing countries to support their actions for climate change mitigation and adaptation.<sup>31</sup>

Sierra Leone could benefit from activating the carbon market by (a) creating a system to value, monitor, and track its forest and other natural resources; (b) control illegal logging, by strengthening enforcement of laws; (c) intensifying its interventions to reverse deforestation; and (d) identifying areas for green financing, including solar and hydro energy generation and distribution, sustainable fisheries and coastal management, and agriculture and agro-processing. It is also critical to build institutions; governance structures; legal and regulatory framework; and monitoring, reporting, and verification systems to enhance the country's participation in results-based climate financing and carbon market. Doing so could improve Sierra Leone's institutional credibility, strengthen its credit monitoring systems, and ensure the integrity of the carbon credits generated, to strengthen its position in carbon credit markets.

**The government is already taking action.** The development of a carbon market framework is under way, and the government is planning to develop a carbon market regulatory framework and conduct an inventory of its national assets that could be leveraged for carbon trading. Plans for the systematic registration and demarcation of customary land are being prepared for large-scale implementation in 2025.

#### **Disaster risk financing**

**Disaster risk finance instruments could be leveraged to increase preparedness and response.** For events with high frequency and low severity, expenditures could be financed from budgetary reserves set aside for this purpose. The World Bank's Catastrophe Deferred Drawdown Option (CAT DDO) provides immediate liquidity following a disaster, but this has not yet been used in Sierra Leone.<sup>32</sup> For events with low frequency and low severity, risk transfer solutions, such as insurance products, could be considered.

With support from the World Bank's Crisis and Disaster Risk Finance team, the government has developed a comprehensive Disaster Risk Financing Strategy (DRFS) to establish a long-term policy commitment to enhance the management of financial risks associated with disasters. The strategy includes five priorities: (1) strengthening Sierra Leone's capacity to assess and manage economic losses and financial risks associated with disasters; (2) enhancing fiscal stability at both the national and local levels by establishing a comprehensive portfolio of disaster risk financing instruments; (3) reducing the impact of disasters on vulnerable populations by supporting social protection programs; (4) enhancing the resilience of farmers, homeowners, and small and medium enterprises to floods and wildfire; and (5) strengthening coordination and institutional capacity for disaster risk financing and management.

Sierra Leone has also started to collaborate with organizations such as African Risk Capacity (ARC) to explore disaster risk financing insurance schemes, with a focus on agriculture. Insurance products such as

<sup>&</sup>lt;sup>31</sup> See https://unfccc.int/process-and-meetings/the-paris-agreement.

<sup>&</sup>lt;sup>32</sup> The Cat DDO is a contingent financing line that provides immediate liquidity following a natural disaster and/or healthrelated event. Funds become available for disbursement after the drawdown trigger—typically the member country's declaration of a state of emergency—is met. This credit line can serve as a vital source of rapid financing to fund disaster response.

parametric insurance<sup>33</sup> are an innovative way to safeguard local farmers and the agriculture sector against financial losses from climate-related events. To address climate-induced food insecurity and enhance resilience, Sierra Leone could also leverage the World Bank's Crisis Response Window (CRW), a financial mechanism that disburses funds when predefined climate crisis triggers are met. The CRW complements other IDA mechanisms, covering events such as prolonged droughts, excessive rainfall, landslides, and other climate threats that cause food insecurity. Leveraging the CRW would allow the government to swiftly access resources, mitigating the impact of climate-induced food insecurity and supporting affected communities. The government could greatly enhance its disaster preparedness by enhancing expenditure tracking and capacity to plan and prepare for disasters, establishing a National Disaster Management Fund as a risk-retention instrument, and adopting risk-transfer instruments with a focus on property and agriculture insurance to enhance disaster resilience.

#### Green lending by domestic banks

Domestic financial institutions have a role to play in channeling climate finance to viable projects and supporting an orderly transition to a resilient low-carbon economy. Given their dominance, banks are more likely to be the first movers in the provision of green finance.<sup>34</sup> Demand for green finance is likely to come from a variety of sectors. They include CSA, fishing, and aquaculture; renewable energy; energy efficiency in agro-processing, manufacturing, and mining; forestry; management and protection of tourism sites; electrification of the transport sector (including e-bikes and motorbikes, a move that is gaining momentum in some African countries); water efficiency; and waste management, among others. None of these sectors is currently receiving significant credit.<sup>35</sup> As of September 2023, the top three sectors represented in commercial banks' credit portfolios were commerce and trade (26 percent), business services (14 percent), and personal services (12 percent). Very little credit is going to other sectors, such as agriculture, mining, and marine resources.

The concept of green finance is new to financial institutions operating in Sierra Leone. Recent discussions with commercial banks reveal limited knowledge and capacity to provide green finance. Most financial institutions are unaware of and/or unprepared for climate change and its effects on their activities. They do not know what green assets are and, as a result, do not have policies for climate risk management or green finance. Banks also claim to struggle to find projects with adequate risk-return characteristics. Some financial institutions—particularly larger international and regional banks that are subject to their parent group policies—have started to adapt their business models and practices to address climate and sustainability concerns, but even they have not clearly defined green assets. The portions of portfolios that are considered green are those with loans to sectors that banks have earmarked as environmentally friendly. They include manufacturing, renewable energy, agriculture, and mining— and all other sectors that require certification from the EPA-SL. Discussions indicate interest among financial institutions to learn about and deploy climate-smart financial instruments.

<sup>&</sup>lt;sup>33</sup> Instead of reimbursing the insured for actual losses, parametric insurance triggers predetermined payouts based on objective parameters such as rainfall and temperature.

<sup>&</sup>lt;sup>34</sup> Sierra Leone's financial system is dominated by banks. As of December 2022, the combined assets of all 14 commercial banks represented about 44 percent of GDP; the assets of nonbank credit institutions (including deposit-taking microfinance institutions [MFIs], credit-only MFIs, rural financial institutions, and credit unions) accounted for less than 2 percent of GDP; and insurance companies' assets represented less than 1 percent of GDP

<sup>&</sup>lt;sup>35</sup> Lending to the private sector in general is limited. For instance, credit to the private sector stood at just 5 percent of GDP in 2022 (down from 6 percent in 2020)—one of the lowest levels of credit intermediation in low-income SSA. As of June 2023, the private sector loan to deposit ratio was 16 percent, and only 11 percent of banks' total assets were lent out to the private sector.

**Facilitating green domestic finance in Sierra Leone requires several steps,** including (a) aligning incentives, (b) addressing capacity constraints within financial institutions, (c) identifying opportunities for private sector finance, and (d) identifying opportunities for mitigating project risk and building resilience.

To ensure the availability of bankable green projects and motivate financial institutions, aligning incentives is crucial. The government should define a long-term transition strategy and develop policies to green the entire economy, supported by national taxonomies to identify climate-positive opportunities. Public awareness and collaboration with private sector associations are essential for sensitizing clients about climate risks and generating green investments. The central bank must build its capacity to address climate risks, develop risk assessment and data capabilities, and provide supervisory guidance. In the medium to long term, a regulatory framework should be established, setting expectations for banks to assess and report on climate-related risks, ensuring compliance, and allowing a transition period for financial institutions to build necessary skills. Joining international networks like the Central Banks and Supervisors Network for Greening the Financial System can further support these efforts.

**Financial institutions require support to address capacity constraints to identify viable green investment opportunities.** International and regional development finance institutions can provide technical assistance on climate finance, helping financial institutions define their strategic climate strategies and commitments, develop and originate green business, and train staff. Additionally, these institutions can assist in upgrading tools and methodologies for assessing climate risks in loan portfolios and opportunities, and incorporating climate considerations into credit approval processes. This support is crucial for building the capacity of financial institutions to effectively engage in climate finance.

Scaling up financial instruments and incentives for green investments in Sierra Leone is essential due to the large up-front costs and long gestation periods of such projects. Most domestic financial institutions lack the large balance sheets needed to finance these medium- to long-term projects, as they primarily rely on short-term deposits. The provision of long-term liquidity, such as through the World Bank's Sierra Leone Second Financial Inclusion Project, can support lending to micro, small, and medium enterprises (MSMEs), including green projects. Loan syndication, although unfamiliar to many local banks, and partial credit guarantee schemes could also facilitate financing for larger green projects. Additionally, de-risking instruments such as risk-sharing facilities or insurance guarantee schemes provided by public international financial institutions could help narrow the financing gap, share risks, and increase resources for green lending. Establishing a sector-agnostic credit guarantee scheme with a special window for agriculture could further support effective risk management and encourage green investments.

The private sector in Sierra Leone has several opportunities for green investments that can support economic growth and sustainability. In the power sector, private investments in innovative renewable energy solutions, like containerized solar power, can address the inconsistent and costly power supply. In manufacturing, financing clean cooking solutions, such as LPG production, can provide a cleaner alternative to coal. In agribusiness, opportunities exist for small and medium enterprises (SMEs) to engage in post-harvest food production and for large-scale agribusinesses to reduce dependency on imported food through backward integration. Additionally, the private sector can contribute to reducing deforestation by collaborating with the government on carbon credits and improved forestry waste management practices.

## 5.3 Creating an enabling environment for attracting climate finance

Sierra Leone can attract more climate financing if it strengthens the capacity of national institutions and the policy framework to design and implement bankable green projects and programs. Favorable conditions for climate finance in Sierra Leone include strong political will and leadership from the government; the presence of high-carbon habitats, such as forests and woodlands, for implementation of REDD+; and the potential for community involvement in the forestry sector. Robustness of policy and credibility of regulatory and governance frameworks are also crucial to build transparency and readiness required to attract global climate financing for investment in priority sectors for low-carbon and climate-resilient development.

The government of Sierra Leone is taking steps to put institutional structures in place to mobilize climate finance. It took an important step forward in March 2023, when it established a Climate Finance Unit (CFU) within the Macro Fiscal Division under the Ministry of Finance. The CFU provides leadership and coordination of climate finance in Sierra Leone, but it is still in its early stages and yet to start full operation. Lack of data to inform climate actions, limited technical expertise and capacity, human resources, and lack of an overarching climate finance policy and strategy are the main challenges the CFU faces in fulfilling its mandate. Significant capacity-building efforts will be required to support the unit.

