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COUNTRY CLIMATE AND DEVELOPMENT REPORT



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Executive Summary

Global climate change poses an existential threat to peace and prosperity in Liberia. As the oldest republic in Africa, Liberia has navigated a treacherous path to stability, weathering civil conflict, economic volatility, and health emergencies. But unlike past trials, the climate crisis cannot be relegated to one chapter of Liberia's development story. The effects of a warming climate are slow building and chronic. Hotter days will gradually evolve into extreme seasons and years. Erratic rainfall patterns will intensify into more frequent and catastrophic floods. The consequences will not be confined to environmental degradation but will permeate the economy and the well-being of Liberia's people.

Many factors leave Liberia particularly vulnerable to climate change. Its economy is highly dependent on its natural wealth, its fiscal space is limited, its infrastructure and services are inadequate, and its human development outcomes are among the lowest in the world. Farmers often use inefficient technologies that are vulnerable to weather and lack access to credit, good-quality seeds, and other inputs and markets, making agricultural productivity low and food insecurity high. Half of the population lives below the national poverty line, and over a quarter lives below the international poverty line of US\$2.15 per day. Just 28 percent of the population has access to electricity, transport connectivity is low, and access to water and sanitation services is limited, with a quarter of the population without basic drinking water services and nearly 40 percent practicing open defecation.

This Country Climate and Development Report (CCDR) examines Liberia's development trajectory through the lens of the country's vulnerability to climate change. It identifies Liberia's development risks and opportunities, models various scenarios of climate impact and intervention, and proposes ways to strengthen resilience and finance climate actions that support Liberia's development aspirations of inclusive growth and poverty reduction.

Though Liberia is among the lowest emitters of greenhouse gases (GHGs) responsible for global climate change, it has low readiness to adapt to its effects. This paradox frames the subsequent analysis, and many of the climate actions recommended in this report are responsive to adaptation needs rather than mitigation.

For instance, rice, a main staple in Liberia, is extremely reactive to higher humidity, extreme temperatures, heavy rainfall, and the pests that flourish under these conditions. The CCDR finds that Liberia's rain-fed rice production could be reduced by up to 13 percent over 2041–2050 from climate change compared to the baseline scenario. The resultant decrease in income and heightened reliance on costly imports could exacerbate poverty and food insecurity for many Liberian households.

The number of preventable deaths could also increase. For example, malaria and diarrheal diseases—the top two causes of mortality for over two decades in Liberia—are acutely sensitive to climate. While there has been progress in improving health outcomes, most Liberians still lack the basic infrastructure—comprehensive water and sanitation services, solid waste management, drainage networks, and strong housing structures—that would protect them from escalating exposure to environmental hazards. Climate change will exacerbate the range of health issues, including infectious disease, undernutrition, and noncommunicable diseases. If Liberians do become sick, many will struggle to access health care. In rural areas, health facilities are scarce, and roads are mostly unpaved and in rough condition. Flash floods (which are expected to increase with climate change) are known to inundate and destroy routes to essential health services.

Liberia's forests, which cover over two-thirds of the country's landscapes and serve as a significant global carbon sink, are also at the crux of climate and development risks. The annual rate of tree cover removal has steadily increased since the end of the second civil war. Logging, mining, and agriculture have formally and informally claimed new areas. Rapid urbanization has also contributed to changing land use and led to haphazard spatial planning, proliferating informal settlements and assets that are highly exposed to climate hazards. Climate change is expected to reduce the availability of natural resources and biodiversity by restricting access to forests during extreme weather events, introducing new pests and diseases, reducing tree growth and biomass, and eroding soil quality. These effects are dangerous in a country in which a large share of households depend on forests and natural wealth to meet their basic needs and where ecosystem services are integral to climate resilience.

If nothing is done, climate change could shrink Liberia's economy by 15 percent and push 1.3 million people into poverty by 2050. Implementing just a few adaptation interventions could boost agricultural productivity and enhance climate resilience of almost 800,000 people.

The CCDR attempts to quantify a few of these impacts on gross domestic product (GDP) and poverty under two climate condition scenarios (wet/warm and dry/hot) and two economic growth scenarios (medium and high). The wet/warm scenario is optimistic and projects small precipitation changes and moderate temperature increases from climate change. The dry/hot is pessimistic and projects large precipitation changes and much higher temperatures. The medium-growth scenario is based on recent growth performance. Under it, Liberia achieves middle-income status by 2040. The high-growth scenario is aspirational. Under it, Liberia reaches middle-income status by 2034.

Under both growth scenarios, dry/hot climate conditions could reduce Liberia's potential GDP by up to 6 percent as early as 2030 and by 15 percent by 2050 compared with the baseline growth. The decline would push into poverty an additional 5 percent of the population (300,000 people) by 2030 and an additional 15 percent (1.3 million people) by 2050. The deviation in GDP from the baseline is lower in the optimistic wet/warm scenario, but it could still reduce by 11 percent in 2050.

The damages are based on estimates of loss of labor productivity from heat stress and poor health, lower crop yields from the shift in climate and soil erosion, and the increased costs of repair and renewal of capital caused by flooding. While these figures provide a glimpse into the potential economic and poverty repercussions, they are based on a few impact channels and likely underestimate the true costs of climate change. Some effects are intangible or difficult to measure.


However, even a few adaptation interventions could boost agriculture productivity and reduce climate-induced losses from 15 percent of GDP to 7 percent by 2050 under the pessimistic climate scenario, regardless of the growth trajectory. These measures would enhance the climate resilience of 800,000 people. The adaptation interventions examined (based on data availability) narrowly target heat stress, crop erosion, rain-fed crop production, and coastal flooding. These possible interventions are not meant to be prescriptive but offer perspective on the transformative impact of strategic adaptation.

Priority climate actions will need to respond to essential infrastructure needs, human development promotion, sustainable land management, and climate risk and readiness.

The report proposes four themes of climate actions (Table ES.1). Most of the actions respond to adaptation needs (scaling protective infrastructure, preparing the health system, adopting climate-smart agriculture practices, prioritizing forestry communities, promoting strategic land use planning, and improving disaster risk response); many can also facilitate mitigation and low-carbon pathways (decarbonizing the energy

sector, realizing carbon market potential, investing in education, and improving the governance of traditional growth sectors).

Table ES.1. Priority climate actions for Liberia

Theme	Policy shift	Actions
01 CLIMATE RISKS AND READINESS 	Shift toward a policy framework that integrates climate finance, risk, and coordination	Prepare climate finance policy framework to facilitate readiness for climate finance and mainstream climate considerations within development planning and budgeting processes. Improve climate risk assessment, early warning, emergency preparedness, and disaster response systems. Protect carbon sinks and ecosystem services while ensuring shared benefits through the carbon market.
02 ESSENTIAL INFRASTRUCTURE 	Shift toward upgrading and scaling infrastructure with climate risks and opportunities in mind	Scale up electrification and decarbonize the power sector. Increase the resiliency and sustainability of transport networks to climate risks. Scale up safe and reliable water and sanitation services and solid waste management practices. Promote sustainable land use in cities, ensuring settlements and assets consider climate risks and hazards.
03 HUMAN DEVELOPMENT PROMOTION 	Shift toward investments in human capital to increase social resilience and reduce dependency on natural wealth	Reduce the burden of disease from climate-sensitive health risks. Reduce disruptions in educational attainment from climate shocks and hazards and develop green skills.
04 SUSTAINABLE LANDSCAPE MANAGEMENT 	Shift toward sustainable land use across sectors, emphasizing community benefits from natural capital	Prioritize forestry communities through sustainable forestry management. Improve governance and regulation of mining activities. Promote climate-smart agriculture innovations and irrigation to increase yield while restoring land and managing land, energy, water use.

Climate risks and readiness. It is critical that there is a policy shift toward an integrated approach that encompasses climate finance, readiness, and coordination. Given Liberia’s vast natural capital, the potential for carbon markets and benefit sharing of climate financing is immense. Liberia is likely to face a growing threat from climate disasters such as floods, windstorms, and heat waves. However, the country lacks detailed data on these disasters, which hampers effective risk assessment. Efforts to improve monitoring, forecasting, and early warning are progressing but need support, particularly in meteorological and hydrological services. Investment in early warning systems could yield significant returns, but current limitations include the lack of digitization, power supply, and the availability of qualified administrators. Coordination across various agencies and a focus on community-level response plans are essential. There is also a need for a digital land information system to manage data on land boundaries, ownership, use, and value, which could help in preventing and preparing for climate shocks. The current practice of funding response to disasters is unsustainable, and a more comprehensive approach involving a risk-layering strategy is required. This could include developing a disaster contingency fund based on a detailed risk financing diagnostic and considering various instruments such as sovereign disaster risk financing (DRF),

insurance strategies, and possibly contingent credit instruments. To better prepare itself to participate in carbon markets, the country can focus on improving its implementation of frameworks such as Reducing Emissions from Deforestation and Forest Degradation (REDD+). Not only does REDD+ align with the need for better land use planning, it also offers Liberia the opportunity to attract investments and unlock revenue. Finally, Liberia should design the architecture for a comprehensive climate finance framework that enables transparent and efficient receipt and allocation of climate funds and builds off past efforts such as REDD+.

Essential infrastructure needs. Liberia has key opportunities to invest in climate-resilient infrastructure. In growing city centers, this could mean a policy shift in urban planning, ensuring that homes and other assets are built with climate risks in mind. Informal settlements need to be upgraded, sustainable land use planning promoted, reliable water and sanitation services and solid waste management scaled up, and investment in drainage and flood protection systems made to safeguard vulnerable populations from heavy rainfall and flooding from storm surges. The transport sector can also focus on increasing the resilience and financing of operations and maintenance (O&M) of unpaved roads and explore public-private partnerships in low-carbon mass transit. Meeting the energy demand is central to infrastructure needs. Fortunately, Liberia can do this sustainably because the no-thermal pathways the government has chosen are already low emission. Efforts can prioritize improving regional power trade, optimizing renewable energy sources such as hydropower and solar PV and storage, modernizing the power network (through smart grids and digitalization) and soft infrastructure (grid codes, demand response regulation), and implementing a clean cooking agenda. These measures will support the scale-up of electrification, mitigation targets, and/or the rollout of adaptive infrastructure including digitalization for improved connectivity and coordination.

Human development promotion. With one of the youngest and fastest-growing populations in Africa, Liberia stands at a pivotal juncture where targeted investment in human development could significantly reduce its dependency on natural wealth and reduce vulnerability to climate change. Strong human capital, which encompasses the knowledge, skills, and health of individuals, can nurture a generation that is better equipped to innovate and respond to climate risks. Liberia's human capital accounts for 42 percent of its total wealth. Yet, per capita, it is valued at US\$5,000, significantly lower than the world average (US\$101,00) and many countries in the region. Further, children born today in Liberia are projected to be only 32 percent as productive as adults as they would have been if they had complete education and good health, which could stand to lower in light of climate effects. Interventions for addressing climate-sensitive diseases will need to improve coordination between central and local agencies and resolve key bottlenecks in health systems. Efforts to strengthen capacities and improve service delivery, particularly at the periphery and in community health care systems, should be accompanied by targeted, concerted improvements in infrastructure (including roads leading to health facilities, emergency operation centers (EOCs), laboratories, and water and sanitation in health facilities). Initial steps in the education sector could include strengthening education information systems and assessing climate risks, fortifying school infrastructure, and integrating climate literacy and green skills into curricula.

Sustainable landscape management. Liberia's forestry, mining, and agriculture sectors face intertwined challenges and opportunities in sustainable land management. The forestry sector struggles with balancing commercial, conservation, and community interests, while the mining sector grapples with unchecked land degradation and environmental issues. Agriculture is marred by unsustainable land use practices, low yields, and climate vulnerabilities. The country must therefore strengthen its ability to regulate and manage land use, with emphasis on ensuring community benefits from its natural capital. The government needs to improve its monitoring and enforcement mechanisms to curb illegal logging, protect Liberia's forests, and ensure that communities are resilient from forestry changes. Strategies to enhance agricultural productivity should be developed to mitigate climate impacts on food security. Examples include climate-

smart agriculture practices, improved irrigation systems, and better water and energy management, and investment in low-carbon infrastructure must support the value chains of production, collection, transport, and storage of agricultural products for local and export markets. Addressing constraints like the lack of land ownership data and the weak capacity of the Liberia Land Authority (LLA) to regulate land use and manage conflicts is also imperative. These initiatives aim to foster resilience and promote sustainable land management across all sectors, ensuring a balanced approach that protects Liberia's rich natural resources while supporting low-carbon growth.

Inadequate access to finance is a key barrier to meeting Liberia's climate and development goals. While concessional finance will be essential, deepening the domestic capital market offers a way to diversify financing mechanisms and attract foreign investments. However, the investment challenge will require building institutional capacity across the government and developing an enabling environment that can unlock (private) finance.

Annual climate finance commitments to Liberia averaged US\$112 million in 2019/20, most of it in the form of grants and low-cost project debt. Liberia projects that full implementation of its proposed climate actions under its Nationally Determined Contributions (NDCs) would cost US\$491 million through 2025 alone. This figure is likely an underestimate, given that many of the actions in the NDC lean toward mitigation (82 percent of the proposed financing) over adaptation. Even the limited adaptation interventions modeled in this CCDR are estimated to cost 2–3 percent of GDP a year through 2050. The benefits (equivalent to 3.7 percent of GDP a year) exceed the costs, however.

Liberia's limited borrowing capacity, fiscal resources, and institutional constraints make mobilizing climate finance difficult. Adaptation investments require different mechanisms, incentives, and actors than mitigation financing, because adaptation benefits tend to be difficult to monetize, have high transaction costs, and generally involve local public goods. Concessional finance will therefore continue to play an important role in supporting Liberia's climate actions in the short term. The investment challenge will also require building institutional capacity across the government and developing innovative approaches to unlock private finance, including from the carbon market, for adaptation, resilience, and infrastructure projects. On mitigation actions, crowding in private sector financing may seem more likely, but public resources are still required to de-risk projects, provide concessional credit, and act as a backstop against shocks to attract private financing. Liberia can design an enabling environment for both national and foreign private investments, while ensuring that all citizens and particularly vulnerable populations will benefit from them.

The private sector must not only finance but take a leading role in bringing in innovative climate solutions in production processes and services delivery.

Private sector investment in climate-smart solutions is crucial to advancing linked development and climate goals. Specifically, the private sector can take the lead in areas such as engaging with farmers to implement climate-smart agricultural technologies and investing in renewable energy sources, including untapped solar and hydropower potentials. These initiatives have the dual benefit of reducing energy costs for both businesses and households. Additionally, the private sector can play an active role in promoting cleaner cooking methods and adopting a circular economy for waste recycling. Crucial to this are public-private partnerships that can offer innovative solutions in transport, like a shared Arcelor railway, which could expedite market access for mining and agricultural products. Such partnerships could also focus on the development of high-speed intercity rail systems and sustainable urban infrastructure. The financial sector can also lead the way in promoting green lending to accelerate the shift toward sustainable production processes.

Climate change poses complex challenges in Liberia, but there is room for optimism. Climate action can play a leading role in Liberia's development story.

Many climate actions overlap with goals of reducing poverty and pursuing inclusive growth. Investment in climate-resilient infrastructure, renewable energy sources, and human development can improve resource efficiency, enhance energy security and electrification, and create greener job opportunities for a higher-skilled workforce. By promoting sustainable practices within its traditional growth sectors, such as agriculture, forestry, and mining, Liberia can uphold its rich biodiversity and natural capital while meeting global demands for mitigation opportunities. Climate action can serve as a catalyst for transformative and inclusive development, paving the way for a brighter, more resilient future for Liberia and its people.

Abbreviations

ASM	Artisanal Small-Scale Mining
BESS	Battery Energy Storage System
CARI	Central Agricultural Research Institute
CBL	Central Bank of Liberia
CBO	Community-Based Organization
CCDR	Country Climate and Development Report
CCKP	Climate Change Knowledge Portal
CCKSP	Climate Change Knowledge Sharing Platform of Liberia
CC-MFMod	Climate Change Macro-Fiscal Model
CGS	Credit Guarantee Scheme
CHA	Community Health Assistant
CHSS	Community Health Services Supervisor
CIF	Climate Investment Funds
CMIP6	Coupled Model Inter-Comparison Project Phase 6
DALYs	Disability-Adjusted Life Year
DNA	Designated National Authority
DRF	Disaster Risk Financing
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EKMS	Environmental Knowledge Management System
EOC	Emergency Operation Center
EPA	Environmental Protection Agency
EPML	Environmental Protection and Management Law
ESG	Environmental, Social, and Governance
ESMAP	Energy Sector Management Assistance Program
EU	European Union
EVD	Ebola Virus Disease
FAO	Food and Agriculture Organization
FDA	Forestry Development Authority
FLEGT	Forest Law Enforcement, Governance, and Trade
FTS	Financial Tracking Service
GCF	Green Climate Fund
GCM	General Circulation Model
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GII	Gender Inequality Index
HCI	Human Capital Index
HDI	Human Development Index
HFO	Heavy Fuel Oil
HSSP	Health Systems Strengthening Project
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
IEc	Industrial Economics, Incorporated
IFC	International Finance Corporation
IFISH	Institutional Foundations to Improve Services for Health
IPC	Infection Prevention and Control
IPCC	Intergovernmental Panel on Climate Change
LBDI	Liberian Bank for Development and Investment
LCAA	Liberia Civil Aviation Authority
LHS	Liberia Hydrological Services
LISGIS	Liberia Institute of Statistics and Geo-Information Services

LLA	Liberia Land Authority
LMS	Liberia Meteorological Services
LRA	Liberia Revenue Authority
LUCF	Land Use Change and Forestry
LULUCF	Land Use, Land Use Change, and Forestry
LWSC	Liberia Water and Sewer Corporation
MDA	Mineral Development Agreement
MDGs	Millennium Development Goals
MFDP	Ministry of Finance and Development Planning
MIGA	Multilateral Investment Guarantee Agency
MME	Ministry of Mines and Energy
MoPW	Ministry of Public Works
MoT	Ministry of Transport
MRV	Monitoring, Reporting, and Verification
MSMEs	Micro, Small, and Medium Enterprises
NAP	National Adaptation Plan
NAPA	National Adaptation Program of Action
NAPHS	National Action Plan for Health Security
NCCSC	National Climate Change Steering Committee
NDC	Nationally Determined Contribution
NDMA	National Disaster Management Agency
NEP	National Energy Policy
NEWEOC	National Early Warning and Emergency Operations Center
NGO	Nongovernmental Organization
NPA	National Port Authority
NPHIL	National Public Health Institute of Liberia
NPL	Nonperforming Loan
NTA	National Transit Authority
NWSHC	National Water Sanitation and Hygiene
O&M	Operations and Maintenance
PAPD	Poor Agenda for Prosperity and Development
PCGS	Public Credit Guarantee Scheme
PPR	Prevention, Preparedness, and Response
RCP	Representative Concentration Pathway
RDT	Rapid Diagnostic Test
REDD	Reducing Emissions from Deforestation and Forest Degradation
REDISSE	Regional Disease Surveillance Systems Enhancement
RSDP	Road Sector Development Plan
RST	Resilience and Sustainability Trust
SDG	Sustainable Development Goal
SFM	Sustainable Forest Management
SMEs	Small and Medium Enterprises
SSP	Shared Socio-Economic Pathway
TFP	Total Factor Productivity
TVET	Technical and Vocational Education and Training
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WAPP	West African Power Pool
WASH	Water, Sanitation, and Hygiene
WHO	World Health Organization
WIS	World Information Systems
WMO	World Meteorological Organization

1. Development and Climate Context

Key Points

- Liberia faces enormous development challenges, including an economy that is largely dependent on its natural wealth, limited fiscal space, failing infrastructure and services, and some of the worst human development outcomes in the world. It is still recovering from civil wars, multiple health emergencies, and other external shocks, which have compounded poverty and slowed progress toward social and economic development.
- Liberia is projected to experience increased temperatures, more unpredictable rainfall, and more frequent natural disasters and hazards, such as floods, heat waves, and disease outbreaks, which will exacerbate and reinforce cycles of poverty and instability. The country's development challenges leave it highly vulnerable to the effects of these changes.
- Liberia is one of the world's lowest emitters of greenhouse gases. As it develops, it will need to focus on adaptation measures and sustainably manage its rich landscapes and establish low-carbon development pathways in its leading growth sectors, such as forestry, agriculture, mining, and energy.

This chapter summarizes Liberia's development challenges and identifies the risks to development that climate change poses. It (a) describes Liberia's national vision and development context, (b) outlines potential risks and opportunities from climate change and natural hazards by reporting projected climatology and impacts, and (c) examines Liberia's current emissions levels and the risks and opportunities for investment on a low-carbon growth path.

1.1 Liberia's Development Context

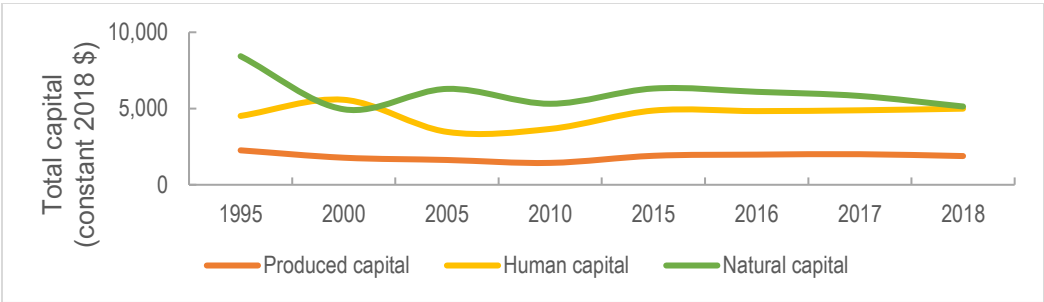
Liberia is a low-income country seeking to build a stable and inclusive environment that embraces its unique national identity, while ensuring all Liberians have access to basic needs and opportunities to thrive. Founded in 1847, Liberia is the oldest republic in Africa. The population is estimated at 5.2 million in 2022, growing at a rate of 3 percent (World Bank 2023c). The country cycled through instability and civil conflicts rooted in political and economic inequality. With a small minority of Americo-Liberians and the 16 indigenous ethnic groups who represent 90 percent of the population, Liberia is still building its national identity, and for many Liberians ethnic loyalties outweigh the bonds of common citizenship, even after 175 years (World Bank 2018). In 2018, the inauguration of the current administration marked the first fully democratic and peaceful transition of power in 73 years. The administration adopts a rights-based approach to development and aspires to forge a national identity that unites Liberians and strengthens the country's competitive advantages and relationships with the rest of Africa. The government also aims to lift 1 million Liberians out of absolute poverty, reduce poverty rates by 23 percent across five of six regions in the coming years, and achieve middle-income status by 2030 (MPDF 2018; Republic of Liberia 2012).

Liberia has a rich endowment of natural resources and enough fertile land to drive economic growth, but its undiversified economy, untapped human capital, pervasive poverty, deficiencies in infrastructure and basic services, and the thwarted potential of its private sector amid weak public institutions are binding constraints to building resiliency and achieving the country's national vision. Since the end of its second civil war, in 2003, Liberia experienced repeated shocks in a relatively short period, including devastating

Ebola virus outbreaks, collapsing prices for ore and rubber, rising prices for imported food, the departure of United Nations (UN) peacekeeping forces, and the COVID-19 pandemic. These events likely caused the economy to shrink: annual growth declined by an average of 0.4 percent between 2014 and 2020, and gross domestic product (GDP) per capita fell by a cumulative 12.3 percent (World Bank 2022). In 2021, real exports of goods and services increased by 14.7 percent, reflecting a post-COVID-19 pickup in external demand for Liberia’s main natural resources (World Bank 2023c).and private investments grew by 8.8 percent. The uptick supported a modest economic recovery, with projected real GDP growth of 5 percent in 2023 (2.9 percent in per capita terms) following a decline of 3 percent in 2020. The economy is projected to grow at an average annual rate of 5 percent in the medium term, supported by soaring demand for and strong world prices of Liberia’s main exports and a return to pre-pandemic activities, particularly in mining and agriculture (World Bank 2022). Yet, macroeconomic stabilization will remain a challenge with elevated public debt-to-GDP ratio, widening fiscal and current account deficits. Meanwhile, with tightening financing conditions, private investments are projected to shrink over the medium term.

Liberia’s high dependency on its natural wealth and low human capital create an unstable foundation for its economic prospects. Historically, Liberia’s wealth was derived primarily from its natural wealth (Figure 1.1). Liberia produces ore, rubber, gold, timber, palm oil, cocoa, rice, and other crops. The share of natural capital contributing to Liberia’s overall wealth has steadily decreased, however, dropping from 70 percent in 2004 to 43 percent in 2018 (World Bank 2021a) because of the decline in the productivity of cropland and, more recently, the dip in the value of metals and minerals as a result of the global decline in commodity prices between 2014 and 2018 (World Bank 2022). Liberia’s weak human capital prevents it from converting its natural resources into other forms of wealth (MFDP 2018; World Bank 2021a, 2022). Private companies have focused primarily on high-technology mining, investments in which have created few jobs for Liberia’s abundant low-skilled workforce (MFDP 2018). Private investment has also been limited partly by the fragile features of the country and its low capacity for implementing reforms, and also by the acute constraints to access to finance. Domestic credit to the private sector represented 14.3 percent of GDP in 2019, before COVID, and declined to 14 percent in 2020, compared to Sub-Saharan African average of 40 percent of GDP in 2019 and 37.3 percent in 2020.

Figure 1.1. Per capita produced, human, and natural capital in Liberia, 1995–2018

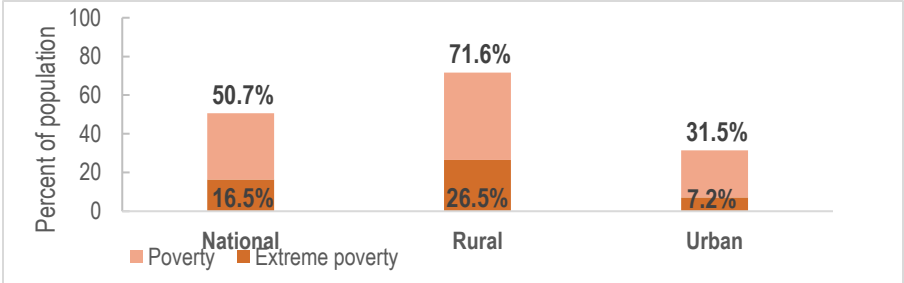


Source: Based on data in World Bank 2021a.
 Note: Produced capital is the productivity from investments in assets such as manufacturing, infrastructure, and services. Human capital is the present value of future earnings over a person’s lifetime. Natural capital is the value of agriculture and renewable and nonrenewable natural resources.

Poverty reduction in Liberia has been uneven and tied to multiple crises and economic performance. According to the 2016 national poverty assessment (the most recent data available), half of the population was living below the national poverty line and over a quarter was living below the international poverty line of US\$2.15 per day (in 2017 purchasing power parity dollars) (LISGIS 2017) (figure 1.2). The Gini index is 0.35 (World Bank 2023c), indicating moderate inequality. National poverty rates reached as high as 61

percent in the first half of 2016, when the Ebola crisis occurred and global commodity prices fell (World Bank 2018). The COVID-19 pandemic was projected to exacerbate poverty by lowering living standards, decreasing GDP, and increasing unemployment in nonagricultural and urban areas (World Bank 2022).

Figure 1.2. Share of Liberia’s national, rural, and urban population living below the national poverty line in 2016



Source: 2016–17 Liberia Household Income and Expenditure Survey.

Rural areas have the highest levels of poverty and food insecurity; they also have limited growth opportunities and services due to weak extents of infrastructures and enabling factors. The vast majority of Liberia’s poor live in large rural households and are self-employed in rudimentary agriculture. Food poverty is high, particularly in remote areas, where access to markets is limited due to poor road conditions and the price of basic staples is often highest. Many farming communities struggle to produce enough food to meet their own dietary needs, with the poorest households able to supply only 35 percent of household food requirements (World Bank 2018). Farmers use inefficient farming technologies that are vulnerable to weather, often rain-fed and on a small scale. Lack of access to credit, good-quality seeds and other inputs, skills, and markets make it difficult for them to raise their incomes. The remoteness of those areas makes it even harder for businesses to expand, limiting quality employment creation for the people.

A growing urban population and a large youth cohort are straining infrastructure and the labor market. Liberia experienced a large migration of people to urban areas during the civil war. After the war ended, few urban migrants returned to rural areas, where poverty is higher and nonagricultural job opportunities are scarce (Republic of Liberia 2012). More than half of Liberia’s population now lives in urban areas, with 20 percent residing in Greater Monrovia. Although urban areas have lower poverty rates, inequality in towns and cities is higher than in rural areas. An increasing number of urban households live in poverty and lack access to the services usually associated with urban areas. Employment growth in nonagricultural sectors is among the slowest in Sub-Saharan Africa. Higher-skilled workers and younger urbanites are finding it increasingly challenging to secure productive jobs in the labor market, a trend that was especially apparent at the start of the COVID-19 pandemic (World Bank 2022). Unemployment is higher in urban areas than in rural areas (43 percent among urban women versus 33 percent among rural women and 24 percent among urban men versus 12 percent among rural men) (LISGIS, MOHL, and ICF International 2021). Under-employment is also prevalent in the country.

Other nonmonetary poverty indicators, such as access to infrastructure and basic services, are weak across the country. Transport networks are rough in quality and poorly developed outside of Monrovia and reach about 73 percent of the total population (World Bank 2018). Just 30 percent of the total population has access to electricity (8 percent access in rural areas and 45 percent in urban areas) (World Bank 2023c). Schools and other public buildings are dilapidated, housing is poor, and access to water and sanitation services is limited, with a quarter of the population lacking basic drinking water services and nearly 40 percent practicing open defecation (WHO and UNICEF 2022). The lack of basic infrastructures and services,

such as reliable and affordable electricity and digital services, constitutes a barrier to businesses and prevents the emergence of a buoyant private sector that would innovate to generate jobs and income.

Liberia ranked 177 out of 188 countries on the Human Development Index (HDI) and 164 on the Gender Inequality Index (GII) in 2021. At least 7 percent of children born in 2021 in Liberia will not survive past their fifth birthday, placing the country in the lowest quartile of the global distribution (World Bank 2021c). Adolescents and adults also exhibit poor survival rates in Liberia compared with other low-income countries. Children entering school can expect to complete only 4.2 years of schooling by the time they turn 18—and this figure is just 2.2 years after adjusting for the quality of learning (World Bank 2021c). These statistics vary widely by gender and region. Women have poorer health and education outcomes and lower voice and participation in government and the labor market than men, particularly in rural areas (UNDP 2021).

