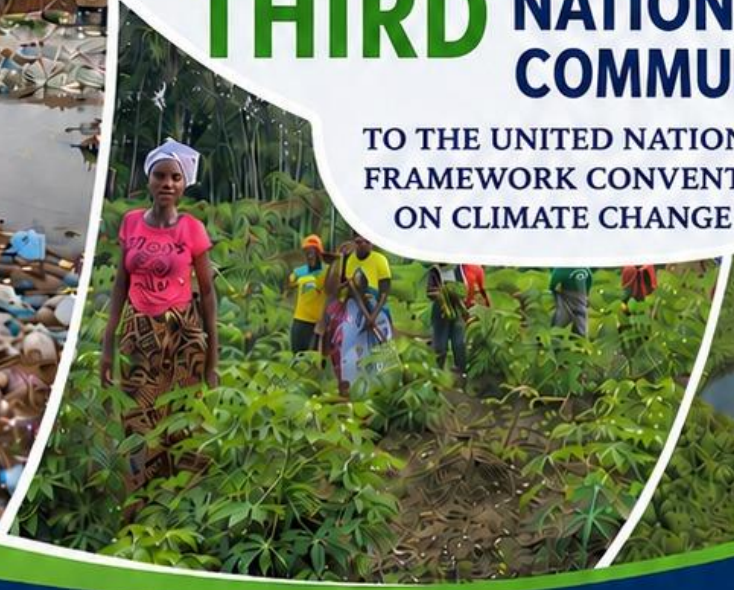
REPUBLIC OF LIBERIA

# FIRST BIENNIAL TRANSPARENCY REPORT

## 2019 - 2022

## THIRD NATIONAL COMMUNICATION

TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE



Environmental Protection Agency (EPA) of Liberia

With support from

The final electronic version of this report is available for download on the Liberia EPA website at https://epa.gov.lr/

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# PREFACE

The preparation of Liberia's First Biennial Transparency Report and Third National Communication (BTR1NC3) marks a historic milestone in the country's climate reporting journey under the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement. This combined report demonstrates Liberia's continued commitment to transparency, accountability, and evidence-based climate action while strengthening the institutional and technical foundations of the national transparency system.

The report has been prepared in accordance with the Modalities, Procedures and Guidelines (MPGs) for the Enhanced Transparency Framework (ETF) adopted under Decision 18/CMA.1, together with the relevant UNFCCC reporting guidelines for National Communications. It presents comprehensive information on Liberia's national circumstances, greenhouse gas inventory, progress in implementing and achieving its Nationally Determined Contribution (NDC), climate change impacts and adaptation, support needed and received, research and systematic observation, education, training and public awareness, and other information relevant to the achievement of the objectives of the Convention and the Paris Agreement.

The preparation of this report was coordinated by the Environmental Protection Agency (EPA) through the BTR1NC3 Project Management Unit under the guidance of the National Steering Committee and with the active participation of government ministries and agencies, academia, civil society organizations, development partners, technical experts, and local stakeholders. The collaborative nature of this undertaking reflects Liberia's commitment to a whole-of-government and whole-of-society approach to climate governance.

Beyond fulfilling an international reporting obligation, the BTR1NC3 has strengthened Liberia's national transparency architecture by improving institutional arrangements, enhancing technical capacity, promoting inter-agency collaboration, and identifying opportunities for continuous improvement in greenhouse gas inventories, adaptation reporting, NDC tracking, and climate support reporting. The lessons learned during this process will serve as an important foundation for future Biennial Transparency Reports and continued implementation of Liberia's climate commitments.

An electronic version of this report is available through the Environmental Protection Agency of Liberia and the UNFCCC submission portal.

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# FOREWORD

It is with great honor and a profound sense of national responsibility that I present the Republic of Liberia's First Biennial Transparency Report and Third National Communication (BTR1NC3) to the United Nations Framework Convention on Climate Change (UNFCCC). These reports represent another significant milestone in Liberia's enduring commitment to the objectives and principles of the Convention and the Paris Agreement, particularly in advancing transparency, accountability, and evidence-based climate action.

Climate change remains one of the greatest challenges confronting humanity today. Liberia, despite contributing minimally to global greenhouse gas emissions, continues to experience the disproportionate impacts of climate change through rising temperatures, changing rainfall patterns, coastal erosion, flooding, biodiversity loss, and increasing threats to food security, public health, and sustainable livelihoods. These realities underscore the urgency of strengthening national resilience while contributing meaningfully to global efforts to reduce greenhouse gas emissions.

The preparation of this combined submission reflects Liberia's commitment to fulfilling its reporting obligations under the Enhanced Transparency Framework (ETF) of the Paris Agreement and Article 12 of the Convention. The reports provide a comprehensive account of our national greenhouse gas inventory, mitigation actions, climate change vulnerabilities, adaptation priorities, financial, technological, and capacity-building needs, and the progress made toward implementing our NDC. They also highlight the institutional and technical advances Liberia has made in strengthening data collection, coordination, and reporting systems that will support continuous improvement in future reporting cycles.

This achievement is the result of strong collaboration among government ministries, agencies, and commissions, development partners, academic and research institutions, civil society organizations, the private sector, local communities, and technical experts. Their collective commitment, dedication, and expertise have made it possible to produce reports that reflect the best available national data and reinforce our shared vision for a climate-resilient and low-carbon future. On behalf of the Environmental Protection Agency of Liberia, I extend my sincere appreciation to all institutions and individuals who contributed to this important national undertaking.

I also express Liberia's gratitude to the Global Environment Facility (GEF) for its financial support and to the United Nations Environment Programme (UNEP), as the implementing agency, for its technical guidance and continued partnership throughout the preparation of these reports. We further acknowledge the invaluable support of our international partners whose sustained cooperation continues to strengthen Liberia's climate governance, institutional capacity, and implementation of national climate priorities.

As we submit these reports, Liberia reaffirms its unwavering commitment to transparency, international cooperation, and climate ambition. We recognize that addressing the climate crisis requires collective global action grounded in equity and the principle of common but differentiated responsibilities and respective capabilities. We therefore call upon the international community to continue supporting developing countries, particularly Least Developed Countries (LDCs) such as Liberia, through enhanced access to climate finance, technology transfer, and capacity-building to enable effective implementation of our climate commitments.

The Environmental Protection Agency (EPA) of Liberia remains committed to working with all stakeholders to translate the findings and recommendations contained in these reports into concrete actions that promote sustainable development, environmental integrity, and the well-being of present and future generations of Liberians. As Executive Director and Chief Executive Officer of the Environmental Protection Agency of Liberia, I am pleased to submit Liberia's First Biennial Transparency Report and Third National Communication to the UNFCCC, reaffirming our nation's steadfast commitment to transparency, accountability, and collective action in addressing the global climate crisis.

**Hon. Emmanuel King Urey Yarkpawolo, PhD.**
**Executive Director/Chief Executive Officer**
**Environmental Protection Agency of Liberia**

## ACKNOWLEDGEMENTS

The Government of the Republic of Liberia is pleased to present its First Biennial Transparency Report & Third National Communication (BTR1NC3) to the United Nations Framework Convention on Climate Change (UNFCCC). This landmark achievement reflects Liberia's steadfast commitment to the Enhanced Transparency Framework (ETF) under the Paris Agreement and represents the culmination of extensive collaboration among national institutions, development partners, technical experts, and stakeholders nationwide.

On behalf of the Project Management Team, I express profound appreciation to His Excellency Joseph Nyuma Boakai, the 26th President of the Republic of Liberia, and the Government of Liberia for the continued commitment to addressing climate change and strengthening national environmental governance.

Our sincere appreciation is extended to the Global Environment Facility (GEF) for providing the financial resources that made this important national undertaking possible. We are equally grateful to the United Nations Environment Programme (UNEP), serving as the GEF Implementing Agency, for its unwavering technical guidance, quality assurance, and continuous support throughout the project's implementation.

We express our deepest gratitude to Dr Emmanuel King Urey Yarkpawolo, Executive Director and Chief Executive Officer of the Environmental Protection Agency (EPA), for his visionary leadership and steadfast commitment to advancing Liberia's climate agenda and ensuring the successful completion of this report.

Special recognition is accorded to Mr. Benjamin Saagieh Karmorh, Jr., Chief Technical Advisor to the EPA and UNFCCC Focal Point for Liberia, whose strategic guidance, technical oversight, and invaluable advice were instrumental throughout the preparation and finalization of this report. We also sincerely acknowledge Mr. Arthur Richard Melvin Becker, Director of Multilateral Environmental Agreements (MEAs), for his exceptional coordination, institutional leadership, and continuous support throughout the reporting process.

We gratefully acknowledge the outstanding technical leadership provided by our International Consultant, Dr. Daniel Benefoh, whose expertise, mentorship, and meticulous technical reviews significantly enhanced the quality, consistency, and completeness of the report in accordance with the Modalities, Procedures and Guidelines (MPGs) under the Enhanced Transparency Framework.

Our sincere appreciation goes to the members of the National Climate Change Steering Committee (NCCSC), the Project Management Unit, the sectoral technical working groups, and all national consultants and experts who contributed their knowledge, time, and dedication in preparing the greenhouse gas inventory, adaptation information, mitigation actions, NDC tracking, support needed and received, research and systematic observation, education, training and public awareness, and all other chapters contained herein.

We also recognize the invaluable contributions of all government ministries, agencies, commissions, academic and research institutions, civil society organizations, private sector entities, and development partners that generously shared data, technical information, and professional expertise. Their collaboration reflects the collective national ownership that underpins Liberia's transparency system.

The Environmental Protection Agency of Liberia extends special appreciation to the University of Liberia, particularly the National University Climate Action Laboratory (NUCAL), for providing technical collaboration and facilities that supported the final stages of the ETF Reporting Tool and ETF Submission Module, as well as national technical consultations.

Finally, I wish to express my sincere gratitude to every individual who contributed, whether through technical analysis, data provision, administrative support, financial management, logistics, review, or coordination. Your professionalism, dedication, and commitment have enabled Liberia to successfully prepare and submit its inaugural Biennial Transparency Report under the Enhanced Transparency Framework of the Paris Agreement.

This report belongs to the people of Liberia. It reflects our collective determination to strengthen transparency, improve climate governance, and contribute meaningfully to global efforts to address climate change while pursuing sustainable and climate-resilient development.

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The preparation of this report benefited from the active participation and technical contributions of numerous government ministries, agencies, and commissions, including:

- Environmental Protection Agency (EPA)
- Ministry of Finance and Development Planning (MFDP)
- Ministry of Mines and Energy (MME)
- Ministry of Agriculture (MoA)
- Forestry Development Authority (FDA)
- Liberia Institute of Statistics and Geo-Information Services (LISGIS)
- Liberia Land Authority (LLA)
- Ministry of Public Works (MoPW)
- Ministry of Transport (MoT)
- Liberia Electricity Corporation (LEC)
- National Fisheries and Aquaculture Authority (NaFAA)
- Liberia Maritime Authority (LiMA)
- Other collaborating ministries, agencies, commissions, and local government institutions.

**ACADEMIC, RESEARCH AND OTHER PARTNERS**

- University of Liberia (UL)
- National University Climate Action Laboratory (NUCAL)
- Academic and Research Institutions
- Civil Society Organizations
- Private Sector Partners
- Development Partners
- Local Communities and Stakeholders

## Acronyms

| | |
|---|---|
| AD | Activity data |
| BOD | Biochemical oxygen demand |
| BUR | Biennial Update Report |
| C | Confidential |
| CBIT | Capacity Building Initiative for Transparency |
| CH4 | Methane |
| CMA | Carbon Market Authority |
| CO2 | Carbon dioxide |
| CO2eq | Carbon dioxide equivalent |
| COD | Chemical oxygen demand |
| DOM | Dead organic matter |
| DWEHS | Department of Waste, Environmental Health and Sanitation |
| EF | Emission factor |
| EPA | Environmental Protection Agency |
| FAO | Food and Agriculture Organization of the United Nations |
| FAOSTAT | UN Food and Agriculture Organization statistical database |
| FOLU | Forestry and Land Use |
| GEF | Global Environment Facility |
| GHG | Greenhouse gas |
| GWP | Global warming potential |
| HFCs | Hydrofluorocarbons |
| HWP | Harvested wood products |
| IE | Included elsewhere |
| IEF | Implied emission factor |
| IPCC | Intergovernmental Panel on Climate Change |
| IPPU | Industrial Processes and Product Use |
| KCA | Key category analysis |
| LDC | Least developed country |
| LEC | Liberia Electricity Corporation |
| LISGIS | Liberia Institute of Statistics and Geo-information Services |
| LWSC | Liberia Water and Sewer Corporation |
| MCC | Monrovia City Corporation |
| MODIS | Moderate resolution imaging radiometer |
| MS | Method statement |
| N2O | Nitrous oxide |
| NA | Not applicable |
| NC | National Communication |
| NE | Not estimated |
| NMVOC | Non-methane volatile organic compounds |
| NO | Not occurring |
| ODS | Ozone depleting substances |
| PFCs | Perfluorocarbons |
| QA/QC | Quality Assurance and Quality Control |
| SAR | IPCC Second Assessment Report |
| SF6 | Sulphur hexafluoride |
| SME | Small and medium-sized enterprises |

| | |
|---|---|
| SOC | Soil organic carbon |
| SWDS | Solid waste disposal sites |
| T1 | Tier 1 approach |
| T2 | Tier 2 approach |
| TCCCA | Transparency, Consistency, Comparability, Completeness and Accuracy |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UL | University of Liberia |

# EXECUTIVE SUMMARY

## Reporting Mandate

This document is Liberia's First Biennial Transparency Report and Third National Communication (BTR1NC3), prepared by the Environmental Protection Agency under the Paris Agreement's Enhanced Transparency Framework. It includes the 2019–2022 GHG inventory, progress on Liberia's NDC, climate impacts and adaptation, and support for climate actions. The inventory follows the 2006 IPCC Guidelines, using Tier 1 (Tier 2 for waste) and AR5 global warming potentials.

## National Greenhouse Gas Inventory (2019–2022)

Liberia's total emissions (excluding FOLU) dropped from 1,799.57 Gg $CO_2$eq in 2019 to 1,587.89 Gg $CO_2$eq in 2021, then rose by 7% to 1,709.59 Gg $CO_2$eq in 2022, reflecting economic slowdown and recovery. The Energy sector leads with 61% of emissions, followed by Agriculture (31%) and Waste (8%). IPPU data is unavailable. The FOLU sector was a net sink, but its capacity decreased sharply from –10.45 to –1.08 Gg $CO_2$eq, indicating growing land-use pressure. Methane (52%) is the main gas, then $CO_2$ (40%) and $N_2O$ (8%); fluorinated gases are not estimated. Per-capita emissions are low at 0.33 t $CO_2$eq, typical of a Least Developed Country with minimal historical emissions.

## Tracking Progress towards the NDC

Under its updated NDC (NDC 2.0, submitted August 2021), Liberia aims to cut economy-wide GHG emissions by 64% below the BAU level by 2030, including a 10% unconditional reduction and 54% conditional on international support. In 2025, Liberia submitted NDC 3.0, extending the plan to 2035 and setting a net-zero goal for 2050. This report tracks NDC 2.0's implementation from 2019–2022 against a BAU projection of 55,507 Gg $CO_2$eq, using prescribed indicators and CTF tables. Liberia is exploring Article 6 cooperative approaches to mobilize finance for the conditional part; no Internationally Transferred Mitigation Outcomes were authorized or transferred during this period.

## Climate Change Impacts and Adaptation

Liberia is highly vulnerable to climate change despite its negligible contribution to global emissions. Mean annual temperature is projected to rise by about 1.8 °C between 2040 and 2059, with up to 44 additional hot days per year by mid-century under a high-emissions (RCP 8.5) scenario, alongside shifting rainfall patterns and rising sea levels along the country's 570 km coastline. Guided by the National Adaptation Plan (2020–2030), the report identifies priority adaptation needs across nine sectors — Agriculture, Coastal Zone, Energy, Fisheries, Forestry, Health, Industry, Transport and Waste — and assesses the hazards, exposure and vulnerability facing the coastal, agriculture, fisheries, forestry, health, waste and energy sectors.

## Finance, Technology and Capacity-Building Support

Liberia's climate commitments rely heavily on international support. During the reporting period, it received funding and technical aid from the Green Climate Fund, GEF (including USD 1.3 million for transparency), the Initiative for Climate Action Transparency, Climate Technology Centre, GHG Management Institute, World Bank, and bilateral partners. This enhanced national inventory, MRV, and adaptation capacity, but funding remains insufficient for full implementation. Gaps in data systems, institutional capacity, and technology transfer persist, especially in estimating the IPPU sector and fluorinated gases, which are key priorities for future transparency reporting.

# I. NATIONAL INVENTORY REPORTS

# A. Introduction

Liberia, a country in West Africa, is characterized by its rich biodiversity, significant forest cover, and a growing economy. As a Party to the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement, Liberia is committed to reducing its greenhouse gas (GHG) emissions and enhancing transparency in its climate actions. This section outlines Liberia's national circumstances and institutional arrangements relevant to the preparation of its GHG inventory, as part of the First Biennial Transparency Report and Third National Communication (BTR1NC3).