The Sierra Leone Climate Fund (SLCF)—which both the NCCP and the updated NDC indicate should support both mitigation and adaptation activities—needs to be established. Upon its establishment, its board of directors will be led by the EPA-SL chair and include representatives of relevant ministries, departments, agencies, private sector entities, international donors, and civil society. The fund will include three windows: domestic, international (bilateral and multilateral), and private climate finance. The fund will start by offering grant financing, gradually offering a wider range of financing instruments. It hopes to attract private sector funding by collaborating with financial intermediaries such as commercial banks. Its governance structure is expected to include representatives from the government, civil society, and the private sector. Accelerating the establishment of the SLCF and building the capacity for its operations would be useful.

However, there is no national strategy, policy, or legal framework to source, mobilize, or coordinate climate finance to support the implementation of NDC targets. Currently, green PFM instruments are not included in existing PFM practices to integrate climate targets and prioritize climate spending. There is also no regulation for climate expenditure tagging. As a result, the public expenditure on climate action is not tracked within Sierra Leone's PFM systems. The forestry sector has not developed regulatory frameworks for benefit-sharing with communities or rules to govern carbon trading and payments for ecosystem services. The government makes no direct budgeting allocations for climate change; climate actions have been financed primarily through donor projects.

Therefore, a climate finance policy and resource mobilization plan are needed to increase international climate finance. A new climate finance mobilization plan should target enhancing the country's access to outcome-based financing, including external grants and concessional loans while maintaining debt sustainability, and results-based climate financing, including revenues from the carbon market. It should also address the challenges to REDD+ implementation, including the lack of a district, provincial, and national-level institutional framework for REDD+ carbon, unclear ownership rights to carbon by communities, local councils and the national government, the risk of illegal activities by private actors as a result of limited technical expertise and monitoring of forests, and low institutional capacity at the national and district levels. Sierra Leone would also benefit from expanding the number of locally accredited institutions by global donors such as the GCF and the Adaptation Fund.

Engagements in regional and global forums and institutional structures are also useful for exchanging experiences with other countries. Sierra Leone joined the Coalition of Finance Ministers for Climate Action in 2023. It brings together policy makers from over 80 countries to lead the global climate response and promote low-carbon resilient development through climate-informed public expenditure and tools such as carbon taxes and emissions trading systems.

Ensuring Sierra Leone's debt sustainability in the medium and longer term is also critical to create an enabling environment for international climate finance. Accessing external grants and concessional loans

will be crucial for meeting climate commitments while maintaining debt sustainability. However, mobilizing these financing for NDC implementation while ensuring debt sustainability in the medium term is challenging. To address this challenge, the International Monetary Fund (IMF) has proposed careful evaluation of costs and benefits of adaptation and other climate actions, transparent appraisal and prioritization of climate projects with realistic financing plan, enhancing the capacity to access external grants for adaptation actions, exploring the scaling up of issuing carbon credits for climate finance, and considering green PFM practices to integrate climate objectives into the budget cycle (IMF 2022). The IMF is providing technical assistance to the CFU on climate budget tagging, expenditure tracking, and the Climate-Public Investment Management Assessment (C-PIMA)<sup>36</sup>. The CFU requires further support to enhance the technical capacity of its team and allocate resources for its leadership role in developing a climate finance policy and resource mobilization strategy to address the financing needs of the NDC.

However, Sierra Leone's prevailing macroeconomic imbalances— limited fiscal space and foreign exchange risks—make it difficult to attract investors for projects and balance the risk-reward profile. For example, in critical enabling sectors such as energy, increasing transparency and accountability of the main utility (EDSA) is paramount to regaining investor confidence and catalyzing private investments across the energy sector value chain, including renewables. Addressing these systemic financial risks will be necessary for unlocking climate finance and private capital for climate-related projects.

**Public-private partnerships (PPPs) are one-way to increase private investments across critical sectors.** However, the existing PPP framework has been challenged in practice by weak technical capacity and lack of action in delivering projects in a difficult business environment. The lack of 'buy-in' of key stakeholders in relevant ministries and limited technical expertise among its staff remain obstacles to putting the PPP framework into practice.<sup>37</sup> The PPP unit struggles to provide the cross-cutting technical support set forth in its mandate and cross-ministerial collaboration continues to cause delays in the significant implementation of agreements.<sup>38</sup>

The World Bank Group and the International Finance Corporation (IFC) have successfully implemented credit enhancement mechanisms, including guarantees, in challenging environments across the Sub-Saharan region to attract investment and ensure financial stability. These mechanisms are vital for mitigating risks and encouraging private sector investment.. IFC and private sector related IPPs could also be explored to mitigate some of these challenges. For instance, revenue-sharing models or long-term PPAs with guarantees could pave the way for private investment.

<sup>&</sup>lt;sup>36</sup> C-PIMA is a diagnostic tool to assess countries' capacity to manage climate-related infrastructure and helps governments identify potential improvements in public investment institutions and processes to build low-carbon and climate-resilient infrastructure.

 <sup>&</sup>lt;sup>37</sup> "Infrascope: The Enabling Environment for Public-Private Partnerships Sierra Leone." EIU, 2019.
 <sup>38</sup> Ibid.

# Chapter 6. Recommendations for Sierra Leone's climate actions

#### **Key Points**

- Sierra Leone confronts substantial hurdles in the realms of climate change and development. The country grapples with the adverse effects of climate change, including erratic rainfall patterns, escalating temperatures, rising sea levels, and severe weather phenomena such as floods and droughts. These impacts exacerbate existing vulnerabilities, particularly in rural areas where communities depend heavily on agriculture for their livelihoods.
- Efforts to address these challenges are under way, through the on-going development program of the government. However, limited policy direction to address climate change impacts and vulnerabilities, resources, and institutional capacities pose considerable obstacles to implementing comprehensive adaptation strategies essential for tackling climate change risks and impacts effectively.
- This section provides recommendations on how Sierra Leone can pursue development and climate objectives through a multifaceted approach that integrates sustainable development practices with climate resilience and adaptation strategies. Considering the country's status as a low carbon emitter, juxtaposed with significant macroeconomic limitations, the nation must refine its policy trajectory to capitalize on the synergies between climate action and developmental objectives. This entails fostering a strategic climate and development framework that facilitates the integration of cost-effective measures for both adaptation to climate change

Sierra Leone should avoid exacerbating existing climate risks and focus on laying the groundwork to harness the opportunities presented by global climate financing. This involves developing the public sector capacity, correct policies, and regulations, incentivizing private sector involvement through collaboration and partnerships with international allies for development assistance while prioritizing sectoral investments that yield maximum benefits for the populace, economy, and environment.

## 6.1 Priority areas for climate transition and investments

#### Enabling institutions, policy, and legal framework for climate actions

To adopt climate actions, Sierra Leone must fortify its institutions and national capacity. This entails integrating climate targets into development plans and strategies, aligning them with sectoral and national goals. By embedding climate targets into development policies, resilience to sustainable development can be enhanced. Creating coherence among national and sectoral policies and strategies could facilitate synergistic implementation of targets across various sectors.

Establishing a national adaptation committee is necessary to oversee the activities outlined in Sierra Leone's NAP and NDCs, aimed at strengthening resilience to climate change. Adopting a framework law on climate change will strengthen the legal accountability for climate action and ensure climate risks are factored into planning and implementing sectoral policies.

Updating the country's legal and regulatory frameworks to fully reflect climate commitments is essential. The present frameworks do not adequately capture these commitments. These updates should create the enabling environment and incentives for enhanced coordination across institutions and stakeholders to adopt a systemic approach to implement NAP and NDC targets and achieve climate and development outcomes. Boosting institutional capacities and establishing regional counterparts to national agencies and coordinating entities, such as the NCCSC and NDC committees, will extend their roles to local government levels.

#### **Enabling climate finance**

Restoring macro-stability and ensuring debt sustainability are pivotal steps for Sierra Leone to create fiscal space conducive to public financing and facilitate international climate finance. A lack of fiscal space could hinder domestic funding for essential expenditures aimed at enhancing adaptive capacity. Maintaining debt sustainability is crucial for continued access to external grants and concessional loans necessary for meeting climate commitments.

**Developing a national climate finance policy and strategy will guide the mobilization of green funding.** This policy will complement the existing DRFS and provide a comprehensive framework to support and coordinate climate finance initiatives. Notably, it will address challenges such as the absence of institutional frameworks for REDD+ implementation at the district, provincial, and national levels, as well as unclear ownership rights to carbon by local councils and the national government. Supporting the adoption and implementation of the DRFS involves enhancing expenditure tracking to bolster the government's disaster planning capacity. Additionally, establishing a National Disaster Management Fund as a risk-retention instrument and developing risk-transfer instruments, such as property and agriculture insurance, will enhance disaster resilience. Incorporating green PFM instruments into current practices and implementing regulations for climate expenditure tagging will streamline the integration of climate targets into Sierra Leone's PFM systems. This approach will prioritize and monitor climate spending effectively.

Establishing the SLCF will support both mitigation and adaptation activities outlined in the NCCP, NAP, and NDCs. The fund, with domestic, international, and private finance windows, will play a vital role in financing climate projects and can act as the gateway to climate financing in Sierra Leone. Preparing to leverage carbon markets requires several steps, including valuing, monitoring, and tracking forest and natural resources, combating illegal logging, and intensifying efforts to reverse deforestation. Additionally, establishing legal and regulatory frameworks, defining carbon rights, and identifying areas for green financing, such as renewable energy and sustainable fisheries, are essential.