Liberia's fiscal space is severely constrained, making prioritization essential for achieving its development goals and suggesting the critical need for the private sector to play a pivotal role in providing innovative solutions for a sustainable and inclusive growth. The country's limited fiscal capacity can be attributed to several factors, including inadequate domestic revenue mobilization, characterized by a tax-to-GDP ratio below 13 percent and unstable nontax revenue from the natural resource sector, which accounted for only 3 percent of GDP in 2022. Additionally, there has been a sharp decline in grants, with a drop from 18.3 percent of GDP in 2016 to 7.8 percent in 2022, along with large, nondiscretionary expenditures such as a wage bill that consumes half of the domestic resources and increasing debt service payments. Liberia also faces restricted borrowing capacity due to a moderate risk of external debt distress and a high risk of public debt distress, with public and publicly guaranteed debt reaching 55.4 percent of GDP in 2022. The government is tasked with managing external aid inflows and revenues from concessions, and this calls for effectively prioritizing reforms that target physical and human capital development, strengthen institutional foundations, and foster a conducive business environment to attract domestic and foreign investments in the country's potential sectors.

1.2 Risks and Development Opportunities from Climate Change and Natural Hazards

Global climate change has the potential to cause significant physical changes in Liberia's environment that could perpetuate poverty and stunt the country's growth. The West African region is projected to be one of the regions most affected by climate change (IPCC 2022). Liberia is likely to experience hotter temperatures, changes in precipitation patterns, rising sea levels and coastal erosion, and more frequent natural disasters and hazards. This section discusses the potential effects of climate change and opportunities for adaptation. (Chapter 4 describes specific sectoral priorities for adaptation.)

Table 1.1. Projected climatology changes in Liberia by 2040–59 under five emissions scenarios

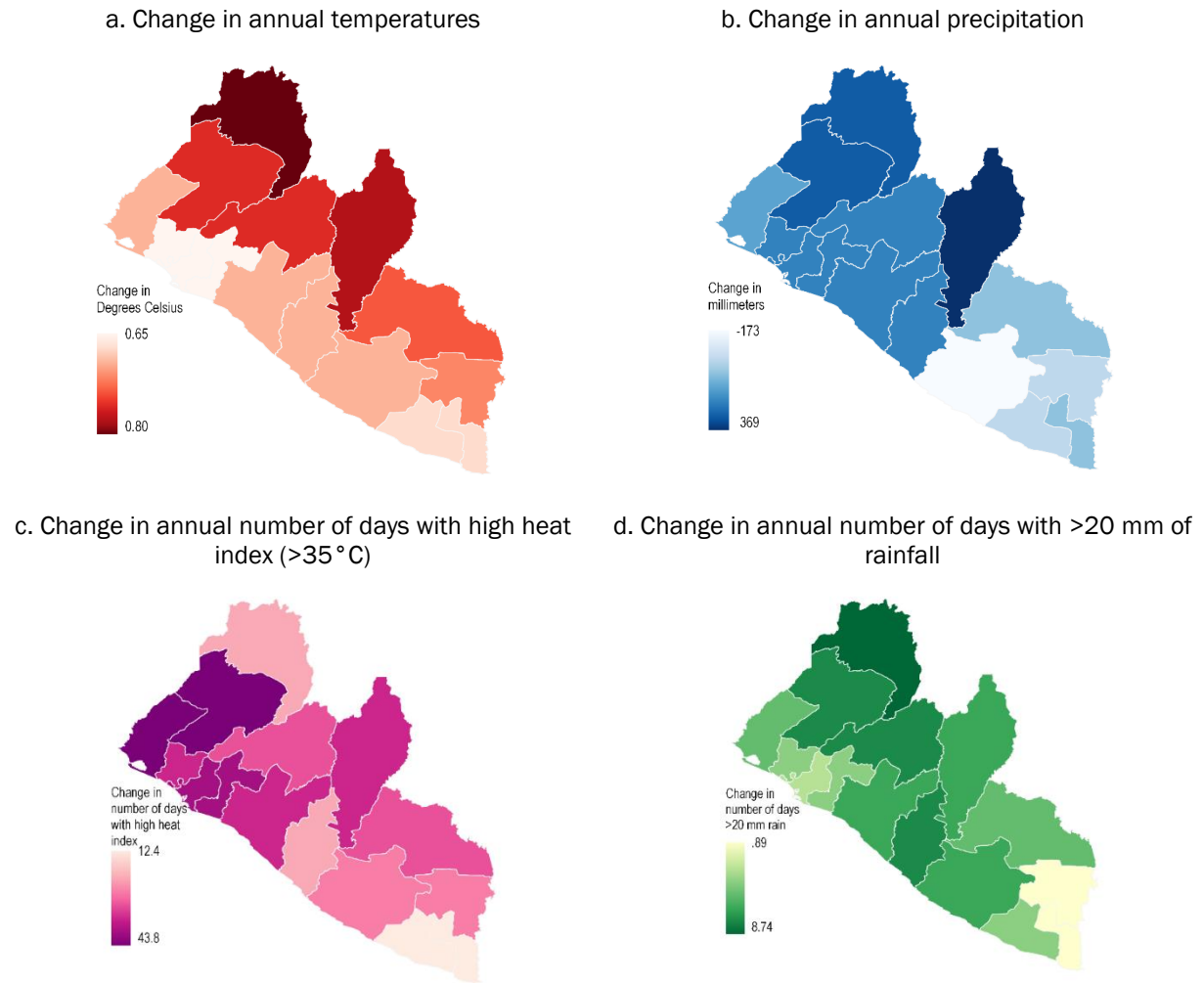
Scenario	Annual temperature (°C)		Annual number of high heat index days (>35°C)		Annual precipitation (mm)		Annual number of heavy rain days (>20 mm)	
	Projection	Change	Projection	Change	Projection	Change	Projection	Change
SSP1-1.9	26.5	0.8	29.0	28.3	2371.3	241.2	21.3	6.0
SSP1-2.6	26.6	0.9	17.4	16.7	2073.4	-56.6	16.2	0.9
SSP2-4.5	26.9	1.2	32.5	31.8	2092.9	-37.2	16.5	1.2
SSP3-7.0	27.2	1.5	47.7	47.0	2154.2	24.2	17.6	2.3
SSP5-8.5	27.4	1.6	60.4	59.7	2045.4	-84.6	16.4	1.0

Source: Based on data from the Coupled Model Inter-Comparison Project Phase 6 (CMIP6) dataset, retrieved from World Bank Climate Change Knowledge Portal.

Note: Estimates represent the median (50th percentile) of mean annual projections of five Shared Socio-Economic Pathways (SSPs) developed by the Intergovernmental Panel on Climate Change (IPCC) with respect to 1995–2014 historical data. 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.

Liberia will likely experience hotter temperatures and extreme heat. Liberia’s climate is humid and tropical, with average temperatures of 24 °C–29 °C. However, temperatures have been steadily rising: Mean annual temperatures increased 0.18 °C per decade between 1960 and 2008, along with a significant increase in the number of ‘hot’ days and decrease in ‘cold’ days. Despite regional variability, there is high confidence that mean annual temperatures and extreme heat events will continue to increase across the country. The warming trend is consistent across all SSPs (table 1.1). By mid-century (2040–59), the annual temperature is projected to rise by 0.76 °C under the most optimistic global emission scenario (SSP1-1.9) and by 1.63 °C under the most pessimistic scenario (SSP5-8.5). These effects translate into more experiences of extreme heat, which are expected to be detrimental to human and ecological lives and economic activities. The number of days with a high heat index (how hot it feels when humidity effects are factored in) is expected to increase by 29 under an optimistic emissions scenario and by nearly 60 under a pessimistic emissions scenario. Hotter seasons are also projected to start earlier and end later. Northern, western, and some eastern areas of the country can expect the most drastic changes in temperatures (**Error! Reference source not found. 1.3**).

Figure 1.3. Projected climate changes in Liberia in 2040–59 under the optimistic emissions scenario (SSP1-1.9), by county



Source: Based on data from the CMIP6 dataset, retrieved from World Bank Climate Change Knowledge Portal.

Note: Estimates represent median (50th percentile) of mean annual changes/anomalies for 2040–59 with respect to 1995–2014 historical data. SSP 1-1.9 (the ‘Sustainability Pathway’) assumes that Paris Agreement emissions targets are met. Regional differences in other climate scenarios may vary, and these maps represent the most optimistic climate scenario.

Changing precipitation patterns are expected to lead to more frequent and unpredictable intense rainfall events. Liberia is among the world’s wettest countries, with average annual rainfall of over 2,000 millimeters (mm), increasing along the coast and decreasing toward the interior plateaus and low mountains. The southern region receives rain year-round; the rest of the country experiences dry and wet seasons from the West Africa monsoon. Average monthly precipitation ranges from 27 mm in the drier months (December–April) to 408 mm in the wetter months (May–November). Because of the wide variability of rainfall patterns in Liberia, projections are inconsistent regarding whether average annual rainfall will increase or decrease. Climate models have been inconsistent on whether Liberia can expect a drier or wetter future. Table 1.1 shows the variation in change of annual precipitation across SSPs. Liberia may experience an increase in the frequency of heavy and unpredictable rainfall events, mostly as a result of shifts in West Africa monsoon seasons. By mid-century, the number of days with heavy rains (>20 mm) is projected to increase by an average of six under the optimistic emissions scenario (**Error! Reference source not found.**1.1). Areas in the north and west are expected to see the largest increases in rainfall; in

some areas in the south, average rainfall could decline (see **Error! Reference source not found.1.3**). Although drier seasons may be longer, Liberia is not considered to be at high risk for droughts (World Bank 2023a).

The frequency and severity of natural disasters and hazards such as flooding, heat waves, and disease outbreaks are expected to increase. Increased flooding poses one of the greatest natural hazard risks in Liberia (World Bank 2021b), because its many rivers, catchments, and aquifers leave it highly vulnerable to flooding after heavy rainfall. Low-lying coastal zones are especially at risk from the interaction of heavy rainfall events with increased sea level rise and coastal erosion (World Bank 2021b). Although data are sparse, there is the possibility that Liberia will face more windstorms along with heavy rainfall, which have historically caused immense damage to infrastructure in a short time. The higher frequency of extreme heat may also raise the risk of heat stroke and heat-related illnesses; damage to infrastructure, such as power outages (with adverse effects on businesses); wildfires; reduced crop yields; and biodiversity loss (Belland and others 2018). The incidence of waterborne outbreaks, such as cholera and other diarrheal diseases, is also projected to rise. Higher temperatures can also affect the survival, replication, and virulence of waterborne pathogens, and heavy rainfall events can spread pathogens and damage water and sanitation infrastructure (Levy and others 2016; Romanello and others 2021). Increased temperatures and precipitation can also lead to more suitable conditions for mosquito-borne disease transmission (Romanello and others 2021).

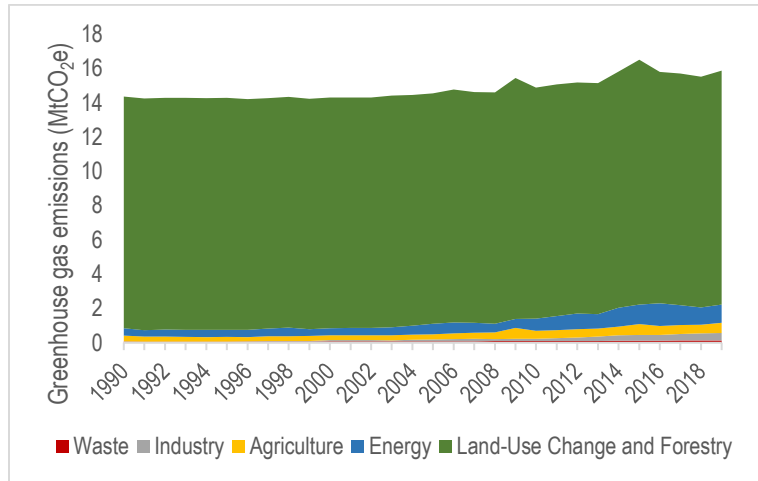
Liberia's low baseline of development leaves it highly vulnerable to the impacts of climate change. The physical changes in the environment will present new hazards and strain ecosystems, biodiversity, natural resources, infrastructure, and services, adversely affecting population well-being and livelihoods. Impacts will spill over into economy, affecting private sector development and job creation. The country's current exposure, sensitivity, and capacity to adapt to the negative effects of climate change are of major concern. Liberia's Vulnerability Index (which considers vulnerabilities arising from deficiencies in food, water, health, ecosystem services, human habitat, and infrastructure) is estimated at 0.61, placing it 173 out of 188 countries. Its Adaptation Readiness Index (which considers economic, governance, and social readiness to leverage investments and convert them to adaptation actions) is estimated at 0.28, placing it 163 out of 197 countries. Chapter 4 explores a few of the sectoral impacts of climate change and priority adaptation investments.

1.3 Risks and Opportunities from a Low-Carbon Growth Plan

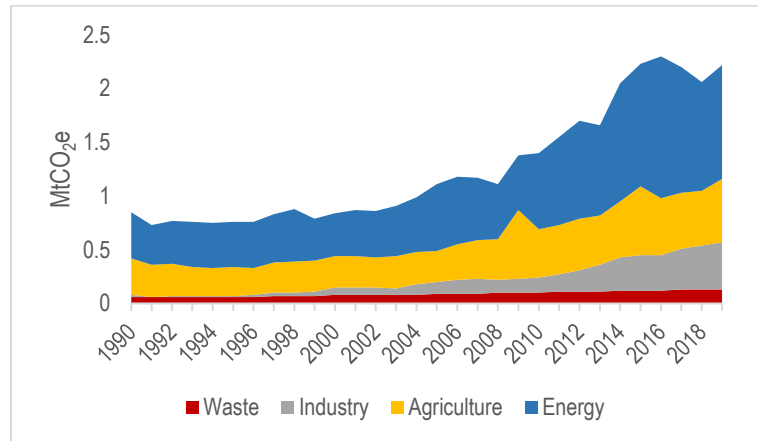
Liberia is among the world's lowest contributors to greenhouse gas (GHG) emissions. Emissions monitoring and reporting are variable across data sources and subject to several limitations in methodology. The World Resource Institute's historical Climate Watch GHG dataset allows for cross-country comparison of 193 countries between 1990 and 2019. According to it, Liberia was the 136th largest emitter, producing just 0.03 percent of global GHG emissions. In 2019, Liberia was estimated to emit 15.87 million tons of carbon dioxide equivalent (MTCO_{2e}), inclusive of emissions from land use change and forestry (LUCF), up from 14.37 MTCO_{2e} in 1990 (Figure 1.4).

Figure 1.4. Sources of Liberia's GHG emissions

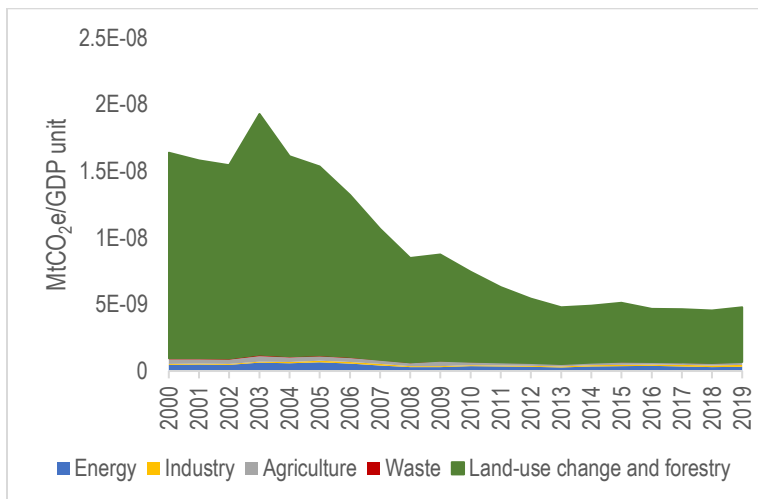
a. By sector inclusive of LUCF, 1990–2018



b. By sector exclusive of LUCF, 1990–2019



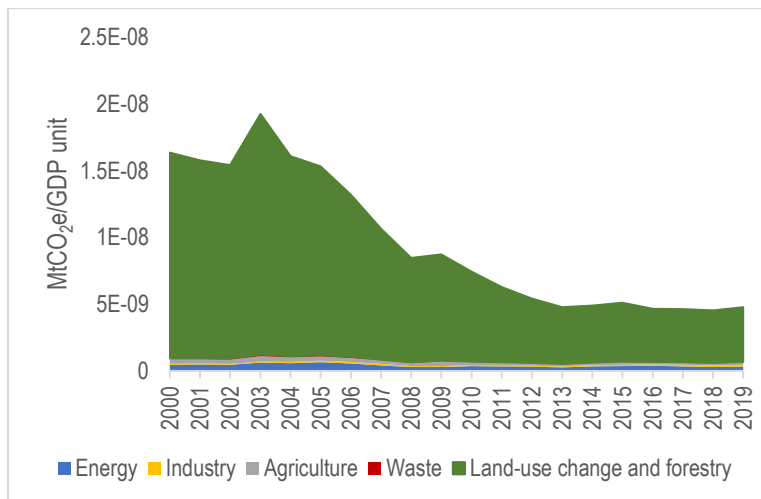
c. Greenhouse gas emissions intensity as share of GDP, inclusive of LUCF



Source: Based on data from Climate Watch 2022.

Note: Climate Watch estimations differ from Liberia’s national GHG accounting reported to the United Nations Framework Convention on Climate Change (UNFCCC) because of differences in methodology and sources of data. For example, data from LUCF emissions 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 (EPA); Liberia’s national accounting uses data from various federal agencies and ministries. Apart from the level of magnitude, Climate Watch data and Liberia’s national inventory report similar trends in leading sector emitters. Climate Watch data are not meant to replace Liberia’s national accounting but rather aim to complement national estimates by providing more updated data and using consistent methodology that allows comparison across countries and years.

c. Greenhouse gas emissions intensity as share of GDP, inclusive of LUCF



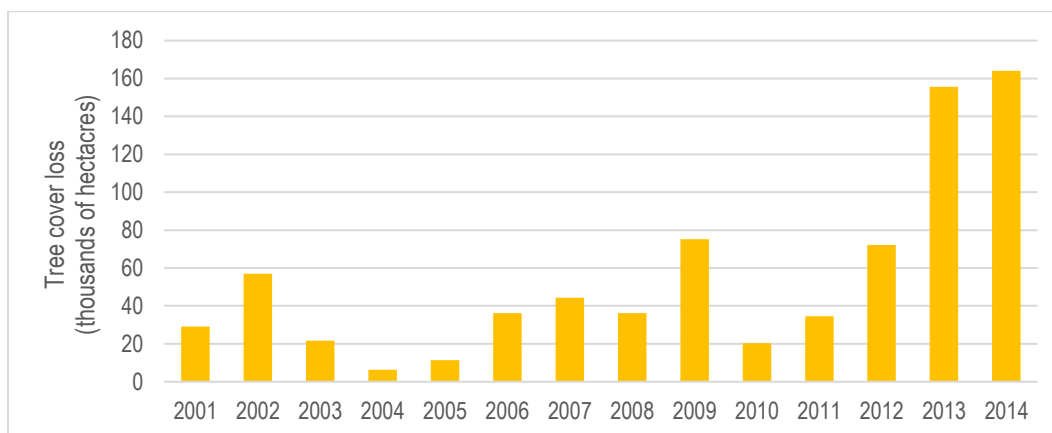
LUCF accounts for the largest share of GHG emissions. Emissions from other sectors, such as energy, agriculture, and industry, have been minimal. Exclusive of LUCF, Liberia emitted 2.22 MTCO₂e in 2019, up from 0.85 MTCO₂e in 1990. Without LUCF emissions, the energy sector has been the leading emitter, followed by agriculture, industry, and waste (e.g., landfills, wastewater). Emissions intensity per GDP has declined over time, as Liberia’s economy has grown.

Because of Liberia’s dense and vast forest cover, its GHG emissions are highly sensitive to LUCF activity. Liberia is home to the largest portion of Upper Guinea rainforests. Forests are estimated to make up two-thirds of the country’s land area and cover 6.69 million ha (FDA 2021). Liberia’s forests provide countless ecosystem services and are a biodiversity hotspot, home to some of the few long-term viable populations of several endemic species. Forests also serve as vital carbon sinks by absorbing and storing CO₂ through photosynthesis. As trees grow, they sequester carbon in their biomass while also transferring some carbon to the soil. Its mature forests could potentially allow Liberia to be a net sink, sequestering more carbon than it emits (limitations in estimating the amount of carbon Liberia’s forests recover annually make it difficult to establish).

Deforestation and forest degradation can reduce a forest's capacity to absorb and store carbon, threatening the forests’ carbon sink capabilities. The annual rate of removal of forest cover in Liberia rose between 2001 and 2014 (Figure 1.5). Deforestation has been driven primarily by logging (often illegal), high demand for charcoal, and widespread use of firewood for heating and cooking. Farming, road development, urbanization, and mining are other important drivers of forest loss (FDA 2021). Sustainable forest management will be key to establishing low-carbon growth and increasing the country’s competitiveness in accessing carbon markets. (Chapter 4 analyzes the key activities driving

deforestation/degradation and provides recommendations for balancing conservation and economic and development priorities in the sector.)

Figure 1.5. Loss of tree cover in Liberia, 2001–14



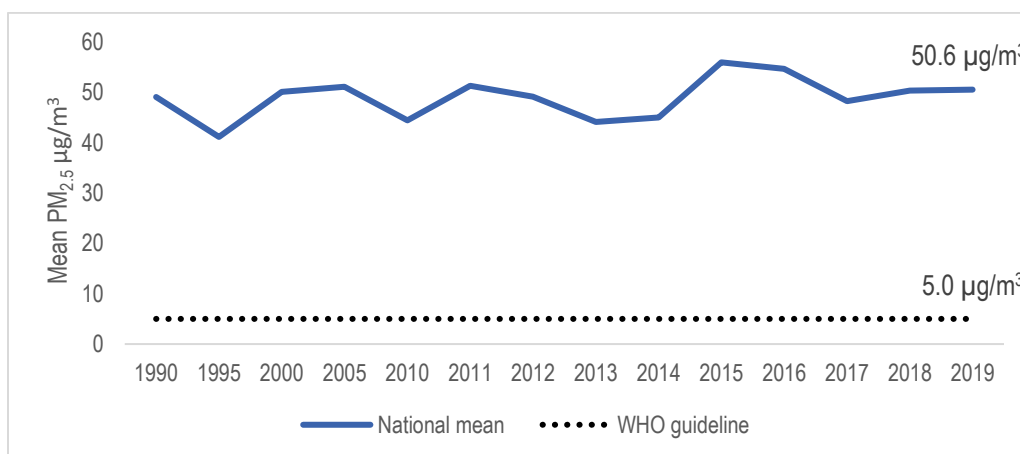
Source: Based on data from Global Forest Watch 2023.

Note: Tree cover is defined areas with over 30 percent tree canopy. It includes land used predominantly for agriculture based on satellite imagery. Data for 2015–21 were excluded from this analysis because the methodology for measuring tree loss and coverage changed after 2014. These changes were concluded to have significant implications for West Africa.

Most of the energy sector’s GHG emissions come from the burning of petroleum products and traditional biomass fuels. Oil accounts for about 14 percent of the country’s energy supply and is consumed mainly by the transport sector. Most households depend on firewood, charcoal, and palm oil for their energy and heating needs, driving deforestation. Dependence on these basic biomass fuels reflects the low level of access to electricity (28 percent) and clean cooking (0.4 percent) (World Bank 2022).

Burning of these traditional fuels contributes not only to GHG emissions but also to poor air quality. Annual ambient air concentrations of PM_{2.5} (an air quality marker of suspended particulate matter capable of penetrating and damaging respiratory systems) are 10 times higher in Liberia than World Health Organization (WHO) thresholds of public health safety (Figure 1.6).

Figure 1.6. Annual ambient particulate matter pollution in Liberia, 1990–2019



Source: Based on data from the Global Burden of Disease Collaborative Network (Murray and others 2020).

The energy sector could be a leading source of future GHG emissions unless early investments in green renewable sources scale. Of Liberia’s electricity generation, 48 percent comes from oil; the other 52 percent comes from renewables, mainly hydropower (50 percent), with some solar (2 percent) (IRENA 2022). Hydropower electricity capacity and generation have increased dramatically since 2015 with the rehabilitation of the Mount Coffee Hydropower Plant. Projected threats of climate change to Liberia’s energy needs include infrastructural damage to power stations and transmission lines; new barriers to collecting biomass fuels (for example, natural disasters and hazards); and changes to the availability of other resources, such as water. Efficient and sustainable sources of energy are also needed to support business operations for a buoyant private sector that can create jobs and drive growth sustainably.

Climate-smart agriculture will play a major role in sustainability managing Liberia’s landscapes and resources, such as water and energy, and reducing GHG emissions. Liberia’s climate is ideally suited for agricultural activities, with abundant fertile land and water resources to facilitate irrigation. The agricultural sector represents 38 percent of GDP and is the primary livelihood for 40 percent of the population (LISGIS, MOHL, and ICF International 2021). Despite its importance, an estimated 80 percent of Liberia’s population is moderately or severely food insecure (FAO 2023), and agricultural yield is low relative to its endowment potential—and likely to decline as a result of climate change. For example, Liberia’s annual production of rice (1.48 metric tons per hectare) is significantly lower than that of nearby countries. The low level of production in Liberia reflects the dependence of smallholder farmers on unsustainable subsistence farming and their focus on low-value food items. Attempts to commercialize agriculture with the support of the private sector face obstacles because of insufficient access to productive resources, effective value chains, and credit. (Chapter 4 discusses opportunities to upgrade agricultural systems and balance water and energy resources to be more resilient to climate change impacts.)

This chapter has described the development challenges faced in Liberia through the lens of climate change and constraints faced by the private sector in playing the central role for job creation and sustainable development. It also outlined the specific sectors that will be investigated to provide relevant policy recommendations to address climate mitigation and adaptation. The following chapter provides a summary of the national and international climate change commitments and the opportunities for climate finance and private sector involvement to meet these commitments and beyond.

2. Liberia’s Climate-Related Commitments, Supporting Policies, and Capacities

Key Points

- Liberia’s capacity for meeting its international climate commitments is weak. Technical capacity is low, and turnover of cadres tasked with preparing national inventories, vulnerability assessments, and other activities related to climate change adaptation and mitigation is high. Weak institutional coordination leads to duplication of efforts. Building capacity would help attract investors.
- Legislation and business regulatory frameworks are complex and difficult for foreign investors to navigate. Procedures need to be simplified, and agencies involved in issuing and monitoring of concessions need to be more transparent. Centralized databases of laws, legislative acts, mandates, and other national and local regulations could help attract foreign investment.
- The legal and policy framework related to climate change and broader natural resource management (land, water, other resources) is evolving, but in general has important gaps, and faces implementation and enforcement challenges. Amending national regulatory frameworks in light of the country’s NDC pledges, NAP, and Long-term Strategy (LTS) and harmonizing with international and regional frameworks that are applicable to Liberia would be beneficial.
- The national budget is insufficient for meeting climate change adaptation and mitigation needs.

This chapter summarizes Liberia’s national commitments for climate change mitigation and adaptation and the underlying legal, institutional, and policy frameworks of Liberia.

2.1 Liberia’s International Commitments on Mitigation and Adaptation

Liberia submitted the revised version of its first Nationally Determined Contribution (NDC) document in July 2021.¹ It sets mitigation and adaptation targets for the agriculture, forests, coastal zones, fisheries, health, transport, industry, energy, and waste sectors. Although Liberia’s emissions are comparatively lower than other countries, the NDC recognizes that under a business-as-usual economic development scenario, population growth, increased demand for food and land, poverty reduction, and technological development will be accompanied by an increase in GHG emissions and deforestation.

Liberia’s NDC identifies strong interlinks between sectors and suggests policy updates and improvements in institutional and infrastructure provisions for climate change adaptation and mitigation. During the first stakeholder engagement meeting for the Liberia Country Climate and Development Report (CCDR), the nexus of forests, energy, governance, and climate finance themes has been identified as a top priority. Consequently, the revised NDC (2021) targets to amend by 2030 “national policies to address the interlinkages between forests and mangroves, coastal ecosystems, water quality, fisheries, mining and energy production, agricultural production, transport infrastructure, and urban green corridors.” This is because the forests are central to Liberia’s development objectives due to the sector’s strong links to the energy sector (complements by supplying fuel, charcoal, and fuelwood), to agriculture and food production (competes with the agriculture sector for access to land yet can supply shade and vegetation for silvopasture and/or food for people), to the health sector (as a potential source of zoonotic diseases), to

¹ https://unfccc.int/sites/default/files/NDC/2022-06/Liberia%27s%20Updated%20NDC_RL_FINAL%20%28002%29.pdf

the transport sector (intercity transportation networks compete with forests for land and cause forest fragmentation and degradation), and to the industry and mining sector (compete for access to land area).

Planning and adaptation strategies for integrated water resources management, in relation to renewable energy generation (hydropower), water, sanitation, and hygiene (WASH) sector, and food security (agriculture sector), are also identified as critical. For example, improved water use and coordinated water resource management will ensure a reliable water balance and complementary use of the resource for agriculture, irrigation, fisheries and aquaculture, energy, rural and urban industrial/commercial and residential uses, and environmental protection. Improvements to WASH infrastructure should be given enhanced attention and priority. There is a critical need to protect river catchments and other sources of freshwater from pollution and degradation, to secure a steady supply of freshwater across all sectors and communities to cope with the additional stress that climate change impacts put on water resources. Adaptation and mitigation measures should be mainstreamed in all water resources management plans and programs to secure environmental safety and sustainable fresh water supply.

Liberia committed to reducing economy-wide GHG emissions by 64 percent below the projected business-as-usual level by 2030. It envisages reducing emissions by 10 percent unconditional on international support and by 54 percent conditional on international support. To achieve these targets, Liberia added sectors in its NDC. When land use and land use change are taken into account, Liberia's GHG emissions have represented about 0.04–0.05 percent of the global total since 1990. When land use, land use change, and forestry (LULUCF) emissions are excluded, Liberia's contribution is even smaller (0.003–0.004 percent) (WRI Climate Watch 2019).

The government has also acknowledged the threats posed by climate change and formulated additional actions to address them in its National Adaptation Plan (NAP). Enabling governance structures are set out in the Liberia Climate Change Act. Some adaptation actions are backed by national funding. However, to fully achieve its adaptation goals, Liberia will need additional financing sources and partnerships. This will necessarily require important reforms that would facilitate the participation of both domestic and foreign private players to provide innovative climate solutions and the financing of their implementations.

2.2 National Legal, Policy, and Institutional Framework Related to Climate Change

Governance for climate change adaptation and mitigation improved in the past decade. Following the ratification and domestication of the UNFCCC, the Kyoto Protocol, and the Paris Agreement, these instruments have been implemented through several climate change programs and activities, including the National Adaptation Program of Action (NAPA), the NAP, the development of Liberia's Initial National Communication, and the development of a National Policy and Response Strategy on Climate Change.