# B. Background

Global climate change is a major environmental challenge with implications for sustainable development and environmental management. In response, governments convened in 1988 and established the Intergovernmental Panel on Climate Change (IPCC). This subsequently led to the creation of the United Nations Framework Convention on Climate Change (UNFCCC), which came into force on 21 March 1994. Currently, there are 198 Parties to the UNFCCC and 1 regional economic integration organization. The purpose of the UNFCCC is to stabilize greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous human-induced interference with the climate system.

Linked to the UNFCCC is the Kyoto Protocol, which committed the developed country (Annex I) parties to the Convention to internationally binding emission reduction targets. Developing country (non-Annex I) parties did not have emission reduction obligations under the Convention and its Protocol. Liberia ratified the UNFCCC and the Kyoto Protocol in 2002. Under the UNFCCC, Liberia is classified as a non-Annex I party and a Least Developed Country (LDC) and can submit National Communications (NCs) and BTR at its discretion. The NCs and BTRs include an inventory of sources and sinks of GHG emissions, a description of the steps taken by the Party to implement the Convention and any other relevant information relevant to the achievement of the objective. Liberia submitted its initial NC in 2013, its BUR1 in 2020, and its SNC in 2021.

A fundamental element of this international reporting is the GHG inventory, which quantifies anthropogenic emissions of carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride ($SF_6$). These annual estimates are the evidence base for understanding sources of emissions and how they are generated and managed.

This section documents the GHG inventory estimated under the "Consultancy to Develop Liberia's National greenhouse gas inventory (GHGI)", with support from the Global Environment Facility (GEF) through the United Nations Environment Programme. The objectives of this section include the following:

- Develop a national greenhouse gas inventory
- Report on the national measurement, reporting and verification (MRV) system for greenhouse gas inventory
- Conduct sectoral training in greenhouse gas emissions and inventories.

This section documents the completion of the national greenhouse gas inventory. The inventory includes GHG emissions estimates for the period 2019-2022 from five major economic sectors: Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land Use (FOLU) and Waste. The GHGs considered in this inventory are carbon dioxide ($CO_2$), methane ($CH_4$), Nitrous Oxide ($N_2O$), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride ($SF_6$).

Emissions for each of these direct greenhouse gases have been presented in carbon dioxide-equivalent ($CO_2e$) terms using the 100-year global warming potentials (GWPs) from the IPCC Fifth Assessment Report (AR5, 2014).

The GHG emission estimates provided in this section have been compiled in accordance with the Intergovernmental Panel on Climate Change (IPCC) 2006 Guidelines for National Greenhouse Gas Inventories (IPCC 2006), and the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2019), where appropriate. The purpose of using the Guidelines was to ensure that GHG emission estimates were transparent, accurate, consistent, comparable, and complete (TACCC). The underlying inventory calculations, documentation, and data were provided to the Environmental Protection Agency (EPA) alongside this report to ensure that future inventory compilation activities can draw on the knowledge gained during this process.

## C. National Circumstances

Liberia's national circumstances play a critical role in shaping its GHG emissions profile and its approach to climate change adaptation and mitigation. Key factors include:

### 1. Economic Structure

Liberia's economy is primarily driven by agriculture, mining, and forestry, all of which contribute to GHG emissions. The country is also heavily reliant on imported fossil fuels for energy.

### 2. Land Use and Forestry

Liberia's forest cover makes up about 43% of its land area (Liberia - National Forest Inventory Report, 2020), highlighting the importance of the Land Use, Land-Use Change, and Forestry (land use, land-use change and forestry (LULUCF)) sector in GHG accounting. Deforestation and forest degradation, mainly caused by agricultural expansion, illegal logging, and illicit mining, are ongoing issues.

### 3. Energy Sector

The energy sector is a growing source of emissions due to increased fossil fuel consumption, particularly for electricity generation and transportation. Renewable energy sources, such as hydro and solar, are underutilized but present mitigation opportunities.

### 4. Population and Development

With a population of over 5 million people (Liberia Institute of Statistics and Geo-Information Services (LISGIS), 2022), Liberia faces developmental challenges, including high poverty rates and limited infrastructure. These factors influence the country's capacity to implement climate actions and manage GHG emissions.

## D. Institutional Arrangements for Greenhouse Gas Inventory

Liberia has established institutional frameworks to support the preparation and management of its GHG inventory. These arrangements support transparency, accuracy and consistency of emissions data. Lead Institutions include:

### 1. Environmental Protection Agency (EPA)

The EPA is the lead agency responsible for coordinating climate change activities in Liberia, including developing the GHG inventory and the Measurement, Reporting, and Verification (MRV) system. It collaborates with other government ministries, agencies, and stakeholders.

The EPA also oversees the development of National Communications (NCs), Biennial Update Reports (BURs), Biennial Transparency Reports (BTRs), and Nationally Determined Contributions (NDCs) submitted to the UNFCCC. It manages data collection protocols, quality assurance, and stakeholder engagement.

**2. Ministry of Agriculture (MoA)**

The MoA plays a key role in providing data and information related to agricultural activities, which are a significant source of emissions, particularly from enteric fermentation and manure management. Agriculture is a major source of greenhouse gases in Liberia, particularly $CH_4$ and $N_2O$ emissions, which arise from livestock and soil management practices. Sectoral data are usually collected and shared with the EPA. The MoA participates in the National Greenhouse Gas Inventory Management Processes, coordinated by the EPA and engages in capacity-building workshops and data harmonization efforts to improve the consistency and reliability of agricultural emissions data.

**3. Forestry Development Authority (FDA)**

The FDA is responsible for managing forest resources and providing data on LULUCF activities, including deforestation and reforestation. FDA oversees Liberia's National Forest Inventory (NFI), which provides data on forest cover, biomass, and carbon stocks. Land-Use Change Monitoring tracks deforestation and reforestation activities using remote sensing, GIS, and field surveys to assess forest changes. Forest data are usually integrated into digital platforms for real-time forest monitoring and emissions tracking, but this is often hindered by capacity gaps. The FDA reports data to the EPA through the Capacity-building Initiative for Transparency (CBIT) Agreement.

**4. Ministry of Mines and Energy (MME)**

The MME oversees the energy sector and provides data on fossil fuel consumption, energy production, and renewable energy initiatives, and it is a key institutional partner in Liberia's national greenhouse gas (GHG) inventory system. The MME collects, manages, and shares data on emissions estimates for energy production and consumption, including fossil fuels, as well as energy production and distribution supplies from electricity sources, such as thermal, hydro, and solar.

The energy sector is one of Liberia's largest sources of GHG emissions, particularly from fuel combustion in transport and electricity generation. MME's data and technical input are important for Liberia's Biennial Update Reports (BURs), Biennial Transparency Reports (BTRs), National Communications (NCs), and Nationally Determined Contributions (NDCs). The MME collaborates with the EPA under formalized data sharing protocol arrangements with the EPA to ensure timely and consistent data flow for GHG inventory compilation. The MME is actively involved with the inventory methodology by contributing to the selection and application of IPCC guidelines and emission factors relevant to Liberia's energy profile.

## E. Data Collection and Management

Liberia has established mechanisms for collecting and managing data for the GHG inventory:

**1. National Climate Change Steering Committee (NCCSC)**

The National Climate Change Steering Committee (NCCSC) is the high-level policy coordination body for Liberia's overall climate change activities.

**2. National Climate Change Secretariat (NCCS)**

The National Climate Change Secretariat (NCCS) is the NCCSC's supportive arm. Specifically, it tracks progress on implementation and alignment of international climate change programs and policies with the national climate change policy, serves as liaison between the NCCSC, the EPA, the various working groups, and other relevant national stakeholders on climate change, and engages in appropriate programs to strengthen national capacity in addressing climate change. Cooperate with international organizations, regional centers, institutions and experts in developing programs of action to mitigate and adapt to climate change in the region.

**3. Carbon Market Authority (CMA)**

Established through Executive Order No. 155 issued on 31 October 2025; the Carbon Market Authority (CMA) manages carbon trading and acts as the lead government agency for carbon market development under the Paris Agreement.

**4. Technical Working Groups (TWGs)**

Sector-specific technical working groups (TWGs), comprising experts from relevant ministries, agencies, and research institutions, are tasked with compiling and verifying emissions data.

## F. Capacity Building and Training

Liberia recognizes the need for technical expertise in preparing GHG inventories. To address this, the country has engaged in capacity-building initiatives, supported by international organizations such as the UNFCCC, UNEP, UNDP, ECCC, CfRN, CISDL at the University of Cambridge, and Global Environment Facility (GEF). These initiatives focus on training national experts in GHG accounting methodologies and the use of tools such as the IPCC Guidelines.

**Challenges and Gaps**

Liberia's GHGI and mitigation profile that Liberia has made clear institutional and analytical progress in climate governance while still navigating the following constraints typical of least developed countries.

**1. Data Availability**

Limited availability of high-quality, sector-specific data remains a significant challenge.

**2. Institutional Capacity**

Despite progress, gaps in technical expertise and resources hinder the effective preparation and management of the GHG inventory.

**3. Financial Constraints**

Insufficient funding for GHG inventory activities limits the country's ability to enhance its reporting systems.

## G. Methodology

The present national GHG inventory has been prepared in accordance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. As the 2006 IPCC Guidelines do not extensively cover all the GHGs, it has been supplemented with the European Monitoring and Evaluation Program/ European Environment Agency (EMEP/EEA) air pollutant emission inventory guidebook for compiling estimates for nitrogen oxides (NOx), carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs) and sulphur dioxide (SO2). Generally, the method adopted to compute emissions involved multiplying activity data (AD) by the relevant and appropriate emission factor (EF), Equation 1, as shown below:

EQ1.
Emissions (E)= activity data (AD) X emission factor (EF)

All methodologies and tools recommended by the IPCC within the inventory cycle have been used in accordance with the 2000 IPCC Good Practice Guidelines (GPG). The 2006 IPCC Guidelines cover tier 1 compilations. The Agriculture and Land Use Software from Colorado State University (CSU) has also been adopted to enable tier-1 estimates for the livestock and FOLU sectors in the future. Therefore, this GHG inventory has been compiled solely using tier 1 methodology, as it is considered best practice and can enhance the accuracy of emission estimates, thereby reducing uncertainties. Global warming potentials (GWPs), as recommended by the IPCC, have been used to convert GHGs other than $CO_2$ to their $CO_2$ equivalent. As per the requirements of Decision 17/CP.8, the values adopted were those from the IPCC Fifth Assessment Report for the three main GHGs, namely: carbon dioxide, methane and nitrous oxide

## 1. Activity Data (AD)

Country-specific AD is not available in the current statistical system, which gathers, verifies, and processes data from most socio-economic sectors to produce official national statistical reports. Consequently, data collected at the national level came from various public and private institutions, organizations, and companies, archived by the EPA and LISGIS, and served as the basis and starting point.

Additionally, missing data required for higher levels of disaggregation beyond Tier I were obtained directly from both public- and private-sector operators. Some data gaps were addressed through expert judgement, surveys, scientific studies, and statistical modelling. In a few isolated cases, due to the restricted timeframe and the absence of a declared national framework for data collection and archiving to meet the requirements for preparing GHG inventories, derived data and estimates were used to fill the gaps. These were considered reliable and sound since they were based on scientific findings and other observations.

For the FOLU sector, UN-FAO FOASTAT online was utilized, and maps were created from Landsat satellite imagery for three periods (2014-2022) by trusted technicians. These maps were then used to determine land-use changes based on land-cover observations during this timeframe. Not all the data necessary to compile a comprehensive GHG inventory could be gathered due to the limited timeframe or the lack of a proper data collection and archiving system. Some categories could not be evaluated because of missing data from 1990 to 2003, owing to the civil crisis in Liberia. Nevertheless, the data collected were used to produce quality-assured estimates.

## 2. Emission Factors

Default country emission factors were used solely for the tier 1 GHG estimation across all sectors, excluding the livestock sector, where it was impossible to estimate both enteric fermentation and manure management. Similarly, the same approach was applied for the FOLU sector, where stock factors have not been tailored to suit national circumstances. Nonetheless, this is also considered good practice for improving inventory quality, especially since these activity areas were major emitters in the previous inventory results.

Additionally, the default IPCC EFs are the only options for all source categories, and they were evaluated for suitability beforehand, particularly with respect to the situations for which they were developed and how well they represent national conditions. Details on the development of the country-specific and default emission factors are provided in the sectoral reports.

## H. National Emission and Removal Estimates and Trends by Sector

This inventory provides estimates of greenhouse gas emissions and removals for all key sectors in Liberia for the period 2019-2022. The emissions profile is dominated by the Energy sector, which accounts for approximately 61% of total national emissions (excluding LULUCF), followed by Agriculture (31%) and Waste (8%). The IPPU sector remains not estimated (NE) due to data limitations.

The FOLU sector acts as a net carbon sink over the reporting period; however, its contribution is relatively small compared to total emissions and shows a declining sink capacity, decreasing from **–10.45 Gg $CO_2$** in 2019 to **–1.08 Gg $CO_2$** in 2022. This trend suggests increasing pressure on land-use systems and a potential risk that the sector could become a net source of emissions in the future.

The overall trend in national emissions (excluding LULUCF) shows a decline from 1,799.57 Gg $CO_2$eq in 2019 to 1,587.89 Gg $CO_2$eq in 2021, followed by a 7% increase to 1,709.59 Gg $CO_2$eq in 2022. This pattern likely reflects reduced economic activity during the 2020-2021 period and a subsequent recovery in 2022. When LULUCF is included, total emissions remain slightly lower, but the impact of removals is minimal and diminishing over time.

While the Agriculture and Waste sectors remain relatively stable across the time series, fluctuations in the Energy sector largely drive the overall emissions trend. The report notes that significant limitations in data availability, particularly in the IPPU sector, affect the completeness of the inventory. Therefore, the trends presented should be interpreted alongside the uncertainty assessment discussed in the following section.

Table 1: Summary of Liberia's GHG emissions and removals by sector, 2019 – 2022

| **Sector** | **2019** | **2020** | **2021** | **2022** | **Contribution to 2022 total** |
|---|---|---|---|---|---|
| | **Gg $CO_2$eq** | **Gg $CO_2$eq** | **Gg $CO_2$eq** | **Gg $CO_2$eq** | **%** |
| Energy | 1139.57 | 957.01 | 968.44 | 1044.18 | 61% |
| Industrial processes and product use | NE | NE | N E | NE | |
| Agriculture | 517.12 | 517.04 | 517.24 | 521.56 | 31% |
| Forestry and other land use | -10.45 | -6.35 | -9.93 | -1.08 | |
| Waste | 142.88 | 150.05 | 144.10 | 143.85 | 8% |
| **Total** | 1,799.57 | 1,624.11 | *1629.78* | 1,709.59 | 100% |

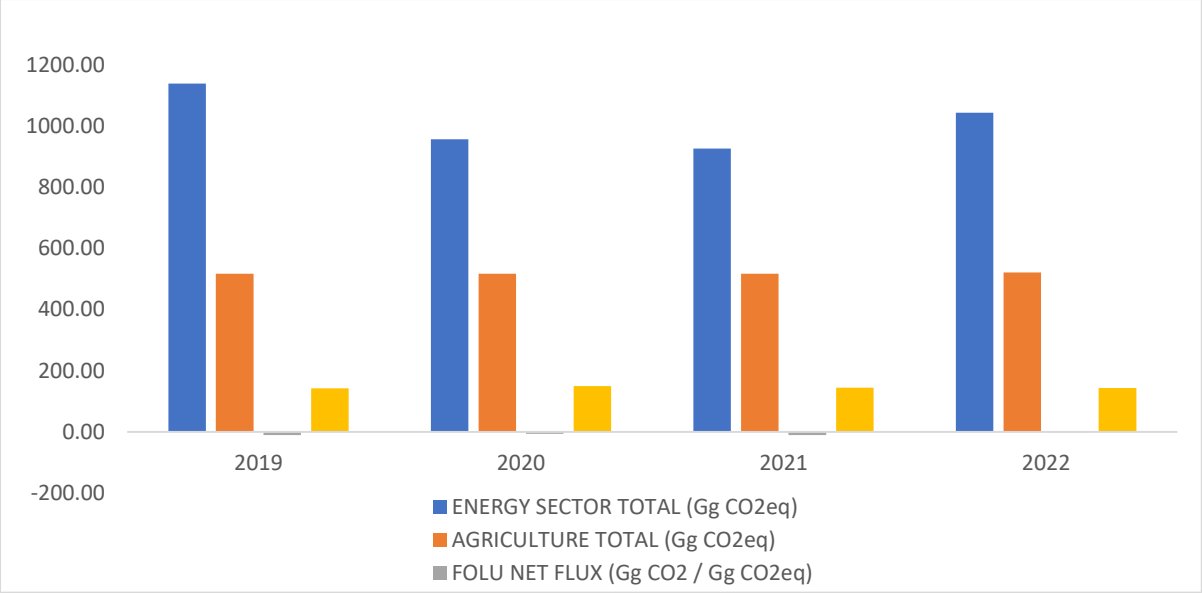



Figure 1: Liberia's GHG emissions and removals by sector (2019 -2022)

## I. National Emission and Removal Estimates and Trends by Gas

This inventory provides estimates for the key greenhouse gases carbon dioxide ($CO_2$), methane ($CH_4$), and nitrous oxide ($N_2O$), as presented in Table 2 and Figure 2. These gases collectively account for the total national emissions over the period 2019-2022, with methane ($CH_4$) being the dominant gas, contributing approximately 52%, followed by carbon dioxide ($CO_2$) at 40% and nitrous oxide ($N_2O$) at 8%.