Building technical and institutional capacity to attract financing for green investments in priority sectors such as forestry, agriculture, and energy is essential. Strengthening the expertise and capacity of the CFU within the Ministry of Finance can streamline the operationalization of its mandates. Furthermore, developing robust data and information systems, including GHG inventories and registry, and enhancing institutional and regulatory frameworks, are necessary for informed climate actions and benefit from carbon markets.

#### Enabling resilient and adaptive sectoral pathways

#### Developing green energy and sustainable cities

To enhance infrastructure resilience, efforts must prioritize systems and services that support sustainable growth while absorbing and recovering from climate change effects. Civil unrest from 1991 to 2001 left much of Sierra Leone's infrastructure in ruins, especially key systems like electricity, water, sanitation, and transport networks. Despite rebuilding efforts, significant deficits remain in accessing these essential services, exacerbated by population growth and climate stress. Urban areas, particularly Freetown, demonstrate acute vulnerability due to unplanned development in high-risk zones, predominantly occupied by the urban poor. Developing resilient infrastructure in growing towns and remote rural areas is critical for fostering balanced development and reducing nationwide poverty. High rural-to-urban migration

underscores the need for comprehensive infrastructure development that bridges the urban-rural divide, ensuring benefits for all Sierra Leoneans and laying the groundwork for a more inclusive future

Energy development is pivotal in Sierra Leone's infrastructure strategy, offering opportunities for low-carbon growth pathways. With only one-third of the population having access to electricity, there is a significant rural/urban divide and reliance on polluting fuels. Expanding energy imports and tapping into hydro and solar potential can lead to substantial savings and emissions reduction. This energy transition aims for universal electricity access through grid electrification, mini-grids, and stand-alone solar systems, catalyzing broader infrastructural advancements such as improved water resource management, cleaner transport, broadband connectivity, and digitalized services. Integrated development efforts are crucial for Sierra Leone's pursuit of sustainable, resilient infrastructure supporting poverty reduction and growth

#### Promoting climate-smart agricultural and natural resource productivity

Investing in resilient landscape management for addressing resource scarcity, environmental degradation, and climate change while promoting economic and social growth will enhance community resilience, create economic opportunities through ecotourism and sustainable forestry, generate green jobs, aid in carbon sequestration, and align with NDCs and Sierra Leone's REDD+ program. Key strategies include transparent land-use planning, secure land and forest tenure, biodiversity conservation, community involvement in forest management, and promoting sustainable agricultural practices such as organic farming and agroforestry. Reorienting the agricultural sector toward agroecological approaches will build resilient and sustainable food systems in Sierra Leone, as they are nutrition-sensitive, gender-responsive, and inclusive, yielding low-cost, safe, and nutritious food with minimal harm to ecosystems.

Recognizing the vital role of the agriculture and fishery sectors in Sierra Leone's socioeconomic structure, strengthening policies through initiatives like *Feed Salone* will provide the foundation for climate resilience and adaptation. This involves modernizing current policies, establishing strategic plans to address immediate and future challenges, and enhancing knowledge and human resources in agriculture and food systems. Fine-tuning regulations to promote innovation while ensuring environmental sustainability is essential, achieved through dialogue with stakeholders to create impactful rules. Furthermore, incorporating climate-resilient practices into national development strategies and funding frameworks will ensure financial planning includes NBS to counteract environmental degradation.

In the fisheries industry, establishing a strategy and roadmap is needed for long-term viability. Comprehensive stock assessments for commercially important species are necessary to address growth demands and mitigate climate-related risks. Developing mariculture and aquaculture through private sector-driven feasibility studies and business models can alleviate pressure on wild fish stocks sustainably.

Sierra Leone's mining industry's rapid development has led to environmental impacts, emphasizing the need for sustainable and responsible mining practices. Governance improvements require updated regulations aligned with Minerals and Artisanal Mining Policies to be fully implemented, adhering to environmental and labor standards, increasing transparency in licensing, formalizing artisanal mining, and undertaking regular compliance audits. Tracking mineral production and exports, alongside promoting eco-friendly technologies, can mitigate negative impacts on forest and agriculture land.

Clear mandates for coastal zone management agencies, including mangrove ecosystems, will ensure achieving long-term conservation outcomes while increasing the resilience of the coastal systems. Reinforcing laws against destructive activities, implementing management strategies for MPAs, and involving local communities in responsible resource use and mangrove preservation through economic incentives like payments for ecosystem services will provide direct benefits to local communities.

#### Strengthening social resilience

To build social resilience against climate change, the country must focus on improving the capacity of communities to adapt and thrive amidst climate challenges and shocks. Enhancing this form of resilience extends beyond merely mitigating the direct impacts of climate disasters on people's well-being and livelihoods. It also involves the development of human capital—skills, knowledge, health, and social safeguards—which equips people to anticipate, withstand, and rebound from climate-related adversities. Investments in human capital can also facilitate a shift from reliance on natural capital to a broader, more diversified economic base. This transition paves the way for the creation of higher-skilled, greener jobs, marking a significant step toward a more climate-resilient economy.

Addressing challenges in the country's health, education, and social protection systems will build social resilience. Improving health infrastructure, surveillance and response systems, and health workforce capacities will be imperative for managing the projected rise of climate-sensitive diseases and public health emergencies. With over 40 percent of the population being school age, human capital development is at risk for a considerable segment of the population. Improving school resilience against climate hazards and integrating climate awareness into curricula can make future generations more capable of addressing climate challenges. Access to adaptive social protection systems will also be vital for building resilience among the most vulnerable groups against climate-related crises and over evolving climate scenarios.

## 6.2 Policy recommendations for Sierra Leone's climate actions

Table 6.1 provides the summary of the policy recommendations of climate actions for Sierra Leone with detailed recommendations in Annex 1. Short- and medium-to-long-term prioritization reflects the feasibility, urgency, and level of preparatory groundwork for proposed actions. Short-term priorities are those that are time-sensitive, already have momentum through existing policies or operations, or can be implemented quickly to generate immediate impact. Medium-to-long-term priorities require sustained investment, resource mobilization, and strategic planning to ensure long-term effectiveness and scalability.

	DEVELODING OBEEN ENERGY AND SUSTAINARLE OTTES
	Developing Green energy and sustainable cities
Energy	<u>Short term</u>
	• Achieve universal electricity access through increased grid electrification, mini-grids, and stand-alone solar systems (for example, access to electrification with an energy mix of grid electrification, mini-grids, and stand-alone solar systems).
	<ul> <li>Take an integrated and cross-sectoral approach to creating an enabling environment that supports the development of the clean cooking market (for example, formalization of cooking energy demand into national energy planning; regulations and standards on clean cooking solutions; national programs for clean cooking with community health or community livelihoods programs).</li> <li>Medium to long term</li> </ul>
	• Develop the country's hydro and other renewable potential and expand energy imports to attain energy security, unlock tremendous savings, and reduce emissions from the sector (for example, Increase hydrobased power generation and/or imports for energy security and emissions).

#### Table 6.1. Key policy recommendations for climate action

	Short term
Urban planning and Infrastructur e	<ul> <li>Promote urban planning that reduces built-up areas exposed to climate risk (for example, land-use zoning and building regulations, digital land management database and tools, capacity building and inter-agency coordination, compliance monitoring).</li> <li>Build a digital foundation for climate and development planning (for example, standardized data, digital collection, digitization needs in energy planning).</li> <li>Integrate climate risks into transport sector planning, development, and management (for example, climate-resilient infrastructure, hazard mapping, DRM systems, climate-informed engineering standards, improved maintenance and development of transport network).</li> <li>Medium to long term</li> <li>Expand and safeguard basic services and infrastructure to ensure they are resilient innovations, digital and integrated data management for early warning systems, expanded coverage of water, sanitation, solid waste services, capacity building of utilities and disaster response agencies).</li> <li>Support low-carbon modes of transport (for example, bus rapid transit, e-mobility pilots, rail freight expansion, stricter vehicle emission standards).</li> </ul>
	PROMOTING CLIMATE-SMART AGRICULTURAL AND NATURAL RESOURCE PRODUCTIVITY
Forestry, mining, and other land uses	<ul> <li>Short term</li> <li>Improve the understanding of forestry and other land uses (for example, national forest inventory and national forest monitoring system, forest capital accounting on revenue, expenditure, GHG emissions/sequestration).</li> <li>Develop key regulations and strengthen the institutional framework for enforcing conservation measures and accessing benefits such as blue carbon credits.</li> <li>Implement governance reforms across all land-use sectors (for example, joint land-use planning, climate-aligned forest sector policies and legislation, carbon market policy, registration and demarcation of customary land, digital land and information management system, updating Environment Protection [Mines and Minera]) Regulations).</li> <li>Medium to long term</li> <li>Invest in community-centered sustainable forest landscape management and restoration (for example, sustainable landscape management, landscape restoration, NBS, sustainable mining technologies and practices).</li> <li>Strengthen co-management of mangroves with CMAs (for example, capacity building, collaborative mangrove restoration and reforestation).</li> <li>Promote alternative livelihoods and improve the productivity of converted areas (for example, sustainable technologies, increasing productivity, alternative livelihood options, financial capital for economic transition).</li> </ul>
Agriculture and fisheries	<ul> <li>Short term</li> <li>Strengthen the policy, regulatory, and institutional framework (for example, climate-aligned Feed Salone and NSADP, irrigation policy, fisheries strategy, digital governance; climate-smart agriculture investment plan).</li> <li>Introduce climate-resilient and climate-smart technologies and management practices (for example, climate-smart crop varieties and mariculture, IVS for rice and fisheries, fishery infrastructure, research and extension services).</li> <li>Medium to long term</li> <li>Invest in weather forecasting, early warning systems, and insurance (for example, advanced forecasting tools, early warning system sensors, mobile alerts, digital platforms for climate advisories; SL-MET, NWRMA, and NDMA coordination; climate insurance access).</li> </ul>
Health	<u>Snort term</u>