Liberia's National Policy and Response Strategy on Climate Change (2018) aims to strengthen coordination for the implementation of climate change matters between the government and all stakeholders, to create an overarching framework for the integration of climate considerations and support the implementation of Liberia's national development strategy as well as other regional and international policies and frameworks. The identified pillars for the policy are improved governance, financing mechanisms, capacity building, technology innovation, infrastructure, integrated planning, and data management. In addition, the policy determines that mitigation, adaptation, and disaster risk management efforts should focus on forestry, wildlife, agriculture, coastal areas, water resources, fishery, energy, mining, industry, transport, tourism,

infrastructure, urbanization, settlement, and health. The policy was a key instrument for developing and validating Liberia's current NDC. Other main national-level policies in the existing policy framework supporting climate action in Liberia include the National Environmental Policy (2003) and Liberia Rising Vision 2030.

Despite peaceful transfers of power and rebuilding of State institutions since the end of the civil war, Liberia ranks low on several governance indicators. For example, the World Justice Project (WJP) 2021 placed Liberia 18th out of 33 States in the Sub-Saharan Africa region and globally 110th out of 139 countries on the rule of law. This is also reflected in the environmental rule of law and governance issues in the environmental sector. The country's statutory framework on the environment mandates the establishment of specialized environmental courts, none of which have been established since 2002. It is recommended that public institutions with environmental mandates be resourced to create visibility on the State's and individual's role in protecting the environment. Liberia should take steps to adequately integrate climate change considerations within its legal framework with specifications of the role of the private sector, because the current framework does not expressly incorporate climate change considerations nor the roles of the public/private sector in building climate resilience for development.

The Environmental Protection and Management Law (EPML) 2002 forms the legal framework for sustainable development, management, and protection of the environment and natural resources by the EPA of Liberia in partnership with relevant ministries, autonomous agencies, and organizations as well as in responsive relationship with the people of Liberia. Among several objectives, the law requires environmental protection standards and monitoring environmental quality changes, including climate change. Further, the EPML addresses various environmental issues, including environmental impact assessment (EIA) guidelines and standards. The EIA requirements do not specifically mandate the impacts of the proposed activity on climate change. However, since the EIA is required for developments in key sectors such as agriculture, forestry, energy, fisheries, industries, wastes, health, and trade (transportation), the process is expected to consider the impact of development on these sectors, covered by Liberia's revised NDC. Nonetheless, the assessment of the scope of application of the ESIA requirements across all sectors is yet to be holistic, and reviews and reports from several sectors point to the weak implementation of the framework. Revising the EIA guidelines to incorporate NDC considerations during the screening of requests would facilitate the achievement of NDC targets.

Further, considering that Liberia's climate governance is more clearly provided in policies rather than statutes, it is recommended that Liberia institute reforms to amend existing statutes on the environmental or sectoral laws to incorporate climate change considerations within their legal framework. It is further recommended that a national climate change law be enacted.

2.2.1 Institutional Framework

The EPA leads activities on the environment and climate change. The EPA is recognized as the Designated National Authority (DNA) for the UNFCCC. It has the mandate as the national regulatory agency for sustainable environmental management in Liberia, including climate change. Based on this mandate, the EPA coordinates with other ministries and agencies to implement climate change activities, and the secretariat plays an essential role in this coordination. Section 5 of the Act Creating the Environment Protection Agency of the Republic of Liberia of 2002 mandates that the EPA collaborates with several key entities, including the Ministry of Finance and Development Planning (MFDP), which serves as chair of the EPA's Board, the Forestry Development Authority (FDA), the Ministry of Agriculture, the National Disaster

Management Agency (NDMA), the Ministry of Mines and Energy (MME), and Ministry of Internal Affairs. This collaboration extends to the fulfilment of Liberia's commitment to the Paris Agreement, including the implementation of the NDC.

The National Climate Change Steering Committee (NCCSC) is the supreme institutional body responsible for coordinating and supervising the implementation of climate change policy and other related activities in Liberia. The NCCSC, established in 2010, is a high-level policy coordination committee. It comprises the President of Liberia, Ministers of Government, Directors of Governmental Agencies, National Energy and Climate Change Advisers to the President, the private sector, civil society, and international partners. The NCCSC is chaired by the office of the President of the Republic of Liberia or his/her designate and supported by a National Climate Change Secretariat seated at the EPA to ensure the implementation of its daily activities. While the private sector is included in the NCCSC, it is not part of the EPA, and there is a coordination gap with the private sector, despite the central role that it owes to play in the implementation of the NDC,

Furthermore, to increase awareness of and resilience to climate change, the government, supported by international partners, has established several national networks, platforms, programs, and groups. They include the Climate Change Knowledge Sharing Platform (CCKSP) of Liberia; the Environmental Knowledge Management System (EKMS); the environmental studies master's degree programs at the University of Liberia; and other information-sharing groups, networks, and programs (such as Talk the Environment, Knowing your Environment, the EPA Intersectoral Department Awareness Campaign, and Climate Saturday).

2.2.2 Sectoral Laws and Policies

Land sector legislation is key to the realization of targets and priorities of the NDC given that land use, management, and tenure are cross-cutting issues. In 2016, Liberia enacted the Liberia Land Authority (LLA) Act, which centralizes land administration and management within the LLA. The Land Right Act was passed in 2019 and is being administered by the LLA to complement land reforms in Liberia, including land rights, management, and use. The Land Rights Act recognizes four categories of land ownership: customary land (communal holding), private land, government land, and public land. Subsisting with these categories is the unique land category called protected areas. The Land Rights Act provides security for tenure for all four categories of land in Liberia. In addition, the law recognizes customary rights. All ownership within the land categories includes the right to possess, use (for non-mineral purposes), include or exclude, and transfer. The Land Rights Act does not have any provision for carbon rights. However, since carbon rights are non-mineral rights, they may be considered the property of the tenure holder.

Customary land rights enable collective ownership of customary communities in the land, which includes land that has been used or possessed exclusively or continuously by the communities or some of its members for socio-cultural and economic purposes for at least 50 years as established by oral testimonies of members of the community and members of neighboring communities. The communities may put their land to several uses, including agriculture, under the self-elected Community Land Management Development Committees. Community members collaborating, regardless of gender, are the highest decision-makers in customary communities. They elect their leadership, Community Land Management and Development Committees, which include equal representation from all community segments, including youth, men, and women.

The legal framework governing the Liberian environment has significant provisions within the various statutes for creating protected areas. Protected areas may therefore be established with terrestrial and marine environments of Liberia within any of the four categories of land which recognizes that land ownership is not exclusive but subject to reasonable regulations. Within customary land categories, the Regulations to the Land Rights Act provide that the direction for land use planning and land conversion is the prerogative of the customary community through its Community Land Management and Development Committee.

Regarding forestry, the National Reform Law of Liberia mandates the establishment of a protected forest areas network to cover at least 30 percent of the existing forested area of Liberia, representing about 1.5 million ha which provides a statutory basis for the forestry targets within the NDC. This is restated within Chapter 5 of Liberia's National Wildlife Conservation and Protected Area Management Law. Chapter 77 of the EPML provides for the protection of forests and provides a statutory basis for establishing protected forest areas. The EPML, NFRL, and NWL provide for the protection of forests and their associated wildlife. Considering that Liberia is a highly forested country with many areas covered with forest, the LLA has collaborated with the FDA of Liberia, the Ministry of Internal Affairs, the Bureau of Concessions, and the Ministry of Mine and Energy to ensure the land formalization of customary communities and the establishment of protected forest areas (for more information, see the Forestry Deep Dive).

The Land Rights Act identifies and legitimizes protection, which may include mangroves as a land use category without making specific reference to mangroves or their protection. However, Liberia's National Wildlife and Protected Area Management Law protects mangroves and other marine species. Section 6.12(a) of the NWL mandates special protection of mangrove species to ensure their viable population.

Regarding the marine/fishery sector, Section 4.6 of the Fisheries and Aquaculture Management Law mandates the establishment of protected areas or special management areas within the fisheries waters of Liberia. It emphasizes collaboration with other agencies of the Liberian government, including the EPA, the FDA, the Ministry of Mine and Energy, the Maritime Authority of Liberia, and the Ministry of Defense. In addition, Section 75(3) authorizes the EPA to establish protected areas in rivers, lakes, or wetlands.

The legal framework on land management and administration does not specify incentives for sustainable land management, which would be relevant for climate change priorities related to land management and agriculture. Some relevant provisions regulating land use can be found within other instruments. The EPML has provisions for soil protection. Section 40 of the EPML establishes standards for soil use and requires the development of guidelines on the disposal of substances in soil, utilization, and other prohibitive practices that would result in soil degradation. Further, the National Forestry Reform Law and the EPML have provisions to promote land rehabilitation and restoration. For example, Section 8.3 of the NFRL mandates developing a reforestation policy and afforestation strategy to address deforestation and promote silvicultural practices that will increase Liberia's forest endowment. This policy remains undeveloped. It is recommended that the legal framework on land be reformed and amended to provide incentives for sustainable land management and explicit incorporation of carbon rights provisions considered within the current rights framework under the Land Rights Act.

Liberia has also developed policies and laws to address disaster reduction, which are key given the country's vulnerability to climate disasters. The Act to Establish the National Disaster Management Agency (NDMA) of 2012, the National Disaster Management Policy, and the National Action Plan for Disaster Risk Reduction 2016–2021 create the law and policy basis for disaster management and risk reduction. The NDMA Act does not provide specifically for the completion of periodic and national climate risk and

vulnerability assessments, but it requires the conduct of vulnerability assessments and the mapping of hazards, which may include climate hazards. The legal framework on disaster risk reduction and management allows for engagement with stakeholders and partners. It is recommended that the framework be reformed to integrate climate change concerns at the statutory and policy levels of the disaster risk reduction and management legal framework.

2.3 Need for Funding to Implement Liberia's NDC

Full implementation of Liberia's mitigation and adaptation actions through 2025 has an estimated cost of US\$491 million (US\$401 million is for mitigation and US\$90 million for adaptation). To implement the conditional portion of its NDC target, Liberia plans to mobilize US\$460 million from the private sector; bilateral and multilateral sources; and other sources, mechanisms, and instruments.

Annual climate finance flows in Liberia averaged US\$112 million in 2019/20, according to the assessment by Climate Policy Initiative (CPI 2022). The main sources were multilateral development institutions (US\$39 million), the government (\$33 million), and multilateral climate funds (US\$15 million) (figure 2.2). Three-quarters of climate financial flows (72 percent) were in the form of grants and low-cost project debt (US\$82 million). The power heat generation subsector received 35 percent of this funding (US\$39 million), which was invested in generation and transmission distribution.

As Liberia emphasized in its NDC, international support is needed to meet its conditional mitigation target.

A successful mobilization of such support to promote sustainable development in Liberia implies a strong private sector financing and additional domestic resources. National funding is available for only a small share of target activities. All areas are highly dependent on donor support. The three areas with the lowest number of projects with secured national funding are industry (0 out of 10), health (2 out of 23), and waste (7 out of 51). It is common to attract foreign direct and local private investments in the industry sector. By contrast, waste management and health care sectors are traditionally financed and managed by public entities. Therefore, attracting external financing for health and waste sectors may require a more creative approach and is likely to need a carefully designed enabling regulatory and policy environment.

Liberia's limited borrowing capacity and fiscal constraints make financing these investment needs difficult.

The World Bank-International Monetary Fund (IMF) debt sustainability analysis assesses Liberia at high risk of overall public debt distress and at moderate risk of external debt distress, with around 90 percent of its external debt with multilateral organizations. In 2001, 60 percent of government revenues were grants. Liberia does not issue international sovereign debt and does not have credit ratings. It has not issued bonds in local capital markets since 2018, and issuances before that were small and had short maturities. Fiscal constraints limit the climate finance alternatives available to Liberia in the short term. Public debt in 2021 totaled US\$1.8 billion (53 percent of GDP), 70 percent external and 30 percent domestic. Although the government's fiscal position improved in 2021, with a fiscal deficit equivalent to 2.9 percent of GDP, the limited space restricts the use of the public budget to scale up investments in climate efforts. Constrained public finances in Liberia are compounded by other factors, including a shallow capital market. As of 2021, Liberia had US\$48 million in sovereign bonds in local currency (2.5 percent of total debt) which was held by commercial banks. On the corporate side, only a few bonds were issued in the past decade, mainly by companies in the oil and transportation sectors.

Concessional finance will continue to play an important role in strengthening Liberia's climate actions in the short term. More than 90 percent of Liberia's external debt (US\$1.2 billion) is held by multilateral lenders on highly concessional terms. Nearly 68 percent of domestic debt consists of government

borrowing from the Central Bank of Liberia (CBL) at favorable terms (interest rate of 4 percent with principal repayments starting in 2029). Given its fiscal situation, the World Bank and IMF recommended that Liberia prioritize concessional financing to keep debt distress vulnerabilities contained. In the short term, given the reliance on public sector financing either directly or as a conduit for international financing from multilateral and bilateral sources, the government should continue to focus on maximizing concessional and semi-concessional sources of financing from multilateral and bilateral sources (development institutions, climate funds), through grants and/or low-cost borrowing. Such funds can be deployed to de-risking and blended finance structures that crowd in private sector investment.

Liberia can additionally access international climate funds. The Green Climate Fund (GCF), the Climate Investment Funds (CIF), and the Global Environment Facility (GEF) have already provided financial support for initiatives in Liberia. The GCF, for instance, is establishing the Forest Territories Facility to support countries in the Gulf of Guinea and Central Africa in their fight against deforestation and forest degradation. It has pledged to blend US\$160 million in grants (33 percent) and loans (67 percent) from distinct sources. For Liberia, the facility plans to support the forestry sector, improving its performance and governance; promote biodiversity conservation in the Tai-Grebo-Sapo Complex; and strengthen regulatory and institutional arrangements for the implementation of reducing emissions from deforestation and forest degradation (REDD). The facility presents a great opportunity for Liberia to leverage such initiatives and access low- or no-cost capital and financing that can catalyze climate projects that may be perceived as high risk, which can then be used to mobilize other financiers.

New initiatives and financial institutions are expanding the scope of their activities, creating additional blended financing opportunities for Liberia. One example is the launch, in January 2022, of the European Investment Bank (EIB) Global, EIB's arm to support climate action, economic growth, and development outside the European Union (EU). Such blended finance facilities can be developed for new investment areas in Liberia, including nature and biodiversity conservation and climate-resilient infrastructure, transportation, and agriculture. The funding for such a facility can blend grants and credits from the International Development Association (IDA) and funding and guarantees from other multilateral development banks, development institutions, and public sector funds. New tools to measure and model risk components of the downstream projects can be deployed to identify the critical risks that require public sector financing to enable private sector investment. Improved modeling of risk components would allow for more pinpointed financing and efficient use of scarce public sector financing. Liberia is eligible for long-term loans granted by the IMF's Resilience and Sustainability Trust (RST), which provides lending on favorable terms to help address longer-term structural challenges, including climate change.

Deepening the domestic capital market is essential to facilitate economic growth, diversify financing options, and attract foreign investment. The government's Medium-Term Debt Management Strategy intends to gradually develop the domestic debt market and build a domestic yield curve with the issuance of longer-maturity Treasury bonds while maintaining concessional and semi-concessional financing from multilateral and bilateral sources. Together with the CBL's financial markets department, the government is driving the process of laying the foundations for capital market development and integration with regional markets. While developing its domestic debt market, Liberia can start laying the foundations for promoting green finance in the medium term. The government could start introducing formal labels for green lending products and banks' financing flows for climate and environmental projects—an important prerequisite, as the overall policy framework for green finance instruments remains underdeveloped in Liberia.

Liberia will require strong private sector investment in climate-smart solutions. The funding gap of US\$460 million for conditional portion of NDC mitigation and adaptation commitments highlights the importance of private sector participation, bilateral and multilateral sources, and other financing mechanisms. Building trust in Liberia's institutions and ensuring that the right preconditions are in place will be vital to addressing the risks and opportunities from climate change. Given the low levels of Liberia's public capacity and its weak institutional framework, priority should be given to building the foundations needed for the financial sector to increase its understanding of and its involvement in climate issues. The authorities are encouraged to focus on creating a conducive enabling environment, enhancing the credibility of their institutions, and defining the prerequisites for the development of climate finance markets, which include development of relevant frameworks, standards, and definitions to support the identification of risks and opportunities. Financial sector policies supporting adaptation and mitigation need to be developed in a way that benefits private sector-led economic growth and financial sector involvement. Given the substantial financing needs for Liberia to meet its mitigation and adaptation objectives and the government's limited fiscal space, progress in domestic revenue mobilization and the mobilization of international finance and development partner support will be critical.

2.4 The Adequacy of Regulations and the Need for Government Oversight of Progress on National and Global Commitments

A growing number of countries are introducing definitions, classification systems, and taxonomies to identify which sectors or economic activities could be considered green. Taxonomies facilitate climate-related risk management and help mobilize capital for green and low-carbon objectives. Ensuring alignment with international guidance and principles will be a useful starting point for the CBL and other authorities in creating awareness of the potential of the green credit market. For example, the Green Loan Principles form an important global baseline standard for structuring green loans. Development of a full-fledged taxonomy is a resource-intensive and potentially long process; guidance by authorities in line with global principles and definitions may support potential lenders in the development of their activities by allowing them to identify green lending opportunities.

The appetite to engage in green and climate-related lending may depend on the availability of risk-sharing mechanisms and other incentives. The concept of green lending is quite new to financial institutions operating in Liberia, including the regulator. This is an area to educate on green lending. The banking sector could explore opportunities for the international donor community to facilitate or guarantee its green lending activities. Several examples exist of international donors or development banks stepping in to support commercial banks through the provision of credit lines or loan guarantees. Given increased global interest, there may be scope for Liberian banks to explore similar arrangements for green credit.

Over time, a national public credit guarantee scheme (PCGS) could play a pivotal role in developing the Liberian green credit market and de-risking lending to underserved sectors. Guarantees could stimulate lending to underserved sectors like agriculture. According to the recent financial sector survey undertaken in the context of this CCDR, at least four of the nine banks in Liberia do not lend to the agricultural sector, and exposure to the agricultural sector accounts for just 5.6 percent of total financial sector exposure. Those lending to the agriculture sector are faced with infrequent repayments, largely attributable to climate shock on productions and/or the mismatch between loan terms and the sector's production cycle. Guarantees can also help micro, small, and medium enterprises (MSMEs) unlock the funding required to transition toward lower-carbon business models, implement energy efficiency measures, or improve their capacities to adapt to the impacts of climate change. A PCGS could enable the de-risking of private green

finance for small and medium enterprises (SMEs) (or potentially even smaller-scale borrowers) or function as a shock absorber by facilitating the provision of emergency finance to SMEs hit by a climate-related natural disaster. Such schemes could help reduce information asymmetries and build capacity through technical assistance to both SMEs and partner financial institutions. SMEs may struggle to present a bankable green financing proposition, and financial institutions may lack the ability to assess the risks and rewards of green investments.

The right preconditions must be in place to establish a PCGS or guarantee mechanism. They include building capacity across government and other authorities to ensure effective governance and management and identify relevant apex institution for the administration. The evolving “Guidelines on Integrating Climate Change Mitigation and Adaptation into Credit Guarantee Schemes (CGS) for SMEs” which aim to promote a principles-based approach on integrating climate change mitigation and adaptation in CGSs can serve as a reference document for the Liberian authorities. Liberian financial institutions have highlighted the importance of government guarantees in supporting their climate-related lending activities, which are often perceived as too risky to warrant private commercial banks’ involvement. A specific opportunity of interest to the sector includes a partnership with a government scheme in which a certain percentage of the collateral for SMEs’ renewable energy financing would be guaranteed. Banks highlighted the importance of not communicating any guarantee arrangements to counterparties to avoid moral hazard.

3. The Macroeconomic and Poverty Impacts of Climate Change and Benefits and Costs of Adaptation

Key Points

- Liberia is projected to grow 5 percent a year on average between 2021 and 2050, with per capita GDP doubling to reach US\$1,470 by 2050. The poverty headcount (based on the national poverty line) is projected to fall by half, to 30 percent. Climate change will create challenges for the country's development path.
- Without adaptation, climate change could reduce potential GDP by up to 6 percent as early as 2030 and by 15 percent by 2050 compared with the baseline. The decline will push an additional 2–6 percent of the population (170,000–330,000 people) into poverty by 2030 and an additional 13–17 percent (830,000–1.3 million people) by 2050.
- Climate change will affect the Liberian economy mainly through changes to labor productivity from heat stress, lower crop yields (from the shift in rain patterns), and the increased costs of repair and renewal of capital (caused by flooding from sea level rise and extreme tide levels).
- Adaptation interventions could cut losses by more than half, reducing them from 15 percent of GDP to around 7 percent by 2050, cutting the number of new poor by around 630,000 by 2050.
- Adaptation interventions are expensive, costing Liberia about 2–3 percent of GDP a year. The benefits (equivalent to 3.7 percent of GDP a year) exceed the costs, however.

This chapter presents the results of modeling conducted for this report that estimates the economic impacts 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.

3.1 Background on Selected Growth Scenarios, Climate Scenarios, and Impact Channels

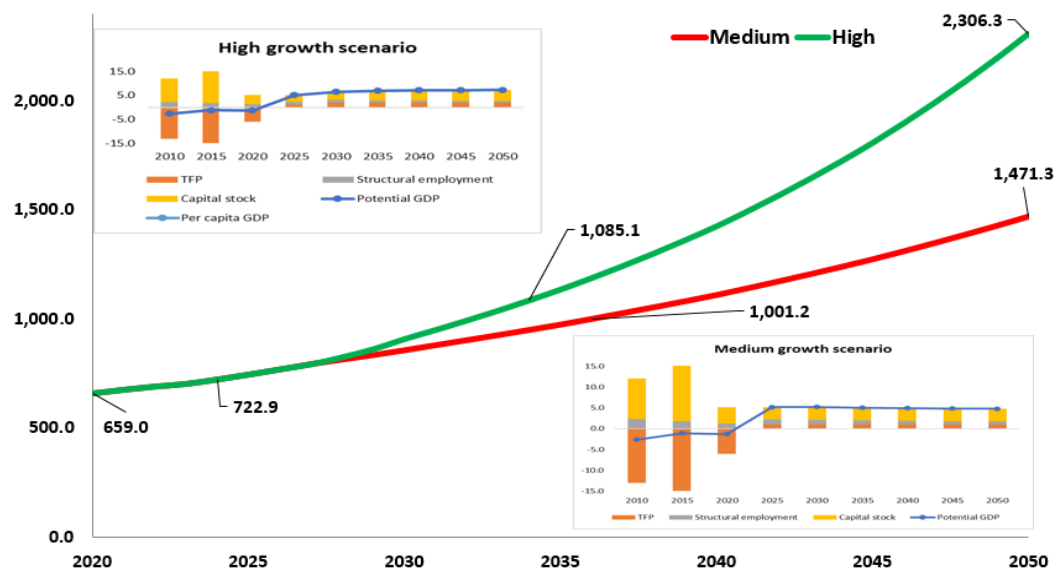
Liberia is among the world's most vulnerable countries to climate change. Floods, droughts, extreme heat, and epidemic events occur frequently and affect a significant and growing share of the population and economic activities.

The macro-modeling reported in this chapter analyzes the economic and poverty impacts of climate change and adaptation policies. It estimates the economic and social costs of failing to adapt to climate change. The chapter examines two growth scenarios, 10 climate scenarios, and nine channels through which climate change could affect Liberia. These channels are only a subset of ways in which climate change will affect growth and poverty; other channels will operate as well.

Growth Scenarios

A medium- and a high-growth scenario are analyzed (Figure 3.1). Both are underpinned by strong policies, reforms, and investments to address gender inequality; strengthen human, physical, and natural capital; and improve the business environment, with stronger achievements in the high-growth scenario.

Figure 3.1. Actual and projected growth in GDP per capita in Liberia under the medium- and high-growth scenarios, 2010–50



Source: World Bank.

Note: In 2010–15, massive foreign direct investment in the mining sector, especially in iron ore, increased the stock of capital, but mining growth plummeted as a result of the commodity price collapse, generating a large negative total factor productivity (TFP), calculated as a residual.

The medium-growth scenario is based on recent growth performance and medium-term projections for Liberia. It is not a trend-based scenario, as growth performance has been weak and volatile. Potential real GDP is projected to grow at an average annual rate of 5 percent over 2021–50, with per capita GDP doubling to reach US\$1,470 by 2050. Under this scenario, Liberia will not reach middle-income status by 2030 (its goal) but in 2040.² Achieving this scenario would require increasing TFP by 1 percent a year, sustaining investment at 21 percent of GDP a year, and implementing some structural transformation from agriculture to industry and services. Access to electricity and roads will continue improving at the current pace with no significant acceleration. Improvement in human capital will follow the trend in the last five years. Growth in employment is expected to mirror demographic growth, with the unemployment rate stabilizing at around 3.0 percent. Both the poverty headcount and the absolute number of poor are projected to fall to 30 percent and 2.7 million, respectively, by 2050.

The high-growth scenario is aspirational. It mirrors the country's growth performance in the first decade of the post-conflict, pre-Ebola period (2004–13). Productive capacities are projected to grow at an average annual rate of 6.5 percent over 2021–50, with per capita GDP more than tripling to reach US\$2,300 by 2050. Under this scenario, Liberia reaches middle-income status by 2034. Achieving it would require a 2 percent annual increase in productivity, significant improvement in fiscal management and better governance of higher public and private investment, and greater structural transformation. Access to electricity and roads will be accelerated and improvement in human capital will be faster. Strong reform implementation will contribute to attracting more private investment outside the mining sector, especially in services and potential sectors like agriculture.

² The World Bank Group's lower-middle-income cutoff was a per capita gross national income (GNI) of US\$1,085 in 2022 (<https://blogs.worldbank.org/opendata/new-world-bank-country-classifications-income-level-2022-2023>).

Climate Scenarios

Ten climate scenarios are examined (Table 3.1). Two were selected to facilitate comparison across emissions scenarios. In the pessimistic scenario (General Circulation Model [GCM] SSP 3-7.0), warming reaches 4°C by 2100. In the optimistic scenario (SSP1-1.9), GHG emissions decline and warming is limited to 1.5°C by 2100.³ Eight scenarios examine climate conditions. The dry/hot scenarios model the 10th percentile of mean precipitation changes and the 90th percentile of mean temperature changes across SSPs 2-4.5 and 3-7.0 as well as a mean across the three other scenarios. The wet/warm scenarios model the 90th percentile of mean precipitation changes and the 10th percentile in mean temperature changes across SSPs 2-4.5 and 3-7.0 as well as a mean across the three scenarios.

Table 3.1. Descriptions of climate scenarios examined

Type	Scenario	Description
Mitigation	Optimistic: SSP1-1.9	Assumes lowest temperature increase of the 10 scenarios and smaller precipitation changes than in the intermediate or pessimistic scenarios
	Pessimistic: SSP3-7.0 mean	Assumes higher temperature increases and larger precipitation changes than the intermediate and optimistic cases
Dry/hot	SSP3-7.0	Examines 10th percentile of mean precipitation changes and 90th percentile of mean temperature changes
	SSP2-4.5	
	SSP3-7.0	
	Dry/hot mean	Examines mean across the three dry/hot future scenarios
Wet/warm	SSP3-7.0	Examines 90th percentile of mean precipitation changes and 10th percentile of mean temperature changes
	SSP2-4.5	
	SSP2-4.5	
	Wet/warm mean	Examines mean across the three wet/warm future scenarios

Impact Channels

This report examines nine (of the many) channels of impact (Table 3.2). Shocks were calculated based on changes in climate variables in 2021-50 relative to the baseline (1995-2020). These shocks were then inputted into the country-specific Climate Change Macro-Fiscal Model (CC-MFMod). All figures in this section should be interpreted with caution given the caveats presented in box 3.1.

Box 3.1. Caveats regarding estimates of economic loss or damage

- *Missing channels.* Of the many potential impact channels, this report models only nine. 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 life-long consequences for health, learning, productivity, and earnings. Even within a channel, some pathways cannot be captured. Furthermore, the effects of climate change on Liberian forests and ecosystem services as well as the trade-off between agriculture and forestry and their impact on forest communities are not modeled because of data limitations.
- *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

³ The climate scenarios are provided by the World Bank's Climate Change Knowledge Portal (CCKP) for 29 GCMs from CMIP6 suite of IPCC model outputs. Each GCM has up to five combinations of SSPs and Representative Concentration Pathway (RCP) emissions scenario runs. For each GCM-SSP combination, the CCKP provides a modeled history for 1995-2014 and projections for 2015-2100 for monthly mean temperature and precipitation at a 1° x 1° grid resolution.

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.* In terms of structural 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) would enable households and firms to reduce the impacts of climate shocks.⁴ Incorporating these effects would reduce the impact on GDP losses.

Table 3.2. Potential effects of climate change on human capital, agricultural and natural resources, and infrastructure and services

Channel	Description
<i>Human capital</i>	
Labor heat stress	Shock to labor productivity from daily heat stress to indoor and outdoor workers; incorporates occupation-specific work ability curves from the International Labour Organization
Human health	Shock to labor supply from changes in incidence of and mortality associated with vector-borne, waterborne, and temperature-related diseases
Clean cooking	Shock to labor supply from indoor air pollution, including effect of changes in cooking services and co-benefits from reduction in fuelwood use
<i>Agriculture and natural resources</i>	
Rain-fed crops	Shock to crop revenues through changes in 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 flooding. Impacts on erosion are estimated from changes in rainfall.
Hydropower	Shock to energy generation from changes in river runoff, based on a water systems model
<i>Infrastructure and services</i>	
Urban flooding	Shock to capital in selected cities from peak precipitation events that result in pluvial flooding. Estimates are based on a study of Monrovia.
Coastal flooding sea level rise and extreme tide levels	Shock to coastal capital from changes in mean sea level and extreme tide levels, using a bathtub approach
Roads and bridges	Shock to capital from damage to and need for maintenance of roads and bridges modeled through the Infrastructure Planning Support System (IPSS) model. Also considers effects of road disruption on labor supply

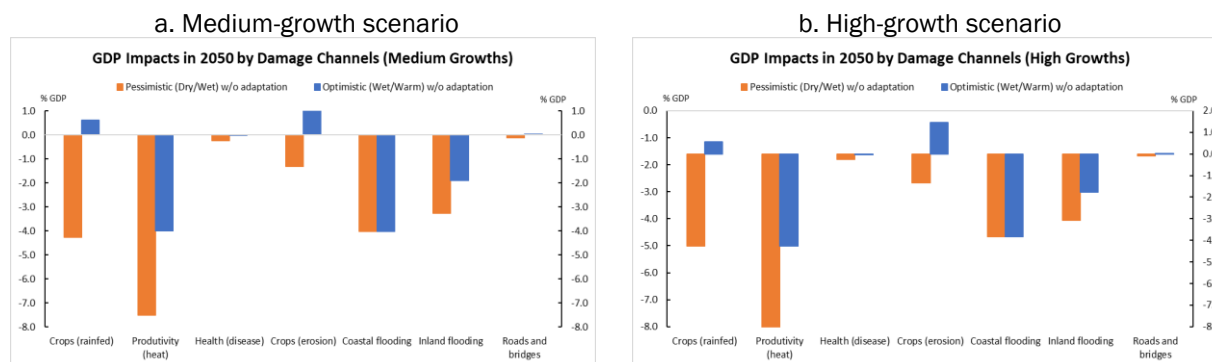
3.2 Projected Impacts of Climate Change without Adaptation Policies or Investments: The High Cost of Inaction

Climate change will affect the Liberian economy mainly through changes to labor productivity from heat stress, lower crop yields from shifts in rain patterns, and the increased costs of repair and renewal of capital

⁴ Higher GDP and income could reduce vulnerabilities in several ways, including the following: (a) by investing in inputs and irrigation, richer farmers could buffer the negative effects of climate change on agricultural yields; (b) better access to improved water and sanitation could reduce the impact of higher temperatures on waterborne disease and diarrhea; and (c) more resources for mechanization of agriculture could reduce the physical intensity of labor, reducing the impact of higher temperatures on labor productivity.

caused by flooding.⁵ The largest impact on the economy stems from its effect on labor productivity. Under both growth scenarios, higher temperatures (the dry/hot pessimistic scenario) could lead to economic losses of up to 7.5 percent of GDP by 2050. The second-largest impact stems from the effect of shifting rain patterns on crop yields. A dry or lower-precipitation shock to the economy is expected to reduce GDP by 4.3 percent by 2050 (Figure 3.2). The other two significant impact channels are coastal flooding (projected to reduce GDP by 4.0 percent by 2050) and inland flooding (projected to reduce GDP by 3.3 percent by 2050) under the medium-growth scenario.