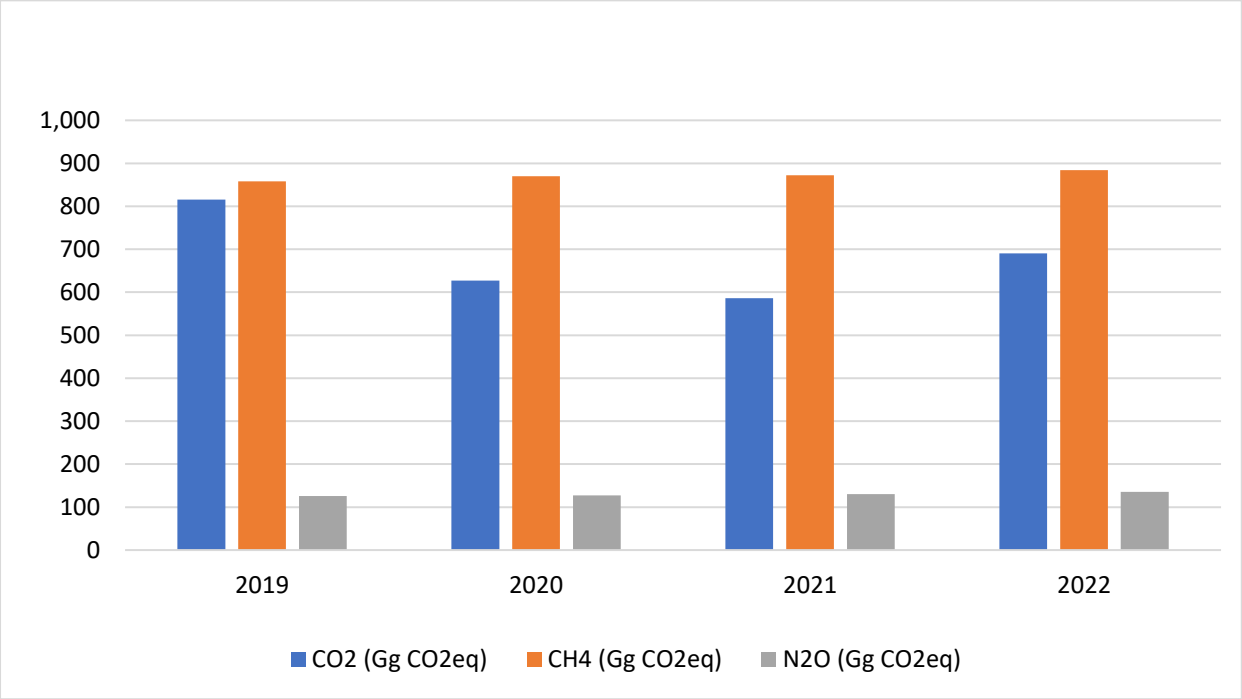
Emissions of perfluorocarbons (PFCs) are considered not occurring (NO) in Liberia, as there are no known industrial activities such as aluminium production or semiconductor manufacturing that typically generate these gases. Emissions of hydrofluorocarbons (HFCs) and sulphur hexafluoride ($SF_6$) were not estimated (NE) due to the absence of reliable and country-specific activity data. There is currently no comprehensive national data collection system for refrigeration and air-conditioning equipment, electrical transmission systems, or industrial applications that would enable the estimation of these gases in accordance with the 2006 IPCC Guidelines.

The overall emissions trend shows a decline from 2019 to 2021, followed by a moderate increase in 2022, rather than a flat trend. This pattern is largely driven by changes in the energy sector, particularly fuel consumption. Methane emissions increased steadily over the period, reflecting contributions from agriculture and waste, while $CO_2$ emissions decreased during 2020-2021 and then rose again in 2022. Nitrous oxide emissions show a gradual upward trend, consistent with agricultural activities. The report notes that significant limitations in data availability, particularly for fluorinated gases and the IPPU sector, affect the completeness of the inventory. Therefore, the trends presented should be interpreted alongside the uncertainty assessment discussed in the following section.

Table 2: Summary of Liberia's GHG emissions by gas from 2019 to 2022

| Greenhouse gas | 2019 | 2020 | 2021 | 2022 | Contribution to 2019 total |
|---|---|---|---|---|---|
| | Gg $CO_2eq$ | Gg $CO_2eq$ | Gg $CO_2eq$ | Gg $CO_2eq$ | % |
| Carbon dioxide | 815.90 | 626.91 | 585.92 | 690.38 | 40% |
| Methane | 858.15 | 870.24 | 871.85 | 883.90 | 52% |
| Nitrous oxide | 125.525 | 126.955 | 130.119 | 135.315 | 8% |
| Hydrofluorocarbons | *NE* | *NE* | *NE* | *NE* | *NE* |
| Perfluorocarbons | *NE* | *NE* | *NE* | *NE* | *NE* |
| Sulphur hexafluoride | *NE* | *NE* | *NE* | *NE* | *NE* |
| Total | 1,799.57 | 1,624.11 | 1,587.89 | 1,709.59 | *100%* |

Figure 2: Liberia's GHG emissions by gases (2019-2022)



# J. Energy

## 1. Sector Overview

The Energy sector accounts for greenhouse gas (GHG) emissions from the combustion of fuels across all economic sectors, including electricity and heat production, transport, manufacturing, commercial/institutional activities, and residential use. It also includes fugitive emissions associated with the extraction and distribution of fossil fuels. However, in Liberia, there is no domestic production of fossil fuels; therefore, fugitive emissions are not occurring (NO) and are not included in this inventory. As such, this section focuses exclusively on fuel combustion activities (IPCC category 1A).

Emissions of carbon dioxide ($CO_2$), methane ($CH_4$), and nitrous oxide ($N_2O$) occur from all fuel combustion processes. Estimates of these emissions have been developed for the full time series (2019-2022) and are presented in Figures 3 and 4, disaggregated by source category and gas type. Emissions are reported in Gg $CO_2$eq using the 100-year Global Warming Potentials (GWPs) from the IPCC Fifth Assessment Report (AR5), in accordance with the Modalities, Procedures and Guidelines (MPGs).

Total Energy sector emissions (excluding biomass $CO_2$) were estimated at **1,139.57 Gg $CO_2$eq** in 2019, decreasing to **926.55 Gg $CO_2$eq** in 2021, and increasing to **1,044.18 Gg $CO_2$eq** in 2022, reflecting changes in fuel consumption patterns, particularly in the transport sector.

All estimates were developed using a Tier 1 methodology, consistent with the IPCC 2006 Guidelines. This approach combines activity data with default emission factors and was applied because country-specific emission factors were unavailable and disaggregated national data required for higher-tier methods were limited.

Activity data used in this inventory were compiled and cross-checked from multiple sources to ensure completeness and time-series consistency, including:

1. The Ministry of Mines and Energy of Liberia,
2. The UN Energy Statistics Database, and
3. A national draft energy balance prepared for Liberia.

In accordance with IPCC reporting guidance, $CO_2$ emissions from biomass combustion (e.g., fuelwood and charcoal) are excluded from national totals and reported as memo items, while $CH_4$ and $N_2O$ emissions from biomass combustion are included in total emissions. This approach avoids double-counting with the AFOLU sector.

A summary of GHG emission estimates for the Energy sector, disaggregated by IPCC categories, is provided in Table 3. Figure 3 shows emission estimates by category and gas for the full-time series.

Figure 3: Emission Estimates from the Energy Sector by Category (2019-2022)

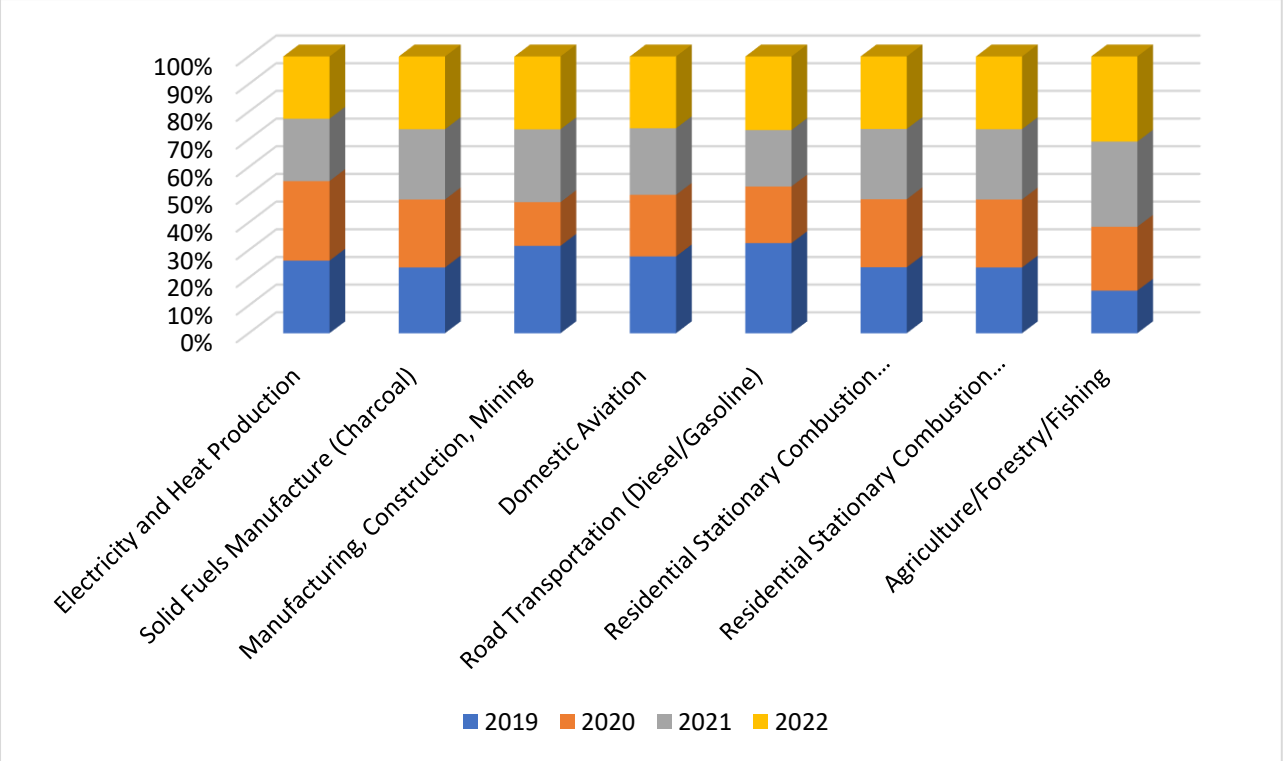



Figure 4: Emission estimates from the Agriculture sector by gas (2019-2022)

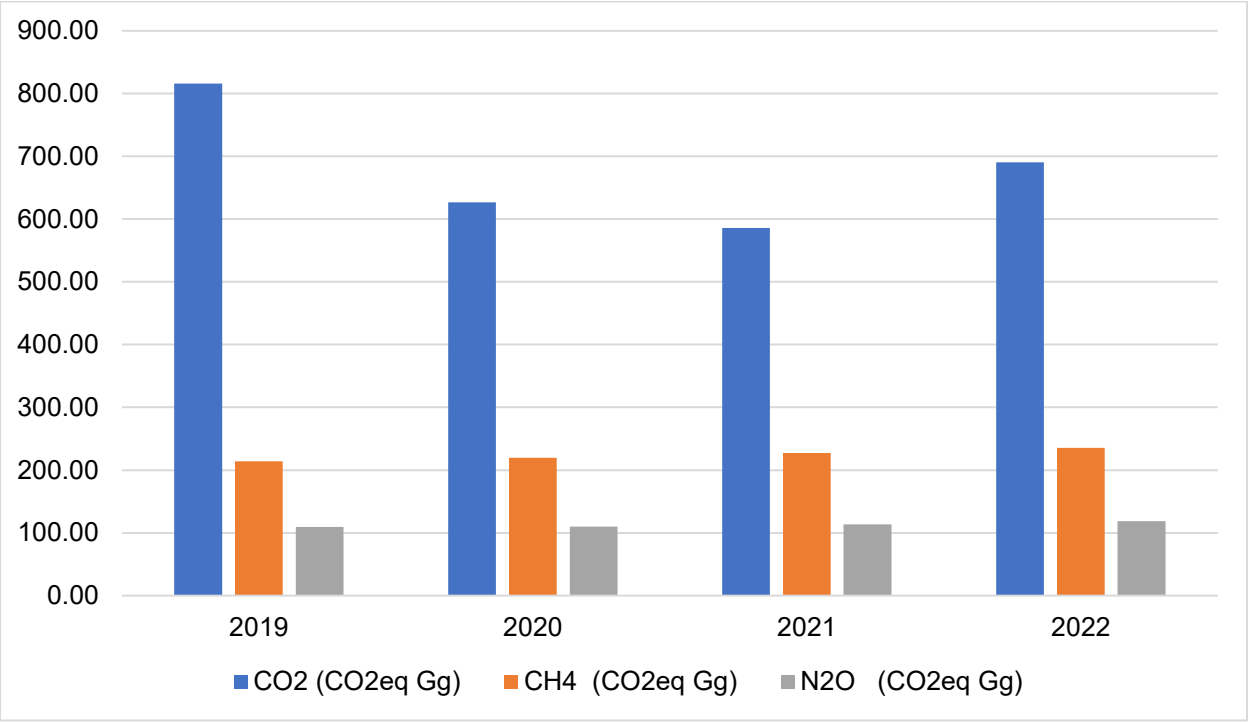


Table 3: Method summary for the Energy sector

| **1. Energy**<br>**Greenhouse Gas Source and Sink Categories** | **Gases Included** | **% 2022 Energy Emissions** | **Key Category** | **Uncertainty %** | **Tier/ Notation key** | **Method statement** | **Notes** |
|---|---|---|---|---|---|---|---|
| Sub-Categories | | | | | | | |
| 1A1a Electricity and heat production | $CO_2$, $CH_4$, $N_2O$ | 6.22 | Yes | NE | T1 | E1 | |
| 1A1c Manufacture of solid fuels? | $CO_2$, $CH_4$, $N_2O$ | 38.81 | Yes | NE | T1 | E1 | |
| 1A2: Combustion in manufacturing industries and construction | $CO_2$, $CH_4$, $N_2O$ | 0.51 | Yes | NE | T1 | E1 | |
| 1A3a domestic aviation | $CO_2$, $CH_4$, $N_2O$ | 0.20 | No | NE | T1 | E1 | Emissions from this sector are included in Memo item 1A3ai. |
| 1A3b Road transport | $CO_2$, $CH_4$, $N_2O$ | 14.07 | Yes | NE | T1 | E3 | |
| 1A3c Railways | $CO_2$, $CH_4$, $N_2O$ | - | - | NE | IE | E3 | Emissions from this sector are assumed to be included in 1A3b |
| 1A3d Domestic navigation | $CO_2$, $CH_4$, $N_2O$ | - | - | NE | IE | E3 | Emissions from this sector are assumed to be included in 1A3b |
| 1A4a Commercial and public | $CO_2$, $CH_4$, $N_2O$ | 0.20 | No | NE | T1 | E4 | |
| 1A4b Residential | $CO_2$, $CH_4$, $N_2O$ | 39.57 | Yes | NE | T1 | E4 | |
| 1A4c Agriculture, forestry and fishing | $CO_2$, $CH_4$, $N_2O$ | 0.41 | No | NE | T1 | E4 | |
| Memo item: 1A3ai International aviation | $CO_2$, $CH_4$, $N_2O$ | - | - | NE | T1 | | |

## 2. Methods, Data Sources, and Assumptions

Detailed methodologies for each Energy sub-category are provided in the Method Statements (Annex II). This section presents a summary of the approaches applied. All emission estimates were developed using a Tier 1 methodology, consistent with the IPCC 2006 Guidelines, combining activity data (AD) with default emission factors (EFs). This approach was adopted due to:

- Limited availability of disaggregated national activity data, and
- Absence of country-specific emission factors.

Activity data were compiled from:

- The Ministry of Mines and Energy of Liberia,
- The UN Energy Statistics Database, and
- A national draft energy balance.

Where inconsistencies or gaps existed, expert judgment and cross-checking across sources were applied to ensure time-series consistency.

## 3. 1A1a: Energy Industries

This category includes GHG emissions from fuel combustion by main activity producers of electricity and heat (IPCC category 1A1a). Auto-producers are excluded and reported under the sectors that consume energy. In Liberia, electricity supply is dominated by the Liberia Electricity Corporation (LEC) and independent power producers, with generation largely diesel-fired, complemented by hydropower from the Mount Coffee Hydropower Plant. Although hydropower helps reduce fossil fuel use, diesel generation remains significant due to limited grid coverage and reliability challenges.