	<ul> <li>Integrate and operationalize health interventions into climate policy planning and financing and vice versa (for example, Climate Change and Health National Strategy and Action Plan, establishment of climate and health agencies and roles, district-level climate and health action plans, climate-informed health workforce planning, integration of climate and health data into early warning systems, climate and health investment cases).</li> <li>Medium to long term</li> <li>Strengthen the climate resilience of healthcare technologies and infrastructure (for example, National Health Infrastructure Assessment; training programs for healthcare workers; Improved standards and regulations for sustainability, health waste management, building codes).</li> <li>Manage the environmental determinants of health and strengthen HEPPR capacities (for example, One Health and Whole of Society framework for responding to climate and health risks; Integrate health risks into environmental standards; Pandemic Preparedness and One Health capacity assessments; inter-agency and sector coordination; established plans for stockpiling and distribution for climate-sensitive diseases; community health programs).</li> </ul>
Education	<ul> <li>Short term</li> <li>Reduce the climate vulnerability of schools (for example, Climate-Resilient School Infrastructure Standards; inter-agency and sector coordination for DRM and provision of basic infrastructure and services in WASH, transport, health, energy).</li> <li>Medium to long term</li> <li>Strengthen teacher training and resources for climate change education (for example, updated national curriculum and teacher training standards on climate change; capacity-building programs).</li> </ul>
Social Protection and Inclusion	<ul> <li>Short term</li> <li>Create fiscal space and increase domestic funding for shock-responsive social protection programming (for example, financial assessment, legislation).</li> <li>Support locally led climate action, bolster women's climate resilience, increase transparency and accountability for green policies (for example, gender-responsive policies, improved data on climate risks and social vulnerability, capacity building of local leaders and community organizations).</li> <li>Medium to long term</li> <li>Expand social protection program coverage to households in disaster-prone areas and in extreme poverty (for example, expansion of Et Fet Po and integration with early warning systems and risk mapping of disaster-prone households).</li> </ul>
	ENABLING CLIMATE FINANCE AND GOVERNANCE
Governance and Financing	<ul> <li>Short term</li> <li>Develop a comprehensive national climate finance policy and strategy to mobilize green funding and address institutional gaps.</li> <li>Incorporate green PFM instruments and adopt regulations for climate expenditure tagging to prioritize and track climate spending within Sierra Leone's financial systems.</li> <li>Establish the SLCF to support both mitigation and adaptation activities, providing avenues for domestic, international, and private climate finance, and prepare to leverage carbon markets through robust valuation systems and clear regulatory frameworks.</li> <li>Medium to long term</li> <li>Ensure macro-stability and debt sustainability to create favorable fiscal space and facilitate public financing for climate initiatives, enabling continued access to external grants and concessional loans.</li> <li>Support the adoption and implementation of DRFS, including enhanced expenditure tracking and the establishment of a National Disaster Management Fund, to strengthen disaster resilience.</li> <li>Prepare to leverage carbon markets, through investments in institutions, the legal framework and technical infrastructure to better manage its natural assets.</li> </ul>

# **Annex 1. Policy recommendations for climate actions**

Table A1.1. Sectoral policy recommendations for Sierra Leone's climate actions

Policy Recommendation	Policy Instruments	Responsible agency, Ministry or stakeholder (incl. private sector)	Example Indicators for Implementation	Key Implementation Barriers	Prioritization	Sector	Policy Outcome
		Sectoral J	pathways to climate resilienc	e and adaptation			
		Devel	oping Green Energy and Sust	tainable Cities			
			Energy Transition				
Develop the country's hydro and other renewable potential and expand energy imports to attain energy security, unlock tremendous savings, and reduce emissions from the sector.	<ul> <li>Increase hydro- based power generation and/or imports for energy security and emissions.</li> </ul>	Ministry of Energy; private sector	<ul> <li>Increased imports from CLGS</li> <li>Increased power generation from hydropower and other renewables</li> <li>Annual emission reductions by 0.5 mtCO<sub>2</sub> and/or by 1.6mtCO<sub>2</sub> by 2040.</li> </ul>	Political economy: Access to financing for energy sector development.	Medium to long term	Energy	Adaptation and Mitigation
Achieve universal electricity access through increased grid electrification, mini-grids, and stand-alone solar systems.	<ul> <li>Access to electrification with an energy mix of grid electrification, mini-grids, and stand-alone solar systems.</li> </ul>	Ministry of Energy; private sector	<ul> <li>Universal electrification access by 2030.</li> </ul>	Political economy: Access to financing for energy sector development.	Medium term	Energy	Adaptation
Take an integrated and cross-sectoral approach to create an enabling environment that supports clean cooking market development.	<ul> <li>Formalization of cooking energy demand into national energy planning; regulations and standards on clean cooking solutions.</li> </ul>	Ministry of Energy; Ministry of Environment and Climate Change; Ministry of Health and Sanitation; private sector.	<ul> <li>Increase LPG uptake to 25% by 2030.</li> </ul>	Political economy: Access to financing for energy sector development; multisectoral coordination with other ministries such as health and environment.	Medium- term	Energy	Adaptation and Mitigation

Policy Recommendation	Policy Instruments	Responsible agency, Ministry or stakeholder (incl. private sector)	Example Indicators for Implementation	Key Implementation Barriers	Prioritization	Sector	Policy Outcome
	<ul> <li>National programs for clean cooking with community health or community livelihoods programs.</li> </ul>			Technological: Lack of affordable, preferable, and scalable clean cooking technologies on the market.			
			Infrastructure				
Promote urban planning that reduces built-up areas exposed to climate risk.	<ul> <li>Legislation</li> <li>Land-use zoning, and building regulations</li> <li>Digital land management database and tools</li> <li>Capacity building and inter-agency coordination, compliance monitoring.</li> </ul>	Ministry of Lands, Housing, and Country Planning; Ministry of Planning and Economic Development; SL-MET; National Water Resources Management Agency; National Disaster Management Agency; Freetown City Council; Other Municipal Councils.	<ul> <li>Mapped urban areas designated and no-build red zones by 2028</li> <li>Updated building codes by 2027</li> <li>50% reduction of people living in high-risk red zones by 2030</li> <li>Area of green zones that are integrated into urban planning by 2028.</li> </ul>	Political economy: Lack of capacity to enforce land-use, building, and zoning laws. Institutional readiness: Limited capacity for multisectoral and interagency coordination.	Short term	Urban planning	Adaptation
Expand and safeguard basic services and infrastructure to ensure they are resilient and inclusive in the face of projected	<ul> <li>Policy and legislation updated on energy-efficient innovations, digital and integrated data management for</li> </ul>	Ministry of Lands, Housing, and Country Planning; SL-MET; National Water Resources	<ul> <li>Increased access to safely managed water and sanitation services in five cities by 2030</li> <li>Improved the operational efficiency of water utilities by 2030</li> </ul>	Political economy: Access to financing; Institutional readiness: Lack of capacity to enforce regulations; Limited capacity for	Medium to long term	Infrastructure, water, transport, energy, digital	Adaptation and Mitigation

Policy Recommendation	Policy Instruments	Responsible agency, Ministry or stakeholder (incl. private sector)	Example Indicators for Implementation	Key Implementation Barriers	Prioritization	Sector	Policy Outcome
increases in climate risks.	<ul> <li>early warning systems</li> <li>Expanded coverage of water, sanitation, solid waste services</li> <li>Capacity building of utilities and disaster response agencies</li> <li>Improved maintenance and development of transport network built with climate risks in mind</li> <li>Tax incentives.</li> </ul>	Management Agency; National Disaster Management Agency; Freetown City Council and Other Municipal Councils; water utilities; Ministry of Transport and Aviation; Sierra Leone Roads Authority, local authorities; private sector.	<ul> <li>100% water bodies monitored (quality and quantity) by 2040</li> <li>Increased capacity and utilization of wastewater treatment plants by 2040</li> <li>Increased solid waste collection and recycling rates by 2030</li> <li>Improved drainage networks by 2040</li> <li>Reduction in PM2.5 (air quality) by 2040</li> <li>% increase of paved roads</li> <li>% increase in utilization of public transit</li> <li>% increase in low- emission and electric vehicles registered</li> <li>Increased maintenance of transport network</li> <li>Reduction of transport networks in high-risk zones; new roads and bridges are elevated or existing</li> <li>% of existing infrastructure that is climate resilient.</li> </ul>	multisectoral and interagency coordination.			
		Promoting climate	e-smart agriculture and natu	ral resources productiv	/ity		
			Agriculture and Food Syst	tems			

Policy Recommendation	Policy Instruments	Responsible agency, Ministry or stakeholder (incl. private sector)	Example Indicators for Implementation	Key Implementation Barriers	Prioritization	Sector	Policy Outcome
Strengthen the policy, regulatory, and institutional framework.	<ul> <li>Climate-informed food system policies</li> <li>Irrigation policy</li> <li>Fishery strategy</li> <li>Climate-resilient fishery management plans</li> <li>Climate-resilient integrated agriculture and fishery regulations.</li> </ul>	Ministry of Agriculture and Food Security; Ministry of Fisheries and Marine Resources	<ul> <li>Updated Feed Salone initiative and NSADP 2010-2030 by 2025</li> <li>Fishery sector strategy and roadmap by 2025</li> <li>Stock assessments of at least five key species and, fishery management plans under implementation by 2028</li> <li>Amended agriculture and fishery regulations by 2026</li> <li>Adoption of irrigation policy by 2025.</li> </ul>	Institutional readiness: Limited capacity. Political economy: Conflicting priorities between short-term gains vs. long-term sustainability.	Short term	Agriculture and Fisheries	Adaptation
Invest in weather forecasting, early warning systems, and insurance.	<ul> <li>Weather forecasting and early warning systems</li> <li>Agriculture and fisheries insurance schemes</li> <li>Digital platform for climate information dissemination</li> <li>Emergency response and recovery plans.</li> </ul>	SL-MET; National Water Resource Management Agency; Ministry of Agriculture and Food Security; Ministry of Fisheries and Marine Resources; National Disaster Management Agency; private sector	<ul> <li>Operational weather forecasting and early warning systems by 2030</li> <li>Agriculture insurance scheme (30% of farmers by 2030)</li> <li>Fisheries insurance scheme (30% of fishers by 2030)</li> <li>Operational climate information digital platform by 2030</li> <li>Emergency response and recovery plans for agriculture and fishery sectors by 2028.</li> </ul>	Institutional readiness: Limited capacity. Political economy: Lack of approaches to engage private sector and limited private sector confidence to set up insurance schemes. Financing: Lack of access to financing for farmers and fishers for insurance premium.	Medium term	Agriculture and Fisheries	Adaptation
Introduce climate- resilient and climate-smart technologies and management practices.	<ul> <li>Integrated approaches to agriculture and fishery management</li> </ul>	Ministry of Agriculture and Food Security; Ministry of Fisheries and Marine	<ul> <li>Adoption of integrated approaches (30% of agriculture and coastal fishery areas by 2030)</li> <li>Adoption of climate-smart technologies/crop</li> </ul>	Institutional readiness: Limited capacity, limited access to resilient and climate-smart technologies	Short term	Agriculture and Fisheries	Adaptation