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



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

3.2.1 Impact on Human Capital

Liberia’s human capital outcomes are among the worst in the world. Its Human Capital Index (HCI) was just 0.32 in 2020.⁶ Only 3 of the 174 countries assessed—the Central African Republic (0.29), Chad (0.30), and South Sudan (0.31)—had lower scores. Climate change may reduce the contributions of labor productivity and human capital to growth by increasing temperatures that result in excess mortality, reduced labor capacity, and the spread of infectious diseases. These effects are estimated by examining labor heat stress, human health, and clean cooking.

Effect of heat stress on labor productivity

Higher temperatures will increase heat stress and reduce the productivity of outdoor labor. Heat stress could lead to economic losses of up to 7.5 percent of Liberia’s GDP by 2050. Lower labor productivity will have significant impact on economic outcomes, because of the large number of Liberians employed in agriculture and informal services. Agriculture is projected to experience the largest labor productivity losses (8.4–15.8 percent), followed by industry (6.4–13.1 percent) and services (5.4–11.1 percent).

Effect of heat stress on health

Heat stress can reduce labor productivity through increased illness and death from malaria, dengue, diarrhea, and heat-related respiratory and cardiovascular disease. Productivity falls under all scenarios,

⁵ 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 differs with the size and structure of the economy, the shocks are introduced and run for each of the three growth baselines described above. The combined impacts of the channels are more than the total of the individual channels because of the multiplicative effect of shocks.

⁶ An HCI of 0.32 implies that a child born in Liberia today may reach only 32 percent of his/her productivity potential as a result of shortfalls in education and health.

with losses higher in scenarios with higher temperatures. These losses are small compared with the direct labor productivity losses from heat stress, however, because fewer laborers are affected by increased disease exposure. By 2050, the impact on labor productivity is no more than 0.3 percent in the pessimistic climate scenario.

Clean cooking

This channel assesses the health-related benefits of investing in cleaner cooking technologies using the approach in the Clean Cooking Planning Tool prepared by the World Bank's Energy Sector Management Assistance Program (ESMAP).⁷ Most Liberians use fuelwood in traditional stoves, which produces pollutants that result in respiratory illnesses and heart disease. Indoor air pollution affects human capital through illness and death from fuelwood use, which reduces the labor supply. Women and children are disproportionately exposed to indoor air pollution health effects in many developing countries, because they spend more time performing indoor domestic activities (World Bank 2019).

Improved cooking technology could free up more than 5.6 hours a week per household by 2050, with the largest share coming from reduced fuelwood and biomass collection. This scenario assumes that the share of households relying on improved and modern energy cooking services in urban areas rises from an average of 58 percent over 2030–50 in the business-as-usual scenario to 80 percent in the aspirational scenario. In rural areas, an increase from 15 percent at baseline to 33 percent in the aspirational scenario is assumed. The business-as-usual trajectory would result in no impacts on total labor supply; the aspirational scenario would result in increase in labor supply of about 0.4 percent by mid-century.

3.2.2 Impact on Sectoral Productivity

Despite favorable climate and fertile soils for a large variety of crops, agricultural productivity in Liberia is low. Climate change could reduce already low agriculture yields.

Rain-fed crop yields

This channel models changes in crop productivity as a function of the availability of irrigation (for irrigated crops) and rainfall (for both rain-fed 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. In the wet scenario, some crop yields rise and others fall, with deviations generally not far from the baseline. In the dry scenario (which is also hotter), the shocks are largely negative, with the magnitude increasing over time (as the dry scenario becomes dryer). By 2050, crop revenues in the dry scenario are 6–22 percent below their baseline.

Soil erosion

Soil erosion can be detrimental to landscapes, adversely affecting plant and animal life, reducing the efficacy of reservoir storage and hydropower production through sedimentation, and causing declines in agricultural production by removing valuable nutrients from the topsoil. All these changes will be exacerbated if climate change intensifies rainfall. The wet/warm scenario mean is expected to result in an increase in erosion and the dry/hot mean to result in a decrease in erosion.

⁷ <https://energydata.info/cleancooking/planningtool/>

Changes in annual erosion range from 0 to 50 tons per hectare throughout the country. The greatest losses are expected under a wet/warm scenario, as a result of higher precipitation. A dry/hot scenario could result in a reduction in erosion. The combined effect on crop yield will depend on the magnitude of water availability and heat stress effect.

3.3.3 Impact on Capital Stock

Infrastructure gaps in Liberia are huge. Electricity access is one of the lowest in the region, with less than 30 percent of the population having access, and power outages are frequent. Internet penetration is also one of the lowest in the region, with just a third of the population having access; roughly 80 percent of the population has access to a mobile phone. Liberia's road network deteriorated significantly because of lack of maintenance during and since the long civil wars. More than 90 percent of paved roads are in good or fair condition, but nearly 60 percent of unpaved roads are in poor or very poor condition. About half of Liberia's 2,884 bridges and a quarter of its 7,651 culverts are in poor condition, limiting accessibility during the rainy season; only 15 percent of bridges and half of culverts are in excellent or good condition.⁸ Climate change could weaken the country's infrastructure and increase the already huge gap.

Inland flooding

Climate change is projected to significantly increase the risk and intensity of floods, as precipitation increases and becomes more severe. Floods will damage or destroy houses and other properties, agricultural land, and transport infrastructure. Damage is projected to be greater under the SSP3.70 (pessimistic) scenario than under the SSP1-19 (optimistic) scenario, in which higher emissions are expected to cause greater climate variability. By 2050, the change from the baseline could exceed 35 percent in major cities, including Buchanan, the main port for mining exports.

Coastal flooding

Rising sea levels and temporary flooding from extreme tidal levels threaten infrastructure and land in low-elevation coastal zones. By 2050, impacts from coastal flooding are projected to result in an incremental loss of 0.75 percent of capital relative to the baseline.

Road and bridges

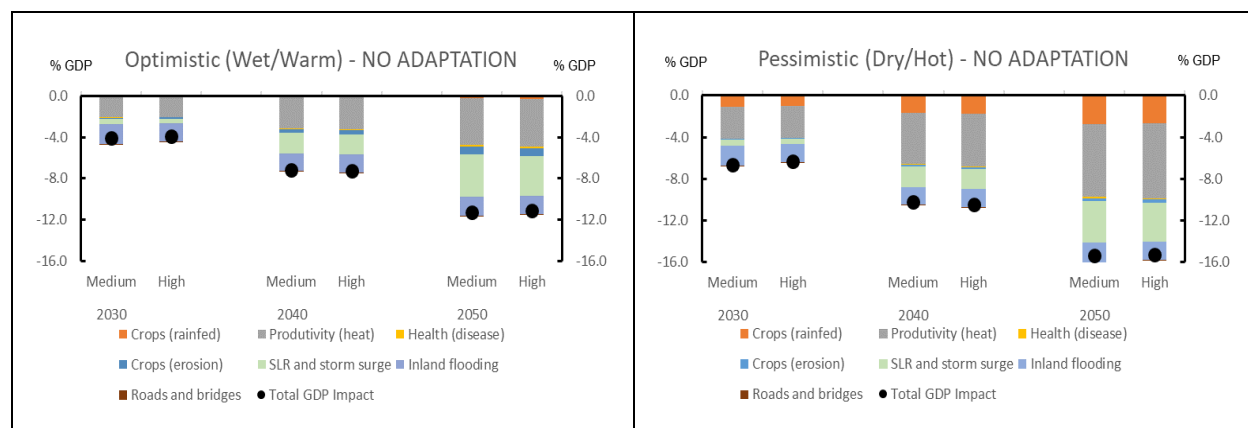
Changes in precipitation, temperature, and flooding can damage roads and bridges, increasing annual maintenance costs, causing delays for passengers, and reducing labor productivity. The modeling results show large increases in both maintenance costs and travel delays. Impacts are generally higher under the wet/warm scenario than the dry/hot scenario because extreme precipitation and flooding cause the greatest damage to roads and bridges. By 2050, delays could reach 12.5 million additional hours relative to the baseline. Annual weather-driven repair costs over 2031–50 could rise to US\$900 per km.

The cost of climate inaction in Liberia is high. Without any adaptation, losses could reach 4 percent of GDP as early as 2030 and 15 percent of GDP by 2050 (Figure 3.3). These losses are equivalent to an 18 percent decline in real per capita income by 2050 in the dry/hot pessimistic scenario. The deviation in GDP per capita from the baseline is lower in the wet/warm optimistic climate scenario but could still reach 13 percent by 2050.

⁸ Spatial Analysis of Liberia's Transport Connectivity and Potential Growth: <https://documentsinternal.worldbank.org/search/29983054>

The combined effects of climate shocks across the various channels will cause significant setbacks to the already weak private sector, delaying its ability to play the central role in the country's development. However, the climate challenges also present important opportunities for the private sector, if the business climate is made conducive, to serve as the agent of change at the climate-development nexus. As the producer and supplier, the private sector can introduce innovative climate-friendly production technologies. Public-private partnerships in building reliable infrastructures are other opportunities to stimulate business operations.

Figure 3.3. Projected effect of climate change on GDP in Liberia in 2050 without adaptation



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

3.3 Poverty Impact of Climate Change Shocks without Adaptation

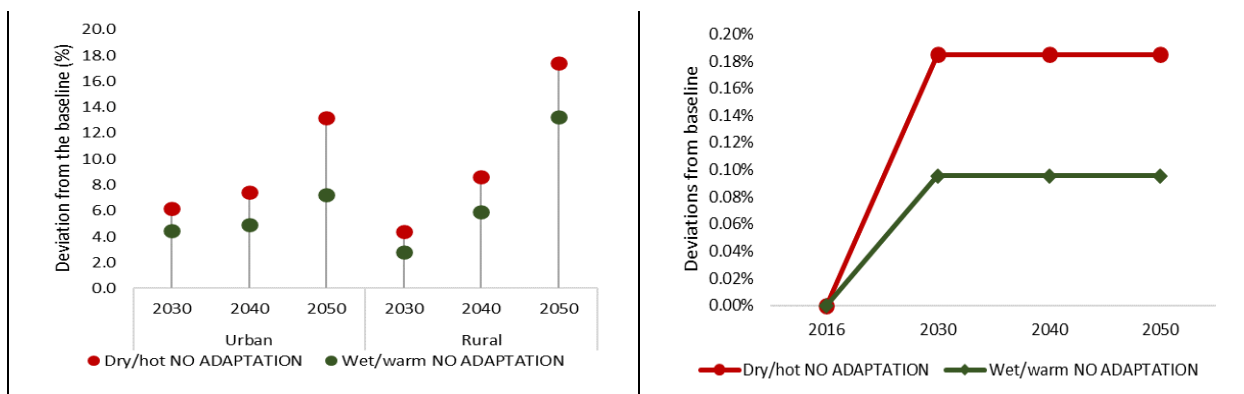
This section examines poverty and inequality trends under different growth scenarios for different segments of the population. It links the CC-MFMod results to the micro simulation model over the entire forecast period. Macroeconomic projections for demographics and employment are based on the most recent available household survey data.

With no adaptation, climate change will increase poverty in Liberia. Poverty could increase by 2–6 percentage points over the baseline, creating 170,000–330,000 new poor as early as 2030. The poverty impact reaches 13–17 percent points by 2050, creating between 830,000 and 1.3 million new poor. Poverty impacts in the dry/hot scenario are higher and more persistent than in the wet/warm scenario. The dry and pessimistic climate scenarios lead to larger impacts on rural communities working in subsistence agriculture. In addition, the gap between rural and urban increases over time toward 2050.

With no adaptation, climate change will increase inequality in Liberia by 0.08–0.18 percent as early as 2030. The Gini index (a measure of inequality) is likely to first rise and then level off in 2030 (Figure 3.4). Climate change will increase inequality because the poor are more exposed to climate shocks, such as natural disasters, droughts, and health challenges, and benefit less from government redistributive efforts, which are small and not well targeted.

Figure 3.4. Projected effect of climate change on poverty rate and Gini coefficient in Liberia without adaptation

a. Poverty rates by area Deviation from the baseline (no adaptation)	b. Gini coefficient Deviation from the baseline (no adaptation)
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Source: World Bank estimations using MFMod and IEc.

3.4 Benefits and Costs of Adaptation to Climate Change: Selected Interventions

This CCDR considers five channels of impact: heat stress, crop erosion, rain-fed crop, coastal flooding, and road and bridges. Adaptation actions selected include a realistic balance between adaptation costs and residual impacts. Like the estimates of losses and damages, the figures in this section should be interpreted with caution.

Adaptation interventions can significantly reduce damage and losses. In the dry/hot climate scenario, the selected adaptation actions could reduce GDP deviations to around 7 percent by 2050 for both the medium- and high-growth scenarios, less than half the 15 percent in the scenario with no adaptation. For the wet/warm climate scenario, the adaptation effects are even higher, with GDP deviations reduced to just 3 percent in both growth scenarios, compared with 11 percent in the scenario with no adaptation (Figure 3.5). The largest effects are from the reduction in heat stress as a result of the use of air conditioning for the indoor workforce as the economic structure shifts toward greater formal employment in services and manufacturing and agriculture becomes less labor-intensive. The effect of adaptation to coastal flooding is also high. Adaptation to rain-fed crop yield and crop erosion includes developing new irrigation infrastructure to address water stress for priority crops such as rice and cassava, switching crops by increasing the production share of climate-resilient crops, and increasing the share of heat-tolerant crop varieties.

Table 3.3. Modeling of adaptation interventions in Liberia, by channel

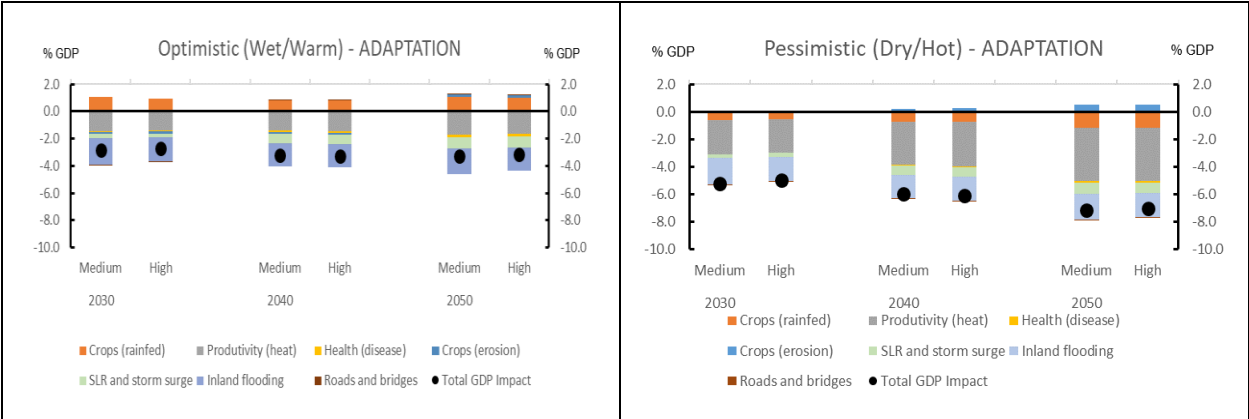
Channel	Adaptation measure	Hypothesis	Cost
Heat stress	Increased air conditioning to cover 30 percent of indoor workforce	Adaptation ramps up linearly starting in 2021, reaching the target by 2050	Capital cost of new air conditions units required by 2040–50 (CAPEX) plus annual cost of energy consumption (OPEX)
Crop erosion	Conservation tillage and/or leaving of crop residue after harvest	Leaving adequate residue on the ground after harvest reduces sheet and rill erosion. Measure begins in 2025; 20 percent of adoption by 2050.	Conservation tillage is assumed to be cost neutral to farmers, as labor and/or tractor use declines; intervention could increase need for pesticides or other inputs.
Rain-fed crop	Development of new irrigation infrastructure to reduce water stress, crop switching	Irrigation infrastructure for cash crops is rehabilitated and new irrigation	Capital costs of developing new irrigated hectares by 2041–50 (CAPEX) plus annual operation

Channel	Adaptation measure	Hypothesis	Cost
	(increasing production share of climate-resilient crops), and increased share of heat-tolerant crop varieties to reduce heat stress on priority crops	infrastructure built for smallholders for cash crops and food crops	and maintenance costs (OPEX). CAPEX considers a high-end value.
Coastal flooding and road and bridges	New infrastructure built above projected sea level change by 2050 for SSP3-70, to protect new infrastructure from coastal caused by sea level rise and high tidal levels; measure protects existing infrastructure, with highest annual expected damage in SSP3-70 by 2050 by building sea walls	Rate of new infrastructure constructed is assumed to follow population growth rate of Monrovia. New infrastructure would be built away from most hazardous areas and raised to first-floor elevation. Benefit-cost ratio exceeding 1. Adaptation starts in 2025.	Cost: 15% of structure value Effectiveness: reduces vulnerability by 80% ^a

Source: World Bank and IEC.

Note: CAPEX = Capital expenditure; OPEX = Operating expenses.

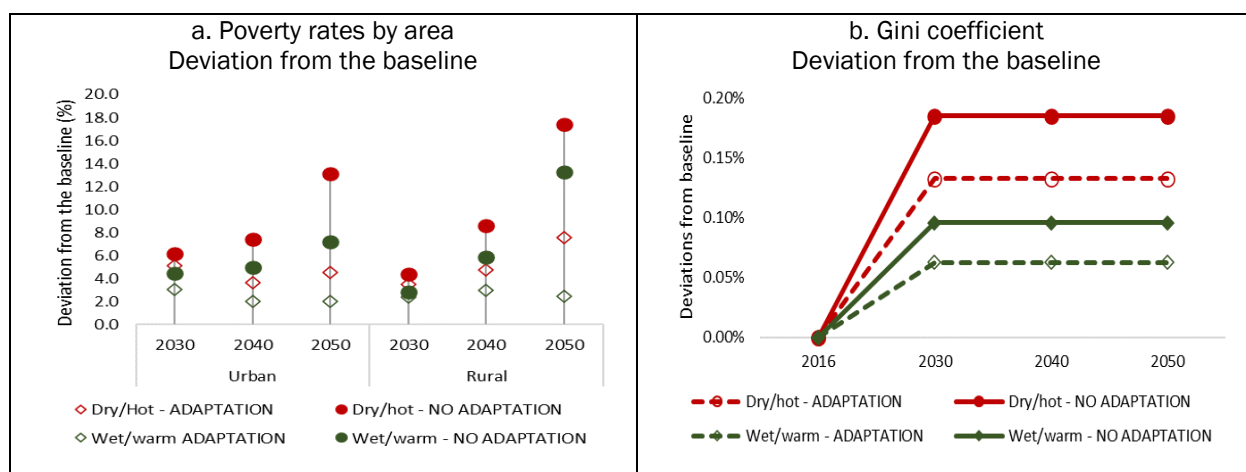
Figure 3.5. Projected effect of climate change on GDP in Liberia given adaptation



Source: World Bank estimations using MFMod and IEC.

Adaptation can reduce the poverty and inequality effects of climate change up to half by 2040 compared with the baseline (Figure 3.6). The number of new poor will be reduced from 1.3 million and 830,000 in the dry/hot and wet/warm scenarios, respectively, with no adaptation to 500,000 and 190,000, respectively, in the scenarios with adaptation. Some adaptation interventions—especially those that increase the resilience of agriculture, including new irrigation infrastructure, and rural communities—could bring about large gains in poverty reduction even if rural areas remain most affected by climate change. These win-win interventions also have an inequality-reducing effect.

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

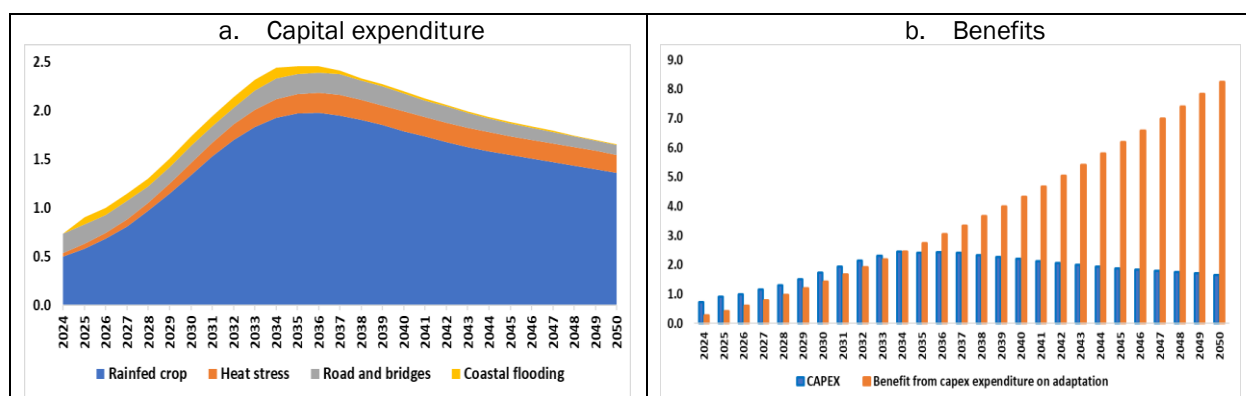


Source: World Bank estimations and IEc.

The benefits of the selected interventions outweigh their costs. The average annual benefit (3.7 percent of GDP) outweighs the average annual cost (2.1 percent of GDP) over the period (Figure 3.7). Most costs are frontloaded and benefits backloaded, as it is for typical long-term investment projects. If operation and maintenance (O&M) expenditures are considered, the average annual cost of the interventions increases to 3.0 percent of GDP, 0.7 percentage points below the average annual benefit.

Nevertheless, covering the cost of the selected interventions will be challenging. With the limited fiscal space (weak domestic revenue mobilization and limited borrowing space) available, only half of the financing needs (1 to 1.5 percent of GDP) are assumed to be funded by public resources, while the rest, consisting mainly of O&M costs, are assumed to be financed by the private sector. The government should prioritize mobilizing concessional resources to top up the current allocations.⁹

Figure 3.7. Annual capital expense and benefits of adaptation intervention, by channel in % of medium-growth scenario baseline GDP



Source: World Bank estimations and IEc.

⁹ Liberia has a limited national IDA allocation of around US\$70 million per year and around US\$20 million accessible from the IDA regional window. As a moderate risk of debt distress country, Liberia has access to the IDA Scale-Up Facility (SUF) but drawing from it is constrained by the country's debt sustainability limits.

4. Selected Development and Climate Priorities

Key Points

- Liberia’s development and climate vulnerabilities are scattered across sectors and prioritization of interventions is needed.
- Deep-dive analyses reveal four thematic areas of intervention: (a) essential infrastructure needs in energy, water and sanitation, urban flood resilience, and transport and connectivity; (b) human development promotion through strengthened health and education systems; (c) sustainable landscape management in forestry, mining, and agriculture; and (d) cross-cutting enablers such as climate and disaster risk preparedness, climate resilience in the financial sector, and protecting carbon sinks while improving carbon market readiness

This chapter identifies several development and climate priorities that can boost Liberia’s resiliency to climate change and promote low-carbon development. The priorities selected are based on the findings of five deep dives or sectoral/cross-sectoral analyses that were identified through a stakeholder consultation workshop held in January 2023.¹⁰ To ensure ownership of the CCDR by the right agencies, the Ministry of Finance, Development Planning Department presented how the CCDR would contribute to the updated Pro-Poor Agenda for Prosperity and Development (PAPD) and how climate change will be included in the ministry’s national development planning exercise in 2023. The EPA discussed how the CCDR would contribute to the update of the NDCs for COP28. After these presentations, stakeholders were asked to rank five of seven proposed deep dives in order of their urgency for climate action and synergies with Liberia’s development objectives.

The following deep dives were selected: (a) the forests, energy, governance, and climate finance nexus; (b) building more sustainable cities and resilient infrastructure systems; (c) strengthening preparedness to climate shocks and disasters; (d) the food, water, and energy nexus; and (e) climate and health. Multisectoral teams across the World Bank and IFC carried out each of the deep-dive analyses, through literature review, data analyses/modeling (where possible), and discussions with sectoral experts working in Liberia. Deep dives outlined key climate challenges/vulnerabilities and priorities for intervention, including policy and institutional reforms and private sector opportunities, where applicable. Full deep dives are provided in the annex.

The 12 development and climate priorities examined in this chapter emerged across the deep dives (Table 4.1). They can be grouped into four thematic areas: (a) essential infrastructure needs, (b) human development promotion, (c) sustainable landscape management, and (d) cross-cutting enablers.

Table 4.1. Selected development and climate priorities

Theme	Priorities	Deep dives
Essential infrastructure needs	Decarbonizing the energy sector and supporting electrification scale-up	a, b, d
	Scaling safe WASH services	b, e
	Strengthening flood resilience in cities	b
	Expanding resilient transport and connectivity	d, e

¹⁰ Stakeholders included government officials and representatives from the private sector, academia, think tanks, UN agencies, development partners, and civil society.

Theme	Priorities	Deep dives
Human development promotion	Preparing the health system for climate-sensitive diseases	e
	Investing in the education sector	e
Sustainable landscape management	Adopting climate-smart agriculture practices	d
	Prioritizing forestry communities through sustainable forestry management	a
	Improving governance and regulation of mining activities	a, d
Cross-cutting enablers	Improving climate risk assessment, early warning, emergency preparedness, and disaster response systems	c
	Integrating climate considerations within the financial sector	a, c
	Protecting carbon sinks while improving carbon market readiness	a

While the public sector must implement reforms and ensure sustainable land and forest management, the role of the private sector cuts across the selected thematic and priority areas. It is up to the private sector to play a leading role in providing and financing innovative solutions. For instance, the power sector is essential for private sector activities. At the same time, achieving a sustainable development of these essential infrastructures requires strong private sector participation in co-investing in renewable energies to scale up electrification. Private sector intervention to scale up the development of innovative solutions such as clean cooking stove toward carbon credit will be key in reducing deforestation and emission. The private sector is well placed to advance waste collection and management toward renewable energy production while improving city environment. The private sector has also a role to play in WASH and human capital development to build labor skills that meet the market demand. Moreover, partnerships between the public and private sectors to build shared transport infrastructures are good practices that can be applied in Liberia to preserve both land and forest space while achieving development impacts.

4.1 Essential Infrastructure Needs

4.1.1 Decarbonizing the Energy Sector and Supporting Electrification Scale-Up

Liberia is still at a nascent stage of rebuilding its electricity infrastructure. The Emergency Power Program (2006–12), the 2009 National Energy Policy (NEP), and donor-funded programs have financed progress in the reconstruction and reform of the energy sector. The generating capacity of the Mt. Coffee Hydropower Plant (88 MW) and three heavy fuel oil (HFO) thermal plants (38 MW) allows Liberia to meet its short- to medium-term needs during the wet season. Because Mt. Coffee generation is highly seasonal, total available generation capacity falls to about 48 MW in the dry season, however. Access to electricity soared between 2010 and 2021 (albeit to still low levels), rising from 5 percent to 30 percent (8 percent rural areas 45 percent urban) (World Bank 2023). Liberia’s population is highly dependent on fuelwood, charcoal, and shrubs and grass for cooking, lighting, and heating. Limited access to electricity and cleaner cooking fuels and technologies drives demand for solid biomass (see Box 4.1).

Power sector emissions are low in Liberia and decarbonizing the sector is within reach, owing to the country’s early investment in hydropower and vast water resources. To inform the discussion on clean energy transition pathways, the study team conducted an exploratory analysis to identify the policy and investment priorities needed to achieve net-zero emissions by 2050. The team used the World Bank’s Electricity Planning Model to understand the implications of a no-thermal pathway on the capacity and generation mix given assumptions about demand growth and available technologies. It explored four scenarios: (a) status quo: Saint Paul 2 (SP2) dam is deployed, and new thermal plants are built; (b) SP2 without thermal: SP2 is commissioned in 2031, and no new thermal plants are built; (c) SP2 + VIA: SP2 is

commissioned in 2031, the VIA dam is commissioned in 2035, and no new thermal plants are built; and (d) net zero: SP2 is commissioned in 2031, VIA is commissioned in 2035, and emissions fall to net zero by 2050 (Figure 4.1).

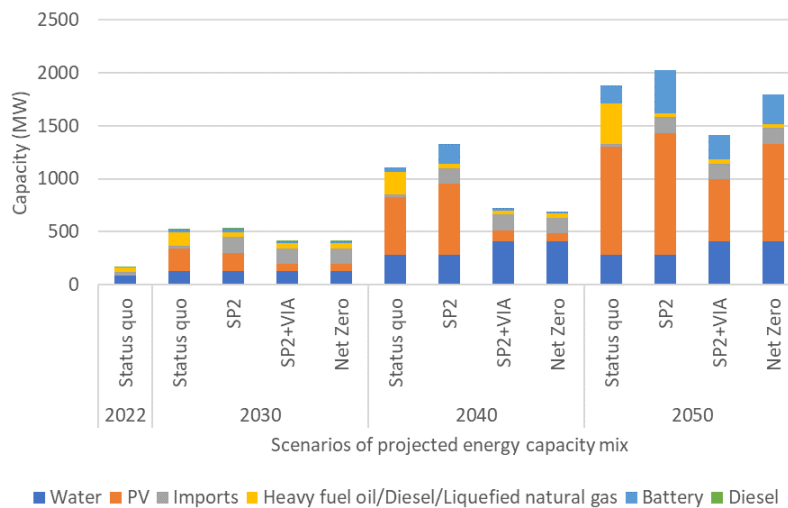
In the status quo scenario, emissions from Liberia’s power sector could increase to around 1 million tons a year in 2050—about six times the current level, as thermal generation and hydropower continue to be built while regional integration is limited. This scenario is unlikely, because the government has already chosen a no-thermal pathway and is committed to maximizing local renewable energy resources benefits rather than deploying new thermal plants. Realization of this scenario requires improving regional power trade with neighboring West African Power Pool (WAPP) countries and scaling up hydropower, given its high seasonal variability in Liberia. To balance the variability of hydropower, increasing import capacities is cost-effective in all scenarios; it is critical if no hydropower with a reservoir (like VIA) is built.