Access to electricity remains low, particularly in rural areas, and a substantial proportion of electricity is generated through private and community generators, whose fuel consumption is accounted for under the residential and commercial sectors (1A4). Activity data for centralized electricity generation is limited; therefore, estimates are based on available national energy balance data. Emissions in this category reflect the continued reliance on liquid fossil fuels for electricity generation, although hydropower helps moderate emissions.

## 4. 1A1c: Solid Fuel Manufacture

This category includes emissions from charcoal production, which is widely used for cooking and heating in Liberia. Charcoal production is a significant activity, driven by high reliance on biomass energy. Recent data indicate that a large proportion of households depend on charcoal, particularly in urban areas. This inventory provides updated and consistent estimates of emissions from charcoal production, including $CH_4$ and $N_2O$ emissions, which were not comprehensively reported in earlier national communications (NC1, NC2, and BUR1).

In accordance with IPCC guidelines:

- $CO_2$ emissions from biomass are excluded from totals and reported as memo items,
- Non-$CO_2$ emissions are included in national totals.

## 5. 1A2: Combustion in Manufacturing Industries and Construction

This category includes emissions from fuel combustion in industrial activities, such as mining, manufacturing, and construction. In Liberia, industrial activity is relatively limited, and emissions from this category account for a small share of total Energy sector emissions (approximately 2% in 2022), according to updated estimates. Previous inventories reported only $CO_2$ emissions, with limited data availability. This inventory improves completeness by including $CH_4$ and $N_2O$ emissions, estimated using Tier 1 methods. Activity data remain limited, and estimates rely on aggregated energy consumption data from national and international sources.

## 6. 1A3: Transport

This category includes emissions from fuel combustion in road transport, domestic aviation, railways, and domestic navigation.
In Liberia:

- Road transport (1A3b) is the dominant source, accounting for the largest share of Energy sector emissions (approximately 43% in 2022).
- Domestic aviation (1A3a) contributes a small but consistent share.
- Railways (1A3c) are reported as NO (Not Occurring).
- Domestic navigation (1A3d) is reported as NE (Not Estimated) due to lack of reliable activity data and inconsistencies in the energy balance.

Due to the absence of disaggregated fuel consumption data by transport mode, total diesel and gasoline consumption has been allocated to road transport, consistent with national circumstances and expert judgment.

## 7. 1A4: Commercial/public; Residential; Agriculture, Forestry and Fishing

This category includes emissions from fuel combustion in buildings, households, and primary production sectors.
In Liberia:

- The residential sector (1A4b) is a significant contributor due to extensive use of fuelwood and charcoal.
- Commercial/institutional (1A4a) and agriculture/forestry/fishing (1A4c) contribute relatively small shares.

Unlike previous reports, this inventory provides estimates for all sub-categories, using activity data from the national energy balance. Biomass dominates this sector:

- $CO_2$ emissions are excluded (memo items),
- $CH_4$ and $N_2O$ emissions are included, making this sector a key contributor to non-$CO_2$ emissions.

## 8. 1A3ai: Memo Item: International Aviation

This category includes emissions from international flights departing Liberia. Estimates of jet fuel consumption were obtained from the Ministry of Mines and Energy and are reported as a memo item, in accordance with IPCC guidelines. These emissions are excluded from national totals.

## 9. Quality Assurance and Quality Control

All calculations and estimation procedures have been fully documented and archived to ensure transparency and reproducibility.
QA/QC procedures included:

- Cross-checking activity data across multiple sources,
- Verification of calculations by international experts, and
- Consultation with national stakeholders.

Despite these efforts, some uncertainties remain due to limitations in the underlying data.

## 10. Description of Uncertainties

A quantitative uncertainty analysis was not undertaken due to data limitations. Key sources of uncertainty include:

- Lack of country-specific emission factors,
- Limited availability of sector-specific activity data, particularly for electricity generation and transport,
- Reliance on international datasets, which may not fully reflect national circumstances, and
- Inconsistencies in historical data from previous inventories.

These uncertainties are considered moderate to high, particularly for categories relying on proxy data.

## 11. Time Series Consistency Issues

To ensure time-series consistency, harmonized activity data sources and methodologies were applied across all years (2019-2022).
Where data gaps existed, assumptions were made based on:

- Expert judgment, and
- Consistency with national energy balance trends.

In cases where earlier data were limited (e.g., pre-2019), consistent assumptions were applied across the time series to maintain comparability.

## 12. Recommendations for Improvements

Table 4: Proposed improvements for the Energy Sector

| Category | Description of improvement | Related to a key category | Priority |
|---|---|---|---|
| 1A1a: energy industries | It is recommended that annual fuel consumption be collected from LEC and other independent power producers so that a more accurate emission estimate can be produced | Yes | High |
| 1A1c: solid fuel manufacture | It is recommended that the National Charcoal Union of Liberia document be consulted to determine whether it provides data on annual fuel consumption by charcoal manufacturers. The amount of fuel consumed by charcoal manufacturers could be estimated from the country's charcoal consumption, rather than from UN Data. | Yes | High |
| 1A2: Combustion in manufacturing industries and construction | It is recommended that a list of industries operating in Liberia be compiled (a list is available in the NDC2, but it needs to be updated), and then fuel consumption data be collected on an annual basis | Yes | Medium |
| 1A3a: Domestic/International aviation | It is recommended that annual aviation gasoline and jet fuel consumption be collected from Liberia's airports. | No | Low |
| 1A3b: Road Transport | It is recommended that the annual consumption of motor gasoline and diesel by the road transport sector be collected. Types of imported engines and cars are reported by the National Port Authority and the Ministry of Commerce. A license registry through the designated entity should be provided. | Yes | High |
| 1A3c: Railways | It is recommended that the amount of diesel consumed by the railway sector each year be collected from the rail operators | No | Medium |
| 1A3d: Domestic navigation | It is recommended that the amount of diesel/fuel oil consumed by domestic shipping be collected annually from ports, the Liberia Maritime Authority, and the National Fisheries and Aquaculture Authority (NaFAA). Types of ship engines, fleet and last port called. | No | Medium |
| 1A4: Commercial/public, residential, agriculture, forestry and fishing | It is recommended that data on the amount and types of fuel consumed by these sectors be collected annually from the Ministry of Agriculture and NaFAA. | Yes | Medium |

# K. Industrial Processes and Product Use (IPPU)

## 1. Sector Overview

The Industrial Processes and Product Use (IPPU) sector includes GHG emissions from processes across all industrial activities. It does not cover emissions from industry fuel combustion, which are addressed in the Energy sector. The IPPU sector also encompasses GHG emissions resulting from the use of products, such as HFCs used as refrigerants in air conditioning and refrigeration. Since the IPPU sector encompasses a broad range of activities, it is essential to fully understand national circumstances to ensure an accurate and comprehensive GHG inventory.

Liberia has a small but growing industrial sector and primarily imports products for further processing rather than producing primary materials locally. This underscores the importance of understanding which activities take place within Liberia, as many that generate GHG emissions occur internationally, with products such as clinker for cement imported. Based on consultations with key national stakeholders, two industries were identified where activities within Liberia contribute to GHG emissions: soda ash production and steel manufacturing. Activity data were not obtained from the main soda ash producer, and confidentiality issues prevented access to data from the steel production site. Additional details on the inventory's completeness are provided in Table 5.

The IPPU sector also includes product use. These activities range from the use of paraffin wax to the use of nitrous oxide in hospitals, and the availability of activity data is often limited, as has been the case in this inventory. The following activities were identified by national experts: use of lubricants, paraffin wax, ODS substitutes (HFCs and PFCs), electrical equipment, and $N_2O$ in metered-dose inhalers in hospitals. When activity data were available, estimates were made. Emissions from non-methane volatile organic compounds (NMVOC) and indirect $CO_2$ are not included in this inventory.

Table 5: Method summary for the IPPU sector

| **2. Industrial Process and Product Use**<br>**Greenhouse Gas Source and Sink Categories** | **Gases Included** | **IPPU 2022 Emissions %** | **Key Category** | **Uncertainty %** | **Tier/ Notation key** | **Method statement** | **Notes** |
|---|---|---|---|---|---|---|---|
| [Sub-sector] | | | | | | | |
| 2A Mineral industry | - | - | - | - | NO | - | |
| 2B Chemical industry (exc. 2B7) | - | - | - | - | NO | - | |
| 2B7 Soda ash production | | NE | No | NE | T1 | I1 | |
| 2C Metal industry (exc. 2C1) | - | - | - | - | NO | - | |
| 2C1 Iron and steel industry | | - | - | NE | C | - | Data was deemed confidential by the industry and not provided to the inventory compilers. |

| 2. Industrial Process and Product Use<br>Greenhouse Gas Source and Sink Categories | Gases Included | % 2022 IPPU Emissions | Key Category | Uncertainty % | Tier/ Notation key | Method statement | Notes |
|---|---|---|---|---|---|---|---|
| 2D1 Lubricant use | | - | - | NE | NE | - | Activity data unavailable |
| 2D2 Paraffin wax use | | NE | No | NE | T1 | I2 | |
| 2D3 Solvent use | - | - | - | - | NE | - | |
| 2D4 Other | | - | - | - | NE | - | Activity data unavailable |
| 2E Electronics industry | - | - | - | - | NO | - | |
| 2F Product uses as ODS substitutes | HFCs | 100% | Yes | NE | T1 | I3 | |
| 2G Other product manufacture and use (exc. 2G1b, 2G3) | - | - | - | - | NO | - | |
| 2G1b Use of electrical equipment | | - | - | - | NE | - | Activity data unavailable |
| | | - | - | - | NE | - | Activity data unavailable |
| 2H Other | - | - | - | - | NE | - | |

## 2. Methods, Data Sources and Assumptions

Detailed methodology information for each category is provided within the Method Statements in Annex II.

## 3. 2A7 – Soda Ash Production

Mano Manufacturing Company has been selling POP detergent since at least 2017. This detergent contains soda ash, which Mano Manufacturing produces. It is believed that soda ash is produced using a national production process that emits $CO_2$. Since emissions from this industry were not included in BUR1, it counts as a new source. Activity data were obtained from Mano Manufacturing, the main detergent producer, and used to conservatively estimate $CO_2$ emissions using the Tier 1 methodology outlined in the 2006 IPCC Guidelines.

## 4. 2C1 Iron and Steel Production

Emissions from this industry were not included in this inventory due to difficulties obtaining the relevant activity data. The BUR1 estimates were not used because there was insufficient information about their source and appropriate use for estimating emissions. In addition, there is no evidence of significant iron and steel production activity in Liberia during the reporting period, suggesting that emissions from this category are likely negligible. This category is therefore reported as NE (Not Estimated) due to data limitations, with improvements planned in future inventories as data availability increases.

## 5. 2D1 Lubricant Use

Emissions from lubricant use were not included in this inventory because suitable activity data were unavailable. The BUR1 estimates were not utilized as there was insufficient information on their source and appropriate use to estimate emissions.

## 6. 2D2 – Paraffin Wax Use

Paraffin wax is used for multiple purposes. Some of these uses lead to the oxidation of paraffin wax, resulting in $CO_2$ emissions. This is most evident in the burning of candles. Mano Manufacturing Company has been selling candles in the domestic market since at least 2017. As national statistics on candle consumption were unavailable, it was assumed that the consumption rate matched the company's production rate. $CO_2$ emissions were estimated using a Tier 1 approach and default emission factors.

## 7. 2F1 – Refrigeration and Air Conditioning

Liberia has phased in fluorinated gases to substitute ozone-depleting substances (ODS) as refrigerants for environmental reasons. These refrigerants are imported into Liberia either within prefilled equipment or in bulk canisters. Gathering data for this category was particularly difficult due to the specificity of the required information. The report: “Ozone Depleting substances Alternative Survey Report” (EPA, February 2017) served as a useful source of information about the market composition, offering data on the proportion of blends present in the Liberian market. The 2006 IPCC Guidelines Tier 1 calculation spreadsheet for 2F1 emissions was utilized along with default parameters. There remains considerable uncertainty in the estimates for this category, primarily due to limited data on refrigerant consumption (imports and exports) by species.

## 8. Quality Assurance and Quality Control

All calculation and estimation processes have been archived to ensure document integrity. Complete documentation of all steps in the emissions estimations is also available, with data sources properly referenced. Where relevant, other stakeholders who could verify the data were consulted. Quality control was conducted by verifying the calculations.

## 9. Description of Uncertainties

No quantitative uncertainty analysis has been undertaken due to insufficient data. The following issues have been identified as contributing to overall inventory uncertainty:

- Lack of national consumption and production data
- Lack of country-specific emission factors
- Lack of reliability of data from previous inventory, as there was no way to verify in some cases.

## 10. Time Series Consistency Issues

The main issue with time series consistency was that data were not always available for the full time. Gap-filling was performed using interpolation and/or extrapolation.

## 11. Recommended Improvements

Table 6: Proposed improvements for the IPPU Sector

| Category | Description of improvement | Related to a key category | Priority |
|---|---|---|---|
| **IPPU** | Check the assumptions regarding ‘not occurring’ activities and ensure the inventory is complete by | Yes | High |

| Category | Description of improvement | Related to a key category | Priority |
|---|---|---|---|
| | collecting activity data for all categories that are 'not estimated', such as steel production. Where IPPU activities are present in Liberia, check whether the specific processes result in GHG emissions. | | |
| **2F1 Refrigeration and Air Conditioning** | Investigate the availability of national HFC import and export data, like the information obtained for the ODS report. Check the completeness of the data, ensuring that it includes refrigerants imported into Liberia in pre-filled units. | Yes | High |
| **2F1 Refrigeration and Air Conditioning** | Investigate the disposal practices for units containing refrigerants. | Yes | Medium |
| **2A7 Soda Ash Production** | Further engagement with Mano Manufacturing Company to discuss the assumptions that have been made regarding units of activity data, manufacturing practices, proportion of soda ash in detergents | No | Medium |
| **2D2 Paraffin wax use** | Investigate the availability of national paraffin wax consumption data through national energy balances or other data sources. Undertake further consultation with Mano Manufacturing Company to review the assumptions applied, such as export, sole manufacturing, and the makeup of the candles. | No | Low |
| **2A7 Soda Ash Production** | Confirm that Mano Manufacturing Company is the sole producer of soda ash | No | Low |

# L. Agriculture

## 1. Sector Overview

Emissions reported under the Agriculture sector (IPCC categories 3A–3C) arise from biophysical processes associated with livestock and crop production systems, primarily enteric fermentation (3A), manure management (3B), and rice cultivation (3C). These emissions are mainly in the form of methane ($CH_4$) and nitrous oxide ($N_2O$). Emissions from mechanical activities, such as fuel combustion in agricultural machinery, are excluded and reported under the Energy sector.

In Liberia, agriculture is characterized by a mix of smallholder subsistence farming, cooperatives, and large-scale commercial operations. Major crops include rice, cassava, rubber, oil palm, and cocoa, with rice serving as a staple food and a key driver of agricultural emissions. The livestock sub-sector, dominated by cattle, has shown gradual recovery following earlier declines, contributing significantly to emissions from enteric fermentation.

Total GHG emissions from the Agriculture sector were estimated at:

- 517.12 Gg $CO_2$eq in 2019,
- 517.04 Gg $CO_2$eq in 2020,
- 517.24 Gg $CO_2$eq in 2021, and
- 521.56 Gg $CO_2$eq in 2022.

The overall trend is relatively stable, with a slight increase in 2022.

Agricultural emissions are strongly methane-driven, with $CH_4$ accounting for approximately 97% of total emissions, while $N_2O$ contributes about 3%, originating mainly from manure management. The largest emission source is rice cultivation (3C), contributing 58%, followed by enteric fermentation (3A) at 34%, and manure management (3B) at 8%.

Activity data used in this inventory were primarily sourced from the FAOSTAT database, supplemented by national data where available and expert judgment to fill gaps and ensure consistency across the time series.

All emissions were estimated using a Tier 1 methodology, consistent with the IPCC 2006 Guidelines and 2019 Refinement, applying default emission factors due to limited availability of country-specific data. Livestock systems and rice cultivation practices were represented using simplified assumptions appropriate to national circumstances (e.g., typical production system distributions). Compared to previous inventories (e.g., BUR1), this inventory provides improved completeness, including:

- Updated estimates for all major Agriculture sub-categories (3A–3C),
- Inclusion of both $CH_4$ and $N_2O$ emissions, and
- A more consistent time series.

A summary of emissions for the Agriculture sector is presented in Table 6, while the figure below illustrates emissions by category and gas across the reporting period.