Policy Recommendation	Policy Instruments	Responsible agency, Ministry or stakeholder (incl. private sector)	Example Indicators for Implementation	Key Implementation Barriers	Prioritization	Sector	Policy Outcome
	<ul> <li>Climate-smart technologies including climate- resilient crop varieties, mariculture development, and so on</li> <li>IVS under rice and fishery production</li> <li>Large-scale managed farms</li> <li>Co-management approaches to fisheries</li> <li>Climate-resilient fishery infrastructure</li> <li>Research and extension services.</li> </ul>	Resources; local authorities; Private sector	<ul> <li>varieties (30% of farmed areas by 2030)</li> <li>Rice and inland fishery production using IVS (30% of area by 2030)</li> <li>Large-scale managed farm (one in each district by 2030)</li> <li>Active CMAs (10 by 2030)</li> <li>Modernized and climate-resilient fishing port in Freetown by 2030</li> <li>Climate-resilient fishery landing sites (30% of sites by 2030)</li> <li>Active research and extension services (100% by 2030).</li> </ul>	Political economy: Lack of approaches to engage the private sector to manage large farms and provide extension services. <i>Financing:</i> Lack of financing to research and adopt on scale climate-smart technologies, lack of access to financing for farmers and fishers to adopt climate-smart technologies.			
			Forestry and other land u	Jses			
Improve the understanding of the status of forestry and other land uses.	<ul> <li>National forest inventory and national forest monitoring system, forest capital accounting (revenue, expenditure, GHG emissions/ sequestration).</li> </ul>	Ministry of Environment and Climate Change; Ministry of Agriculture and Food Security; local authorities; private sector	<ul> <li>National forest inventory by 2027</li> <li>National forest monitoring system by 2027</li> <li>Forest capital accounts by 2027</li> <li>Registration of customary land of four districts by 2030</li> <li>Digital land and information management system by 2026.</li> </ul>	Institutional readiness: Limited capacity to maintain and continuously update the systems.	Short term	Forestry and other land uses	Adaptation and Mitigation

Policy Recommendation	Policy Instruments	Responsible agency, Ministry or stakeholder (incl. private sector)	Example Indicators for Implementation	Key Implementation Barriers	Prioritization	Sector	Policy Outcome
Implement governance reforms across all land-use sectors.	<ul> <li>Alignment of forestry and other land-use sector policies and legislation</li> <li>Consolidation of forest sector policies and legislation integrating climate change aspects</li> <li>Carbon market policy</li> <li>Joint land-use planning</li> <li>Registration and demarcation of customary land</li> <li>Digital land and information management system</li> <li>Regulations to address environmental and climate change issues in the mining sector</li> <li>Updating the Environment Protection (Mines and Mineral) Regulation of 2013.</li> </ul>	Ministry of Environment and Climate Change; Ministry of Agriculture and Food Security; Ministry of Lands, Housing, and Country Planning; Ministry of Mines and Mineral Resources	<ul> <li>Consolidated forest sector policy by 2025</li> <li>Consolidated forest act by 2026</li> <li>Carbon market policy by 2025</li> <li>Joint land-use plan by 2026</li> <li>Customary land registered and demarcated by 2040</li> <li>Digital land and information management system by 2026</li> <li>Updated regulation for Environmental Protection Agency Act 2022 by 2026</li> <li>Updated Environment Protection (Mines and Mineral) Regulation of 2013 by 2027.</li> </ul>	Institutional readiness: Limited capacity and institutional fragmentation with overlapping mandates. Political economy: Opposition by institutions for consolidation, delays in approving legislation. Lack of incentive for collaboration.	Short term	Forestry and other land uses	Adaptation and Mitigation
Invest in community- centered sustainable forest	<ul> <li>Resilient and sustainable landscape</li> </ul>	Ministry of Environment and Climate Change;	<ul> <li>Zero deforestation by 2040</li> <li>Protected areas effectively managed</li> </ul>	Institutional readiness: Limited capacity and institutional	Medium to long term	Forestry and other land uses	Adaptation and Mitigation

Policy Recommendation	Policy Instruments	Responsible agency, Ministry or stakeholder (incl. private sector)	Example Indicators for Implementation	Key Implementation Barriers	Prioritization	Sector	Policy Outcome
landscape management and restoration.	management investments Landscape restoration Nature-based solutions Adopting sustainable mining technologies and practices.	Ministry of Agriculture and Food Security; Ministry of Lands, Housing, and Country Planning; Ministry of Mines and Mineral Resources; local authorities; private sector	<ul> <li>using Spatial Monitoring and Reporting Tool (SMART) and Management Effectiveness Tracking Tool (METT) (five by 2030).</li> <li>At least 50% of forest landscapes using nature- based solutions by 2030.</li> <li>100% of registered mining concessions adopting and reporting on sustainable mining technologies and practices by 2030.</li> </ul>	fragmentation with overlapping mandates. Unclear land tenure and ownership rights. <i>Political economy:</i> Lack of incentive for collaboration. Opposition from settlements of limited access to Protected Areas and farmers to adopt low-intensity agriculture and/or alternative livelihoods.			
			Coastal Wetlands				
Develop key regulations and strengthen the institutional framework for enforcing conservation measures and accessing benefits such as blue carbon credits.	<ul> <li>Adopt Wetland Bill.</li> <li>Update ICZM Plan</li> <li>National Wetland Inventory and Strategic Plan</li> <li>National Mangrove Restoration Action Plan</li> <li>Management Plans for SLRE and Mamunta- Mayossoh Wildlife Sanctuary</li> <li>New MPAs designated</li> </ul>	Ministry of Environment and Climate Change; Ministry of Fisheries and Marine Resources; Ministry of Lands, Housing, and Country Planning	<ul> <li>Wetland Bill adopted by 2025</li> <li>Updated ICZM plan by 2026</li> <li>Updated National Wetland Inventory and Strategic Plan by 2026</li> <li>Updated National Mangrove Restoration Action Plan, and Management Plans for SLRE and Mamunta-Mayossoh Wildlife Sanctuary by 2026</li> <li>At least two new MPAs established by 2027.</li> </ul>	Institutional readiness: Limited capacity and institutional fragmentation with overlapping mandates. Unclear land tenure and ownership rights. Political economy: Lack of incentive for collaboration. Opposition from coastal communities, farmers and fishers to adopt sustainable practices and/or move to alternative livelihoods. Lack of	Short term	Coastal zone	Adaptation and mitigation

Policy Recommendation	Policy Instruments	Responsible agency, Ministry or stakeholder (incl. private sector)	Example Indicators for Implementation	Key Implementation Barriers	Prioritization	Sector	Policy Outcome
				incentives by coastal population to participate in coast conservation actions.			
Strengthen co- management of mangroves with CMAs.	<ul> <li>Strengthen effectiveness of CMAs</li> <li>Collaborative mangrove restoration and reforestation.</li> </ul>	Ministry of Environment and Climate Change; Ministry of Fisheries and Marine Resources; local authorities; private sector	<ul> <li>75% of CMAs functioning effectively by 2030</li> <li>50% of the degraded mangrove areas restored/reforested by 2030.</li> </ul>	Institutional readiness: Limited capacity. Unclear land tenure and ownership rights. Political economy: Lack of financing to sustain the CMAs, Lack of incentives by coastal population to participate in mangrove restoration / reforestation.	Medium term	Coastal zone	Adaptation
Promote alternative livelihoods and improve the productivity of converted areas.	<ul> <li>Environmentally friendly technologies for fish smoking and increasing productivity of rice farms</li> <li>Alternative livelihood options</li> <li>Financial capital for economic transition.</li> </ul>	Ministry of Environment and Climate Change; Ministry of Fisheries and Marine Resources; Ministry of Agriculture and Food Security; local authorities; private sector	<ul> <li>50% of coastal fishers and farmers adopting environmentally friendly technologies by 2030</li> <li>30% of coastal communities adopting alternative livelihoods by 2030</li> <li>50% of coastal communities have access to financing options by 2030.</li> </ul>	Institutional readiness: Limited capacity. Political economy: Lack of financing and incentives to coastal communities to adopt sustainable practices. Technological: Lack of affordable, preferable, and scalable technologies on the market.	Medium term	Coastal zone	Adaptation
			Strengthening Social Resil	lience			
Policy Recommendation	Policy Instruments	Responsible agency, Ministry or stakeholder (incl. private sector)	Example Indicators for Implementation	Key Implementation Barriers	Prioritization	Sector	Policy Outcome
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			Population Health				
Integrate and operationalize health interventions into climate policy planning and financing and vice versa.	Development of Climate Change and Health National Strategy and Action Plan; establishment of climate and health agencies and roles; district-level climate and health action plans; climate-informed health workforce planning; integration of climate and health data into early warning systems, climate and health investment cases.	Ministry of Health and Sanitation National Secretariat for Climate Change Committee	Incorporation of climate change in health policies; establishment of climate change and health units and roles; Number of health workers deployed to in climate- vulnerable areas; Number of early warning systems in place that track climate-sensitive diseases and associated risks factors.	Political economy: Access to financing. Institutional readiness: Limited capacity for multisectoral and interagency coordination. Knowledge and technological: Lack of localized knowledge on climate and health effects and evidence- based interventions that respond to climate and health needs.	Short term	Health	Adaptation
Strengthen the climate resilience of healthcare technologies and infrastructure.	National Health Infrastructure Assessment; training programs for healthcare workers; improved standards and regulations for sustainability, health waste management, building codes.	Ministry of Health and Sanitation National Secretariat for Climate Change Committee; private sector	Number of health facilities climate-proofed; Number of health professionals trained on climate-related health risks.	Political economy: Access to financing. Institutional readiness: Limited capacity for multisectoral and interagency coordination. Knowledge and technological: Lack of localized knowledge on climate and health effects and evidence- based interventions that respond to	Medium to long term	Health	Adaptation and Mitigation