In the SP2 + VIA scenario, the power balance is more stable, as import needs are significantly reduced and the export potential is more stable. Investing in VIA would allow Liberia to displace thermal generation, use imports to meet demand during the dry season, and reduce oversupply during the wet season. In the short and medium term, the development of PV plus storage could also be a robust least-cost option. Solar energy plus a battery energy storage system (BESS) makes important contributions in all scenarios, providing half of all of capacity after 2030 (Figure 4.1). In the absence of hydropower with a reservoir (VIA)—that is, in the status quo scenario or if additional import options are delayed—PV + BESS is scaled up quickly, moving from almost none today to 70–300 MW in 2030.

Reaching net zero in the power sector in Liberia does not necessarily increase investment costs significantly, as the no-thermal pathway chosen by the government is already low emission. Total discounted investment needs in power generation reach US\$0.9 billion in the status quo scenario by 2050, rising to US\$1.4 billion in the net zero by 2050 scenario. Both the SP2 and SP2 + VIA scenarios are low-emissions scenarios for which investment needs and costs are close to the those of the net zero by 2050 scenario. Adding the carbon constraint to the SP2 + VIA scenario, for example, increases total cost by less than 1 percent.

Harmonizing the power sector’s regulatory framework with those of neighboring countries could improve regional power trade and optimize the use of renewable energy resources. To meet the need for increased interconnections and maximize the impact of new renewable capacity, Liberia will need to find offtakers in the region to deal with the large seasonal variability of its renewable resource. It will also need to create an enabling environment for privately led PV and storage deployment as well as for the management of water resources. Limited public funding and fiscal space remain a major barrier to funding large energy infrastructure.

Figure 4.1. Projected energy capacity mix in Liberia under five scenarios



Source: Based on data in World Bank ESMAP EPM model data 2023.

Box 4.1. Adopting the clean cooking agenda

About 90 percent of rural households use wood for cooking, and about 70 percent of urban households use fire coal or charcoal (LISGIS 2021). Dependence on solid biomass—which is readily available to many households and usually free—contributes to deforestation and emissions and increases households’ vulnerability to climate change (by making it harder to access forests, for example). Further, the majority of the population uses inefficient traditional stoves, such as locally made coal pots (49 percent) and three-stone stoves (48 percent) (World Bank 2017). Use of improved or cleaner cookstoves (such as stoves fueled by natural gas, liquefied petroleum gas, or solar power) is extremely low.

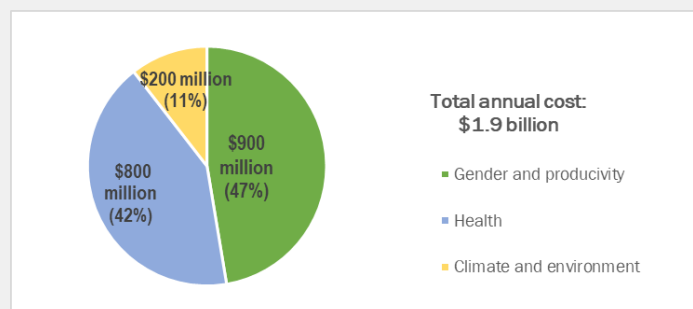
The burning of biomass fuels in unimproved cookstoves is estimated to cost Liberia US\$1.9 billion a year (Figure 4.2). These cookstoves produce GHG emissions and release pollutants such as PM_{2.5}, which have severe consequences for air quality and health. PM_{2.5} concentrations in Liberia are 10 times higher than WHO thresholds (see Error! Reference source not found.).¹PM_{2.5} has been linked to higher incidence of maternal and neonatal complications, respiratory diseases, cardiovascular problems, undernutrition, and other health problems (Cohen and others 2017). Women and children are disproportionately affected, because they are primarily responsible for cooking and therefore more exposed to toxic smoke¹ The combination of extreme heat—an expected climate change effect—and poor air quality increases health risks, particularly heat stroke and cardiovascular problems (Rahman and others 2022).

Implementation of the clean cooking agenda would help Liberians adapt to and mitigate the effects of climate change. Liberia’s NDC commits to making sure 60 percent of households currently using fuel wood or charcoal are supplied with energy efficient cookstoves by 2030, to reduce emissions by 588 Gg CO_{2e} per year. The energy efficient cookstoves in this context will be fueled with fuel wood or charcoal—but with higher efficiency (thus cooks faster and produces less smoke) compared to traditional cookstoves/technologies such as three-stone stoves (47.7 percent) or locally made coal pot stoves (49.1 percent) that are predominately used by Liberian households now. Increasing access to electricity makes it easier for households to transition away from solid biomass fuels, but it needs to be accompanied by a dedicated clean cooking agenda that offers affordable and desirable energy alternatives. Meeting the NDC goal will require annual investment of about US\$5.9 million. Supporting the development of the clean cooking market, which is still in its early stages in Liberia, requires working across sectors to address supply, demand, and enabling environment factors. Both

high-level political commitment and dedicated grant resources that can leverage public and private sector investments are needed.

Four clean cooking actions are priorities: (a) building institutional capacity and designating a leading agency to coordinate with other agencies, (b) formalizing cooking energy demand in national energy planning, (c) crafting a strategy for achieving universal access to clean cooking, and (d) scaling up public and private financing by collaborating with development partners and establishing incentive mechanisms that can attract private investments.

Figure 4.2. Estimated annual cost of burning biomass in unimproved cookstoves in Liberia



Source: World Bank.

Note: Costs are estimated as follows.

Gender and productivity: A factor multiple for annual time spent on fuel collection, cooking, and stove cleaning is applied to Liberia's proportion of primary fuels. This value is then multiplied by the value of a woman's time, which is conservatively set at US\$0.54 per hour.

Health: The cost of morbidity is the cost of one year of life lost to disability, including work absenteeism and medical treatment, from household air pollution. The cost of mortality is the cost of a life lost from household air pollution. Estimates of deaths and disability-adjusted life years (DALYs) are multiplied by per capita GDP expressed in purchasing power parity. DALYs are estimated at 5 times GDP per capita, and the cost of one death from household air pollution is estimated at 70 times GDP per capita.

Climate: A fixed carbon cost is applied to a global estimate of the carbon footprint of the current global cooking fuel mix. The social cost of carbon (the present value of all future damages to the global society of one additional metric ton of CO₂ equivalent GHGs emitted today) is set at US\$45.92. This cost value is then multiplied by a volume value to estimate the carbon footprint of the current global cooking-fuel mix (in tons of CO₂ per year).

4.1.2 Scaling Up Resilient and Safe WASH Services

Many Liberians lack access to basic WASH services. In 2020, 75 percent of Liberians had access to basic drinking water services (water retrieved from protected sources within 30 minutes of roundtrip access), and 18 percent had access to basic sanitation (structurally improved facilities that are unshared between households). Disparities between urban and rural regions and wealth groups are wide, however. Nearly all urban households have at least some water services. In contrast, about one-quarter of rural households lack services, obtaining water from lakes, streams, ponds, and other unprotected sources. Nearly 60 percent of rural areas practice open defecation (18 percent in urban). Access to handwashing facilities is virtually nonexistent, with 97 percent of households lacking a place to wash hands (WHO/UNICEF 2022).

The disease and social burdens associated with unsafe water and sanitation are high. Diarrheal diseases are the second-leading cause of mortality in Liberia (Vos and others 2020). Repeated exposure to fecal

pathogens also raises the risk of other complications, such as impaired intestinal function and undernutrition. Schistosomiasis, onchocerciasis (river blindness), and hookworm infections are rare globally but are endemic to Liberia. They have a complex etiology, caused by parasites found in a variety of vectors (including snails and insects), and are highly prevalent among populations that depend on surface water and/or practice open defecation (Esrey and others 1991). Standing water and poor drainage also create breeding grounds for mosquitoes, increasing the risk of malaria, the leading cause of death in Liberia. Lack of services also affects human capital, gender equality, and intergenerational poverty. Sick days, time spent collecting and managing water, and the absence of WASH facilities in public spaces reduce empowerment, employment, and schooling, disproportionately affecting women and girls.

WASH-related burdens are expected to increase under most climate scenarios. The modeling results presented in Chapter 3 show increases in mortality from diarrhea under both the wet/warm and the dry/hot climate scenarios. Hotter temperatures improve the survival and replication of several enteric pathogens responsible for the bulk of diarrheal cases in Sub-Saharan Africa.¹¹ During heavy rainfall and flooding, people are more likely to interact with sewage and contaminated surface waters or experience disruptions in WASH services, including from damage to water treatment and sewage and drainage systems. Reduced rainfall can concentrate fecal pathogens in drinking water and lead to unhygienic practices (Levy and others 2018). Climate change may also alter the abundance and spatial and seasonal distribution of parasites and their related vectors (De Leo and others 2020).

Liberia made slow progress in expanding basic access to WASH in the last two decades, despite developing numerous policy and strategy documents to shape the WASH sector.¹² In the 20 years between 2000 and 2021, basic water coverage increased by just 13 percentage points and basic sanitation increased by a mere 5 percentage points (WHO/UNICEF 2021). The Liberia Water and Sewer Corporation (LWSC), the utility tasked with WASH services in urban areas, underperforms in key performance indicators compared with its peers in the region.¹³ Several factors account for this slow progress and poor service delivery, including the lack of time-bound objectives, which makes monitoring and evaluation difficult, and policies that do not adopt recent Sustainable Development Goal (SDG) targets on water and sanitation. Despite creating a sector investment plan, Liberia has unclear budgetary allocation to the sector. A recent analysis reveals that only 1 percent of WASH spending was provided through public financing (the rest came from development partners). Moreover, although there are standards for water and sanitation facilities, service standards and tariff-setting guidelines are absent.

New water and sanitation service provision should aim to cover entire communities and integrate climate-responsive standards of accessibility, quality, and reliability, as recommended by the SDGs. They prioritize universal coverage of ‘safely managed’ drinking water and sanitation services over the basic access targets of the predecessor Millennium Development Goals (MDGs).¹⁴ Schools and hospitals should also adopt

¹¹ Most of these findings refer to bacterial and protozoal diarrhea. Viral diarrhea, including rotavirus, does not have clear links to warming temperatures.

¹² See the Water and Sanitation Policy (2009), the WASH Compact (2011), the WASH Sector Strategic Plan (2012–17), the Sector Investment Plan (2012–17), the Sector Capacity Development Plan (2012–17), the One WASH Program (2018), and the National Water Sanitation and Hygiene (NWSHC) Commission (2018).

¹³ Staff productivity is extremely low, with 66 staff per 1,000 connections—11 times the average for Africa of 6. At 52 liters per connection, Liberia’s daily water consumption is less than half the average for Africa (108 liters). The LWSC provides only 9.5 hours of water supply per day, less than half the African average (20 hours). The percentage of nonrevenue water, or water loss, is more than twice the African average (79 percent versus 34 percent, respectively).

¹⁴ Access to safely managed water means access to a structurally improved drinking water facility that is accessible on premises, free of fecal and priority chemical contamination, and available when needed. Access to safely managed sanitation means that people use structurally improved sanitation facilities that are not shared with other households and that excreta/wastewater is either treated and disposed of in situ or safely transported and treated off-site.

WASH targets. The SDG targets seek to develop transformative infrastructure that can help people mitigate and adapt to extreme water-related events and respond more effectively to the needs of a rapidly growing population. Water demand in Liberia, for example, is projected to quadruple between 2010 and 2050.¹⁵

Routine and representative monitoring data on drinking water quality, service intermittency, and the treatment of excreta and wastewater are urgently needed to understand the main service delivery gaps and identify needed interventions. National estimates of safely managed WASH coverage are unavailable because of the absence of monitoring data on major indicators. Data on other metrics, however, suggest that coverage is extremely low. Most Liberians (85 percent) travel off-site to collect drinking water, less than 5 percent use piped water, and less than 1 percent of households are connected to sewerage systems (WHO/UNICEF 2022). Only about half of all schools have access to at least one improved drinking water source, and a little over a quarter have access to an improved single-sex sanitation facility. There are no hygiene/handwashing data for schools or health care centers (WHO/UNICEF 2022), but estimates suggest that nearly half of health care facilities have no water services and about 27 percent have no or only unimproved sanitation facilities. Liberia can improve monitoring by adopting standardized indicators of WASH access (including indicators on water quality and wastewater treatment), undertaking annual performance reviews of water and sanitation utilities, institutionalizing water point mapping across the country, and conducting dedicated monitoring efforts of the unique service delivery gaps and needs of informal urban settlements.

Accelerating progress will require stronger sector leadership and more clearly defined roles in policy formulation, regulation, monitoring, service provision, capacity building, and financing. The NWSHC/WASH Commission created a strategic plan in 2019, but capacity constraints have prevented it from establishing itself as a regulatory body. Instead, it has begun to expand into service delivery (World Bank 2021). The LWSC complicates the regulatory landscape by regulating commercial water producers, including tariff setting. The government should define clear roles and coordination mechanisms at the national and local government levels. It is also vital to build technical and managerial capacity in sector institutions and county administrations and ensure that they receive sufficient funding to fulfill their mandated functions. Liberia can improve its financing strategy by reporting annual sector financing, updating the WASH Sector Investment Plan (last produced in 2012), defining clearer roles for the private sector, and exploring performance-based financing.

4.1.3 Strengthening Flood Resilience in Cities

More than half of Liberia's population (53 percent) lived in urban areas (defined as areas with at least 2,000 residents) in 2021, up from just 19 percent in 1960.¹⁶ Between 1985 and 2015, the built-up area doubled, from around 300 km² to nearly 600 km².¹⁷ Greater Monrovia accounts for 56 percent of the urban population. The next most populous cities are Buchanan, Ganta, Gbarnga, and Kakata.

This urban expansion increases vulnerability to flooding, because urbanization has been unplanned and uncontrolled, resulting in increasing numbers of people and assets in flood-prone areas. Monrovia is already the wettest capital in the world, with average annual rainfall of over 5 meters. Greater Monrovia incurs direct annual losses of about US\$22 million from pluvial flood events alone, nearly 90 percent of the

¹⁵ Municipalities accounted for 87 percent of total withdrawals in 2010; demand is projected to rise by 238 percent by 2050.

¹⁶ Many areas categorized as urban lack the infrastructure, health care, public utilities, and educational services of a functional city (UN-Habitat 2017). Statistics are from the World Bank's AFR DRM Analytics team presentation.

¹⁷ Ibid.

country's total annual flood risk. Losses from pluvial flooding are projected to rise from 0.7 percent of GDP in 2020 to as much as 1.26 percent of GDP by 2050 (depending on the socioeconomic and climate change scenario). Flooding is projected to damage at least 5 health facilities, 98 schools, and 154 km of road infrastructure a year by 2050.

Coastal flooding is considered a secondary flood risk, but rising sea levels and coastal erosion have increased it, especially in Greater Monrovia and the surrounding Mesurado wetlands. West Point, New Kru Town, and areas north of the St. Paul River mouth have experienced significant coastal retreat. The coastline of New Kru Town, for example, has been eroding by 2–3 meters a year over the past 30 years, leading to a staggering 50- to 100-meter retreat over that period. Projections suggest that a 1-meter increase in sea level rise could submerge about 95 km² of Liberia's coastal zone by the end of the century. About half of this inundation is expected on sheltered coasts (shorelines facing smaller bodies of water) and shoreline retreat areas. More than 230,000 people are at risk, and 2,150 km² of land could be lost. Projected damages and losses (infrastructure and land) to cities such as Monrovia, New Kru Town, River Cess, Buchanan, and Robertsport are estimated at US\$250 million (2017 estimates).

Smaller but growing cities also face increasing flood risks. Ganta, Gbarnga, and Harbel are experiencing booms in built-up areas. Detailed flood maps are available only for Greater Monrovia, but estimates for the entire country based on the distribution of GDP suggest that between 2030 and 2064, pluvial flood risk could increase by 10–40 percent above baseline across all considered climate change scenarios (8–4 percent in the mildest climate change scenario [SSP1-19] and 15–40 percent in the most extreme climate change scenario [SSP3-70] considered).

Unmanaged growth of Liberia's cities is increasing flood risks, as more people and assets expand into low-lying flood plains and wetlands. More than 60 percent of Liberia's urban population live in informal settlements, where they are highly exposed to natural hazards. Because of limited availability of land in Greater Monrovia, people often purchase plots illegally in protected wetlands, filling in the plots with waste and other fill material. During the rainy season, these dwellings become waterlogged and flood (Figure 4.3). Unplanned urban expansion also leads to deforestation, mangrove destruction, and sand mining. Replacing ecosystems that absorb rainfall and storm surge with infrastructure that increases surface runoff elevates the risk of flooding.

Figure 4.3. Aerial view flooded homes in Clara Town during the rainy season



The government's capacity to enforce land use plans to mitigate flood exposure is limited. Urban planning legislation is outdated, and the capacity to carry out and enforce development planning is weak. The Zoning Act for the City of Monrovia (1979) was meant to guide the growth of Monrovia and other cities. The zoning map for Monrovia was misplaced during the war, however, and the act was never applied. In 2016, Liberia passed the LLA Act, which transferred all land-related activities, including land use planning and zoning, from various central government institutions to the LLA. However, some planning and zoning functions have

not yet been fully transferred to the LLA. The Local Government Act of 2018 requires the establishment of planning bodies within local government structures. Under it, local governments are to be given more authority and financial independence to initiate an inclusive planning process to halt the ongoing sprawl and the encroachment of protected and restricted areas. The Land Rights Act (2018) creates specific land categories that are to be protected by all relevant government entities. However, there is no building code for Liberia; international standards are used on an ad hoc basis.

Comprehensive spatial planning using detailed flood hazard and risk maps for urban environments should be prioritized. In the short term, land use and zoning regulations could be improved, zoning maps and spatial plans developed, and new building codes for resilient construction (based on the likelihood of flooding now and in the future) written and enforced, to increase the housing density of the safer areas of Greater Monrovia. Other useful measures that could be adopted over the medium term include capturing low-risk land value, building higher-density housing developments, taxing unused/underused land in safer zones, and creating no-build zones in higher-risk areas. However, the absence of a complete legal cadastre makes application of these policy instruments difficult, as land and property owners that could be targeted are not known.

Improving stormwater drainage in cities is essential. Inadequate stormwater drainage is a major challenge in urban centers. In Monrovia, for example, the low gradient between most of the land and the open water means that flood water drains slowly and often stagnates. Most communities lack interconnected drainage networks, so isolated areas can remain under water until the water either infiltrates or evaporates. Even in the dry season, patches of water remain in slum settlements. Isolated inundation of the road network occurs throughout the city, disrupting road transportation, primarily because of inadequate road drainage. Recurrent sewage overflows in the streets of Monrovia from storm water/runoff reduce the availability and compromise the quality of surface water supply. A drainage system that links traditional concrete drainage of roads with wetlands and open water areas could create temporary storage for stormwater. Preserving open green spaces and creating effective links and outlets could improve the drainage of pluvial flood water.

Coastal flood and physical riverine defense structures would help prevent coastal and fluvial flooding. Coastal flood defenses are physical structures designed to reduce the likelihood of waves overtopping the beach and inundating areas inland. The United Nations Development Programme (UNDP) and Liberia's Ministry of Environment initiated a coastal risk assessment and feasibility study focused on West Point and New Kru Town. The report recommends placing stone revetments on the beach to prevent further coastline erosion. Similar infrastructure projects may need to be considered along built-up coastal areas. Physical riverine defense structures may also be necessary to reduce the fluvial flood hazard of major rivers. Measures could include river embankments and an operational sluice to keep high flows in the river channel. Upstream storage in a series of reservoirs in the upper catchment might be more cost-effective and even provide dry season flows for hydropower generation. Although expensive, it may also be possible to store monsoon river water in the flood plain above the Mt. Coffee hydropower reservoir.

Improving the O&M of solid waste management systems and flood management infrastructure is critical but overlooked and underfinanced. Urban stormwater drain systems in Greater Monrovia—such as the Sonniwein, an extensive concretized open drain built in the early 1970s—have not been well maintained; they need to be cleaned and repaired regularly. Engineered and natural drainage throughout the city is clogged with waste. Waste and plastics represent an enormous challenge in all Liberian cities, clogging waterways, and drainage channels, especially in Greater Monrovia. Improper waste disposal also

contributes to emissions. The sector is severely underfinanced. As waste management is a core mandate of city governments, they rely heavily on central government transfers to sustain the systems. If sufficient financing is not provided to support the O&M of the solid waste management system and flood management infrastructure, it quickly becomes ineffective, making the up-front capital investment a waste of money.

Narrowing infrastructure and service gaps, particularly for the poorest Liberians, would strengthen climate resilience in urban centers. Greater Monrovia grapples with immense infrastructure challenges related to transportation, WASH, solid waste management, electricity, and digital connectivity. Outside Monrovia, piped water, sewer systems, paved secondary roads, and engineered drainage systems are essentially nonexistent. Waste is dumped illegally and burned, frequently ending up in the drainage system, where it blocks the flow of water and intensifies flooding. Data collected in Greater Monrovia suggest that only 45 percent (800 tons) of domestic waste is collected a day—among the lowest collection rates in Africa.

Policy makers need to recognize that urban dwellers with limited resources or services to mitigate their vulnerability will continue to live in areas prone to medium to high flood risks. Immediate strategies to reduce their vulnerability include enhancing living conditions in slum areas, fortifying housing against flooding, providing solid waste management services, and mitigating the risk of post-flood waterborne diseases by improving WASH services (discussed earlier).

Given the large share of Monrovia’s people who live in highly flood-prone areas, helping communities ‘live with water’ makes sense. Simple, low-cost community-level measures to reduce exposure and vulnerability include the following: (a) build community-level awareness as the basis for all other activities; (b) adopt building codes for more resilient structures above flood levels; (c) use simple, standard construction designs for reinforced concrete piles and wooden board walkways and raised building foundations; (d) improve WASH facilities, to reduce the risk of post-flood waterborne diseases; (e) create simple, locally appropriate community-level flood response plans (communication should be in local languages); and (f) assess and narrow gaps in green, blue, and grey infrastructure. Dealing with backlogs should be the immediate and short-term priorities for interventions and investment.

4.1.4 Expanding Resilient Transport and Connectivity

Transport and connectivity are of poor quality. Liberia’s road density is officially estimated at 13.42 km of road per 100 km², below the average for Sub-Saharan Africa but generally sufficient in terms of coverage (World Bank 2018). A recent Road Sector Development Plan (RSDP) funded by the World Bank in 2023 identifies 11423 km of roads, 2,448,884 bridges, and 7,593,651 culverts. Although this coverage in theory can provide transport mobility across the country, quality remains low. Just 6 percent of roads are paved (most of which are around Monrovia and at least well maintained). Further, 60 percent of unpaved roads, 50 percent of bridges, and 25 percent of culverts are classified as either being in poor or very poor condition. These rough conditions primarily restrict rural accessibility. Current estimates suggest that at least 2.3 million rural people are not connected to a good road network. Accessibility is lowest (<10 percent) in Lofa county and the southwestern region where poverty is especially high (Iimi and Rao 2018).

Access to reliable transport infrastructure and services is a major challenge, in part due to the poor condition of road infrastructure which was not built to a durable standard or maintained. As per the World Bank rural transport study of the 2016, more than 2,958 villages are more than 2 km from an all-weather road in fair or better condition. These communities depend on tracks, trails, and footpaths. Approximately 0.5 million rural people must always start their journeys by walking 20–30 minutes before reaching a

reliable road. Walking is the primary mode of transport in rural areas; other transport modes include motorcycle use, National Transit Authority (NTA) buses, private buses, minibuses, taxis, pickup trucks, and jeeps (if coming from/to poor roads), multipurpose freight trucks, and motorcycle taxis (mainly for short-distance local transport). Motorcycles can transform rural transport if appropriate bridges are provided. Once people reach a road, there is the additional constraint of limited transport services (generally unpredictable, infrequent, and expensive), particularly on feeder roads.

The RSDP highlights the challenge of adequately funding road maintenance. The value of Liberia's road assets is equal to 73 percent of its GDP. This indicates that the economy is not capable of generating the funding necessary to keep the roads in decent condition. It is essential to ensure that the rate of development of the road network does not exceed the country's capacity to maintain the completed roads as inadequate maintenance, particularly of drainage, is a key factor exacerbating flood damage to road infrastructure. Moreover, as maintenance spending yields much higher economic benefits than spending on new construction or rehabilitation, prioritizing maintenance is critical to the physical and financial sustainability of the road network. This will ensure that economic benefits for the country are maximized through the focus on a core road network, that is, the key road links that provide mobility and connectivity to the population and serve their economic needs. The critical need for efficient mass-transport system provides an opportunity for the private sector to explore investment in shared infrastructure options such as Arcelor railway to speed up delivery and market access for both mining and agricultural products, coupled with high-speed rail system of intercity passenger ground transportation.

Road network improvements are vital to increasing climate resilience and stimulating private sector activities in the country. Less than half of Liberia's primary road network is in good condition, and the good condition primary road network has little redundancy. This means that a single climate or natural disaster affecting a primary road link can sever connectivity to significant parts of the country, resulting in high economic and social costs such as difficulty accessing markets or medical services. Secondary, feeder, and unpaved primary roads are often washed away or inundated during the monsoon season and can frequently become impassible. These significantly delay deliveries and production processes for businesses and households. Approximately 12 percent of the road network is located in flood-prone areas. Health care access is already restricted by rough roads and climate change effects may intensify this issue (in terms of both road damage and increased disease outbreaks projected with climate change). Almost the entire population lives within 20 km of some type of health facility. However, two-thirds of hospitals and other major health centers are not well connected to the population due to poor condition of roads (about 1,100 km of roads need to be improved for better connectivity to higher-level facilities) (Iimi and Rao 2018). Connecting major health facilities to the capital is especially critical given that Liberia's medical supply often comes through Monrovia. The climate resiliency of the agriculture sector is also hampered by low connectivity, which disrupts various value chains of production, collection, transport, and storage of agricultural products for local and export markets. Despite having plenty of fertile land, agricultural production is considered low and concentrated around Monrovia. Limited rural accessibility to the road network is highlighted as a main barrier to stimulating agricultural production.

There are opportunities for low-carbon interventions in the transport sector, but sustainable transport policies remain underdeveloped. Road vehicles are inefficient (with the majority of imports being at least 10 years old) and use low-quality fuel (low-grade diesel and mixed petroleum). While the bad road conditions and connectivity contribute to low fuel economy, it delays the country's economic development, suggesting that a climate-smart and efficient transport network system could play a business accelerator and stimulate private sector-led growth in Liberia. Monrovia is expected to become more congested and

polluted because of the growing concentration of firms and population. The NDC targeted transport as a primary sector for mitigation and identifies interventions such as the introduction of electric vehicles, the NTA buses and private vehicles' transition to compressed natural gas, mass transit systems, improved regulation of vehicles, and promotion of diesel particulate filters. However, the Ministry of Transport (MoT) needs to lead a sustainable transport policy along with other agencies such as the Ministry of Public Works (MoPW), EPA, Liberia Civil Aviation Authority (LCAA), and the National Port Authority (NPA). Such a policy must overcome severe fiscal resource constraints and large gaps in transport and energy infrastructure. This requires not only prioritizing to use government funds and existing infrastructure more efficiently but also insuring private sector participation. In Monrovia, measures that provide safe conditions for nonmotorized transport, improve management of public transit services, ensure efficient management of urban road rights of way, and support increased private investment in bus services should be prioritized. As in other countries in the region, stricter enforcement of vehicle import age restrictions is vital to containing pollution.

4.2 Human Development Promotion

4.2.1 Preparing the Health System for Climate-Sensitive Diseases

Extreme weather events negatively affect the health of Liberians. Heavy rainfall events have triggered flooding in Liberia, with negative effects on food security, disease transmission, and access to health services. In rural areas and slums in Greater Monrovia, for example, floods, combined with lack of formal water supply, inadequate sanitation services, and poor drainage, perpetuate the burden of vector-borne diseases (for example, malaria and neglected tropical diseases) and increase the risk of disease outbreaks (for example, viral hemorrhagic fevers and cholera). Increases in rainfall-triggered flash floods coupled with poor road infrastructure and weak health systems reduce access to health facilities and delivery of health services, particularly for rural and remote populations.

The consequences of climate change are challenging Liberia's health systems, which are already strained by tremendous health burdens. Liberia's maternal mortality rate (742 deaths per 100,000 live births) ranks among the highest globally, and neonatal mortality (37 deaths occurring in the first 28 days of life per 1,000 live births) accounts for a third of all under-five deaths. Many leading causes of death and disability in Liberia are climate sensitive; climate variability is likely to increase their incidence in the mid to late twenty-first century. In 2019, malaria accounted for 15.4 percent of all deaths in Liberia, diarrheal diseases for 7.9 percent, neonatal disorders for 7.5 percent, and lower respiratory infections for 6.5 percent (IHME 2021). Chronic undernutrition is also widespread, with 30 percent of children under five experiencing stunted growth (LISGIS 2021). These figures stand to increase, as climate change reduces food security.

Liberia's health system has been weakened by repeated shocks from civil conflict and disease outbreaks (namely, Ebola virus disease [EVD] and the COVID-19 pandemic). These events have taken massive tolls on the health system. During the civil wars (1989–1997 and 1999–2003), 242 of Liberia's 293 health facilities were destroyed, and migration and death ravished the health workforce. Between 2014 and 2016, Ebola infected an estimated 10,678 people and claimed 4,810 lives, including those of 375 health workers (Dahn and others 2021). The need to control EVD (and later COVID-19) outbreaks disrupted the delivery of routine health and nutrition services.

The government has prioritized the health sector, increasing government spending on health from 8 percent of general government expenditure in 2007/08 to 13 percent in 2018/19. EVD prompted the

government to undertake several steps to improve prevention, preparedness, and response (PPR) to health emergencies. Through World Bank support, the government has accessed funds for PPR through the Ebola Emergency Response Project, the Regional Disease Surveillance Systems Enhancement (REDISSE) Project, and the COVID-19 Emergency Response Project. These projects contributed to the implementation and strengthening of the One Health approach, which lies at the interface of human, animal, and environmental health; disease surveillance; and laboratory systems for diagnostic capacities. The government also developed and implemented a number of policies and strategic plans on health and nutrition, including PPR. They include the National Health Policy and Investment Plan (2011–21), the successor National Health Sector Strategic Plan (2022–26), the National Action Plan for Health Security (NAPHS) 2018–21, and the successor NAPHS (2023–27) which is currently under preparation. The new NAPHS is expected to streamline efforts anchored in the One Health approach and highlight the need for coordinated activities with the animal and environmental health sector. Liberia established the National Public Health Institute of Liberia (NPHIL) in 2016, to dedicate one institution solely to addressing emerging and re-emerging diseases. The NPHIL works in collaboration with the Ministry of Health, the Ministry of Agriculture, and other agencies on the PPR agenda.