Figure 5: Emission estimates from the Agriculture sector by category (2019 - 2022)

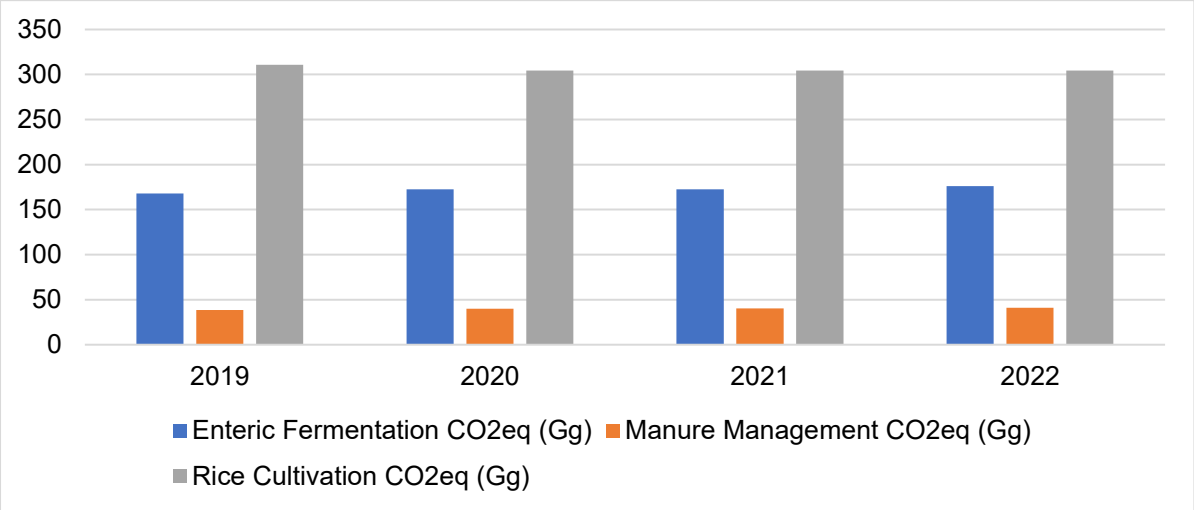



Figure 6: Emission estimates from the Agriculture sector by gas (2019-2022)

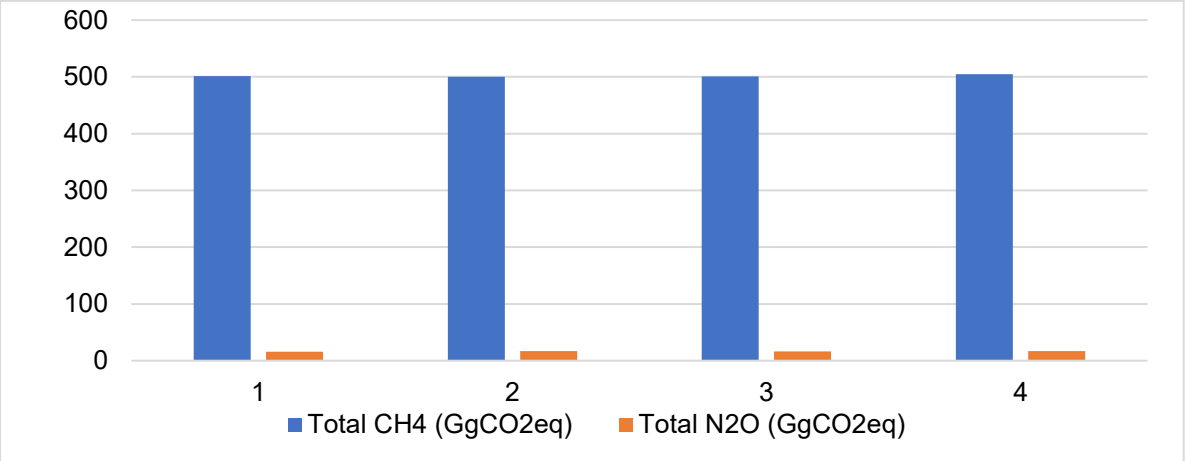



Table 2: Method summary for the Agriculture sector

| **3. Agriculture** | **Gases Included** | **% 2022 AGRICULTURE EMISSIONS** | **KEY CATEGORY** | **UNCERTAINTY %** | **TIER/ NOTATION KEY** | **METHOD STATEMENT** | **Notes** |
|---|---|---|---|---|---|---|---|
| Greenhouse Gas Source and Sink Categories | | | | | | | |
| A. LIVESTOCK | | | | | | | |
| 1. ENTERIC FERMENTATION | | | | | | | |
| ai. Dairy cattle | $CH_4$ | - | - | - | NO | - | |
| aii. Non-dairy cattle | $CH_4$ | 13% | YES | NE | T1 | A1 | |
| b. Buffalo | $CH_4$ | - | - | - | NO | - | |
| c. Sheep | $CH_4$ | 8% | YES | NE | T1 | A1 | |
| d. Goats | $CH_4$ | 10% | YES | NE | T1 | A1 | |

| **3. Agriculture**<br>Greenhouse Gas Source and Sink Categories | **Gases Included** | **% 2022 AGRICULTURE EMISSIONS** | **KEY CATEGORY** | **UNCERTAINTY %** | **TIER/ NOTATION KEY** | **METHOD STATEMENT** | **Notes** |
|---|---|---|---|---|---|---|---|
| e. Camels | $CH_4$ | - | - | - | NO | - | |
| f. Horses | $CH_4$ | - | - | NE | NE | - | Insufficient data |
| g. Mules and Asses | $CH_4$ | - | - | NE | NE | - | Insufficient data |
| h. Swine | $CH_4$ | 3% | NOS | NE | T1 | A1 | |
| j. Other | $CH_4$ | - | - | - | NO | - | |
| 2. MANURE MANAGEMENT | | | | | | | |
| ai. Dairy cattle | $CH_4$, $N_2O$ | - | - | - | NO | - | |
| aii. Non-dairy cattle | $CH_4$, $N_2O$ | 1% | NO | NE | T1 | A1 | |
| b. Buffalo | $CH_4$, $N_2O$ | - | - | - | NO | - | |
| c. Sheep | $CH_4$, $N_2O$ | <1% | NO | NE | T1 | A1 | |
| d. Goats | $CH_4$, $N_2O$ | <1% | NO | NE | T1 | A1 | |
| e. Camels | $CH_4$, $N_2O$ | - | - | - | NO | - | |
| f. Horses | $CH_4$, $N_2O$ | - | - | NE | NE | - | Insufficient data |
| g. Mules and Asses | $CH_4$, $N_2O$ | - | - | NE | NE | - | Insufficient data |
| h. Swine | $CH_4$, $N_2O$ | .01% | NO | NE | T1 | A1 | |
| i. Poultry | $CH_4$, $N_2O$ | <1% | NO | NE | T1 | A1 | |
| j. Other | $CH_4$, $N_2O$ | - | - | - | NO | - | |
| C. AGGREGATE SOURCES AND NON-$CO_2$ EMISSIONS SOURCES ON LAND | | | | | | | |
| 1. GHG emissions from biomass burning | $CH_4$, $N_2O$ | - | - | NE | IE | F1 | Included in the FOLU sector |
| 2. Liming | $CO_2$ | - | - | - | NO | - | |
| 3. Urea application | $CO_2$ | - | - | - | NO | - | |
| 4. Direct $N_2O$ emissions from managed soils | $N_2O$ | 79% | YES | NE | T1 | A2 | Synthetic fertilisers and mineralisation of N from carbon stock change in mineral soils not |

| 3. Agriculture<br>Greenhouse Gas Source and Sink Categories | Gases Included | % 2022 AGRICULTURE EMISSIONS | KEY CATEGORY | UNCERTAINTY % | TIER/ NOTATION KEY | METHOD STATEMENT | Notes |
|---|---|---|---|---|---|---|---|
| | | | | | | | included due to lack of data; sewage sludge and other organic fertilisers not occurring in Liberia. |
| 5. Indirect $N_2O$ emissions from managed soils | $N_2O$ | 1% | YES | NE | T1 | A2 | |
| 6. Indirect $N_2O$ emissions from manure management | $N_2O$ | 1% | NO | NE | T1 | A1 | |
| 7. Rice cultivation | $CH_4$ | 58% | YES | NE | T1 | A2 | |

## 2. Methods, Data Sources and Assumptions

Detailed methodology information for each category is provided within the Method Statements in Annex II.

## 3. 3A1 Enteric Fermentation

Methane ($CH_4$) emissions from enteric fermentation were estimated using a Tier 1 approach, consistent with the IPCC 2006 Guidelines and 2019 Refinement. Livestock population data obtained from FAOSTAT were multiplied by default emission factors to derive emissions for the period 2019-2022.

The livestock population in Liberia is dominated by cattle, which represent the primary source of emissions in this category. Other livestock types are present in smaller numbers and contribute less significantly. All livestock were assumed to be raised under low-productivity systems, consistent with national circumstances.

Enteric fermentation is the second-largest source of agricultural emissions, contributing approximately 34% of total Agriculture sector emissions in 2022, reflecting the importance of livestock in national agricultural systems.

## 4. 3A2 Manure Management

Emissions from manure management, including both $CH_4$ and $N_2O$, were estimated using a Tier 1 methodology based on the IPCC 2006 Guidelines and 2019 Refinement.

Default parameters for:

- Animal mass,
- Volatile solids (VS), and
- Nitrogen excretion rates (Nex)

These were applied for low-productivity livestock systems in Africa. Emission factors for $CH_4$ and $N_2O$ were selected from the IPCC default values for different manure management

systems. Due to limited national data, expert judgment was used to allocate manure across different management systems (e.g., pasture/range, unmanaged systems), following approaches applied in previous inventories. Manure management contributes approximately 8% of total Agriculture sector emissions, with $N_2O$ emissions originating exclusively from this category.

**5. 3C4 Direct $N_2O$ Emissions from Managed Soils**

The IPCC 2006 Tier 1 methodology was used to estimate nitrous oxide emissions from managed soils. The nitrogen content in manure applied to soils, including that deposited by livestock during grazing, was calculated using the livestock population and accounting for emissions from manure management. Crop residue nitrogen was estimated using FAOSTAT crop production and harvest area data for 2019-2022, from the "pre-harvest final report Agali" provided by the Ministry of Agriculture. Since no data were available on the quantity of mineral fertilizer applied, it was excluded as a source. Sewage sludge and other compost types are not applied in Liberia. To estimate nitrogen mineralized through carbon soil loss, the area of drained or cultivated organic soil was obtained from the FOLU sector calculations using FAO data. No data on carbon stock change in mineral soils was available; therefore, this was not included as a nitrogen source.

**6. 3C5 & 3C6 Indirect $N_2O$ Emissions**

The Tier 1 method, using default parameters from the IPCC 2006 Guidelines and the 2019 Refinement, was used to estimate leaching and volatilization of nitrogen from managed soils and from manure storage, respectively. This is based on the nitrogen content of the system, as estimated from calculations of direct $N_2O$ emissions from managed soils and manure storage. The default EF for $N_2O$ emissions following deposition was taken from Chapter 11 of the IPCC 2006 Guidelines (Table 11.3).

**7. 3C7 Rice Cultivation**

Methane ($CH_4$) emissions from rice cultivation were estimated using the IPCC 2006 Tier 1 methodology.

Activity data on rice cultivation area were sourced from FAOSTAT and national agricultural reports for the period 2019-2022. In the absence of detailed national data, rice cultivation practices were represented using simplified assumptions; a distribution of cultivation systems (e.g., irrigated, rainfed, and upland) was applied using expert judgment; and cropping duration and conditions were assumed to be consistent across the time series.

Rice cultivation is the largest source of agricultural emissions, accounting for approximately 58% of the Agriculture sector's total emissions, underscoring the importance of flooded rice systems that promote methane generation.

**8. Quality Assurance and Quality Control**

All calculations and estimation procedures have been documented and archived to ensure transparency and reproducibility.

QA/QC procedures included:

- Cross-checking activity data from multiple sources,
- Internal consistency checks across the time series, and
- Consultation with national experts and stakeholders.

Where possible, calculations were reviewed to ensure alignment with IPCC methodologies and reporting requirements.

## 9. Description of Uncertainties

A quantitative uncertainty analysis was not undertaken due to data limitations. The main sources of uncertainty include:

- Reliance on FAOSTAT data, which are partly based on modeled or imputed estimates,
- Limited availability of country-specific livestock and agricultural activity data,
- Use of default IPCC emission factors and parameters, which may not fully reflect national conditions, and
- Dependence on expert judgment for key assumptions, including livestock systems and rice cultivation practices.

Overall, uncertainties are considered moderate to high, particularly for categories dominated by proxy data.

## 10. Time Series Consistency Issues

Time-series consistency was ensured by applying:

- Uniform data sources (FAOSTAT), and
- Consistent Tier 1 methodologies across all years (2019-2022).

Where data gaps existed, consistent assumptions were applied across the time series to maintain comparability. As a result, the Agriculture sector shows a stable emissions trend, with only minor variations over time.

## 11. Recommended Improvements

Table 3: Proposed improvements for the Agriculture Sector

| Category | Description of improvement | Related to a key category | Priority |
|---|---|---|---|
| 3A Livestock | Using more complete and regular national data collection on livestock numbers, including horses and mules. Currently, FAOSTAT data is not based on actual reported data. This would allow a consistent time series to be built up. | Yes | High |
| 3C4 Direct $N_2O$ emissions from managed soils | Collecting data on synthetic fertilizers applied to land, in order to estimate emissions from this source. This will be achieved through data collected from farmers through the MOA. | Yes | High |
| 3C4 Direct $N_2O$ emissions from managed soils | Estimating carbon stock change in cropland and grassland on mineral soils to allow emissions of $N_2O$ from mineralization to be estimated | Yes | High |
| 3A Livestock | Collecting data on the fraction of animals in high- and low productivity systems, rather than assuming low productivity that is based on expert judgment. | Yes | Medium |
| 3A2 manure management | Collecting data on the fraction of manure handled in different management systems, rather than relying on expert judgement. | No | Medium |
| 3C4 and 3C7 Rice cultivation | Collecting data or expert opinion on organic amendments added to rice fields, to enable use of a more appropriate and accurate $N_2O$ and $CH_4$ emission factors. | Yes | Medium |

| | | | |
|---|---|---|---|
| 3C7 Rice cultivation | Collecting data on the area of rice cultivated under different conditions, rather than relying on expert judgement. | Yes | Medium |
| | Develop country-specific estimates for parameters such as typical animal mass, which are relatively easy to measure and have a high impact on emissions estimates. | Yes | Low |

# M. Forestry and Other Land Use (FOLU)

## 1. Sector Overview

The Forest and Other Land Use (FOLU) sector includes all greenhouse gas (GHG) emissions and removals associated with land use, land-use change, biomass burning, and harvested wood products (HWP). This sector reflects changes in carbon stocks across land-use categories, including forest land, cropland, grassland, wetlands, settlements, and other land.

Liberia's total land area is approximately 11.14 million hectares (National Forest Inventory Report, 2020), with forest land covering about two-thirds of the total area, followed by cropland (approximately 19%). The FOLU sector plays a critical role in the national GHG inventory due to the country's extensive forest resources.

The sector is characterized by a combination of carbon removals (sinks) and emissions (sources):

Removals are primarily driven by forest land remaining forest land (4A), which consistently acts as a major carbon sink.
Emissions are mainly associated with land-use change, particularly conversion of forest land to cropland (4B).

Based on the current inventory estimates ($CO_2$ only, Tier 1 approach):

- Net FOLU flux was estimated at –10.45 Gg $CO_2$ in 2019,
- –6.35 Gg $CO_2$ in 2020,
- –9.93 Gg $CO_2$ in 2021, and
- –1.08 Gg $CO_2$ in 2022.

These results indicate that the FOLU sector remains a net carbon sink throughout the reporting period, although the sink strength is declining over time, largely due to increasing emissions from land conversion.

Forest land remaining forest land contributed the largest removals (approximately –39 to –41 Gg $CO_2$ annually), while land converted to cropland was the dominant emission source, reaching up to 39.64 Gg $CO_2$ in 2022. Land converted to forest land provided a smaller but consistent sink.

Activity data for this inventory were derived from a combination of:

- National land-use datasets, and
- FAO data sources, used to fill data gaps and ensure time-series consistency.

Where country-specific emission factors were unavailable, default Tier 1 emission factors were applied, consistent with IPCC guidance.

This inventory also includes, for the first time, estimates of the harvested wood products (HWP) pool, improving completeness in line with IPCC reporting requirements.

Activity data provided by national experts cover the period 2014-2022, allowing for a consistent time series. However, analysis in this report focuses on 2019-2022 to align with the scope of other sectors, while earlier years support time-series consistency.

A summary of emissions and removals from the FOLU sector is presented in Figure 7.
Figure 8 shows emission estimates by category and gas for the full-time series.