Policy Recommendation	Policy Instruments	Responsible agency, Ministry or stakeholder (incl. private sector)	Example Indicators for Implementation	Key Implementation Barriers	Prioritization Sector		Policy Outcome
				climate and health needs.			
Manage the environmental determinants of health and strengthen HEPPR capacities.	Develop a One Health and Whole of Society framework for responding to climate and health risks; integrate health risks into environmental standards; Pandemic Preparedness and One Health capacity assessments; inter- agency and sector coordination; established plans for stockpiling and distribution for climate-sensitive diseases; community health programs.	Ministry of Health and Sanitation National Secretariat for Climate Change Committee; Ministry of Environment and Climate Change; Ministry of Agriculture, Forestry and Food Security, Ministry of Water Resources; Disaster Management Agency, private sector; Ministry of Energy	Improved scores in International Health Regulations (IHR) Monitoring and Evaluation Framework (for example, SPAR, JEE); Increased frequency of scenario-based/tabletop exercises for pandemic preparedness; Uptake of improved WASH behaviors; Uptake of clean cooking practices; Uptake of mosquito-control interventions.	Political economy: Access to financing. Institutional readiness: Limited capacity for multisectoral and interagency coordination Knowledge and technological: Lack of localized knowledge on climate and health effects and evidence- based interventions that respond to climate and health needs.	Medium to long term	Health, Water, Energy, Climate, DRM, Transport, Agriculture	Adaptation and Mitigation
			Education				
Reduce the climate vulnerability of schools.	Climate-Resilient School Infrastructure Standards; inter- agency and sector coordination for DRM and provision of basic infrastructure and services (WASH,	Ministry of Education	Number of schools climate- proofed; Implementation of Sustainability practices in schools; Percentage coverage of basic services in schools (WASH, transport, health, energy).	Political economy: Access to financing.	Short term	Education	Adaptation

Policy Recommendation	Policy Instruments	Responsible agency, Ministry or stakeholder (incl. private sector)	Example Indicators for Implementation	Key Implementation Barriers	Prioritization	Sector	Policy Outcome
	transport, health, energy).						
Strengthen teacher training and resources for climate change education.	Update national curriculum and teacher training standards on climate change; capacity building programs.	Ministry of Education	Number of teachers trained in CCE; Increase in student knowledge and skills in CCE; Percentage of schools implementing CCE.	Political economy: Access to financing.	Medium to long term	Education	Adaptation and Mitigation
			Social Protection and Incl	usion			
Expand social protection program coverage to households in disaster-prone areas and all households in extreme poverty.	Expansion of <i>Et Fet</i> <i>Po</i> and integration with early warning systems and risk mapping of disaster- prone households.	National Commission for Social Action; Ministry of Labour and Social Security; Ministry of Social Welfare, Gender, and Children's Affairs; National Social Protection Inter- Agency Forum; the Social Protection Technical Steering Committee	At least 50% of eligible households in disaster- prone areas covered by <i>Et</i> <i>Fet Po</i>	Political economy: Access to financing for improved coverage. Knowledge: Poor data collection and analysis of eligible households and understanding of disaster-risk areas.	Medium to long term	Social Protection	Adaptation
Create fiscal space and increase domestic funding for shock- responsive social protection programming.	Financial assessment, legislation.	Ministry of Finance; National Commission for Social Action; Ministry of	A budget line for shock- responsive (levels 1 and 2 disaster risks) social protection programming.	Political economy: Access to financing.	Short to medium term	Social Protection, Ministry of Finance	Adaptation

Policy Recommendation	Policy Instruments	Responsible agency, Ministry or stakeholder (incl. private sector)	Example Indicators for Implementation	Key Implementation Barriers	Prioritization	Sector	Policy Outcome
		Labour and Social Security					
Support locally led climate action, bolster women's climate resilience, increase transparency and accountability for green policies.	Development of gender-responsive policies; improved data on climate risks and social vulnerability; capacity building of local leaders and community organizations.	Ministry of Environment and Climate Change; Ministry of Social Welfare, Gender, and Children's Affairs; National Commission for Persons with Disabilities	Disaggregated data of climate risks and program beneficiaries of women, girls, and people with disabilities. Number of DRM and climate action plans incorporating gender and disability considerations.	Political economy: Access to financing.	Short term	All sectors	Adaptation

# **Annex 2. Climate scenarios**

Table A2.1 Descriptions of climate scenarios analyzed

Scenario	Description						
Mitigation							
SSP1-1.9 mean	Scenarios examine three global mitigation efforts (for sea-level rise and						
SSP2-4.5 mean	urban flooding channels only).						
SSP3-7.0 mean							
Dry/hot							
SSP2-4.5 CNRM-CM6-1	Scenarios examine 10th percentile of mean precipitation changes and						
SSP3-7.0 KACE-1-0-G	90th percentile of mean temperature changes.						
SS-3-7.0 BCC-CSM2-MR							
Dry/hot mean	Scenario examines mean across the three dry/hot future scenarios.						
Wet/warm							
SSP2-4.5 NESM3	Scenarios examine 90th percentile of mean precipitation changes and						
SSP2-4.5 INM-CM4-8	10th percentile of mean temperature changes.						
SSP3-7.0 INM-CM4-8							
Wet/warm mean	Scenario examines mean across the three wet/warm future scenarios.						
Aggregate							
Combined wet/warm mean	Scenario combines wet/warm scenario with SSP3-7.0 (for sea-level rise)						
	and SSP2-4.5 (for urban flooding).						
Combined dry/hot	Scenario combines wet/warm scenario with SSP3-7.0 (for both sea-						
mean	level rise and urban flooding).						

## Annex 3. Nature-based solution opportunities in Sierra Leone

Nature-based solutions (NBS) offer opportunities to address key climate and development challenges in Sierra Leone. Climate change is projected to raise temperatures and make rainfall patterns more erratic in Sierra Leone, affecting crop yields, increasing erosion, complicating decisions around land use, and increasing the intensity and frequency of disasters caused by natural hazards. NBS can help increase climate resilience to heatwaves, floods, droughts, and sea-level rise in ways that can be more flexible and resilient than traditionally engineered solutions, while providing multiple benefits such as improved land productivity, soil health, water quality and quantity, enhanced biodiversity, and carbon sequestration. NBS can be cost-effective and create employment, with some estimates suggesting that these practices can provide 28 percent better value for money spent than gray infrastructure,<sup>1</sup> and create up to 750 full-time jobs in developing countries for every million US dollars invested in NBS activities.<sup>2</sup> To better understand how NBS could address Sierra Leone's vulnerability to climate change and development challenges in key sectors, this analysis explores NBS options that could support climate priorities in the country, while addressing climate hazards and development challenges in key economic sectors (ES Table 1). The benefits, costs, considerations, and challenges for their implementation in Sierra Leone are summarized In Table A3.1.

Sector NBS options		NBS benefits	Climate impacts addressed		
Agriculture	Conservation	Water and soil retention	Crop and livestock loss due		
	agriculture	Mitigation of heat stress	to heat stress and water		
	Agroforestry	Control of disease and pests	scarcity		
		Carbon sequestration	Decreased crop yields and		
		Improved soil fertility	increased risks of flooding		
		Biodiversity conservation	due to soil erosion		
Urbanization and	Urban trees, parks, and	Cooling air temperature	Floods		
infrastructure	urban forests	Regulation of water runoff	Heatwaves		
	River floodplains and	Carbon sequestration	Landslides and soil loss		
	river and stream	Biodiversity conservation	due to extreme rainfall		
	renaturation	Improvement of air quality	events		
	Terracing	Improvement of water quality and			
	Constructed inland	quantity			
	wetlands	Human health and well-being			
Fisheries and	Mangrove forest	Coastal flooding control	Sea-level rise		
coastal areas	conservation and	Carbon sequestration	Storm surges		
	restoration	Biodiversity conservation	Coastal erosion		
	Coral reef restoration	Recreation			
Landscape	Protection of forests	Control floods through improved	Floods		
management and	Reforestation	water retention and flow regulation	Droughts		
forestry		Slope stabilization	Landslides and soil loss		
		Carbon sequestration	due to extreme rainfall		
		Biodiversity	events		
Energy	Protection of forests	Erosion control to increase water	Droughts		
	Reforestation	quality and quantity for hydroelectric	Fires		
	Vegetative buffers	power			
		Increase water retention and			
		moisture to slow or stop fire spread			

#### Table A3.1. Potential NBS options in Sierra Leone

NBS options in agriculture offer a pathway for simultaneously addressing productivity, food security, climate, and socioeconomic objectives. When deployed properly, NBS can provide multiple benefits in terms of building agricultural production, enhancing climate resilience and enhancing ecosystem services and biodiversity. Conservation agriculture and agroforestry are two NBS options in the agriculture sector that could support climate priorities established in the NDC and NAP, offering opportunities to build resilience to heat stress, droughts, and floods. These NBS options can also reduce soil erosion and improve water quality and storage. In addition to the climate and environmental benefits, conservation agriculture has the potential to increase crop yields when implemented as a set of integrated practices in rain-fed systems and can result in the reduction of farm operation costs, water savings, and crop yield stability. Agroforestry can create additional income and resources through food, fodder, and other high-value products. In addition, agroforestry systems incorporating a diversity of native tree species represent an option for reconnecting forest fragments and act as buffers around conservation areas.