The government has taken steps to enhance the functionality of the health system. Liberia’s Health Workforce Program Strategy (2015–21), for example, drew on the learnings from the EVD response, focusing on reducing barriers to medical training, formalizing new cadres of community health workers, establishing regulatory bodies, improving clinical infrastructure, and enhancing infection prevention and control (IPC) protocols. As a result, the health workforce has increased to an estimated 11.8 health workers per 10,000 population in 2016 (Dahn and others 2021). The National Community Health Program has scaled up the community health workforce to almost 4,500 community health assistants (CHAs), over 450 community health services supervisors (CHSS), and over 5,000 community health volunteers (CHVs) (CHW2023). Among the responsibilities of this community health workforce is the delivery of key prevention, diagnosis, and treatment of malaria and diarrheal diseases. The World Bank has supported the strengthening of health infrastructure and the community health workforce through the Liberia Health Systems Strengthening Project (HSSP) and the Institutional Foundations to Improve Services for Health (IFISH) project.

While there has been a lot of progress in strengthening PPR and the broader health system in Liberia, significant systemic gaps still remain. Given the country’s weak fiscal position, financing of health programs in Liberia is largely dependent on households through out-of-pocket spending followed by external financing. The country faces challenges in absorbing and retaining the multidisciplinary workforce trained for both PPR and service delivery. Moreover, weak infrastructure limits PPR core capacities and service delivery. PPR efforts in Liberia should strive to (a) strengthen surveillance systems from the peripheral to central levels, (b) detect health threats early through speedy specimen transfer, and (c) control disease through IPC measures. Current efforts to enhance access to health services include Liberia’s community health program, which is designed to link CHAs in the periphery with CHSSs at facility levels. The efficacy of these PPR and health systems initiatives is contingent on good roads, internet, electricity, and/or water, which are inadequate or nonexistent in several parts of the country (as detailed elsewhere in the report). These shortcomings are perpetuated by systemic weaknesses in the stewardship and leadership of government institutions, inadequate accountability mechanisms, and limited coordination within and outside the health sector.

Climate challenge will exacerbate the challenges faced by Liberia’s PPR and health systems. Floods and windstorms are already straining Liberia’s infrastructure. Rising temperatures and changes in rainfall will

also likely increase the country's disease burden. Liberia has made commendable progress toward reducing the malaria burden. Between 2007 and 2021, a 67 percent reduction in malaria deaths was observed in the national health management information system (US PMI 2023). The percentage of children ages 6–59 months who tested positive for malaria by rapid diagnostic test (RDT) fell from 45 percent in 2016 to 18 percent in 2022 (NMCP and ICF 2023). These declines can be attributed to nationwide use of insecticide-treated bed nets, improved access to malaria testing, and treatment. This progress notwithstanding, malaria remains the leading cause of morbidity and mortality in Liberia, and climate change is likely to increase its incidence. Climate change has a complex relationship with malaria distribution.¹⁸ The main hypothesis for its spread is that warmer temperatures create more suitable breeding grounds for *Anopheles* mosquitoes (Tanser and others 2003). Hotter temperatures and fluctuating water security also increase the spread of fecal pathogens, especially in the context of weak WASH, flood management infrastructure, and public health facilities. The modeling results in Chapter 3 show an increase in malaria mortality under the wet/warm scenario and a decrease in the dry/hot scenario; diarrheal mortality increases under both the climate scenarios. Unaccounted drivers such as land use changes for irrigation and unplanned urban growth may also increase disease transmission.

A detailed analysis of the health, economic, and social implications of climate change and the adaptive capacities of the health system, including an assessment of geographic risks, should be undertaken. The CCDR analysis on climate-sensitive risks was restricted because monitoring data were available for limited diseases and subnational levels. Evidence on effects of climate change on Liberia's health system is lacking. For example, climate-related disasters in neighboring countries may cause a flow of refugees. Heavy rains, storm surges, sea level rise, extreme heat, and increased erosion affect not only the well-being of people but also the health and habitats of animals, raising the risk of zoonotic disease spillover and reducing livestock. Cost assessments of climate and health damages can help policy makers understand the scope of the problem and induce them to advocate for strengthening health systems and implementing multisectoral interventions. It will be important to integrate and strengthen surveillance of climate-sensitive diseases and environmental exposures into existing surveillance systems, to improve modeling and inform local decision-making on PPR efforts.

Improved governance and coordination between the central government, the Ministry of Health, the NPHIL, and other agencies and among decision-makers at both the central and county levels are essential. It will require (a) integrating health into national-level climate adaptation planning, particularly future iterations of Liberia's NAP; (b) integrating climate adaptive interventions in the NAPHS 2023–27, which is being developed; and (c) integrating climate adaptive and mitigation measures in the Health Workforce Program; and (d) through the One Health platform, establishing coordination channels to ensure effective implementation and monitoring of adaptive and mitigation measures.

Interventions for addressing the changing burden of disease will need to resolve key bottlenecks in PPR and health systems, including basic infrastructural challenges. Efforts to strengthen capacities to prevent, detect, and respond to health threats and improve service delivery, particularly at the periphery, should be accompanied by targeted, concerted improvements in infrastructure (including roads leading to health facilities, emergency operation centers (EOCs), laboratories, and WASH for IPC at health facilities). For

¹⁸ Higher temperatures, which are projected across Liberia, have the strongest link to habitat suitability; the effects from changing precipitation patterns and flood events are mixed. Although more rainfall can increase the presence of stagnant water, which attracts mosquitoes, extreme rainfall events may wash away or destroy existing breeding grounds. There is also debate on how climate change would affect the distribution of *Anopheles* mosquitoes, with some evidence suggesting that the distribution would expand across all areas and other evidence suggesting that various *Anopheles* species would instead migrate to new areas that were previously unsuitable for their survival, especially places at higher elevations (Tonnang, Kangalawe, and Yanda 2010).

example, as Liberia rolls out the malaria vaccine to complement disease control efforts, it needs to consider the inputs required for delivery. The malaria vaccine should be maintained at a temperature of 2–8°C. Cold chains from the central to the peripheral levels will need to be fortified, through improvements in electrification (described elsewhere in the report) and innovations such as cold boxes/carriers for CHAs and CHSSs. Lessons learned from the COVID-19 vaccination process will need to be applied during the rollout of the malaria vaccine.

The impacts of climate change on Liberia’s malaria and diarrheal disease burden will require targeted strengthening of the country’s community and primary health care systems. Household water treatment (boiling, chlorine, filtration, solar disinfection) and handwashing are among the most effective ways to reduce diarrhea in low-resource settings (Wolf and others 2022). But 75 percent of Liberia’s population does not treat drinking water, and 97 percent do not have access to handwashing facilities (LISGIS 2021; WHO/UNICEF 2021). The community health system could become overburdened if no additional community-level investments are made to support the delivery of WASH, surveillance, vaccination, and treatments for malaria and diarrheal diseases. The government will need to address key constraints in its community health program. Actions include ensuring adequate training and supervision of CHAs for their increasing roles/responsibilities, paying CHAs incentives on time, and providing protection and transportation of CHAs particularly in harsh environments.

4.2.2 Investing in Education

Liberia’s poor education system is the primary driver of its low human capital (other drivers include poor health and nutrition). It accounts for 41 percent of productivity losses. Repeated humanitarian crises destroyed and closed schools, perpetuating cycles of dropout and low enrollment. School enrollment rates are low: 15–20 percent of children ages 6–14 years are not enrolled in basic education, and only 54 percent of children complete primary education (UNICEF 2023). On average, children in Liberia receive 4.4 years of schooling by their 18th birthday; adjusted for the quality of learning, this figure falls to just 2.3 years of learning, the lowest value in the world (World Bank 2021c). Inadequate facilities, the paucity of learning materials, and the small size and insufficiently trained teaching workforce are significant barriers to improving the quality of education.

Climate change may significantly erode learning and school attainment in Liberia. A growing body of global evidence shows that high temperatures lead to lower learning and attainment. Data from 60 countries show that each 1°F increase in temperature during the school year reduces learning by 1 percent (Park and others 2022). Studies from the United States and China find that students who take examinations on hotter days perform worse and are less likely to graduate than students who take examinations on days when temperatures are more moderate (Park and others 2022; Zhang, Chen, and Zhang 2021). Temperature increases and episodes of extreme heat are expected throughout Liberia. Extreme weather events can reduce children’s ability to go to or stay in school as well as their ability to learn. Flooding—which is projected to become more frequent in Liberia—has led to decreased attendance and increased dropout in other countries (Ahmed and others 2022; Mudavanhu 2015). Windstorms, which have damaged schools in Liberia in recent years, pose significant threats to school infrastructure. (

A strong education system can provide the skills and knowledge that increase the population’s ability to understand and navigate climate change effects. Worldwide, educational attainment is the single best predictor of climate change awareness and is strongly correlated with concern for the environment, climate-friendly behaviors, and support for policies that benefit the environment (Lee and others 2015). *The Global*

Education Monitoring Report estimates that closing the financing gap in education in low- and middle-income countries could reduce global emissions by 51.5 gigatons by 2050 (UNESCO 2020), because better-educated people are more likely to possess the skills and knowledge needed to adapt to and manage climate-related risks.

‘Climate change literacy’—awareness of climate change and understanding of its causes—is weak in Liberia. According to a 2021 study, only 37 percent of the population in Africa and less than 30 percent in Liberia are climate change literate. Education is the strongest predictor of this metric (Simpson and others 2021).

A systematic diagnosis of how prepared the education sector is to face short- and long-term climate change risks and shocks could serve as the basis for detailed plans to address the impacts of climate change on education and use education to help Liberians adapt to climate change. Strong education information systems are lacking in Liberia, and data collection on key education statistics needs to be strengthened. Schools can help communities adapt to climate change and become more resilient. An emergency and resilience plan, for instance, could train and prepare school principals and teachers to lead evacuations and inform communities at the onset of extreme weather events and use schools as shelters and community hubs during climate-induced emergencies.

Infrastructure investments can help make schools more resilient to extreme weather events, especially in flood-prone areas. Cost-efficient investments such as better ventilation help schools adapt to extreme heat. More significant investments in the medium and long term could help improve school safety and climate resilience through storm, flood, fire, and seismic resilience measures.

A strategic plan should be developed to offer programs of study in technical and vocational education and training (TVET) and higher education that support a green transition. TVET can accelerate a green economic transformation by fostering green skills (such as those needed in the renewable energy, mining, and agriculture sectors) and serving as innovation hubs for climate change solutions. Study programs on the energy sector should be strengthened so that they respond to climate change-related demands, including skills in demand by renewable energy industries. Training should align with the demand for higher-skilled jobs, as mechanization and disruptive technologies increase in sectors such as mining and manufacturing.

4.3 Sustainable Landscape Management

4.3.1 Prioritizing Forestry Communities through Sustainable Forestry Management

Liberia’s forests face growing threats of deforestation, degradation, and fragmentation as the country experiences population and economic growth. Two-thirds of Liberia (69 percent) is covered with forests, making Liberia one of the most forested countries in West Africa (FDA 2021). The annual rate of tree cover removal has steadily increased since the end of the second civil war (see **Error! Reference source not found.**). With the restoration of peace, rural development and rehabilitation projects of infrastructure have increased in forested areas. Logging, mining, and agriculture—all economic engines of growth—have also formally and informally claimed new areas. Formal forestry activities, primarily commercial logging, contribute 10 percent of Liberia’s GDP, and informal chainsaw logging accounts for another 3–4 percent (Agyeman and others 2022).

Climate change is expected to further degrade forest resources and biodiversity. Rising temperatures and unpredictable rainfall is expected to erode soil quality, introduce new pests and disease, reduce tree growth

and biomass, and restrict access during extreme weather events (Agyeman and others 2022). If action is not taken, the value of one of Liberia’s most important resources could decline.

The loss of forests is especially dangerous in a country in which a large share of households depend on them. Nearly half of Liberia’s population—including many of its poorest people—live within 2.5 km of a forest. In 2018, the average annual household income for this group was estimated at US\$783—less than one-third of the already low national average of US\$2,441 (World Bank 2020). Liberians use forests to generate income and meet their energy, food, and housing needs. Fuelwood, poles, bushmeat, rattan, and fronds are among the top forestry products collected. About 70 percent of forest-proximate households participate in at least one forestry activity and, on average, earn 35 percent of their annual income from forestry products. About 43 percent of them reported clearing forested land in the five years before being surveyed, with the majority using the cleared land to plant crops such as rice, cassava, and cocoa (World Bank 2020). Nearly half of them report using forestry products to cope with economic and natural shocks, especially increased food prices (World Bank 2020).

Comprehensive strategies that focus on the needs of forest communities are needed. The approach should aim to alleviate poverty and enhance resilience by reducing Liberians’ over-reliance on forests and generally supporting development and adaptation activities needed across the country. These strategies could include (a) developing skills and capacity that would allow households to engage in non-forest-related income-generating activities; (b) supporting the transition to agroforestry and sustainable agricultural practices, to enhance food security while preserving the forest ecosystem; (c) implementing social safety net programs tailored to forest households, to boost resilience during times of stress, when they are most likely to use forestry resources in unsustainable ways; and (d) scaling and improving basic infrastructure and services (roads, electricity, housing, water and sanitation, health services, and schools).

Apart from basic development interventions, forestry communities would benefit from stronger sector governance that protects community interests and improves regulation and enforcement on the sustainable use of forests. Forestry management has historically favored commercial interests over the needs of local communities. The rapid expansion of commercial forestry in the 1960s and 1970s increased corruption, hurt the environment, and disregarded community interests (Agyeman and others 2022). Timber exports funded the civil wars, resulting in UN sanctions on Liberian timber exports from 2003 to 2006. After the civil war ended, the government, in partnership with the international community, introduced the Liberia Forest Initiative, under which it implemented laws that increased transparency, accountability, and governance in logging, to lift sanctions and promote sustainable forest management.

Although the government adopted a ‘3C’ approach, which aims to balance the interests of commercial enterprises, conservation, and communities, community participation in forest management and support to forestry households remain low. In the past decade, the government shifted its focus from commercial logging to community forestry, with the Community Rights Law (2009) and its related implementing regulations (2017) serving as the legal foundation. The shift increased timber harvests in community-managed forests but has had only a limited effect on conservation and community empowerment. Just a quarter of forest communities report participating in any forestry management programs in the five years before being surveyed, for example, and less than 20 percent report receiving any external inputs, such as training, product processing assistance, or fertilizers and seedlings (World Bank 2020). Most communities that sell timber, bushmeat, and gold (the top cash-generating products in forest communities) are not aware of formal regulation (World Bank 2020). Regulatory capture by logging companies means that community members have limited input in the awarding of logging contracts, which still lack transparency.

Forest Law Enforcement, Governance, and Trade (FLEGT) and REDD+ have been the main international initiatives driving reforms of forest governance in Western Africa.¹⁹ These initiatives have engaged and trained non-state actors to monitor the forest, advocate for local communities, and interact with government institutions at the local and national levels. Efforts have been concentrated within a limited number of NGOs working at the national level, however; more engagement is needed with local-level non-state actors and civil society groups, including associations of forest dwelling communities, farmers, small forest-based enterprises, local authorities, women, youth, and other marginalized groups, to ensure that the benefits from FLEGT and REDD+ are widely shared. Further discussion on strengthening REDD+ implementation is provided in a later section on protecting carbon sinks under ‘cross-cutting enablers’ (Tropenbos International 2018).

A primary challenge to sustainable forestry management lies in the limited capacity of its two principal governing bodies, the EPA and the Forest Development Authority (FDA). The EPA, based in Monrovia, is the main agency in charge of implementing the EPML. It focuses solely on environmental protection and has no profit incentives (it does not grant concessions). The FDA enforces the New Forestry Reform Law. It maintains a presence outside the capital, monitoring the movement of timber and other forest products across the country. It also facilitates commercial logging and thus faces some degree of profit-seeking incentives. Reporting lines within the FDA are not clear, and some of its units do not cooperate smoothly (World Bank Group Forest Carbon Partnership Facility 2013). In 2007, EPA and FDA signed a memorandum of understanding on collaboration. The document expressed commitment on collaboration but did not describe operationalization.

Transparency and accountability need to be increased. The New Forestry Reform Law introduced transparency provisions for commercial forestry and generated revenue. Under the law, operators offering bribes may have their concessions revoked. However, capacity limitations, such as poor rural infrastructure, prevent the FDA from enforcing these provisions.

Several measures could increase transparency in the forestry sector. They include (a) making the FDA public databases comprehensive and up-to-date, (b) expanding LEITI’s remit to cover more than just commercial forestry, (c) making information from the LibFor chain of custody system public, and (d) expanding the capacity and resources available to the General Audit Commission to facilitate the timely auditing of the FDA.

Interministerial coordination and engagement with local governments also need strengthening. Collaboration between the FDA, the Liberian National Police, and the Ministry of Justice needs to be increased to boost accountability and strengthen law enforcement in the forestry sector. The FDA should engage with the Ministry of Mines and Energy and the Ministry of Agriculture and the LLA to resolve possible conflicts of interest over carbon sequestration and extraction of mineral and agricultural resources on forest land, respectively (World Bank 2020). The lack of interministerial coordination on sectoral planning and a clear process for medium- and long-term land use planning complicates management of Liberian forest areas. Although land use and management functions, including land use planning and zoning, were legally transferred to the LLA in 2016, several line ministries and local authorities continue to carry out these functions in an uncoordinated manner. County and district development councils determine local

¹⁹ REDD+ is the framework of UNFCCC for creating financial incentives to reduce carbon emissions from deforestation and enhance existing carbon stocks.

development plans, with possible impacts on forest areas (World Bank Group Forest Carbon Partnership Facility 2013); increasing engagement with them could improve outcomes.

Given the government's limited capacity to monitor forests, civil society organizations, in partnership with the media, could be trained and deployed to monitor Liberia's forests The EU-supported project on strengthening the capacity of non-state actors to improve FLEGT-VPA and REDD+ processes in Western Africa (which ran from 2017 to 2020) raised awareness about forestry legal and regulatory frameworks among the communities and linked community members to national print and radio media. The project's main beneficiaries included the Independent Forest Monitoring Team, the National Union of Community Forestry Development Committees, and the National Union of Community Management Bodies. The project trained investigative journalists and created the Liberia Forest Media Watch, which investigated and reported on issues such as illegal logging, the sharing of benefits with local communities, processes to obtain Authorized Forest Community status, labor conditions, and environmental hazards. The FDA responded to some of the issues investigated and mentioned in the program (Tropenbos International 2021). However, citizen and third-party monitoring of Liberian forests alone do not necessarily guarantee forest conservation. The most salient problems in community forest management in Liberia relate to accountability at the local level, where external actors can influence local authorities through corruption, bribery, and other forms of elite capture.

Conservation requires compensating community members for forgoing forest use, through initiatives that provide payments to communities for ecosystem services and REDD+, for example. Elite capture may undermine such schemes. Citizen monitoring can complement REDD+ initiatives to boost benefit sharing and ensure that conservation agreements reflect households' interests and contribute to their economic well-being while also preserving Liberia's forests. Fostering the LLA's efforts to establish a cadastre with complete information on customary land boundaries and land rights would establish legal clarity about the ownership of resources. It would help the government identify areas and communities that are eligible for compensation payments.

4.3.2 Improving the Governance and Regulation of Mining Activities

Liberia's mining sector is a significant source of revenue and employment. Iron ore mining alone accounted for 47 percent of export earnings in 2020 (World Bank 2021). Mineral resources include large deposits of iron ore, diamonds, gold, and construction materials. Current investments are characterized as large-scale mining investments (iron ore, industrial gold); quarries (construction materials) and alluvial artisanal small-scale mining (ASM) of diamond and gold. Illegal ASM is also prevalent. Liberia has no state-owned mining operations.

Liberia's ore potential remains largely unexplored, but sectoral productivity could increase in the context of rising global demand for metals needed for the transition to greener technologies. A complete geological map of the country (which would facilitate better land use planning) is unavailable. However, Liberia is known to have large reserves of metals that are in high demand by green technologies (renewables, batteries, e-vehicles). As a result, ASM opportunities have become increasingly attractive, especially as agricultural productivity has decreased (Landrigan and others 2022). The environmental and social impacts from development of the mining sector have been largely unchecked. Some environmental impacts include land degradation and loss of forest cover and vegetation, loss of biodiversity, chemical pollution, and accelerated riverine and coastal erosion (from sand mining, for example). Without proper regulation, mining

also has significant occupational and safety risks, which are exacerbated by preexisting vulnerabilities, such as high poverty, low education, and high female participation in mining communities.

Laws and a regulatory framework that govern mining in Liberia are not enforced or monitored. An array of policy and legislation has been adopted, including a 2016 roadmap regulating ASM and the Mining Policy and the Land Rights Act in 2018. However, the roles and responsibilities of stakeholders are unclear. Failure to adopt environmental management tools and the lack of government capacity have caused poor environmental monitoring and enforcement (World Bank 2021).

Management of the mining sector needs improvement in four areas: (a) contracts, licenses, and exploration; (b) mining operations; (c) taxation, revenue distribution, and management; and (d) local impact, with ASM a priority. The update of the mining governance framework, the definition of mining licensing processes, and the strengthening of regulatory oversight of ASM should be priority areas for mitigating the impact of mining activities. Specific reforms could include the following.

Contracts, licenses, and exploration. Priorities include modernizing geodata management through the adoption of modern technologies, conducting an airborne geophysical survey, and updating geological maps. The licensing system should be updated to optimize mineral development, and license definitions, rights, and obligations should be clarified. Due diligence and award processes need to be strengthened to optimize investments and consider their impacts. Compliance with Mineral Development Agreements (MDAs) should be improved and time-based license processes prepared and published. Legal ownership of surface land rights in areas where mining potential exists should be established through a legal cadastre, including ownership and boundary data of customary communities. Such a cadastre would enable the government to ensure adequate consultations. It would increase the negotiation power of landowning communities and the compensation of communities in which mineral resources are identified.

Mining operations. Interventions include updating mining legislation, strengthening environmental stewardship, improving labor practices and occupational safety, consolidating ASM management, enhancing mine safety, and developing processes and regulations for mine closure. Efforts to combat child labor, especially at artisanal mine sites, should be prioritized.

Taxation, revenue distribution, and management. The Natural Resources Taxation Section within the Liberia Revenue Authority (LRA) needs strengthening, and the staff of the LRA needs capacity building. Future MDA and taxation obligations need to be harmonized with existing legislation. The MME needs capacity-building and coordination mechanisms with the LRA to improve the reporting and tracking of mineral production, sales, and payment of taxes and fees. Enhanced accountability of government equity and in-kind transactions related to mining is needed. There is a need to enforce and monitor compliance with MDA and consolidate community-based payments, including social and in-kind contributions, to ensure equitable benefits sharing. Drawing lessons from forestry, community working groups can be established, leveraging existing county development funds instead of creating new funding channels.

Local impact. There is a need to improve public access to information and raise awareness of mining operation among citizens and increase community engagement on legislative requirements related to communal lands. Establishing a cadastre of customary land rights would legally identify landowning communities and enable targeted programs for ensuring their participation and consultation on mining activities occurring under their land. The sector should take formulate policy principles that promote local content, including services, procurement, and employment. Efforts must also be made to support the transition of child miners out of hazardous work environments. Programs on technical training and

alternative livelihoods are needed, as deposits of some resources (such as diamonds) are depleted, and demand for higher-skilled jobs in the green tech transition has increased.

4.3.3 Adopting Climate-Smart Agriculture Practices

Agriculture accounts for about 38 percent of GDP and more than 40 percent of all jobs in Liberia. About 37 percent of Liberia’s population is food insecure, however, and agricultural yields are low. Smallholders face numerous challenges, including lack of fertilizer; poor breeding stock; and inadequate irrigation, extension services, credit, machinery, transport, storage, and marketing infrastructure. Severe weather conditions, including heavy rains, exacerbate these weaknesses, damaging roads and facilities, restricting market access, and causing post-harvest losses.

Many of the Liberia’s agricultural areas are likely to face hotter temperatures, more unpredictable rainfall, and more frequent and severe heavy rainfall events. These changes will increase waterlogging and put additional stress on already limited water infrastructure. They are also likely to reduce agricultural labor productivity, as heat limits the number of hours people can work without risking heat-related illnesses and potentially increases the incidence of diseases like malaria and diarrhea.

The yields of key crops—including rice, cassava, maize, cocoa, groundnuts, bananas, and plantains—are projected to decline under a dry/hot scenario, partly as a result of soil erosion, as shown in Chapter 3 modeling results.

- Rice—Liberia’s most important staple crop—is highly sensitive to increased humidity, temperature, and intense rainfall and to the pests that thrive in these conditions. Under the dry/hot scenario, rain-fed production is projected to deviate by 13 percent from its 2020 baseline by 2050.²⁰ Intense rainfall and associated flooding and erosion of fields will reduce output by depleting nutrient-rich topsoil and reducing the total arable land area.
- Cassava is the country’s second-most important staple. It is more resilient to climate changes (particularly higher temperatures) than rice. Still, under the dry/hot scenario, cassava production is projected to fall 8 percent from its 2020 baseline by 2050
- Cocoa production, the main source of income in rural areas, is projected to deviate by 14 percent from its 2020 baseline by 2050. Declines in food supply and income from cocoa production could limit the ability of rural and urban households to attain food and nutrition security.
- Climate change affects animal productivity and health as well as the yields of forage and feed crops. It may also accelerate the degradation of grazing land and the threat of disease.
- The fishery sector is also at high risk. In coastal areas, the destruction of mangroves (which provide critical breeding grounds for important fish species) and rising seas pose a risk to coastal ecosystems. These implications of these changes are grave, as fishing provides 65 percent of Liberia’s animal protein and contributes around 3.2 percent to Liberia’s GDP, making it central to Liberia’s food security. Fish are also a key source of protein for children in many coastal areas.

Various sectors are degrading the quality of resources needed for resources. Agro-industrial concessions for rubber, palm oil, and logging, which span all 15 counties and cover over a quarter of Liberia’s land, are reducing water quality and biodiversity in freshwater wetlands and coastal mangroves, including protected

²⁰ Rising temperatures could render areas in the north, where rice has not been grown, more suitable for rice production,

sites. Toxic substances from mining activities, pesticides and agrochemicals from farming, and untreated or poorly treated industrial waste are discharged into Liberia's water bodies and soil. This pollution, combined with oil residues and raw sewage, significantly diminishes the quality of the resources needed for agriculture.

Several climate-smart practices that would increase resiliency could be adopted immediately. Subsidizing the adoption of such practices would incentivize farmers to do so. Climate-smart soil management practices both increase productivity and output and reduce land use and deforestation; the preserved forest resources could become a revenue source for Liberia through carbon credit revenues. Liberia could also train farmers to use and equip them with better-quality seeds and varieties, diverse cultivation techniques, integrated pest management, and improved fishery and livestock management (better herd health management, less reliance on antibiotics, and improved management of grassland). By promoting the adoption of practices that reduce emissions or encourage carbon sequestration, additional payments for environmental and ecosystem services can contribute to a greener agricultural sector.

Modern storage systems would reduce post-harvest losses and help maintain the quality of harvested products. Investing in transport and logistics systems to facilitate the delivery of agriculture input and market access would help ensure that the hard work and resources invested in farming are not wasted.

Just 2–5 percent of arable land in Liberia is under irrigation; increasing this share could significantly improve production and resilience. By enabling multiple cropping even in dry seasons, irrigation would stabilize yields during droughts and potentially increase yields. Using new techniques for storing rainwater would increase its availability for irrigation while mitigating the risk of flooding. Multipurpose storage of surface water and groundwater could be increased—through conventional surface water storage infrastructure, nature-based solutions, and adaptive and flexible water allocation mechanisms—diversifying the country's water sources.

Promotion of circular economy approaches in the delivery of water services could greatly increase the sustainable use of water resources for agriculture. Recommended practices include reducing unrecoverable water losses; managing water demand; and recovering valuable resources such as biogas, nutrients, and heavy metals from wastewater treatment. Protection of watersheds and other landscapes is essential to sequester carbon in soil and biomass and increase resilience to variable streamflow. Aging hydraulic infrastructure also needs to be modernized or decommissioned to ensure efficient water management. Investing in coastal wetland protection and integrating water bodies with the management of renewables such as wind and solar power is a forward-looking approach that binds environmental protection with energy sustainability. Preventing and repairing water leaks, updating pumping methods and treatment technologies, and integrating water-energy innovations would improve water efficiency. These strategies would both build resilience and manage variable water supplies for agriculture and domestic needs and boost hydropower generation, which is needed to drive the green energy transition.

The government, private sector, and research institutions need to work together to establish a policy framework and enabling environment that promote the implementation and financing of climate-smart agriculture and integrated landscape management. The government and private sector should collaborate to establish policies and standards that will unlock more private investment and secure international offtake across sectors. Several policy reforms could support such an effort: (a) a food pricing policy should focus on enhancing domestic rice production, which should be coupled with a policy that incentivizes private sector investment in the sector, promotes public-private partnerships, and ensures access to good-quality inputs and services like rural financing for smallholder farmers; (b) a policy should define the

government's role in agricultural growth and development and address public financing of the sector, which should explore various types of transfers to farmers, including one-time grants for capital formation and recurrent subsidies; and (c) allocating resources to targeted sectors can attract private investment and expertise, particularly in the waste management and water sectors, which would enhance agricultural value chains. Long-term tenure security is key to ensuring that land disputes do not derail private investments.

Training experts, enhancing logistics, and leveraging technology would increase the capacity of the Ministry of Agriculture and the Central Agricultural Research Institute (CARI). Emphasis should be placed on climate-smart agriculture initiatives, such as setting up seed banks, implementing soil management systems, diversifying crops, and improving livestock breeds.

Investment in research and (especially) extension services is critical. Research is needed to assess crop vulnerability and suitability and identify ways to increase the climate resiliency of staple crops, and this knowledge needs to be transferred to smallholders. The monitoring of land restoration commitments—which informs the establishment of a new partnership model for large-scale integrated landscape investment programs—needs to be improved. Adoption of adaptive management frameworks, better data and tools, inclusive decision-making, uncertainty-based adaptive tools, water accounting, and adequate pricing mechanisms can improve institutions and regulations for water resources management. Deploying modern flood/drought forecasting and early warning systems can help increase resilience.