Figure 7: Emission estimates from the FOLU sector by category (2019-2022)

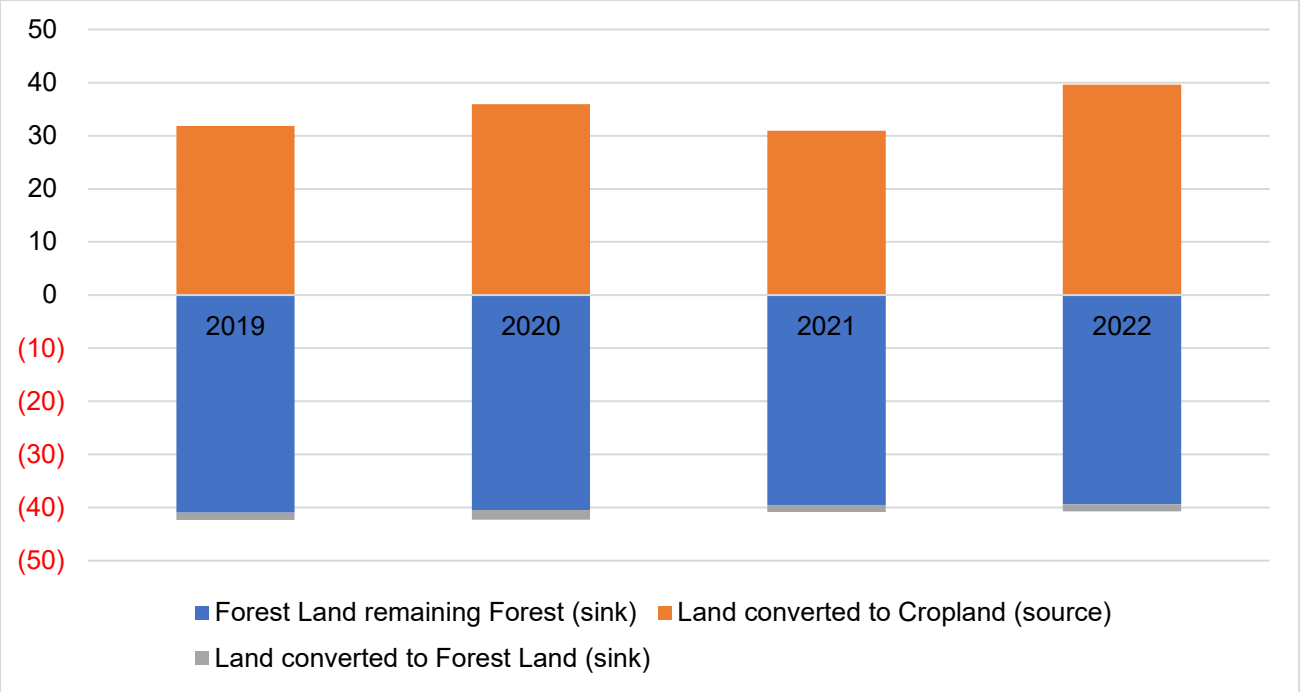



Figure 8 Emission estimates from the FOLU sector by gas (2019-2022)

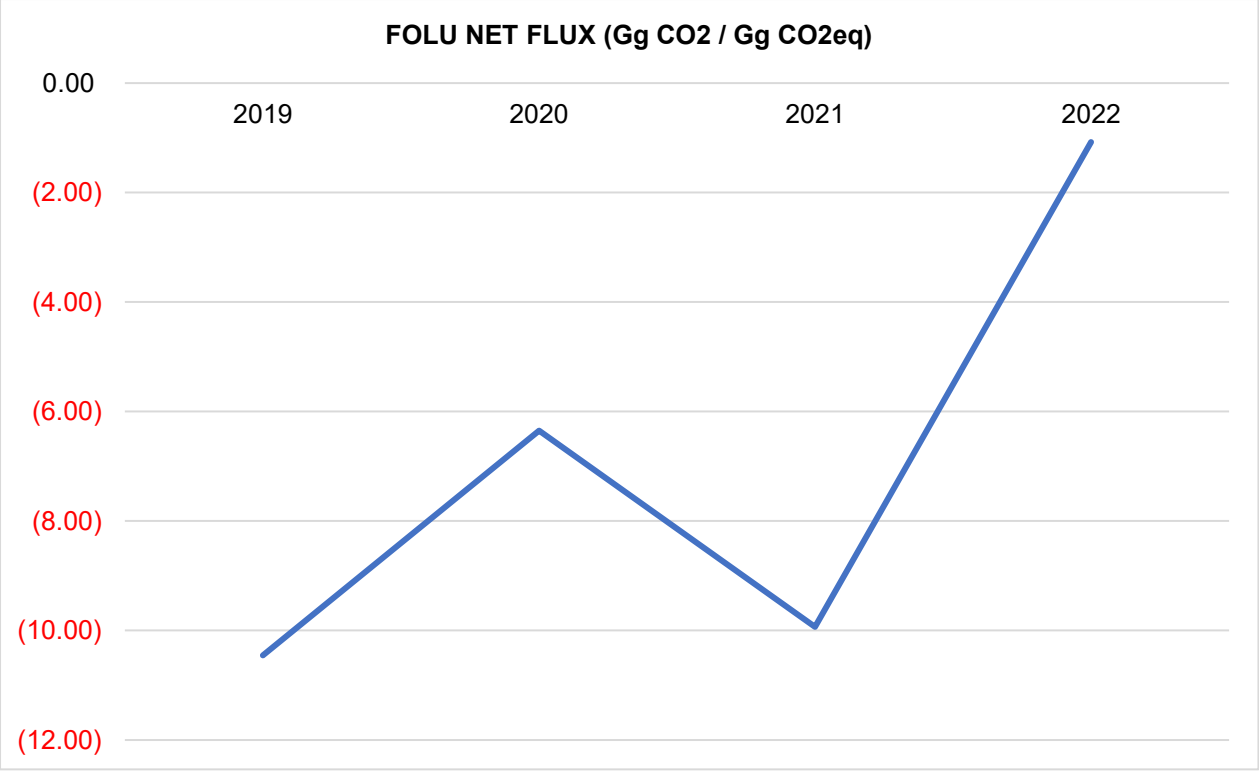



Table 4: Method summary for the FOLU sector

| 3. Forestry and other land use | Gases Included | % 2022 FOLU Emi | Key Category | Uncertaint | Tier/ Notation | Method state | Notes |
|---|---|---|---|---|---|---|---|

| Greenhouse Gas Source and Sink Categories | | | | | | | |
|---|---|---|---|---|---|---|---|
| **B. Land** | | | | | | | |
| **1. Forest Land** | | | | | | | |
| a. Forest land Remaining Forest land | $CO_2$ | -39.39 | Yes | NE | T1 | T1 | |
| b. Land Converted to Forest Land | $CO_2$ | -1.33 | Yes | NE | T1 | T1 | |
| **2. Cropland** | | | | | | | |
| a. Cropland Remaining Cropland land | $CO_2$ | - | Yes | NE | T1 | T1 | |
| b. Land Converted to Cropland | $CO_2$ | 39.64 | Yes | NE | T1 | T1 | |
| **3. Grassland** | | | | | | | |
| a. Grassland Remaining Grassland | $CO_2$ | NE | No | NE | T1 | T1 | |
| b. Land Converted to Grassland | $CO_2$ | NE | Yes | NE | T1 | T1 | |
| **4. Wetlands** | | | | | | | |
| a. Wetlands Remaining Wetlands | $CO_2$ | NE | - | NE | NE | - | |
| b. Land Converted to Wetlands | $CO_2$ | NE | - | NE | NE | - | |
| **5. Settlements** | | | | | | | |
| a. Settlements Remaining Settlements | $CO_2$ | NE | - | NE | NE | - | |
| b. Land Converted to Settlements | $CO_2$ | NE | - | NE | T1 | T1 | |
| **2. Other land** | | | | | | | |
| a. Other land Remaining Other land | $CO_2$ | NE | - | NE | NE | - | |
| b. Land Converted to Other land | $CO_2$ | NE | - | NE | NE | - | |
| C. Aggregate sources and non-$CO_2$ emission sources on land | | | | | | | |
| **1. Biomass burning** | | | | | | | |
| a. Biomass burning – forest land | $CH_4$, $N_2O$ | NE | - | NE | NE | NE | Biomass burning on 'Humid tropical forest' and 'Other forest' allocation to forest land, burning on 'organic soils' allocated to cropland |
| b. Biomass burning – cropland | $CH_4$, $N_2O$ | NE | - | NE | NE | NE | |
| c. Biomass burning – grassland | $CH_4$, $N_2O$ | NE | - | NE | NE | - | |
| d. Biomass burning – all other land | $CH_4$, $N_2O$ | NE | - | NE | NE | - | |
| **D. Harvested Wood Products** | | | | | | | |
| 1. Harvested Wood Products | $CO_2$ | NE | - | NE | NE | NE | |

## 2. Methods, Data Sources and Assumptions

Detailed methodology information for each category is provided within the Method Statements in Annex II.

## 3. 3B Land

The national land use dataset provides partial data on land use and land use change, categorized as either forest land, cropland, grassland, or settlements. No emissions or removals are linked to other lands or wetlands. The consultants only provide implied emission

factors for carbon stock changes in the living biomass carbon pool. No emissions or removals have been estimated from the dead organic matter (DOM) or soil organic carbon pools (SOC). Emissions from this sector primarily result from the conversion of forest land to other land uses. It has been assumed that 80% of the converted forest land becomes cropland, with the remaining 20% designated as settlements. This assumption is based solely on expert judgement.

**4. 3C1 Biomass Burning**

This sector includes emissions from biomass burning on forest and cropland, based on FAO estimates. $CO_2$ emissions from biomass burning on forest land are included under 3B Land within the carbon stock change factor. $CH_4$ and $N_2O$ emissions from biomass burning on forest land are included together with all emissions from biomass burning on cropland. Emissions from forest land in 2009 suggest that significant anthropogenic forest fires occurred in those years. Biomass burning on cropland occurs only in certain years within the series (2014-2022).

**5. 3D Harvested Wood Products (HWP Model)**

Emissions and removals originate from the HWP pool. This sector covers the production and trade of roundwood and primary wood and paper products. The main types of primary forest products include roundwood, sawnwood, wood-based panels, pulp, paper, and paperboard. Activity data sourced from the FAO between 2014 and 2022 are used, and emissions or removals are calculated through the stock-change approach with the IPCC HWP model.

**6. Quality Assurance and Quality Control**

All processes for the calculations and estimations were archived to ensure document integrity. There is also complete documentation of all the steps in the emissions estimations, and sources of data have been referenced. Where applicable, other stakeholders who could verify data were consulted. QC was performed by checking the calculations. The calculated emissions and removals from the area and IEF data have been compared with the FAO emissions and removals.

**7. Description of Uncertainties**

No quantitative uncertainty analysis has been undertaken due to a lack of available national data. The following issues have been identified as contributing to overall inventory uncertainty:

- Emission and removal estimates from land are incomplete, as currently only the living biomass carbon pool is included. DOM and SOC are currently not estimated for some years.
- Land use types have not been disaggregated; average implied emission factors have been applied, which may not be representative, e.g. one IEF has been applied to all Forest land
- Lack of reliability of data from previous inventory, as there was no way to verify in some cases.
- Lack of national data on HWP to verify the FAO activity data and application of the default IPCC emission factors.

**8. Time Series Consistency Issues**

The main issue with time-series consistency was that national data on land use and land-use change were not available for all sectors, so FAO data were used instead. The FAO makes basic assumptions about consistent annual area changes, so the time series does not reflect actual changes in Liberia.

## 9. Recommended Improvements

Table 5: Proposed improvements for the FOLU Sector

| Category | Description of improvement | Related to a key category | Priority |
|---|---|---|---|
| **3B Land** | Using country-specific land use data for all land uses and land conversions | Yes | High |
| **3B1 Forest land** | Using country-specific parameters, particularly for forestland available from the latest national forestry inventory) | Yes | High |
| **3 FOLU** | Improve institutional arrangements for the FOLU sector through: (1) training national experts and ensuring institutional memory is kept through training material and documentation, and (2) data supply agreements/ MOUs to facilitate the regular provision of accurate data for the inventory | Yes | High |
| **3B Land** | Improved data flow from the inventory to the FDA to facilitate improvements in the FOLU inventory. Regular reporting of data, together with feedback, to drive improvements. | Yes | High |
| **3C1 Biomass Burning** | Identifying national data sources for biomass burning, primarily from agricultural practices, for which there is currently no information available, to use available international data from MODIS. | Yes | Medium |
| **3D Harvested wood products** | Implementation of a system to track HWPs from harvesting, conversion, translocation and final use in Liberia | Yes | Low |
| **3D Harvested wood products** | Review national data on HWP for consistency through comparison with the FAO data | Yes | Low |

# N. Waste

## 1. Sector Overview

The Waste sector inventory covers greenhouse gas (GHG) emissions from the treatment and disposal of solid and liquid waste, consistent with IPCC categories 5A (Solid Waste Disposal on Land), 5B (Biological Treatment, Incineration, and Open Burning of Waste), and 5D (Wastewater Treatment and Discharge). In Liberia, the Waste sector includes emissions from:

- Solid waste disposal (5A), primarily municipal solid waste (MSW) disposed of in landfills,
- Open burning uncollected waste (5A/5B),
- Medical waste incineration (5B), and
- Domestic wastewater treatment and discharge (5D).

Total GHG emissions from the Waste sector were estimated at:

- 142.88 Gg $CO_2$eq in 2019,
- 150.05 Gg $CO_2$eq in 2020,
- 144.10 Gg $CO_2$eq in 2021, and
- 143.85 Gg $CO_2$eq in 2022.

The overall trend is relatively stable, with a slight increase in 2020 followed by a gradual decline through 2022. Emissions in the Waste sector are dominated by methane ($CH_4$), which accounts for over 99% of total emissions, primarily from solid waste disposal. The largest source is municipal solid waste (MSW) disposal (5A), contributing more than 90% of total Waste sector emissions, due to methane generation from anaerobic decomposition of organic waste in landfill conditions.

Open burning of uncollected waste contributes a smaller but notable share (approximately 6%), reflecting gaps in waste collection systems. Emissions from medical waste incineration and domestic wastewater are negligible in comparison. With reference to previous reporting (e.g., BUR1), the Waste sector in Liberia operates under an established institutional arrangement for GHG inventory management, involving:

- The Monrovia City Corporation (MCC) for solid waste collection and disposal,
- The Liberia Water and Sewer Corporation (LWSC) for domestic wastewater management,
- The Liberia Institute of Statistics and Geo-Information Services (LISGIS) for statistical data,
- The Environmental Protection Agency (EPA) for oversight and industrial wastewater, and
- The University of Liberia (UL) for coordination, QA/QC support, and data archiving.

Emission estimates were developed using a Tier 1 methodology, consistent with the IPCC 2006 Guidelines and 2019 Refinement.

Specifically:

- Solid waste disposal (5A) was estimated using a simplified First-Order Decay (FOD) model,
- Open burning emissions were calculated using default parameters, including an assumed burn fraction (10%),
- Medical waste incineration (5B) emissions were estimated using default emission factors, and
- Domestic wastewater (5D) emissions were calculated using a per-capita approach.
- Default emission factors and parameters were applied due to limited availability of country-specific data, in accordance with IPCC decision-tree guidance.

A summary of GHG emission estimates for the Waste sector is presented in the table below, while the figures that follow illustrate emissions by category and gas across the reporting period.