However, agriculture NBS options are not a 'one-size-fits-all' solution, can be knowledge intensive, and face challenges for their uptake. While transitioning to nature-based agricultural practices can yield significant benefits, the up-front costs and uncertainty associated with adopting new practices can pose a barrier for their adoption. The costs of transitioning to nature-based agricultural practices are immediate, while the benefits can take years to manifest. For poor farmers who face significant resource constraints, it is extremely difficult to take on the added costs and risks of transitioning to a new way of farming. The adoption of conservation agriculture in SSA has been limited, often attributed to the lack of an immediate increase in farm income, and the fact that many smallholder farmers implement mixed crop-livestock farming systems in which crop harvest residues are preferably used as fodder for livestock, preventing their use as soil cover.<sup>3</sup> While Sierra Leone has experience implementing agroforestry systems, these practices can be complex and the outcomes are highly dependent on the specific agroforestry practice and site conditions.<sup>4</sup> Thus, their implementation and scaling up in Sierra Leone will require their adaptation to the local context and farming systems, integrating local knowledge.

Integrating new and existing gray infrastructure with NBS is increasingly recognized as a cost-effective and sustainable approach to overcoming urban resilience and societal challenges while providing multiple cobenefits to urban areas. Incorporating NBS can provide up to 11 percent of total infrastructure investment needs globally and can be up to 50 percent cheaper than traditional infrastructure. This is particularly relevant to least-developed countries (LDCs) with limited fiscal space, such as Sierra Leone. Countryspecific NBS options include (a) urban trees, parks, and urban forests; (b) river floodplains and river and stream renaturation; (c) terracing and slopes; and (d) constructed inland wetlands. In addition to building climate resilience by reducing heat and flood risks, the benefits of these NBS and hybrid approaches include restoring biodiversity, facilitating carbon capture, creating opportunities for recreation, improving air and water quality, and supporting community livelihoods. Sierra Leone's recent experience with implementing urban NBS via the Freetown the Tree Town Campaign, which groups several NBS to address tree cover loss in Freetown and helped build the city's resilience to climate hazards, identified many lessons learned that are transferable to other initiatives. The full array of benefits derived from the first phase of the campaign are expected around 2030, once the planted trees are better established. However, a noticeable reduction in flooding and landslide risk could already be seen only two years into the initiative from planting in the upper catchment areas.

NBS can also help build the climate resilience of Sierra Leone's coastal areas while enhancing ecosystem services and biodiversity benefits to maintain healthy and productive fisheries. As reflected in Sierra Leone's NDC and NAP, coastal NBS are highly regarded for their cost-effective ability to protect shorelines and coastal communities from climate hazards, including sea-level rise storm surges, and erosion. Similarly, coastal NBS such as conservation and restoration of mangrove forests have great potential to

capture and store carbon, as well as prevent saltwater incursion to the benefit of rice farmers. Along with other NBS including coral reef restoration, mangrove forests also support rich biodiversity and high levels of productivity, serving as critical sources to replenish fish stocks and therefore improve local community livelihoods and Sierra Leone's food security.

Nonetheless, urban and coastal NBS in Sierra Leone face significant challenges that require strengthened policies, regulation, financing mechanisms, and management to ensure benefits are maximized. A main challenge to successful implementation of these NBS options relate to land access or land ownership barriers, which is particularly relevant in urban and coastal contexts where available land is scarce. These barriers involve competing land uses (for example, housing development) and engagement and collaboration with multiple landowners and stakeholders, including complex and costly resettlement efforts. Policy interventions and measures related to improving tenure security, spatial planning, cadaster maps and land registry records, and zoning laws, among others, can offer viable solutions, as can establishing protected areas both on land and at sea. Other challenges to NBS implementation and sustainability include startup and maintenance costs, which will require exploring innovative financial mechanisms and multiple revenue sources.

NBS such as reforestation and forest protection offer opportunities for increasing climate resilience while generating multiple co-benefits. Protecting and reforesting forests can help increase climate resilience through improved availability of water for crop irrigation, drought mitigation, avoided sedimentation, flood control, enhanced soil fertility and water regulation for hydroelectric dams. Reforestation can increase the productivity and resilience of land, provide additional opportunities for income generation, and support climate change mitigation efforts in Sierra Leone. As an NBS, reforestation should avoid advancing monocultures or low-diversity plantations that could negatively affect biodiversity. Forest conservation in general is more cost-efficient than afforestation or reforestation, as the opportunity costs of land-use change can be very high and it helps avoid large emissions from existing carbon stock that would happen if deforestation were to occur.<sup>5</sup>

Forest protection, reforestation, and agroforestry can be integrated under a landscape approach for restoration, which will need strengthened policies, defined targets, and financing. The landscape approach can help manage the complex interplay between agricultural land use, forest conservation and rural livelihoods in Sierra Leone. However, restoration efforts will need to be tailored to the specific ecosystem and local populations' needs. Implementation of the landscape approach in Sierra Leone will benefit from policy options that empower communities as key stakeholders, including by addressing tenure security and rights of local communities. It will also benefit from the expansion of the protected area network and the protection of the forest remnants under the jurisdiction of local communities. Up-front and continued long-term investment is essential for the success of restoration initiatives. It is also to establish clear targets and actions. Sierra Leone has already identified and mapped land degradation hotspots under the UNCCD target setting toward land degradation neutrality, which can be used as a basis to enhance restoration efforts under the landscape approach.

Agriculture, forestry, urban, and infrastructure NBS are relevant for the energy sector, particularly in the energy-water-agriculture nexus. Constructed wetlands can be used for both wastewater treatment and bioenergy production. Forest protection, forest restoration, and incorporating trees into croplands can provide benefits to farmers as well as the watershed surrounding a reservoir. In addition, these practices can decrease sedimentation in the reservoir behind the hydroelectric dam, reducing maintenance costs.

### Annex 4. Description of the CC-MFMod model

The CC-MFMod was developed to accommodate the impact of climate change. It was developed as an extension of the MFMod for Pakistan and Jamaica (Burns, Jooste, and Schwerhoff 2021). It draws on the climate literature to introduce emissions and pollution modules and damage functions from higher temperatures, pollution, and flooding on economic activity and includes an adaptation module to analyze the economic benefits of adaptation investments (Figure A4.1). The climate-augmented version provides a vehicle for systematically evaluating climate impacts (tons of carbon emitted, energy transition, economic and health damages from higher temperature and pollution, and so on) as well as the traditional social and economic impacts (growth, fiscal sustainability, inflation, and current account stability) of both climate and non-climate policies. The model can also quantify associated co-benefits from reduced pollution, better health and productivity outcomes, increased temperatures, and rain variability. Efforts in Uganda included mapping aggregate economic activity to natural capital, including estimates of adjusted national savings, which account for resource depletion, the cost of carbon and pollution, and education expenditures.



#### Figure A4.1. Stylized representation of CC-MFMod dynamics

#### Sectoral detail in the model (production side)

An important feature of modeling is the mapping of demand and supply components to value added. Ideally, one would model the factor input choices in each sector, using data on labor, capital, rental rates, and wages at the sectoral level. Time-series data for these variables are not available for most countries. Many macrostructural models neglect this part of the model by either omitting the value-added block entirely or by writing this block as reduced forms, with an identity determining the level of each sector.

Standard MFMod models three sectors of the economy: agriculture, industry, and services. The CC-MFMod disaggregates industry into non-energy industry and energy value added, mapping energy inputs (coal, oil, gas, renewables) into the production and consumption of electricity. Further disaggregation into subsectors would require detailed time-series data at the subsectoral level, which are not available in most countries.

For the CCDR, the team looks at country-specific issues; where data allow it to do so, it disaggregates sectors into subsectors that are critical for the economy (now and in the future) and are significantly affected by climate change and climate change policies or significantly affect the level of emissions. Possible further disaggregation includes subsectors within agriculture which employs more than two-thirds of the labor force in the selected countries. Livestock herding contributes 10–15 percent of GDP in Burkina Faso, Chad, Mali, and Niger, and an even larger share in Mauritania, where half the population is pastoralist

and the vulnerability of pastoral systems to climate change is very high. Fishing is a key livelihood activity, offering one of the least-expensive protein sources to people living in these countries. Both coastal and inland fishing suffer from overfishing and habitat degradation.

#### Climate change components in the CC-MFMod

Potential GDP is the supply potential of the economy; it anchors the real side of the model. It determines how much output can be produced when all the resources in the economy are fully employed (given existing distortions, technology, and preferences). In the CC-MFMod, the standard Cobb-Douglas specification for potential GDP is modified along two main dimensions to accommodate the climate focus of the model. Energy is included as a factor of production (see Hassler, Krussel, and Olovsson 2012), and the production function is modified to account for damages from climate change. The additional climate components in the CC-MFMod include the following:

• A more disaggregated energy sector is integrated into both the production and consumption sides, given the importance of hydrocarbons as a source of GHG emissions and particulate pollution.

• Emissions from different activities and emission reductions policies are included to capture the main channels through which economic activity affects climate outcomes.

• Damage functions are introduced to capture how pollution, flooding, and higher temperatures affect economic activity by reducing working time, labor productivity, and agriculture productivity. Protection functions are introduced to capture how investments to increase the climate resilience of the economy can reduce the damages that might otherwise occur. The response to investments depends on the extent of the investments. Long-run impacts will depend on how they are paid for.