4.4 Climate Risk and Readiness

4.4.1 Improving Climate Risk Assessment, Early Warning, Emergency Preparedness, and Disaster Response Systems

Most natural climate shocks and disasters in Liberia are water related, and extreme rainfall events and associated floods are projected to intensify with climate change. Mean and extreme temperatures will increase under all climate scenarios. There is no clear direction in the change in annual precipitation levels from climate change. However, the frequency and intensity of extreme rainfall events are projected to increase under all medium- and high-emission scenarios (IPCC 2022). In 2020, about 11 percent of Liberia's population was adversely affected by rainfall. By 2050, this share is projected to increase to 16 percent under moderate-emissions scenarios and 44 percent under high-emissions scenarios. Medium-confidence climate projections indicate that the mean wind speed in West Africa will increase, bringing in the risk of increased frequency of windstorms. There is high confidence that Liberia will experience hotter temperatures. The increase in temperature is expected to be more intense in the northern and more inland regions of Liberia than in the coastal zone (see **Error! Reference source not found.**). Whether higher temperatures and lower rainfall will lead to drought is unclear, but concerns about the effects of both changes have been raised by community stakeholders (100 Resilient Cities 2019; Water Aid 2019).

Liberia lacks good baseline data on floods, windstorms, heat waves, and droughts, which are essential to understanding the risks it faces from climate shocks. Global modeling efforts with low resolution are insufficient; downscaling this information and systematically collecting local information on climate variables at high resolution are needed to increase confidence in projections of key climate risks. For example, the only detailed flood assessment is for Greater Monrovia. Hydrological and meteorological information (rainfall, water levels) is lacking, as are spatial data on population characteristics, roads, water infrastructure, residential and government buildings, and economic activities. Information on windstorms and droughts is mostly anecdotal. No detailed countrywide assessments have been conducted of these

shocks. Even detailed observations of past disasters (flood extent, economic damages, affected populations, and other parameters) are limited and scattered. NDMA only recently started archiving occurrences of disasters into a centralized database. Liberia's recent 2022 census collects detailed information on the locations of residential assets. These efforts should be leveraged and an interagency data-sharing mechanism established to ensure that data sets can be used for future assessments.

Liberia also needs better monitoring, forecasting, and warning of everyday weather-related and hydrology hazards. The hydrometric network and services managed by the Liberia Meteorological Services (LMS) have been gradually established since 2010 but need support. LMS provides meteorological monitoring, and the Liberia Hydrological Services (LHS) is responsible for hydrological information.²¹ The LMS' meteorological infrastructure and services are at an early stage of development (Alliance for Hydromet Development 2021). The lack of functional ground-based or upper-air stations and infrastructure makes it difficult to transmit collected data to the World Meteorological Organization (WMO) or World Information Systems (WIS). Other important challenges at the LMS include the lack of data sharing and international data reception and the absence of dissemination of weather forecasts and basic climate services to the public. The network now consists of 14 manual rainfall stations and one automatic rainfall station. In addition, water levels at 16 hydrometric stations along rivers are translated into river discharge information using stage-discharge relationships. Hydrometric stations have been installed along rivers but not along the coast to monitor sea level. The system provides daily observations but does not offer forecasts of rainfall or river discharge.

Being able to forecast floods requires servers with continuous backups and connections to rain and river gauges. This ability could revolutionize monitoring systems, yielding more than a tenfold return on investment. A 24-hour warning for an impending storm or heat wave can reduce damage by up to 30 percent (GCA and WRI 2019). The reliability of internet connections and power supply are major limiting factors for such systems, as is the availability of qualified system administrators. Creating a flood early system could be a good option for Liberia. Policy makers must determine which agency should host, operate, and maintain it and who and how the information from this system will be used.

A good early warning and response system would help residents and agencies to take measures to reduce their exposure and vulnerability. Such a system could include community-level flood response plans (for the evacuation of people and possessions). A flood forecasting system that simulates near-future water levels in urban areas should be connected to a warning system. The forecasting agency could notify the relevant agencies directly. Disaster information is being collected and stored, although a backlog of past events must still be processed. NEWEOC has not yet operationalized its forecasting and warning system for climate-related disasters. NEWEOC's effectiveness depends on collaboration by various agencies, including NDMA, the LMS, the LHS, and emergency services such as police (responsible for flood response, such as road closures and traffic diversion); local government (responsible for flood preparedness and response at the local level); and the media.

NDMA's new NEWEOC is expected to serve as the national hub for early warning information. The center expects to operate 24/7. Disaster information is being collected and stored, although a backlog of past events must still be processed. NEWEOC has not yet operationalized its forecasting and warning system for climate-related disasters. NEWEOC's effectiveness depends on collaboration by various agencies, including NDMA, the LMS, the LHS, and emergency services such as police (responsible for flood response, such as road closures and traffic diversion); local government (responsible for flood preparedness and response at

²¹ Liberia plans to merge the LMS and the LHS into a single agency, to be called the Liberia Hydromet Agency (LHA).

the local level); and the media. NDMA is setting up a mobile EOC, which will enable it to coordinate crises more effectively by bringing together all key governmental and nongovernmental stakeholders to mobilize disaster response and impact assessment efforts. NDMA has plans to establish regional logistics hubs in Bomi, Bong, and Grand Gedeh counties. These hubs will need to be equipped with adequate stocks of response and recovery items and equipment.

Liberia can also use its National Multi-Hazard Contingency Plan to ensure that a coordinated and functional preparedness and response mechanism is in place at every level of government.²² The plan highlights the importance of deploying basic logistics in advance of a disaster or climate shock. Priority response plans for different sectors (shelter and nonfood items, food security and nutrition, health, logistics, WASH, education, protection) have been prepared, including priority actions, targets, indicators, and time frames. NDMA has identified flood-prone communities and developed a Liberia Disaster Database. The contingency plan also requires the installation of regional logistic hubs stocked with response materials and supplies in preparation for disaster response. Although progress has been made, efforts have stalled because of limited funding to stock the facilities.

Liberia needs a digital land information system for storing and managing data on land boundaries, legal ownership, land use, and land values. Despite ongoing digitization efforts by the LLA, there is no comprehensive digital cadastre that confirms the legal ownership and boundaries of private or customary land. Land use and land value data are absent or severely limited. Lack of land data thwarts the government's ability to prevent and prepare for climate shocks as follows: The preparation and enforcement of land use plans and zoning approaches depend to a large extent on the legal ownership and land use decision-making of landowners and land users. Without land ownership and location data, the government is not able to prepare and enforce land use plans. As a result, settlements develop uncontrolled, often in areas of high climate risk (such as flood-prone areas). Lack of land data also limits the government's ability to address land conversions that increase climate shock vulnerabilities, such as deforestation. Location-based land data would enable the government to create early warning systems and target climate shock response mechanisms. Unclear land rights leave tenants vulnerable because they are reluctant to leave their land even in severe conditions because of fears that they might not be able to return. Land data are also a key input for improving post-disaster recovery in cases of temporary resettlement or parcel boundary disappearance (Quan and Dyer 2008).

Liberia's current practice of funding response to damaging disasters is not sustainable. A more viable approach would be to secure financing in advance through a risk-layering strategy. The lack of risk financing policies and financial instruments to safeguard the fiscal budget during times of crises and disasters means that the authorities will have to fund most of the costs from the public budget.

The NDMA Act of 2016 sets out provisions for a disaster risk management multidonor fund, but its scope is broad, encompassing the spectrum of disaster risk management and resilience issues, and the fund has not been capitalized. Donors are estimated to have provided about US\$25.7 million (in 2015 constant prices) of humanitarian and post-disaster recovery support between 2018 and 2022.²³ The disaster protection gap (the difference between insured and total losses) is significant, although the lack of systematic data on historic loss and damages from natural disasters makes it difficult to estimate the scale

²² The plan was initially intended to run from 2018 to 2021. It will be updated once the 2022 Census data are available and kept in place.

²³ Authors' calculation based on the UN-OCHA Financial Tracking Service (FTS) Database. Prices were deflated using Liberia's GDP deflator.

of loss.²⁴ Because no dedicated contingency instruments are in place to finance this burden, funds need to be drawn from other project or sector programs or accepted from donors.

Combining multiple instruments to protect against events of different frequency and severity would increase effectiveness for disaster response. Sovereign disaster risk financing (DRF) aims to increase the capacity of national and local governments to provide immediate emergency funding as well as long-term funding for reconstruction and development. Combining different instruments to protect against events of different frequency and severity allows governments to secure funds for recurring disaster events first and then increase their post-disaster financial capacity to finance less frequent but more severe events. Such risk layering ensures that less expensive sources of money are used first and the most expensive instruments are used only in exceptional circumstances.

A DRF diagnostic is needed. It could (a) estimate the scale of economic losses following disasters, (b) assess prearranged funding available to the government and existing ex post sources of funding, (c) examine key legal and institutional arrangements relevant to DRF, and (d) identify funding gaps (the difference between the prearranged funding available and government liability from a disaster).

Developing and implementing a comprehensive DRF and insurance strategy could help the government become an active risk manager rather than an emergency borrower. Liberia adopted two disaster risk strategies (the National Disaster Reduction and Resilience Strategy [NDRRS] 2020–30 and the National Multi-Hazard Contingency Plan 2018–21), but lack of funding slowed their implementation. After estimating the funding gap, the diagnostic could identify risk financing instruments to target different groups and address disasters of different frequency and severity. This strategy could bring together different forms of sovereign disaster risk finance, agricultural insurance, property catastrophe risk insurance, and social protection programs and leverage private capital to ensure access to rapid, reliable, effective, and cost-efficient finance for recovery and reconstruction. This funding is often uncertain, fragmented, and in-kind, however. Expanding the range of sovereign DRF tools, such as contingent credit, and scaling up market-based solutions, such as sovereign reinsurance, through an optimal risk-layered approach would ensure more timely and predictable access to funds. The introduction of disaster clauses in sovereign debt would help ensure that the authorities are able to provide timely disaster relief instead of using the funds to repay debt obligations.

A next step would be to develop a disaster contingency fund based on the outcomes of the DRF diagnostic. Clear and transparent triggers and channels for disbursement (such as shock-responsive social safety nets) and operational procedures would increase the likelihood of securing support for its capitalization from the government budget and potentially donors and other financiers. To complement the disaster contingency fund, the government could evaluate contingent credit instruments, which could be used for larger disasters, as it usually costs more to draw down these funds.

4.4.2 Integrating Climate Considerations within the Financial Sector

Liberia's financial sector is vulnerable to climate-related risks through the effects on firms and sectors. By adversely affecting the physical assets, markets, and productivity of firms to which financial institutions

²⁴ The best estimates of the economic costs of natural disasters in Liberia relate to the 2014 Ebola outbreak, which cost an estimated 11 percent of GDP.

lend, extreme weather and natural disasters can increase the share of nonperforming loans (NPLs) (from its already high level of 23 percent in 2021).

Liberia's banking sector faces considerable exposure to physical risks, mainly because physical assets are used as collateral. Physical assets, most of which are in Monrovia, are increasingly vulnerable to flooding and storms. Estimates of assets at risk to flooding are set to grow to 1.25 percent of GDP by 2050, presenting growing risks to the financial sector.

In addition to these physical risks, Liberia's banking sector may face transition risks during the shift to a low-carbon economy. The introduction of carbon pricing measures, which Liberia could adopt in the future, could reduce the profitability and debt service capacity of high-emission companies, increasing the risk of NPLs and the probability of default.

Transition risks for Liberian banks are likely to materialize mostly through increased credit risk and losses in lending portfolios, particularly in GHG-intensive industries such as oil and gas, manufacturing, and construction. Commercial banks' trade portfolios, which constitute almost a third of their exposure, are also at risk, because of the effect of climate change on carbon-intensive activities such as transportation and shipping. NPL ratios in the oil and gas portfolios of Liberian banks already far exceed ratios in other sectors. They are expected to further deteriorate with the global low-carbon transition. With the potential for shocks to become more frequent and oil prices persistently suppressed, all companies in the oil value chain may be affected. Liberia exports to countries that are implementing stringent climate policies and carbon pricing and could face spillover risks from these exports that would hurt the banking sector. The construction industry, which accounts for 7 percent of banks' exposure, is highly dependent on energy-intensive and GHG-emitting materials (steel, cement, bricks, timber). Regulatory changes to the construction sector—such as updated building codes to increase climate resiliency and the use of sustainable materials—could require additional investments and changes to construction practices.

Despite the daunting risks stemming from climate, awareness and preparedness to climate change remain limited among operators of the financial sector. Only a few of the financial institutions surveyed for this report were knowledgeable about climate change and green lending, and none of them were conversant with the guiding principles of green lending or how it operates. Some banks consider environmental risk during their loan screening processes, but they do not require that loan proceeds be used to advance green initiatives.

Some commercial banks are beginning to recognize the climate-related risks they face, but appraisal and evaluation processes do not yet assess flood risks or future climate impacts. Capacity building will be needed to ensure that banks are equipped to address climate-related risks. The loan appraisal process will need to be updated to ensure that climate considerations are fully taken into account, particularly when evaluating the value and quality of collateral. The sector could work more closely with the EPA or NDMA to improve its assessment of flood risk exposure. Engaging with potential customers on their climate risk preparedness would further mitigate potential risks. Ensuring that risk managers have the expertise for such assessments will require extensive training and knowledge sharing, which the CBL could provide. The CBL could also monitor some exposures and be flexible about how defaults are booked.

The CBL which regulates the financial sector lacks a prudential framework on green lending and is still at the early stages of incorporating climate considerations into its supervisory and central banking activities, indicating that green lending is also still a new concept for the regulator. This may explain why financial institutions have not begun to venture into this aspect of lending. The CBL has established the basis for

creating a climate team, which is expected to lead and coordinate CBL efforts on climate risk. This team now needs to be formalized. Its effectiveness and capacity will depend on support from across the organization, including senior management and the board. Consideration of climate risks need to be integrated into governance structures or an internal strategy.

Liberia's insurance sector is small, underdeveloped (providing limited protection against physical risks), and dominated by a few foreign-owned companies. Most products insure property (mainly against fire) and provide casualty coverage. Uptake of life and agriculture insurance is limited. Low awareness and trust in insurance products, as well as lack of capacity and experience, are major challenges. The government has tried to improve the regulatory environment and attract private sector investment to the sector, but the market remains underdeveloped compared with other countries in the region. Flood risk insurance is virtually nonexistent, for example, and physical risk mitigation mechanisms are limited. Many properties are required to have fire insurance if they are to be pledged as collateral; flood insurance is not required. Banks may investigate the possibility of requiring flood risk insurance for their collateral. However, insurance companies are generally reluctant to insure against climate-related events or natural hazards.

The CBL recognizes the potential impacts of climate-related risks to the Liberian financial sector, but it has not yet conducted a risk assessment to identify the sector's vulnerabilities. As the risks from climate change are becoming increasingly apparent, the urgency of the issue for the financial sector and the need for a supervisory response have grown.

Having the CBL conduct a survey of the banking sector could be a useful way to start engaging on, gathering information on, and raising awareness of the risks climate change poses to the financial sector. A high-level assessment of sectoral and geographical exposure could be a useful next step for the CBL. Over time, and as data quality and availability improve, more detailed risk analysis could provide insights into the possible effect of climate change on financial stability over different time horizons.

The CBL should also consider climate in its efforts to improve its monetary policy framework. It should continue to build the capacity and infrastructure needed to conduct sound monetary policy. Considering opportunities for 'greening' its monetary policy operations entails integrating climate risk consideration in monetary policy frameworks, credit operations, collateral policies, and asset purchasing programs. The CBL could, for example, make access to some lending facilities conditional on a counterparty's disclosure of climate-related information or on its carbon-intensive/low-carbon investments, adjusting haircuts to better account for climate-related risks or tilting asset purchases based on climate-related risks and/or criteria applied at the issuer or asset level. As the CBL develops standing credit facilities, for example, it could consider including minimum requirements regarding sound climate-related risk management or counterparties' environmental credentials.

Integrating sustainable investment practices would have the dual benefit of reducing climate-related and environmental risks in the portfolio and setting an example and enhancing the enabling environment for green finance domestically. The CBL's portfolio includes its foreign exchange reserves, its own reserves, and its pension assets. In the investment tranche of its general reserves, the CBL applies a strategic asset allocation strategy that seeks to increase its reserves. It invests its reserves primarily in fixed-income securities, US Treasury bills, and central bank deposits. Its strict mandate for managing its reserves prevents it from investing in more frontier instruments, but it provides an opportunity to broaden its investable universe to include green or sustainable instruments (including by requiring securities to be rated above BBB, meet certain tenor requirements, and be provided by certain types of institutions). Although competing priorities mean the time is not right to consider integrating sustainable investment

practices into its portfolio management, the CBL could explore the approaches adopted by other central banks (including exclusion and best-in-class strategies).

The CBL needs to understand the implications of climate and environmental, social, and governance (ESG) considerations for its portfolio management. It has participated in international discussions on the topic and recognizes the importance of considering climate-related physical and transition risks as well as ESG-aligned investment practices. Training and knowledge sharing will be needed to enhance its understanding of how these investment practices, including changes to guidelines and regulations, could be developed. Given competing priorities (including the development of its monetary policy framework and broader capital market development), the CBL is considering more in-depth approach to climate issues in the context of its reserves management, including the importance of engaging the board to ensure buy-in, in the medium to long term.

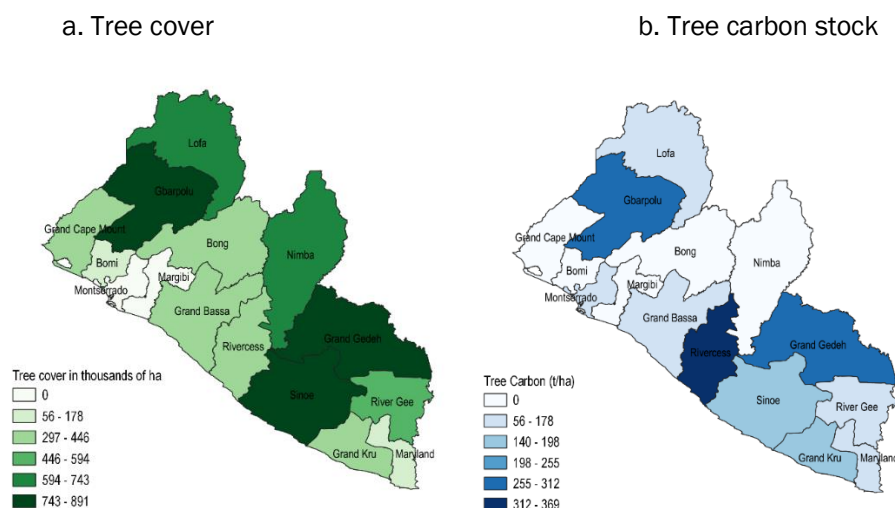
The CBL has a mandate to develop capital markets in Liberia and integrate them within the region, to facilitate intraregional trade. In the absence of a capital markets regulator, the CBL's financial market department, together with the Liberian government, is driving domestic market development. To broaden the local investor base, the CBL is looking to reform the pension sector; it is also pushing for more involvement by local retail investors. Leveraging the potential of local pension funds could supply some of the much-needed longer-term funding. The CBL has affirmed its commitment to consider green and climate risk considerations from the outset. It currently issues securities primarily to local commercial banks (and to a lesser extent to insurance companies). It would like to explore whether there is scope for a green or blue government sovereign bond in the long term.

Integrating climate considerations in CBL operation, especially by promoting green lending, will be critical to mitigate climate risks. It would also enable the central bank to support sustainable development by facilitating access to finance. Steps to promote climate awareness and stimulate a green lending culture within the financial sector include the following: (a) develop specialized credit lines for green lending, which should offer lower rates and longer repayment periods than standard loans and would allow more firms to access green loans and adopt climate-smart solutions; (b) design a framework of green lending policies and procedures alongside an industry-wide capacity-building campaign for the regulator, lenders, and borrowers; (c) provide advisory support to accelerate the onboarding of the financial sector on climate consideration while reinforcing firms' expertise in measuring, tracking, and monitoring green projects, ensuring transparency in the use of green loans, and reporting their impacts; and (d) promote cost-efficient climate-smart solutions. Liberian households understand its benefits of solar energy, but banks report that the cost of solar installation is too high for the average household. Staggering payments would help households and enterprises afford these systems.

4.4.3 Protecting Carbon Sinks While Improving Carbon Market Readiness

The disappearance of Liberia's forests would result in the loss of an enormous carbon sink that reduces emissions—a rare global public good that only a few countries can provide (Figure 4.4). The country hosts more than 40 percent of the Upper Guinean Forests and other rainforest ecoregions that harbor biodiversity hotspots for endemic and endangered species, including over 2,000 flowering plants, 600 bird species, 150 mammals, and 75 reptiles (EPA 2017). Liberia's largely intact forests also serve as effective carbon sinks that reduce emissions. The northeast and southern regions contain the largest areas of tree cover and biomass. The ripple effect of such damage would extend well beyond Liberia's borders, destabilizing ecosystems throughout the region and undermining the global fight against climate change.

Figure 4.4. Tree cover and carbon stock in government-defined forested lands by county, 2018/19



Source: Based on Liberia National Forestry Inventory Data (2020).

Protecting forests can and should bring additional financing for achieving the country’s development and climate goals. In its latest NDC communication, Liberia committed to reduce national deforestation by 50 percent and GHG emissions by 40 percent below its 2014 business-as-usual estimate by 2030 and to engage in other activities that support forest regeneration and enhance the carbon stock. On adaptation, the NDC focuses on increasing the resilience of forest-dependent communities and ecosystems through the development of alternative livelihoods programs, the implementation of the clean cooking agenda, and various adaptive management forestry interventions. Liberia estimates the mitigation funding to achieve its forestry goals at US\$49 million through 2025.

Implementation of the REDD+ framework can help Liberia access more forms of climate finance and sell credits in the carbon market. However, there are several gaps in the current legal and policy framework with respect to implementing REDD+. For instance, no currently enforced laws expressly recognize or regulate carbon and emission rights as property rights, creating ambiguity. The current resource tenure system, bolstered by private agreements, is vulnerable to title contestation and may make Liberia ineligible for some emission rights crediting programs. There is no complete cadastre of customary land rights that would legally confirm the ownership of communities’ land and natural resources claims and potential benefits from REDD+.

Legislation is needed to define carbon credits, their ownership structures, and trade. Whether carbon found on concessions areas, private, communal, or government land is owned by the state or other stakeholders is not legally determined, and there is no legal framework for accounting and trade in carbon credits. Legal instruments are needed to address who owns the carbon or holds emission reductions titles associated with different types of forest lands and who is entitled to manage and transfer the emission reduction titles to third parties.²⁵ The government needs to establish a clear carbon tax policy to monitor revenue flows from REDD+ and design and implement targeted anti-corruption initiatives to ensure widespread public benefits.²⁶ Benefit-sharing mechanisms for REDD+ also need to be defined. A land information system with

²⁵ Legal Gap Assessment on Carbon Rights and Benefit Sharing in the Context of REDD+ - Inception Report, 2022.

²⁶ Forest and Carbon Harvesting: The Case of Liberia, New Dawn, April 4, 2023.

legal ownership and boundary data is fundamental to implementing policies that would identify landowners as beneficiaries.

There is a need to raise awareness on REDD+ policies and incentives and engage with communities to induce greater participation in forest management. Raising awareness on access to and possible benefits from REDD+ initiatives and their impact on local livelihoods is particularly important (World Bank Group 2013). In addition to higher household income, benefits include provision of services and infrastructure for rural communities, secured land rights, and strengthened forest governance, which should help increase investment and long-term planning. Equally important is noting possible limitations and constraints, as well as ways of overcoming them through community organizations, to prevent excessive expectations of financial benefits.

Effective and robust monitoring, reporting, and verification (MRV) systems are critical for triggering results-based payments and monetizing the value of forest preservation. Setting up an MRV system entails establishing a system of data collection, management, and reporting that meets international criteria (including those of possible investors). The REDD+ Implementation Unit within the FDA, in partnership with Liberia Institute of Statistics and Geo-Information Services (LISGIS), should play a leading role in further developing the current system, under the guidance of a dedicated national steering group. The carbon offset market has been growing globally in response to calls from governments and companies to reduce GHG emissions and achieve net zero. Based on Liberia's latest forestry inventory, forests offer an estimated average 153.5 of carbon stock in tree cover per hectare, positioning it well to participate and benefit from these markets (FDA 2021). However, the quality and integrity of some offsetting schemes have been called into question. A recent investigation revealed that lax certification requirements and supervision allowed numerous forest conservation projects to grossly overstate the amount of emissions removed/avoided (Clisson 2023; Government of Liberia 2016).

Institutions need to be strengthened, with strong donor support to the EPA and the FDA as technical leads and to the MFDP regarding climate finance planning across sectors. The institutional arrangement for carbon finance should build on the existing framework for climate change. The government acknowledges the NDC as the entry point for accessing climate/carbon finance and reaffirms the NCCSC as the clearinghouse for climate change-related matters, including climate finance. It could mandate the Carbon Consultative Group under the auspices of the NCCSC to steer efforts toward the carbon market. Other institutions that are critical to this initiative include the MFDP (the chair of the NCCSC); the CBA; the Liberia Bankers Association, particularly the Liberian Bank for Development and Investment (LBDI); and the FDA and the EPA. The government proposes placing the LBDI, a commercial bank, at the center of its climate finance agenda.

5. Conclusions and Recommendations

Liberia faces the complex challenge of addressing its development issues while simultaneously coping with the repercussions of global climate change. Liberia has done little to contribute to global climate change. Its lack of industrialization and low level of development make it one of the world's lowest GHG emitters, and its largely untouched rainforests capture significant amounts of atmospheric carbon. Its heavy reliance on its natural wealth, weak infrastructure and services, and dire human development render it extremely vulnerable to the impacts of climate change.

This CCDR provides numerous recommendations for climate action based on analyses of the strengths and vulnerabilities of Liberia's economy, environment, and population. Modeling of just a few selected adaptation interventions—targeting heat stress, crop erosion, rain-fed crop production, and coastal flooding—is estimated to cut climate-induced GDP losses by more than half, reducing these losses from 15 percent of GDP to 7 percent by 2050 under the dry/hot climate scenario, regardless of growth trajectory.

Mobilizing Climate Finance for Development

Access to finance is a key barrier to meeting Liberia's climate and development goals. Annual climate finance flows in Liberia averaged just US\$112 million in 2019/20, most of it in the form of grants and low-cost project debt. The main sources are multilateral development institutions, closely followed by the government and some multilateral climate funds. Liberia projects that full implementation of its proposed actions in its NDC will cost US\$491 million through 2025 alone—and this figure is likely an underestimate, as 82 percent of the proposed financing goes to mitigation. Even the limited adaptation interventions modeled in the CCDR are estimated to cost 2–3 percent of GDP a year through 2050. The benefits (equivalent to 3.7 percent of GDP a year) exceed the costs, however.

Many climate actions (particularly adaptation actions) are linked with Liberia's development agenda and will depend on unlocking and prioritizing public financing. Liberia's limited borrowing capacity, fiscal resources, and institutional constraints make mobilization difficult. Adaptation investments require different mechanisms, incentives, and actors than mitigation financing, because the benefits of adaptation are difficult to monetize, have high transaction costs, and generally involve local public goods. The investment challenge will require building institutional capacity across the government and developing innovative approaches needed to unlock (private) finance for adaptation and resilience projects. The high-risk environment for climate finance and other financing needs to be addressed through policy reforms that increase investor confidence. On mitigation actions, crowding in private sector financing may seem more likely, but public resources are still required to de-risk projects, provide concessional credit, or act as a backstop against shocks to attract private financing.

Concessional finance will continue to play an important role in strengthening Liberia's climate actions in the short term. Although the government's fiscal position has been improving, its underdeveloped financial sector and limited fiscal space restricts the use of the public budget to scale up investments in climate efforts. Liberia does not issue sovereign bonds in international capital markets or have an international credit rating. It issues sovereign bonds in local currency in the domestic market, typically with maturities of up to one year. In the short term, the government should continue to maximize concessional and semi-concessional sources of financing from multilateral and bilateral sources (development institutions, climate funds) through grants and/or low-cost borrowing, using the funds for de-risking and creating blended finance structures that crowd in private investment.

Deepening the domestic capital market is essential to facilitate economic growth, diversify financing options, and attract foreign investment. The government’s Medium-Term Debt Management Strategy aims to gradually develop the domestic debt market and build a domestic yield curve with the issuance of longer-maturity Treasury bonds while maintaining concessional and semi-concessional financing from multilateral and bilateral sources.²⁷ Together with the financial markets department of the CBL, the government is laying the foundations for capital market development and integration with regional markets. In the medium term, Liberia could create the foundations for green finance. While pursuing deepening sovereign local currency issuances in longer tenors, the government could start introducing labels for green lending products and bank financing flows for climate and environmental projects. Doing so is a prerequisite for crafting a policy framework for green finance instruments.

Over time, Liberia could explore the use of innovative financial tools and instruments to support its climate actions. Although its capital market is not yet developed, Liberia could build on examples of innovative structures being developed globally, which can provide additional sources of finance to the country, crowd in new sources of money, and build private sector confidence. With its high forest coverage, for example, Liberia could partner with organizations that have access to capital markets (multilateral development banks or funds) to finance mitigation-focused projects.

The perceived risk of green and climate-related financing by financial institutions is very high. The underdevelopment of the financial sector poses challenges to scaling its role in the climate finance agenda. Given the limited potential of the banking sector and budgetary resources to address the climate finance gap, different and innovative financing mechanisms need further exploration. At the same time, there may be scope for the banking sector to contribute to the financing of Liberia’s NDC and tap unexplored mitigation and adaptation finance opportunities. Although the need for concessional financing is inevitable, Liberia could consider innovative financing mechanisms, including green, blue, and sustainability bonds and loans; sustainability-linked bonds and loans; pooled investment funds; and revolving adaptation funds.

New initiatives and financial institutions are expanding the scope of their activities, creating additional blended financing opportunities for Liberia. One example is the launch, in January 2022, of the EIB Global, EIB’s arm to support climate action, economic growth, and development beyond the EU. Such blended finance facilities can be developed for new investment areas in Liberia, including nature and biodiversity conservation and climate-resilient infrastructure, transportation, and agriculture. The funding for such a facility can blend IDA grants and credits and funding and guarantees from other multilateral development banks, development institutions, and public sector funds. New tools to measure and model risk components of the downstream projects can be deployed to identify critical risks that require public sector financing to enable private sector investment. Liberia is eligible to benefit from the long-term loans granted by the IMF’s RST, which provides lending on favorable terms to help address longer-term structural challenges, including climate change (IMF 2022).

International climate funds are strategically relevant for Liberia. Some of the most relevant funds—such as the GCF, the CIF, and the GEF—have already provided financial support for initiatives in Liberia. The GCF is establishing the Forest Territories Facility to support efforts by countries in the Gulf of Guinea and Central Africa to fight deforestation and forest degradation.²⁸ The facility has pledged to blend US\$160 million in grants (33 percent) and loans (67 percent) from various sources. For Liberia, the facility plans to support the forestry sector, improving its performance and governance, promoting biodiversity conservation in the

²⁷ Liberia’s Ministry of Finance and Development Planning (2023).