Figure 9 Emission estimates from the Waste sector by category (2019-2022)

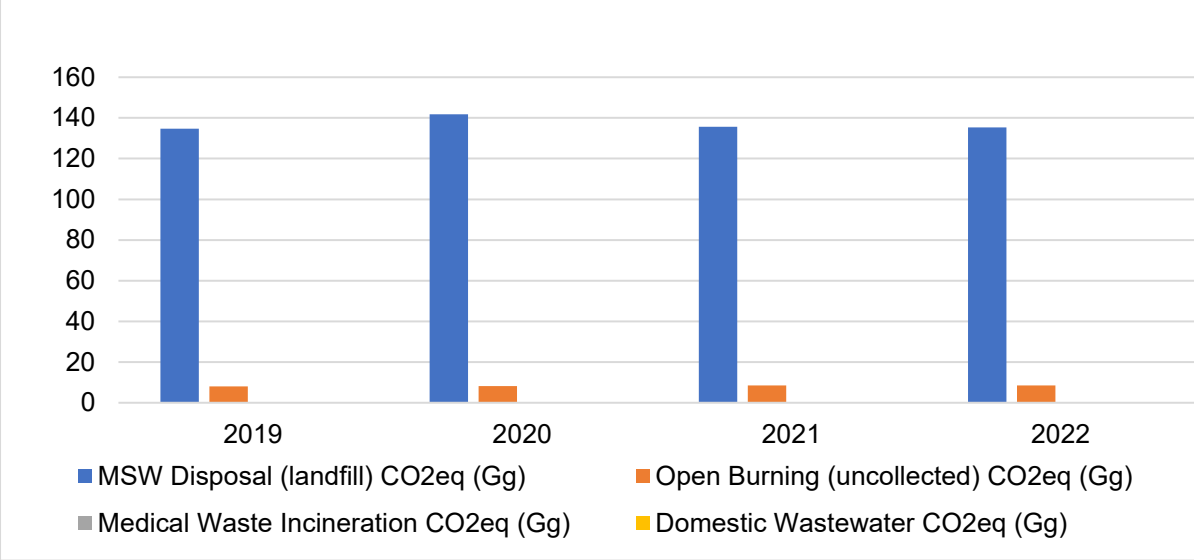



Figure 10: Emission estimates from the Waste sector by gas (2019-2022)

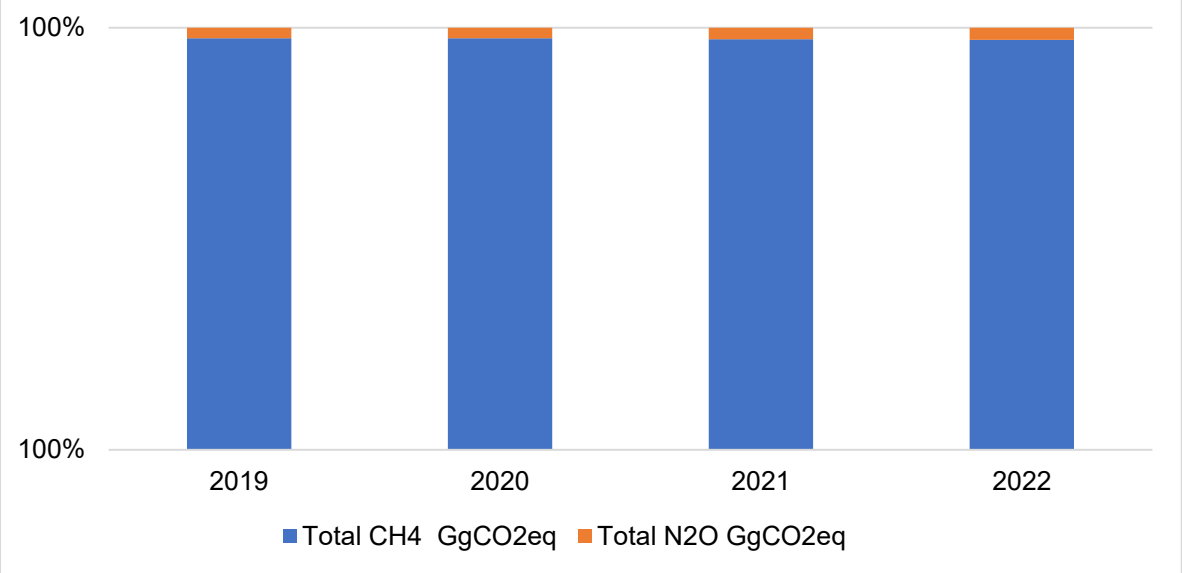



Table 6: Method summary for the Waste sector

| 4. Waste<br>Greenhouse Gas Source and Sink Categories | Gases Included | % 2022 Waste Emissions | Key Categories | Uncertainty % | Tier/ Notation key | Method statement | Notes |
|---|---|---|---|---|---|---|---|
| Sub-sector | | | | | | | |
| 4A Solid Waste Disposal | $CH_4$ | 99.9% | Yes | NE | T1 | W1 | |
| 4B Biological Treatment of Solid Waste | $CH_4$ | - | - | - | NO | - | |
| 4C1 Incineration of wastes | $CO_2$ | 0.1% | - | NE | T1 | W1 | |
| 4C2 Open Burning of Solid Waste | $CO_2$, $CH_4$, $N_2O$ | - | - | NE | NE | W2 | |
| 4D1 Domestic Wastewater Treatment Discharge | $CH_4$ | - | No | NE | T2 | W3 | |
| 4D2 Industrial Wastewater Treatment Discharge | $CH_4$ | - | - | NE | IE | - | |
| 4E Other: Human Sewage | $N_2O$ | - | - | NE | NE | W4 | |

## 2. Methods, Data Sources and Assumptions

Detailed methodologies for each Waste sub-category are provided in the Method Statements (Annex II). This section summarizes the approaches applied.

All emission estimates were developed using a Tier 1 methodology, consistent with the IPCC 2006 Guidelines and 2019 Refinement. Default emission factors and parameters were applied due to the limited availability of country-specific data. Activity data were compiled from national institutions, including the Monrovia City Corporation (MCC), the Liberia Water and Sewer Corporation (LWSC), LISGIS, and other relevant stakeholders, supplemented, where necessary, by international datasets.

## 3. 4A Solid Waste Disposal (SWD)

Solid waste disposal is the dominant source of emissions in the Waste sector, primarily generating methane ($CH_4$) from the anaerobic decomposition of organic waste.

A Tier 1 methodology using a simplified First-Order Decay (FOD) model was applied, consistent with IPCC guidance and appropriate for national circumstances. The quantity of methane generated depends on waste composition, disposal practices, and management conditions at disposal sites.

Activity data were obtained from national sources, including waste disposal records for the period 2014-2022. For urban areas, country-specific waste generation data from MCC were used. For rural areas, the IPCC default waste generation rate for Least Developed Countries (0.21 tonnes per capita per year) was applied.

Most waste in Liberia is disposed of in managed or semi-managed landfill sites, with limited methane recovery, resulting in significant $CH_4$ emissions.

## 4. 4C2 Incineration and Open Burning of Waste

Open burning of uncollected waste occurs where formal waste collection systems are limited. This practice results in emissions of $CH_4$, $N_2O$, and $CO_2$, as well as air pollutants such as particulate matter and black carbon.

Emissions were estimated using a Tier 1 approach, applying IPCC default emission factors and parameters. A burn fraction of 10% of uncollected waste was assumed, based on expert judgment and previous inventory practices.

Although country-specific data exist for waste generation, there are no national emission factors for open burning; therefore, IPCC default values were applied.

Medical waste incineration generates emissions of $CH_4$ and $N_2O$. Emissions from this source were estimated using a Tier 1 methodology, applying default emission factors.

Activity data were limited; therefore, estimates are based on available information from health-sector waste management practices. This source contributes a negligible share of total Waste sector emissions.

**5. 4D1 Domestic Wastewater Treatment and Discharge**

Domestic wastewater can generate $CH_4$ and $N_2O$ emissions, depending on treatment and disposal pathways. In Liberia, emissions are primarily associated with $N_2O$ from human sewage, while $CO_2$ emissions are excluded as they are of biogenic origin, consistent with IPCC guidance.
Emissions were estimated using a Tier 1 per-capita approach, based on:

- Population data (urban and rural), and
- Default IPCC parameters for nitrogen generation and conversion.

Due to limited wastewater treatment infrastructure, most wastewater is assumed to be untreated or minimally treated, with emissions occurring through natural processes. However, overall emissions from this category are negligible in the national context.

**6. 4E $N_2O$ Emissions from Human Sewage Nitrogen in Effluent and Run-Off**

$N_2O$ is produced in rivers and estuaries following nitrification and denitrification of sewage-derived nitrogen. The emissions result from nitrogen discharged from sewage directly into aquatic environments (e.g., rivers, estuaries, and the sea) or from leaching after land disposal of sewage. In Liberia, this is enhanced because about 46% of the population lacks sewage facilities (BUR1, 2020) and is assumed to generally practice land disposal (see LISGIS 2022 report).

The 2006 IPCC Guidelines Tier 1 method was used along with IPCC default parameters. FAOSTAT data on annual total protein supply and consumption activity data, as well as urban and rural population, were used. It is assumed that minimal removal of sewage nitrogen occurs during land disposal or sewage handling effluent disposal; that all sewage nitrogen is discharged with the effluent (treated or untreated) generated from sewage handling systems in Liberia; and that $N_2O$ production in rivers and estuaries and the marine environment is directly related to nitrification and denitrification.

**7. Quality Assurance and Quality Control**

All calculations and estimation procedures have been fully documented and archived with the Environmental Protection Agency (EPA).

QA/QC procedures included:

- Verification of calculations,
- Cross-checking of activity data across sources, and
- Consultation with sector experts and data providers.

These steps ensure transparency, consistency, and reproducibility of the inventory.

## 8. Description of Uncertainties

A quantitative uncertainty analysis was not undertaken due to data limitations. Key sources of uncertainty include:

- Lack of country-specific emission factors,
- Limited data on waste collection efficiency, particularly for rural areas,
- Dependence on default IPCC parameters, and
- Reliance on expert judgment for assumptions such as burn fractions and waste allocation.

Overall, uncertainties are considered moderate to high, particularly for categories relying on proxy data.

## 9. Time Series Consistency Issues

Time-series consistency was ensured by applying:

- Consistent methodologies (Tier 1) across all years, and
- Harmonized data sources for activity data.

Where data gaps existed, interpolation and extrapolation techniques were used to estimate:

- Waste generation rates,
- Collection efficiencies, and
- Allocation of waste to disposal pathways.

These approaches ensure a consistent and comparable time series (2019-2022).

## 10. Recommended Improvements

Table 7: Proposed improvements for the Waste Sector

| Category | Description of improvement | Related to a key category | Priority |
|---|---|---|---|
| **4A Solid Waste Disposal** | **Conduct a capacity needs assessment of MCC, UoL, EPA, and LISGIS and develop a project for the implementation of targeted capacity building of these key institutions of the established Waste Sector institutional arrangement of the waste sector GHG-IMS. The targeted CB should include:**<br>• National waste inventory and GHG activity data collection (See Annex W.8-UoL Support Activity Data Collection Plan and Budget)<br>• Develop country-specific waste composition of the solid waste received at the various disposal sites (managed, unmanaged, and uncategorized), and at the waste generation level. | Yes | High |
| **4C2 Incineration and Open Burning of Waste** | MCC, UoL, and EPA develop and implement 5-year surveys on the amounts and the composition of waste burned by households, authorities, and companies responsible for waste management. This will enable the refinement of open burning of solid waste by rural and urban households. | Yes | Medium |
| **4D1 Domestic wastewater treatment and discharge** | Conduct capacity needs assessment of Liberia Water and Sewer Corporation (LWSC), MCC and UoL for collection of annual AD for the category; and provide the identified financial, technical, and capacity FTC support required for developing ready-to-use GHG inventory data for the category. The CB should include: | No | Medium |

| | | | |
|---|---|---|---|
| | • Characterizing and quantifying all wastewater pathways according to the percentages flowing to different treatment systems (sewer to treatment plants, septic tanks, latrines and discharge pathways.<br>• Developing and comparing country-specific data on BOD in domestic wastewater to IPCC default values; and provide documented justification why such country-specific values are more appropriate for their national circumstances.<br>• MCC, LWSC, and UoL capacity to document and report in the future sectoral inventory how the country-specific data on urban and rural wastewater pathways and the usage in the BUR-1 have been derived (measurements, literature, expert judgement, etc.)<br>EPA and UoL should identify and compile industrial wastewater of the SMEs with significant carbon loading and COD load which are directly and indirectly discharged into the domestic wastewater sewer system, rivers and estuaries, and the Gulf of Guinea marine environment to improve completeness. The data collection should be facilitated by the EPA's industry regulation, permitting and monitoring program. | | |
| | Collection of activity data for industrial or commercial sources that is discharged into the sewer. This will enable the estimation of nitrogen emissions from non-consumed protein sources (e.g., from grocery stores and butchers) using the default fraction of 1.25. (i.e. additional 25 % emissions from industrial and commercial sources.) | No | Medium |

## O. Sources and Sinks (categories, Pools and Gases) Not Considered in the National Inventory Report, But for Which Estimation Methods Are Included in the IPCC Guidelines

Soil carbon stock change in forestland and grassland soils (soil pool) – method exists, but due to the lack of national soil carbon inventories, the pool is excluded (notation "NE"). Dead wood and litter carbon pools in remaining forestland – a method exists, but data on dead wood biomass and decomposition rates were not available. Therefore, it was not estimated in this NIR. $CH_4$ emissions from informal waste disposal sites (open dumps) – a method exists, but lack of formal data on waste flows. It was estimated only qualitatively. Wetland (peat/organic soils) $CO_2/CH_4$ emissions: Liberia has limited mapped peat/organic soils.

This category of land was decided as "does not occur (notation "NO") or is negligible. $NF_3$ or other halogenated gases from electronics/semiconductors – a method exists, but the industrial sector is minimal, so excluded due to insignificance.

Table 8: Excluded Categories for Liberia's Greenhouse Gas Inventory

| **Sector** | **Category/Pool/Gas** | **IPCC Reference (2006 GL or Supplement)** | **Notation Key** | **Reason for Exclusion/ Justification** |
|---|---|---|---|---|
| Energy Sector | Fugitive emissions from oil and natural gas systems | Vol. 2, Ch. 4 | NO | Liberia does not currently produce or process oil or natural gas; therefore, category not occurring or is negligible. |
| Industrial Processes (IPPU) | $NF_3$, halogenated ethers, or indirect $CO_2$ (from NMVOCs, CO, etc.) | Vol. 3, Ch. 6 | NE | Industrial base is minimal; no semiconductor, refrigeration-gas manufacturing, or solvent industries. Emissions are negligible or data not available. |

| Sector | Category/Pool/Gas | IPCC Reference (2006 GL or Supplement) | Notation Key | Reason for Exclusion/ Justification |
|---|---|---|---|---|
| Agriculture (Soils) | $N_2O$ emissions from managed soils (synthetic fertilisers, manure application, crop residues) | Vol. 4, Ch. 11 | NE | Limited or no national data on fertiliser/manure use rates; weak agricultural input data; activity data gaps make estimation uncertain. |
| FOLU – Forest Land | Dead wood and litter pools in the remaining forest land | Vol. 4, Ch. 2 & 4 | NE | IPCC methods exist, but Liberia lacks national data on dead wood and litter biomass. Data collection is technically demanding and costly; considered minor relative to living biomass. |
| FOLU – Cropland/Grassland/ Forest Land | Soil organic carbon stock changes (soil pool) | Vol. 4, Ch. 2–6 | NE | No soil carbon inventory or monitoring data available; lack of national emission factors and soil sampling capacity; uncertainty too high. |
| FOLU – Wetlands (Managed Peatlands/Organic Soils) | $CO_2$ and $CH_4$ emissions from drained or rewetted organic soils | 2013 Wetlands Supplement | NO or NE | Liberia's peatland/organic soil extent is minimal or unmapped; no national data on managed peat or drained wetlands. Excluded due to irrelevance or uncertainty. |
| FOLU (Harvested Wood) | $CO_2$ removals from harvested wood products (HWP) | Vol. 4, Ch. 12 | NE | Method exists, but Liberia lacks consistent data on wood product production, trade, and lifespan; currently excluded pending data development (Ref: NFI Liberia), but is included in this BTR for the first time. |
| Waste Sector | $CH_4$ and $N_2O$ emissions from solid waste disposal sites (SWDS) | Vol. 5, Ch. 3 | NE | Waste is mainly disposed of in informal dumpsites; activity data (waste quantities, composition, management type) are unavailable; formal landfill methods are not applicable. |
| Waste Sector | $CH_4$ and $N_2O$ from wastewater handling | Vol. 5, Ch. 6 | NE | Lack of systematic data on wastewater generation, treatment system types, and BOD; most systems informal or unmanaged. |

## 1. Reasons for the Exclusion

Soil organic carbon (SOC) is an important component of the greenhouse gas inventory, but its treatment can be complex for several reasons:

**Measurement Challenges**: Accurately measuring SOC levels across large areas is difficult due to variability in soil types, land management practices, and environmental conditions. This variability makes it harder to quantify changes in SOC over time.

**Temporal Changes**: SOC levels can fluctuate significantly due to factors such as agricultural practices, land-use changes, and climatic conditions. Capturing these temporal changes requires long-term data and monitoring, which may not always be feasible.

**Carbon Sequestration Dynamics:** The dynamics of carbon sequestration in soil. The processes of formation and decomposition of organic matter can complicate modelling efforts. SOC is influenced by many biophysical processes, making it challenging to accurately predict changes.

**Uncertainty in Ownership and Land Use**: The attribution of SOC changes to specific activities or practices can often be unclear. For example, distinguishing between changes due to land management and those due to natural climatic variations can introduce uncertainty.

**Institutional Frameworks:** Different countries and organisations have varying methodologies and frameworks for reporting GHG inventories. In some cases, SOC is not included as a separate pool or is grouped with other carbon pools, making it less visible in national inventories.

**Data Availability**: Limited data availability on SOC for certain regions, especially in developing countries, can hinder its inclusion in comprehensive GHG inventories. This can lead to an underrepresentation of SOC in national assessments.

**Focus on Emissions:** Many GHG inventories primarily focus on emissions of gases such as $CO_2$, $CH_4$, and $N_2O$, which may overshadow the importance of carbon pools, such as SOC. There may be a greater emphasis on identifying and quantifying direct emissions rather than capturing carbon stocks in soils.

## 2. Recommendations

This report provided a foundation for Liberia's GHG inventory as part of its first Biennial Transparency Report or third National Communications, demonstrating the country's commitment to transparency and climate action under Article 6 of the Paris Agreement. The followings recommendations will inform Liberia's:

- Strengthen data collection, management, and achieve systems across all sectors.
- Enhance technical capacity through targeted training programmes.
- Secure additional funding and resources for GHG inventory activities.
- Foster collaboration among national institutions and international partners to improve the quality of emissions data.
- Follow all protocols concerning the NIR

# II. INFORMATION NECESSARY TO TRACK PROGRESS

**Information necessary to track progress made in implementing and achieving nationally determined contributions under Article 4 of the Paris Agreement**

This Chapter has been prepared in accordance with the Modalities, Procedures and Guidelines (MPGs) for the Enhanced Transparency Framework adopted under Decision 18/CMA.1 (paragraphs 60–103, Annex), and presents the Common Tabular Format (CTF) tables prescribed by Decision 5/CMA.3 (Annex II). It draws on the national greenhouse gas (GHG) inventory data documented in Chapter I (Liberia National Greenhouse Gas Inventory 2019-2022) and the Liberia Nationally Determined Contribution (NDC) submissions to the UNFCCC.