#### Limitations of the CC-MFMod

While the CC-MFMod is a valuable tool for exploring climate-economy links, its projections should be viewed as indicative, not predictive. The CC-MFMod has several limitations for estimating the effects of climate change on the economy:

- Limited sectoral and subsectoral disaggregation: The model's ability to disaggregate sectors—such
  as breaking agriculture into crops, livestock, or fisheries—is constrained by the lack of reliable, timeseries data on key variables such as labor, capital, wages at the sectoral and subsectoral levels. In
  many countries, such granular data are either outdated or missing altogether, which limits the
  model's ability to reflect the structural complexity of the economy.
- Climate uncertainty and limited representation of localized climate impacts: The CC-MFMod captures climate risks through a scenario-based approach, simulating macroeconomic outcomes under a set of plausible climate futures derived from SSP-based projections. While this allows the model to bracket possible trajectories (for example, dry/hot and wet/warm scenarios), it does not incorporate probabilistic uncertainty, such as confidence intervals around projections or variation in shocks. Similarly, while scenario analysis accounts for broad uncertainties in emission trajectories, global climate responses, and technological change, there is no guarantee that any scenario pathway will materialize. This limits its ability to reflect the full range of outcomes, particularly low-probability, high-impact events or tipping points. In addition, the analysis combines percentile-based projections across multiple SSP scenarios (for example, dry/hot and wet/warm composites). While SSPs offer some spatial detail, this granularity is not fully used within the macroeconomic framework. The results reflect averages of temperature and precipitation changes. This approach is useful for capturing broad trends, but it limits the model's ability to account for subnational climate variability and localized risks. As a result, localized vulnerabilities are not fully captured, and priority adaptation needs at subnational levels may be overlooked.

- Missing channels: Of the many potential climate impact channels, the CC-MFMod only considers a select few. For example, the Sierra Leone analysis models only seven. The estimates of GDP impacts are therefore not comprehensive. Some important pathways of climate effects are difficult to model. For example, climate change may affect nutrition and educational attainment, with lifelong consequences for health, learning, productivity, and earnings. Even within a channel, some pathways cannot be captured. Under the hotter and wetter climate scenarios, for example, the livestock yield channel captures the increase in food and water availability but does not reflect the possibility that the prevalence of livestock disease could increase, reducing 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 (such as water), the
  possibility of ecosystem collapse, or the acceleration of climate-induced outmigration. These risks
  are not unlikely, especially after 2050, if global emissions do not drop rapidly. Their realization
  would make total GDP and poverty impacts much larger than estimated in this report.
- Failure to fully capture the positive effect of inclusive development on mitigating the impacts of climate change: The modeling captures only the positive effect of the shrinking of the agriculture sector in the higher-growth scenarios. It does not account for the possibility that higher incomes; better access to infrastructure (such as power for fans, improved water and sanitation, and improved access to healthcare); and financial support (such as access to finance, insurance, and strong social protection) might enable households and firms to reduce the impacts of climate shocks. Higher GDP and income could reduce vulnerabilities in several ways, including through (a) investment in inputs and irrigation, which would allow richer farmers to buffer the negative effects of climate change on agricultural yields; (b) better access to improved water and sanitation, which could reduce the impact of higher temperatures on waterborne disease and diarrhea; and (c) the allocation of more resources for mechanization of agriculture, which could reduce the physical intensity of labor, reducing the impact of higher temperatures on labor productivity. Incorporating these effects would reduce the impact on GDP losses.

#### Detailed Estimates from Sierra Leone CC-MFMod model

#### Business-as-usual growth scenario

No Adaptation Investments					-	BASELIN	E					
		Base	line		Co	mbined \	Wet/Wa	m	Co	mbined	Hot/Dry	/
	2020	2030	2040	2050	2020	2030	2040	2050	2020	2030	2040	2050
					Devi	ation fro	om Base	line	Devi	ation fro	m Base	line
						(Perc	ent)*			(Perce	ent)*	
Services	44.7	26.3	36.0	38.3	0.0	0.4	1.8	3.6	0.0	1.4	1.8	2.3
External balance (% of nominal GDP)												
Current Account Balance	-5.1	-23.5	-25.5	-24.1	0.0	0.3	0.9	1.7	0.0	0.6	1.3	1.7
Net Exports of Goods & Non-Factor Services	-11.8	-21.3	-26.9	-24.5	0.0	0.3	0.9	1.7	0.0	0.6	1.3	1.7
Net Primary & Secondary Incomes	6.7	-2.1	1.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fiscal Aggregates (% of nominal GDP)												
Fiscal revenue	10.4	11.5	11.6	11.5	0.0	0.0	-0.1	-0.1	0.0	0.0	-0.1	-0.1
Fiscal expenditure	15.3	16.7	15.1	14.8	0.0	0.0	0.1	0.2	0.0	0.1	0.1	0.2
<ul> <li>o/w Interest payments</li> </ul>	2.3	2.4	1.7	1.4	0.0	0.0	0.1	0.1	0.0	0.1	0.1	0.1
Budget deficit	-4.9	-5.2	-3.5	-3.3	0.0	-0.1	-0.2	-0.3	0.0	-0.1	-0.2	-0.3
Public debt	46.2	34.1	26.3	22.1	0.0	0.4	1.0	1.7	0.0	0.8	1.4	1.8
- o/w External Public Debt	32.3	23.3	18.3	15.5	0.0	0.3	0.7	1.2	0.0	0.6	1.0	1.3
Emissions												
Emissions (Mtons GHG)	0.0	0.0	0.0	0.0	0.0	-0.7	-2.4	-5.2	0.0	-1.8	-3.3	-4.9
Emissions per unit of ouput (tons GHG)	0.0	0.0	0.0	0.0	0.0	1.4	3.0	4.8	0.0	2.5	4.1	5.4
Impact Channels (% of real GDP)					0.0	-2.0	-5.4	-9.8	0.0	-4.3	-7.3	-10.1
o/w Labor Heat Stress					0.0	-1.2	-2.1	-3.2	0.0	-2.0	-3.5	-4.8
o/w Crop Production (Rainfed)					0.0	-0.3	-1.1	-2.4	0.0	-1.5	-2.7	-3.8
o/w Roads and Bridges					0.0	0.0	0.0	-0.2	0.0	-0.1	-0.1	-0.1
o/w Crop Production (Erosion)					0.0	-0.2	-1.1	-2.3	0.0	-0.3	0.1	0.4
o/w Human Health					0.0	-0.2	-0.3	-0.5	0.0	-0.2	-0.4	-0.5
o/w Sea-level Rising and Coastal Flooding					0.0	-0.1	-0.4	-0.8	0.0	-0.1	-0.4	-0.8
o/w Urban Flooding					0.0	-0.1	-0.3	-0.5	0.0	-0.1	-0.3	-0.6
o/w Placeholder					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

### Ambitious growth scenario

No Adaptation Investments					A	MBITIOU	IS					
		Base	line		Cor	mbined \	Net/Wa	rm	C	ombined	Hot/Dr	y
	2020	2030	2040	2050	2020	2030	2040	2050	2020	2030	2040	2050
					Devia	ation fro	om Base	eline	Devi	ation fro	om Base	eline
						(Perce	ent)*			(Perc	ent)*	
Services	44.7	25.9	34.9	37.6	0.0	0.4	1.8	3.6	0.0	1.4	1.8	2.3
External balance (% of nominal GDP)												
Current Account Balance	-5.1	-36.2	-52.2	-63.6	0.0	0.2	0.8	1.6	0.0	0.6	1.2	1.6
Net Exports of Goods & Non-Factor Services	-11.8	-34.0	-52.8	-63.0	0.0	0.2	0.8	1.6	0.0	0.5	1.2	1.6
Net Primary & Secondary Incomes	6.7	-2.2	0.6	-0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fiscal Aggregates (% of nominal GDP)												
Fiscal revenue	10.4	11.7	12.4	12.7	0.0	0.0	-0.1	-0.1	0.0	0.0	-0.1	-0.1
Fiscal expenditure	15.3	20.4	21.7	24.1	0.0	0.0	0.2	0.5	0.0	0.1	0.2	0.5
- o/w Interest payments	2.3	2.8	3.0	3.5	0.0	0.0	0.1	0.2	0.0	0.1	0.1	0.2
Budget deficit	-4.9	-8.7	-9.4	-11.4	0.0	-0.1	-0.2	-0.6	0.0	-0.1	-0.3	-0.6
Public debt	46.2	42.3	51.1	59.8	0.0	0.2	1.2	3.0	0.0	0.7	1.7	3.1
- o/w External Public Debt	32.3	29.1	35.7	41.8	0.0	0.2	0.8	2.1	0.0	0.5	1.2	2.1
Emissions												
Emissions (Mtons GHG)	0.0	0.0	0.0	0.0	0.0	-0.5	-2.2	-5.1	0.0	-1.6	-3.1	-4.7
Emissions per unit of ouput (tons GHG)	0.0	0.0	0.0	0.0	0.0	0.8	1.9	3.0	0.0	2.0	2.8	3.4
Impact Channels (% of real GDP)					0.0	-2.1	-5.3	-9.5	0.0	-4.4	-7.2	-9.6
o/w Labor Heat Stress					0.0	-1.3	-2.1	-3.1	0.0	-2.0	-3.5	-4.7
o/w Crop Production (Rainfed)					0.0	-0.3	-1.2	-2.4	0.0	-1.6	-2.7	-3.7
o/w Roads and Bridges					0.0	0.0	-0.1	-0.2	0.0	-0.1	-0.1	-0.1
o/w Crop Production (Erosion)					0.0	-0.2	-1.1	-2.3	0.0	-0.3	0.1	0.4
o/w Human Health					0.0	-0.2	-0.3	-0.5	0.0	-0.2	-0.4	-0.5
o/w Sea-level Rising and Coastal Flooding					0.0	-0.1	-0.3	-0.6	0.0	-0.1	-0.3	-0.6
o/w Urban Flooding					0.0	-0.1	-0.3	-0.4	0.0	-0.1	-0.3	-0.4
o/w Placeholder					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Impact - no adaptation





Baseline

Ambitious

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3.0

2.5

2.0

1.5

1.0

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L

Baseline

Ambitious

L



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