²⁸ Details are available at the [GCF website](#).

Tai-Grebo-Sapo Complex, and strengthening regulatory and institutional arrangements for the implementation of REDD+. It provides a great opportunity for Liberia to leverage such initiatives and help provide low- or no-cost capital and financing that can catalyze climate projects that may be perceived as high risk.

Based on the analysis in this CCDR, the following policy recommendations have been identified for strengthening the financial sector and mobilizing climate finance:

- **Strategy, coordination, and capacity building.** As a first step, the authorities could develop a national strategy on climate risks and opportunities. Developing such a strategy could help the authorities align financial sector policies, regulations, and incentives with Liberia's climate goals. A roadmap covering both the risks and opportunities from climate change would help prioritize actions and coordinate the activities of different stakeholders, including financial and climate policy makers, the CBL, and financial institutions. Outlining specific objectives for the development of relevant regulatory or policy standards—including the frameworks for general capital market development (a prerequisite for the development of relevant labelled debt instruments or carbon markets), a national green taxonomy or classification system, relevant disclosure requirements, and climate-related financial sector regulation—is imperative. This strategy should be supported by comprehensive capacity-building activities and adequate coordination across key stakeholders, including relevant ministries, the CBL, financial sector participants, and technical experts to clarify the roles and responsibilities of different parties. The Liberian government and financial sector regulators could consider establishing a national task force to enhance stakeholder coordination, engage the private financial sector in potential regulatory reforms, and allow better-targeted policy design. Involvement and accountability at the level of the CBL Board and other senior-level stakeholders, such as ministerial-level engagement, will be critical to implementation of the strategy.
- **Prudential supervision and central bank response.** Integrating climate-related risks into supervisory practices and financial stability monitoring is needed to improve the management of climate-related risks for the financial sector. Developing a coherent, board-approved strategy for the integration of climate-related risks into the CBL's supervisory practice—including the establishment of an internal operating model and governance structure to define roles and responsibilities, building on the initial steps taken in the formation of a CBL climate team—will be key. An internal supervisory strategy should cover specific milestones related to the micro-prudential supervisory approach and the issuance of supervisory guidance. Pursuing membership of the NGFS for the CBL will help these institutions in strengthening their approach to climate risk and support capacity-building activities. Over time, and guided by an institutional supervisory strategy, the consideration of climate risk needs to be integrated into the CBL's supervisory frameworks. Given the implications of climate change, which are already affecting the determinants of monetary policy, the CBL is encouraged to build internal capacity to evaluate how climate considerations could be integrated in its monetary policy frameworks.
- **Climate risk assessment and data environment.** The CBL, supported by other relevant authorities, should build its technical and data capabilities to conduct a climate risk assessment and improve understanding of the impact of climate change on Liberia's financial sector, with an initial focus on a climate risk assessment of the quality and climate resilience of the banking sector's collateral. A risk assessment will help supervisors focus their attention on the most relevant risks and provide starting points for financial institutions to improve their internal risk management. Given

challenges around the availability and quality of data, the authorities and financial institutions should work together to improve the (regulatory) data environment to allow for more meaningful and in-depth risk assessments over time. The lack of systematic data on historic losses and damages from natural disasters impedes accurate estimates of the scale of total losses and holds back the development of an optimal risk-layering DRF approach.

- **Green financial tools and instruments.** The government is encouraged to implement the MFDP's medium-term debt management strategy, which seeks to gradually issue sovereign bonds with longer tenors and build a domestic yield curve. Longer-term sovereign bonds would help develop the local capital market and build investors' confidence. While working to create a deeper local capital market, the MFDP should work with the CBL to develop guidelines and regulations that lay the foundations for introducing green finance instruments, such as green and sustainable loans and bonds. These foundations could include the development of a national green taxonomy or classification system to identify green assets and activities. Considering the country's debt and fiscal constraints, concessional and semi-concessional finance remain essential in the short term. The government should therefore focus on leveraging more financing from the climate funds and exploring innovative financial structures apart from the traditional multilateral and bilateral sources.
- **DRF diagnostic.** Informed by a DRF diagnostic, the government could develop the appropriate DRF tools to increase its financial response capacity and identify financial tools for an optimal risk-layering approach.
- **Climate risk insurance products.** To address the challenge of low insurance penetration, relevant Liberian authorities could promote opportunities to expand micro- and parametric insurance for climate risks. Inclusive and affordable natural disaster protection is needed to build financial resilience to risks from climate-related natural disasters. With the impacts of climate change becoming increasingly apparent in Liberia, more tailored insurance solutions are required. Closing the protection gap and ensuring affordable and effective protection against climate-related risks will be particularly important to build resilience for low-income households and climate-vulnerable smallholder farmers.
- **Green financial inclusion and a PCGS.** Access to financial services can play a key role in supporting vulnerable parts of the population to adapt to climate change or support mitigation efforts. The authorities are encouraged to consider how enhancing the role of financial services can provide climate-related support to poor and vulnerable groups, including MSMEs and women. Doing so will require the development of effective financial inclusion policies, regulations, and national strategies. Informed by the work on inclusive green finance by the Alliance for Financial Inclusion—in which the CBL is already participating—the authorities should take a holistic green approach to financial inclusion and focus on promoting green products within savings, credit, insurance, money transfers, and new digital delivery channels. Access to green finance—and the broader development of green credit markets—can be supported by a Liberian PCGS, which could play a pivotal role in de-risking lending to underserved sectors. The potential and effectiveness of a PCGS or other guarantee mechanisms depend on the right preconditions being in place and relevant stakeholders having enough technical capacity. The government could assess the future establishment of a credit guarantee mechanism to unlock the necessary funding for SMEs and develop the green credit market.

Thematic Climate Actions

The report examines four groups of climate actions: (a) essential infrastructure needs, (b) human development promotion, (c) sustainable land management, and (d) cross-cutting enablers. Within these areas, interventions were prioritized based on their urgency and feasibility and identified as short-term or medium- to long-term actions.²⁹ Recommendations are summarized in Table 5.1.

Essential Infrastructure Needs

Limited basic infrastructure makes it difficult for Liberia to address many of its development and climate challenges. Liberians lack essential services—such as water, sanitation, waste management, electricity, roads, and housing—that promote economic growth and meet daily needs. They are also left without the adaptive infrastructure that allows them to cope with rising temperatures, flooding, and other climate challenges.

Liberia will need to prioritize investments in climate-resilient and adaptive infrastructure, including by enhancing the resilience of existing infrastructure and designing new projects with climate adaptation in mind. Scaling safe WASH infrastructure across the country will be critical to promote water security and protect populations from diarrheal and vector-borne diseases. In urban centers, focus should be placed on upgrading housing and investing in solid waste management and drainage and flood protection systems, to safeguard vulnerable populations from heavy rainfall and flooding. Improving regional power trade and optimizing the use of renewable energy sources, including solar PV and storage deployment; modernizing the power network (through smart grids and digitalization) and soft infrastructure (grid codes, demand response regulation); and implementing the clean cooking agenda would support low-carbon pathways in the energy sector, the scale-up of electrification, and the implementation of adaptive infrastructure, such as increased air conditioning and digital development for efficient data management and coordination.

Short-term actions

- Diversify and optimize energy sources with renewables such as hydropower and solar. Harmonize the power sector's regulatory framework with the frameworks of neighboring countries to improve regional power trade and optimize the use of renewable energy resources. Scale electrification (particularly in rural areas). Designate a lead agency to craft a strategy for achieving universal access to clean cooking and formalizing demand for cooking energy in national energy planning.
- Clearly define the roles and coordination mechanisms of national public agencies/commissions, utilities, county administrations, NGOs/community-based organizations (CBOs), and the private sector in WASH policy formulation, tariff setting, regulation, monitoring, service provision, and O&M.
- Strengthen annual reporting on sector financing and update the WASH Sector Investment Plan, dedicating and widening pooled funds for unique communities, such as urban informal settlements and remote populations.
- Adopt and monitor climate-responsive standards of accessibility, quality, and reliability in WASH service provision across the regions of Liberia, setting time-bound targets for increasing access to

²⁹ Urgency was determined if the action addressed major climate/development vulnerabilities; feasibility was determined by assessing whether a policy or plan was in place that could serve as a platform for supporting the climate action. Many Liberian policies and strategy documents define many of the same fiscal/institutional or sectoral/cross-sectoral themes identified in the CCDD. Therefore, feasibility also considered sequencing or whether a specific action was iterative.

safely managed drinking water and sanitation services, inclusive of health care centers and schools. Institutionalize routine water point mapping.

- Integrate climate and flood risk into urban spatial planning, land use and zoning regulations, and building codes. Develop detailed flood hazard and risk maps for all urban environments. Improve the government's capacity to enforce land use plans and building codes.
- Implement integrated interventions to help communities 'live with water'. Improve storm water drainage using 'green-blue-grey' solutions. Finance O&M of flood management infrastructure and solid waste management operations.
- Develop a sustainable transport policy. Improve the quality of transport networks, focusing on increasing the resilience and financing O&M of unpaved roads. Explore public-private partnerships in mass transit infrastructure.

Medium- to long-term actions

- Use monitoring data on service intermittency, drinking water quality, wastewater treatment, and utility performance indicators to implement policy interventions and regulations for closing service gaps, including increasing access to piped water supply and sewerage systems.
- Incorporate waste management into development planning and adopt a private sector approach to improving solid waste management, building on international good practices.
- Develop a coastal policy that incorporates physical riverine and coastal defense systems.
- Diversify sustainable water supplies. Explore the significant potential for additional hydropower generation with relatively low GHG emissions on the St. Paul River and beyond. Optimize hydropower plan project design and reservoir operations and manage flood risks.

Human Development Promotion

Climate change could reverse years of progress Liberia has made in improving health and education outcomes. Malaria and diarrheal diseases, the two leading causes of death and disability in Liberia, are acutely sensitive to climate-related variations. Undernutrition, a highly prevalent and significant risk factor for reduced health, learning, and productivity, could increase if the agricultural sector fails to adapt to shifting climate patterns. Growing evidence shows that higher temperatures could lead to lower learning and attainment. Increases in flash floods coupled with infrastructure deficiencies such as unpaved roads and weak building structures could restrict access to schools and health facilities, particularly in rural areas.

Improving human development outcomes could play a transformative role in building climate resilience while also delivering economic gains. Liberia's human capital accounts is valued at US\$5,000, about half the world average (US\$10,100). Climate resilience would increase human capital because (a) education helps people understand and respond to climate risks, innovate climate-smart technologies, and develop sustainable industries that are less reliant on natural resources and (b) a healthier population can better cope with climate-sensitive diseases and injuries. Stronger human capital would also increase GDP. Children born today in Liberia are projected to be only 32 percent as productive as adults as they would be if they had complete education and good health. This means that Liberia's GDP per capita is just a third of what it could be. Liberia's high dependence on its natural wealth increases its vulnerability to climate change. Liberia must invest in other wealth components to attain a more balanced and resilient asset portfolio.

Short-term actions

- Conduct a detailed analysis of the health, economic, and social implications of climate change and the adaptive capacities of the health system, including an assessment of geographic risks. Integrate and strengthen surveillance of climate-sensitive diseases and environmental exposures into existing surveillance systems, to improve modeling and inform local decision-making on PPR efforts.
- Improve governance and coordination by the central government, the Ministry of Health, the NPHIL, and other agencies and among decision-makers at both the central and county levels. Integrate health into national-level climate adaptation planning, particularly future iterations of Liberia's NAP. Integrate climate adaptive interventions in the NAPHS 2023–27 (currently under development). Integrate climate adaptive and mitigation measures in the Health Workforce Program. Through the One Health platform, establish coordination channels to ensure effective implementation and monitoring of adaptive and mitigation measures.
- Undertake a systematic diagnostic of how prepared the education sector is to face short- and long-term climate change risks and shocks. Strong education information systems are lacking in Liberia, and data collection on key education statistics needs to be strengthened. Develop an emergency and resilience plan to train and prepare school principals and teachers to lead evacuations and inform communities at the onset of extreme weather events and use schools as shelters and community hubs during climate-induced emergencies.
- Develop a strategic plan to offer programs of study in TVET and higher education that support a green transition.

Medium-to-long term actions

- Resolve logistical and infrastructural bottlenecks in PPR and health systems' responsiveness to the changing burden of disease. Efforts to strengthen capacities to prevent, detect, and respond to health threats and improve service delivery (such as the rollout of vaccines for malaria and other diseases), particularly at the periphery, should be accompanied by targeted improvement in infrastructure (including roads leading to health facilities, cold chain management, emergency operation centers, laboratories, and WASH for IPC at health facilities).
- Strengthen the community and primary health care systems to support the delivery of WASH, surveillance, vaccination, and treatments for malaria and diarrheal diseases. The government will need to address key constraints in its community health program. Actions include ensuring adequate training and supervision of CHAs for their increasing roles/responsibilities, paying CHA incentives on time, and providing protection and transportation of CHAs, particularly in harsh environments.
- Invest in infrastructure updates to help make schools more resilient to extreme weather events, especially in flood-prone areas. Cost-efficient investments such as better ventilation help schools adapt to extreme heat. More significant investments in the medium and long term could help improve school safety and climate resilience through storm, flood, fire, and seismic resilience measures.

Sustainable Land Management

Unsustainable LULUCF activities threaten low-carbon growth, deteriorate Liberia's natural wealth, and leave the country more vulnerable to climate change. One of the key findings presented in this report is the substantial emissions that arise from these activities. The annual rate of tree cover removal has steadily increased since the end of the second civil war. Logging, mining, and agriculture have also formally and informally claimed new areas. Rapid urbanization has led to haphazard spatial planning, proliferating informal settlements, and areas that lack basic services and infrastructure able to withstand climate hazards. At the same time, climate change is expected to degrade natural resources and biodiversity by restricting access during extreme weather events, introducing new pests and disease, reducing tree growth and biomass, and eroding soil quality. These effects are dangerous in a country in which a large share of households depend on natural wealth to meet their basic needs and ecosystem services are integral to climate resilience.

Liberia needs to strengthen its capacity and enforcement mechanisms on land use to ensure that communities benefit meaningfully from Liberia's natural capital. Growth engine sectors including forestry, mining, and agriculture need to facilitate sustainable land use planning. Agricultural productivity also needs to be increased to address the impact of climate change on food security. Efforts could include developing climate-smart agriculture practices, improving irrigation systems, and better managing water and energy. A binding constraint to sustainable land management is the lack of land ownership and boundary data and weak capacity of the LLA to regulate land use and manage conflicts.

Short-term actions

- Update land policy to digitize land information system for improved management of data on land boundaries, ownership, use, and value to prepare and enforce land use plans based on existing and future climate risks. Conduct a geophysical survey and update geological maps. Strengthen the LLA's enforcement capacity and coordination with forestry, mining, agriculture, and urban planning sectors.
- Update mining legislation to strengthen environmental stewardship, improve labor practices and occupational safety, and develop processes and regulations for mine closure. Update the mining licensing system, clarifying license definitions, rights, and taxation obligations to comply with MDAs and increasing transparency of award processes.
- Increase the capacity of the FDA and MME's to enforce laws, regulate and monitor operations, and coordinate with the LRA.
- Strengthen the capacity of the Ministry of Agriculture and CARI for implementation and research and development of climate-smart agriculture initiatives. Invest in research and extension services, especially on the assessment of crop vulnerability and suitability, the development of climate-resilient crops, and the implementation of adaptation options.
- Incorporate into current policy the need to increase the share of arable land under irrigation from the current level of 2–5 percent of the country's potential. Ensure that the policy allows for subsidies that promote incentives for farmers to adopt climate-smart practices. Modernize storage systems of harvested products and invest in transport and logistics systems to facilitate the delivery of agricultural input and market access.

Medium- to long-term actions

- Through the Pro-Poor Agenda, target poverty reduction, income generation, skills development/alternative livelihoods, food security, and social safety net programs in forestry, mining, and farming communities. Increase community engagement on legislative requirements related to communal lands and establish a cadastre of customary land rights that legally identify landowning communities and enable targeted programs for ensuring their participation and consultation on logging/mining activities. Compensate community members for forgoing forest use, through initiatives that provide payments to communities for ecosystem services.
- Develop a policy to improve energy efficiency in the water sector and promote circular economy approaches in the delivery of water services by reducing unrecoverable water losses; managing water demand; recovering and capturing valuable resources such as biogas, nutrients, and heavy metals from wastewater treatment; and adapting the reuse of drainage, treated effluents, and resource recovery. Modernize or decommission aging hydraulic infrastructure.
- Accelerate the restoration of degraded land by improving data gathering, monitoring progress against the achievement of land restoration commitments, and establishing a new partnership model for large-scale integrated landscape investments.
- Increase and optimize multipurpose water storage (such as for hydropower) for both surface and groundwater, including through conventional surface water storage infrastructure, nature-based solutions, and adaptive and flexible water allocation mechanisms.
- Support climate-smart fisheries, develop coastal zone management strategies informed by climate projections, and invest in coastal wetland protection.

Climate Risk and Readiness

Several cross-cutting actions—including strengthening climate and disaster risk preparedness, increasing climate resilience within the financial sector, and protecting carbon sinks while improving carbon market readiness—could be adopted in the short, medium, and long term. Since there is substantial overlap with the financial sector, data needs, carbon market readiness, and climate finance, a number of the recommendations have also been outlined under the climate finance for development section.

Short-term actions

- Use the National Multi-Hazard Contingency Plan to ensure that a coordinated and functional preparedness and response mechanism is in place at every level of government. Support NDMA's new NEWEOC to serve as the national hub for early warning information. These hubs will need to be equipped with adequate stocks of response and recovery items and equipment.
- Improve baseline data and climate risk assessment of floods, windstorms, heat waves, and droughts and improve monitoring, forecasting, and warning of everyday weather-related and hydrology hazards.
- Undertake a DRF diagnostic and develop a comprehensive DRF and insurance strategy and disaster contingency fund. Expand and combine the range of sovereign DRF tools, such as contingent credit. Scaling up market-based solutions, such as sovereign reinsurance, through an optimal risk-layered approach would ensure more timely and predictable access to funds.


- Survey the banking sector to start engaging with, gathering information on, and raising awareness of the risks climate change poses to the financial sector. Integrate climate considerations in central bank operations, especially by building its capacity to appraise climate risks and promote green lending.
- Strengthen institutions managing REDD+ implementation, through strong donor support to the EPA and the FDA as technical leads and to the MFDP regarding climate finance planning across sectors.
- Address gaps in the legal and policy framework with respect to implementing REDD+. For instance, no currently enforced laws expressly recognize or regulate carbon and emission rights as property rights, creating ambiguity. Legislation is needed to define carbon credits, their ownership structures, and trade. Improve MRV systems. A land information system with legal ownership and boundary data is fundamental to implementing policies that would identify landowners as beneficiaries (also identified as a critical action in sustainable land management).

Medium-to long-term actions

- Integrate sustainable investment practices that have the dual benefit of reducing climate-related and environmental risks in the portfolio and setting an example and enhancing the enabling environment for green finance domestically.
- Raise awareness on REDD+ policies and incentives and engage with communities to induce greater participation in forest management.

In conclusion, adapting to climate change will be challenging in Liberia, but there is room for optimism. Climate action can play a leading role in Liberia’s development story. Many climate actions overlap with the goals of reducing poverty and pursuing inclusive growth. Investment in climate-resilient infrastructure, renewable energy sources, and human development can improve resource efficiency, enhance energy security and electrification, and create greener job opportunities for a higher-skilled workforce. By promoting sustainable practices within its traditional growth sectors, such as agriculture, forestry, and mining, Liberia can preserve its rich biodiversity and natural capital while meeting global demands for mitigation. Climate action can serve as a catalyst for transformative and inclusive development, paving the way for a brighter, more resilient future for Liberia and its people.

Table 5.1. Priority climate actions by theme and sector

01 CLIMATE RISKS And READINESS 	Shift toward a policy framework that integrates climate finance, risk, and coordination	
	Priority sector actions	Enabling environment for implementation
Finance: Prepare climate finance policy framework to facilitate readiness for climate finance and mainstream climate considerations within development planning and budgeting processes.		
<p><i>Short term</i></p> <ul style="list-style-type: none"> Undertake a DRF diagnostic. Survey the banking sector to start engaging with, gathering information on, and raising awareness of the risks climate change poses to the financial sector. Promote green lending within the financial sector toward innovative climate solutions to leverage the private sector’s role of producer and supplier toward a greener economy. Expand and combine the range of sovereign DRF tools, such as contingent credit. Scale up market-based solutions, such as sovereign reinsurance, through an optimal risk-layered approach. Continue to leverage concessional finance options but explore innovative financing mechanisms (for example, green, blue, and sustainability bonds and loans; sustainability-linked bonds and loans; pooled investment funds; and revolving adaptation funds) by partnering with organizations that have access to capital markets (multilateral development banks or funds) to finance mitigation-focused projects. Leverage blended financing opportunities to de-risk the market and promote targeted investments toward natural ecosystem and biodiversity conservation, climate-resilient infrastructure, transportation, and agriculture. <p><i>Medium to long term</i></p> <ul style="list-style-type: none"> Integrate sustainable investment practices that have the dual benefit of reducing climate-related and environmental risks in the portfolio. 	<p><i>Develop a national strategy on climate finance options, emphasizing finance needs for adaptation and the role of the private sector.</i></p> <p><i>Develop a DRF and insurance strategy and disaster contingency fund.</i></p> <p><i>Have in place an effective Policy Framework at the Central Bank (CBL) to raise awareness and mainstream climate change within the financial sector to integrate climate considerations in CBL operations, especially by building its capacity to appraise climate risks and promote green lending.</i></p> <p><i>Facilitate donor support to the MFDP for climate finance planning across sectors and to the EPA and the FDA as technical leads.</i></p> <p><i>Promote business environment reforms to attract foreign investments.</i></p>	
Disaster risk management: Improve climate risk assessment, early warning, emergency preparedness, and disaster response systems.		
<p><i>Short term</i></p> <ul style="list-style-type: none"> Ensure National Multi-Hazard Contingency Hubs are equipped with adequate stocks of response and recovery items. Improve baseline data and climate risk assessment of floods, windstorms, heat waves, and droughts. <p><i>Medium to long term</i></p> <ul style="list-style-type: none"> Improve monitoring, forecasting, and warning of everyday weather-related and hydrology hazards to feed into early warning systems. Prepare climate finance policy framework to facilitate readiness for climate finance. 	<p><i>Have in place a National Multi-Hazard Contingency Plan for coordinated and functional preparedness and response mechanisms at every level of government.</i></p> <p><i>Strengthen NDMA’s NEWEOC capacity to serve as the national hub for early warning information.</i></p>	

01 CLIMATE RISKS And READINESS



Shift toward a policy framework that integrates climate finance, risk, and coordination

Carbon markets: Protect carbon sinks and ecosystem services while ensuring shared benefits through the carbon market.

Short term

- Strengthen institutions managing REDD+ implementation, through strong donor support to the EPA and the FDA as technical leads and to the MFDP regarding climate finance planning across sectors.
- Develop a robust MRV system for REDD+ to effectively monitor forest management and capture benefits.

Medium to long term

- Raise awareness of REDD+ policies and incentives and engage with communities to induce greater participation in forest management.

Address gaps in the legal and policy framework with respect to implementing REDD+, including laws that define carbon credits, their ownership structures, and trade.

Update land policy to digitize land information system for improved management of data on land boundaries, ownership, use, and value to prepare and enforce land use plans based on existing and future climate risks (also identified as a critical action in sustainable land management).

02 ESSENTIAL INFRASTRUCTURE



Shift toward upgrading and scaling infrastructure with climate risks and opportunities in mind

Priority sector actions

Enabling environment for implementation

Energy: Scale electrification and decarbonize the power sector.

Short term

- Diversify and optimize energy sources with renewables such as hydropower and solar and improve regional trade.
- Promote the uptake of cleaner cooking technologies to reduce household dependence on biomass fuels.

Medium to long term

- Explore the significant potential for additional hydropower generation on the St. Paul River and beyond.
- Optimize hydropower plan project design and reservoir operations and manage flood risks.

Transport: Increase the resiliency and sustainability of transport networks.

Short term

- Finance O&M of unpaved roads.

Medium to long term

- Explore public-private partnerships for low-carbon mass transit solutions.

Harmonize the power sector's regulatory framework with frameworks of neighboring countries.

Designate a lead agency to craft a clean cooking agenda and formalize demand for cooking energy in national energy planning.

Develop a sustainable transport policy.



Water: Scale safe and reliable water and sanitation services and solid waste management practices.

Short term

- Use monitoring data on service intermittency, drinking water quality, wastewater treatment, and utility performance indicators to inform interventions to increase access to safely managed drinking water and sanitation services, inclusive of health centers and schools.
- Protect river catchments and other sources of freshwater from pollution and degradation.

Adopt and monitor climate-responsive and SDG standards (quality, accessibility, reliability) in WASH service provision, setting time-bound targets. Institutionalize routine water point mapping.

Medium to long term

- Increase and optimize multipurpose water storage (such as for hydropower) for both surface and groundwater, including through conventional surface water storage infrastructure, nature-based solutions, and adaptive and flexible water allocation mechanisms.
- Incorporate waste management into development planning and adopt a private sector approach to improving solid waste management, building on international good practices.

Clearly define roles and coordination mechanisms of public agencies/commissions, utilities, county administrations, NGOs/CBOs, and the private sector in WASH policy formulation, tariff setting, regulation, provision, and O&M

Update the WASH Sector Investment Plan, dedicating pooled funds for unique communities, such as urban informal settlements, remote and coastal populations.

Urban/Disaster risk management: Promote sustainable land use in cities, ensuring homes and assets consider climate risks and hazards.

Short term

- Develop detailed flood hazard and risk maps for all urban environments.
- Integrate climate and flood risk into urban spatial planning, land use and zoning regulations, and building codes.
- Invest in flood protection systems ‘green-blue-grey’ solutions to improve stormwater drainage to protect against heavy rainfall and storm surge.

Develop a coastal policy that incorporates physical riverine and coastal defense systems.

Improve the government’s capacity to enforce land use plans and building codes.



Priority sector actions

Enabling environment for implementation

Health: Reduce the disease burden from climate-sensitive health risks.

Short term

- Conduct a detailed analysis of the health, economic, and social implications of climate change and the adaptive capacities of the health system, including an assessment of geographic risks.
- Make targeted improvements in health system infrastructure to support the delivery of health services, vaccinations, and essential medicines, such as roads leading to health facilities, emergency operation centers, cold chains laboratories, and WASH.
- Intervene in the environmental determinants of health through behavior change promotion in WASH practices and vector control and scale resilient and protective infrastructure (see essential infrastructure needs).
- Strengthen the health care workforce and community and primary health programs, especially in rural areas.

Integrate climate and health into national-level climate adaptation planning, particularly future iterations of Liberia's NAP, the NAPHS 2023–27, the Health Workforce Program, and One Health platforms.

Improve coordination between central and local health agencies and strengthen health system capacities, especially in peripheral and community health care systems.

Ensure adequate training and supervision of community health workers for increasing responsibilities, paying incentives, and providing protection and transportation, particularly in harsh environments.

Integrate climate hazard, environmental exposure, and weather data into existing surveillance systems to improve modeling and inform local decision-making on PPR efforts.

Education: Reduce disruptions in educational attainment from climate shocks and hazards and develop green skills.

Short term

- Undertake a systematic diagnosis of how prepared the education sector is to face short- and long-term climate change risks and shocks.
- Invest in infrastructure updates to help make schools more resilient to extreme weather events, especially in flood-prone areas. Invest in better ventilation to help schools adapt to extreme heat.

Improve routine data collection for education management information systems.

Craft a strategy to offer programs in TVET and higher education that support the green transition.

Medium to long term

- Integrate climate literacy and green skills in education curricula.



Shift toward sustainable land use across sectors, emphasizing community benefits from natural capital

Priority sector actions

Enabling environment for implementation

Forestry: Prioritize forestry communities through sustainable forestry management.

Short term

- Reduce households' overdependence on forestry resources by targeting poverty reduction, income generation, skills development/alternative livelihoods, food security, agroforestry, social safety net programs, and essential infrastructure in forestry communities.
- Promote collaboration between the EPA, FDA, and private sector to foster sustainable logging and permitting practices to achieve higher international market value.
- Leverage civil society organizations to contribute to forestry monitoring.

Medium to long term

- Increase community engagement on legislative requirements related to communal lands, land rights, and ownership and ensure their participation and consultation on logging/mining activities.
- Compensate community members for forgoing forest use, through initiatives that provide payments to communities for ecosystem services (see carbon markets under climate risk and readiness).

Have in place a capacity-building and coordination strategy within the Forest Development Authority, the Liberian National Police, the Ministry of Justice and Ministry of Mines and Energy to enforce laws, regulate and monitor operations, and coordinate with the Liberia Revenue Authority.

Strengthen the LLA's enforcement capacity and coordination with forestry, mining, agriculture, and urban planning sectors.

Improve land information systems with legal ownership and boundary data (see carbon markets under climate risk and readiness).



Mining: Improve governance and regulation of mining activities.

Short term

- Conduct a geophysical and hydrological survey and update geological and hydrological maps.
- Follow processes on mine closures.
- Develop a program partnered by the government and private sectors to jointly address the negative environmental and social impacts of ASM activities.
- Pilot an incentive-based program for the mining sector that targets poverty reduction, income generation, skills development/alternative livelihoods, and social safety net programs in mining communities.

Medium to long term

- Monitor mining governance periodically and address the gaps identified.

Update mining legislation to strengthen environmental stewardship, improve labor practices and occupational safety, and develop processes and regulations for mine closure.

Update the mining licensing system, clarifying license definitions, rights, and taxation obligations to comply with MDAs and increasing transparency of award processes.

Agriculture: Promote climate-smart agriculture innovations and irrigation to increase yield while reducing land userestoring land and managing land, energy, water use..

Short term

- Increase the share of arable land under irrigation from the current level of 2–5 percent of the country's potential.
- Invest in research and extension services, especially on the assessment of crop vulnerability and suitability; the development of climate-resilient crops; and the implementation of adaptation options.
- Provide incentives to allow farmers to adopt climate-smart agriculture, partnering with the private sector to improve value chain and value addition to a wider market.
- Modernize storage systems of harvested products and invest in low-carbon transport and logistics systems.

Medium to long term

- Accelerate the restoration of degraded agricultural land by improving data gathering, monitoring progress against the achievement of land restoration commitments.
- Support climate-smart fisheries and develop coastal zone management and coastal wetland protection strategies.
- Increase and optimize multipurpose water storage (such as for hydropower) for both surface and groundwater, including through conventional surface water storage infrastructure, nature-based solutions, adaptive and flexible water allocation mechanisms, and circular economy approaches.
- Incorporate waste management into development planning and adopt a private sector approach to improving solid waste management, building on international good practices.

Strengthen the capacity of the Ministry of Agriculture and CARI for implementation and research and development of climate-smart agriculture initiatives.

Establish a framework for partnerships on large-scale integrated landscape investments.

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