# A. Introduction

As a Party to the United Nations Framework Convention on Climate Change (UNFCCC) and a signatory to the Paris Agreement, Liberia is committed to reporting on its progress in implementing and achieving its Nationally Determined Contribution (NDC) under Article 4 of the Paris Agreement. This Chapter responds directly to paragraphs 60 to 103 of the Modalities, Procedures and Guidelines (MPGs) annexed to Decision 18/CMA.1, and integrates the Common Tabular Formats (CTF) adopted under Decision 5/CMA.3.

This Chapter sets out the information necessary to track progress made in implementing and achieving Liberia's NDC, covering: (i) national circumstances and institutional arrangements relevant to the implementation and tracking of the NDC; (ii) a description of Liberia's NDC under Article 4; (iii) information necessary to track progress, including the selection of indicators, methodologies and accounting approaches; (iv) mitigation policies and measures; (v) summary of greenhouse gas (GHG) emissions and removals consistent with the inventory in Chapter I; (vi) projections of GHG emissions and removals; and (vii) the structured summary of progress.

In view of the special circumstances of Liberia as a Least Developed Country (LDC), this Chapter applies the flexibility provisions of Decision 18/CMA.1 (paragraph 6) where appropriate. As Liberia is not currently engaged in cooperative approaches under Article 6 of the Paris Agreement and does not employ Internationally Transferred Mitigation Outcomes (ITMOs) towards its NDC, the corresponding sections of the structured summary are reported as 'Not Applicable' (NA).

All emissions data presented in this Chapter are consistent with Chapter I of this BTR1/NC3 (Liberia National Greenhouse Gas Inventory 2019-2022). All values are expressed in gigagrams of carbon dioxide equivalent (Gg $CO_2$eq) using Global Warming Potentials (GWPs) from the IPCC Fifth Assessment Report (AR5) over a 100-year time horizon: $CO_2$ = 1; $CH_4$ = 28; $N_2O$ = 265, in line with Decision 18/CMA.1 paragraph 37.

# B. National Circumstances and Institutional Arrangements Relevant to the Implementation and Tracking of the NDC

This section provides information on national circumstances and institutional arrangements pursuant to MPG paragraphs 60 to 64. The information presented complements Chapter I and is the basis on which Liberia's NDC is grounded.

## 1. Demographic Profile

The 2022 Population and Housing Census (LISGIS, 2022) reports Liberia's population at 5,250,187, comprising 50.4 per cent men and 49.6 per cent women. The population grew from 3,476,608 in 2008 to 5,250,187 in 2022, representing an average annual rate of 3.0 per cent and a 51 per cent increase over fourteen years. The population is projected to reach approximately 12,051,182 by 2065, with the growth rate decelerating to 2.3 per cent by 2032 and 1.9 per cent by 2065.

Urban areas now host 54.5 per cent of the population, with the urban share projected to rise from 2,862,154 in 2022 to 5,106,454 by 2045, an increase of approximately 2.24 million people. The rural share is projected to decline correspondingly from 45.5 per cent to about 40 per cent by 2045 (LISGIS, 2022). Accelerating urbanization places increasing pressure on energy supply, urban infrastructure, transport, healthcare and waste management, with consequent implications for sectoral GHG emissions trajectories. Liberia's NDC reflects this demographic transition by setting enhanced targets in the Energy, Transport and AFOLU sectors.

## 2. Geographical and Climatic Context

Liberia is in West Africa within the Upper Guinea Rainforest ecoregion and has a total land area of approximately 9,675,287 hectares (96,753 km²). Forestland accounts for approximately 6.35 million hectares (65.7 per cent of total land area in 2022), making forests by far the dominant land cover and the principal carbon pool in the national inventory. The country has a tropical climate with two distinct seasons (a rainy season from May to October and a dry season from November to April), mean annual temperatures of approximately 25.5°C and mean annual rainfall ranging from 1,800 mm in the northern interior to over 2,800 mm along the coast (World Bank, 2024).

## 3. Economic Context

Liberia's economy is predominantly natural-resource based, with agriculture, forestry and mining as principal sectors (Central Bank of Liberia, 2023). Agriculture employs approximately 70 per cent of the rural population and contributes substantially to gross domestic product (GDP) and export earnings. Real GDP grew by 4.6 per cent in 2023 and was forecast to expand by 5.3 per cent in 2024, driven primarily by the primary sector. Inflation rose to 10.1 per cent in 2023 from 7.6 per cent in 2022, reflecting currency depreciation and external commodity price volatility. These macroeconomic dynamics influence energy demand, agricultural intensification and land-use change, all of which are direct drivers of GHG emissions captured in the national inventory.

## 4. Vulnerability to Climate Change

Liberia is highly vulnerable to climate variability and change. Regional Climate Models indicate an increase in mean air temperature of between 0.4°C and 1.3°C by 2050 (EPA, 2018). The African Development Bank (2022) Climate Vulnerability Index ranks Liberia among the ten most vulnerable countries globally, scoring 0.606 and placing the country 177th out of 181 countries assessed. Climate-sensitive sectors—agriculture, forestry, fisheries, water and coastal zones—are among the most affected. Liberia's vulnerability is a central element of the contextual framing of its NDC and underpins the integration of adaptation co-benefits within mitigation actions.

## 5. Biodiversity and Forest Resources

Forests cover approximately 65.7 per cent of Liberia's land area in 2022, including a substantial portion of the remaining Upper Guinea Rainforest. Liberia hosts more than 2,000 species of flowering plants, more than 600 bird species and 125 mammal species (FDA, 2018), and is recognized as one of the world's biodiversity hotspots. Forestland is a critical carbon sink, with the FOLU sector providing net removals of between 1.08 and 10.45 Gg $CO_2$eq per year over the reporting period 2019-2022 (see Chapter I).

The dominant pressures on the forest estate are shifting cultivation, fuelwood and charcoal harvesting, commercial logging, mining-related deforestation and unsustainable harvesting of non-timber forest products. Liberia is committed to conserving at least 30 per cent of its forests through enhanced protected-area management and the implementation of the National REDD+ Strategy.

## 6. Institutional Arrangements for NDC Tracking

Liberia has established institutional arrangements consistent with MPG paragraphs 60 to 62 to support implementation, monitoring, reporting and verification (MRV) of its NDC. The principal entities and their respective mandates are set out in Table 2.1.

**Table 2.1: Institutional Arrangements for NDC Implementation and Tracking**

| Institution | Role and Responsibilities for NDC Tracking |
|---|---|
| Environmental Protection Agency (EPA) | Designated National Authority (DNA) under the UNFCCC and the Paris Agreement; lead institution for the preparation of the BTR/NC and Liberia's NDC; coordinates GHG inventory compilation; oversees the National Climate Change Secretariat (NCCS); host of the National Climate Change Steering Committee (NCCSC). |
| National Climate Change Steering Committee (NCCSC) | High-level inter-ministerial body chaired ex-officio by the President of the Republic; provides strategic oversight and policy direction for climate change action, including NDC implementation and tracking. |
| National Climate Change Secretariat (NCCS) | Provides day-to-day technical and operational support to the NCCSC; coordinates inter-ministerial actions and facilitates technical working groups for inventory and mitigation tracking. |
| Ministry of Finance and Development Planning (MFDP) | Coordinates climate finance mobilization and ensures alignment of NDC implementation with the national budget and Pro-Poor Agenda for Development and Prosperity (PAPD). |
| Ministry of Mines and Energy (MME) | Lead ministry for the Energy and Coastal Zone NDC sectors; provides activity data on fuel consumption, electricity generation and renewable energy investments; tracks energy-sector mitigation actions. |
| Ministry of Agriculture (MoA) | Lead ministry for the Agriculture NDC sector; provides livestock population, rice cultivation area and fertilizer use data; tracks low-emissions rice cultivation and livestock mitigation actions. |
| Forestry Development Authority (FDA) | Lead institution for the Forestry NDC sector; provides annual land-cover and forest-cover change data; coordinates the National REDD+ Strategy and tracks reforestation and forest-conservation actions. |
| Ministry of Internal Affairs (MIA) | Lead ministry for the Waste NDC sector through coordination with city corporations; provides solid-waste and wastewater data and tracks waste-sector mitigation actions. |
| Ministry of Transport (MoT) and Ministry of Public Works (MPW) | Joint leads for the Transport NDC sector; provide vehicle-fleet, fuel-import and road-infrastructure data; track transport-sector mitigation actions. |
| National Fisheries and Aquaculture Authority (NaFAA) | Lead authority for the Fisheries NDC sector; provides activity data on fishing fleet operations and aquaculture; coordinates fisheries-sector mitigation and adaptation actions. |
| Ministry of Health (MoH)/National Public Health Institute of Liberia (NPHIL) | Lead institutions for the Health NDC sector; track adaptation actions and health-related co-benefits of mitigation measures. |
| Liberia Institute of Statistics and Geo-Information Services (LISGIS) | National statistical authority providing demographic, economic and household-level data underpinning activity-data compilation across all sectors of the inventory. |

These arrangements are operationalized through Technical Working Groups (TWGs) for each sector, supported by an NDC Coordinator within the EPA. Each NDC sector has designated NDC Implementation Focal Points to ensure routine reporting of activity data, mitigation action progress, and indicator updates.

## C. Description of Liberia's Nationally Determined Contribution under Article 4 of the Paris Agreement

Liberia submitted its Intended Nationally Determined Contribution (INDC) on 25 September 2015, prior to ratifying the Paris Agreement on 27 August 2018, at which point the INDC became its first NDC. On 4 August 2021, Liberia submitted its updated NDC (NDC 2.0), committing to reduce its economy-wide greenhouse gas emissions by 64 per cent below the projected business-as-usual (BAU) level by 2030, comprising 10 per cent unconditional and 54 per cent conditional reductions. In 2025, Liberia submitted NDC 3.0, which extends the planning horizon to 2035 and articulates a long-term ambition of net-zero emissions by 2050.

This BTR1 reports on the implementation of Liberia's NDC 2.0 over the period 2019-2022, recognizing that NDC 3.0 has only recently entered the implementation phase and that the related implementation plan is being finalized. CTF Table I (Table 2.2) below provides the structured description of Liberia's NDC under Article 4, in accordance with paragraph 65 of the MPGs.

Table 2.2 (CTF Table I): Description of Liberia's Nationally Determined Contribution Under Article 4 of the Paris Agreement

| **Element (per MPG paragraph 65)** | **Liberia's NDC – Reported Information** |
|---|---|
| (a) Target as communicated | Economy-wide reduction of 64% in greenhouse gas emissions below the projected business-as-usual (BAU) level by 2030 (NDC 2.0). The target comprises an unconditional reduction of 10% (5,550.74 Gg $CO_2$eq) and a conditional reduction of 54% (29,973.99 Gg $CO_2$eq), contingent on international support. NDC 3.0 (submitted 2025) extends this commitment to 2035 with the same headline target structure, accompanied by a long-term ambition of net-zero emissions by 2050. |
| (b) Target type | Single-year, economy-wide emissions reduction target relative to a Business-as-Usual (BAU) baseline projection (relative target). |
| (c) Reference year/level (BAU) | Reference baseline: BAU projection of 55,507.41 Gg $CO_2$eq in 2035 (extended in NDC 3.0). Base year for inventory is 2015. The most recent inventory year is 2022, with national totals (excluding LULUCF) of 1,709.59 Gg $CO_2$eq. |
| (d) Time frame and/or period for implementation | Implementation period: 2021–2030 under NDC 2.0; extended to 2021–2035 under NDC 3.0. Target year: 2030 (NDC 2.0); 2035 (NDC 3.0). |
| (e) Scope and coverage – Sectors | All IPCC sectors covered under the inventory: Energy (1A); Industrial Processes and Product Use (IPPU, 2 – currently NE); Agriculture (3); Forestry and Other Land Use (FOLU, 3B/4); Waste (4/5). Nine NDC sectors are addressed: Agriculture, Coastal Zone, Energy, Fisheries, Forestry, Health, Industry, Waste and Transport. |
| (f) Scope and coverage – Gases | $CO_2$, $CH_4$ and $N_2O$ for the inventory and NDC tracking. Fluorinated gases (HFCs, in particular HFC-134a) recognized in mitigation policy but not currently estimated in the inventory due to data limitations (NE). |
| (g) Geographical coverage | National territory of the Republic of Liberia, comprising 9,675,287 hectares. |
| (h) Intention to use cooperative approaches under Article 6 | Liberia is exploring potential participation in cooperative approaches under Article 6 of the Paris Agreement (Articles 6.2 and 6.4) with a view to mobilizing additional climate finance for the conditional component of the NDC. No Internationally Transferred Mitigation Outcomes (ITMOs) are currently being |

| Element (per MPG paragraph 65) | Liberia's NDC – Reported Information |
|---|---|
| | authorized, transferred or applied towards Liberia's NDC during the reporting period (2019-2022). |
| (i) GWP values used | Global Warming Potentials from the IPCC Fifth Assessment Report (AR5) over a 100-year time horizon: $CO_2$ = 1; $CH_4$ = 28; $N_2O$ = 265, in line with Decision 18/CMA.1 paragraph 37. |
| (j) IPCC Guidelines used | 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Tier 1 methodology), with the 2019 Refinement consulted for parameter selection. Tier 2 methodology applied for the Solid Waste Disposal sub-category. The Low Emissions Analysis Platform (LEAP) was used to develop the BAU projection for the Energy, Agriculture, Waste and Transport sectors. |
| (k) Approach to addressing the LULUCF/FOLU sector | Land-based approach (gross-net) consistent with the 2006 IPCC Guidelines. Pools reported: above-ground biomass, below-ground biomass and biomass burning emissions. Net flux from FOLU varied between –10.45 and –1.08 Gg $CO_2$eq over 2019-2022 (net sink throughout the period). |
| (l) How fair and ambitious in light of national circumstances | As a Least Developed Country with negligible historical contribution to global emissions and per-capita emissions of approximately 0.33 t $CO_2$eq/yr (excluding LULUCF, 2022), Liberia's economy-wide 64% reduction below BAU represents a fair and ambitious contribution. The target is consistent with the temperature goal of the Paris Agreement of holding the increase in global average temperature to well below 2°C and pursuing efforts to limit it to 1.5°C above pre-industrial levels. The expansion of mitigation targets to previously adaptation-only sectors (Forestry, Agriculture, Fisheries, Health, and Coastal Zones) under NDC 2.0 reflects increased ambition. |
| (m) How the NDC contributes towards Article 2 of the Paris Agreement | By committing to a 64% reduction below BAU and pursuing net-zero by 2050, Liberia contributes towards holding the increase in global average temperature well below 2°C. The NDC also contributes towards the global goal on adaptation through integrated adaptation–mitigation co-benefit measures, and towards making finance flows consistent with low-emission and climate-resilient development through the NDC Investment Plan. |

## D. Information Necessary to Track Progress in Implementing and Achieving the NDC

In accordance with paragraphs 65 to 77 of the MPGs, this section sets out: (i) the indicators selected by Liberia to track progress; (ii) definitions of those indicators; (iii) the methodologies and accounting approaches applied; and (iv) the most recent levels of GHG emissions and removals consistent with Chapter I.

### 1. Selection of Indicators (CTF Table II)

Liberia has selected indicators that align with the structure of its NDC and with the principles of consistency, transparency, comparability, completeness and accuracy. The economy-wide indicator is total annual GHG emissions excluding LULUCF/FOLU, expressed in Gg $CO_2$eq. Sectoral indicators are total annual GHG emissions for each sector, also expressed in Gg $CO_2$eq, complemented by a small number of activity-based proxy indicators for sectors where the link between mitigation actions and emission outcomes is not yet directly measurable.

Table 2.3 (CTF Table II): Indicators Selected by Liberia to Track Progress in Implementing and Achieving its NDC

| No. | Indicator | Unit | Reference/Baseline | Target Level (2030) | Target Year |
|---|---|---|---|---|---|
| 1 | Total national GHG emissions excluding LULUCF/FOLU | Gg $CO_2$eq/yr | BAU 2030 projection (LEAP) | 64% below BAU | 2030 |
| 2 | Energy sector GHG emissions (excluding Transport sub-category) | Gg $CO_2$eq/yr | BAU 2030 projection | 40.6% below BAU | 2030 |
| 3 | Transport sector GHG emissions | Gg $CO_2$eq/yr | BAU 2030 projection | 15.1% below BAU | 2030 |
| 4 | Agriculture sector GHG emissions | Gg $CO_2$eq/yr | BAU 2030 projection | 40% below BAU | 2030 |
| 5 | Forestry/FOLU sector net GHG flux | Gg $CO_2$eq/yr | BAU 2030 projection | 40% below BAU | 2030 |
| 6 | Waste sector GHG emissions | Gg $CO_2$eq/yr | BAU 2030 projection | 7.6% below BAU | 2030 |
| 7 | National deforestation rate | % reduction relative to 2015 | 2015 deforestation rate | 50% reduction | 2030 |
| 8 | Annual area reforested | hectares/yr | 0 (2015) | 12,285 ha/yr (98,280 ha cum.) | 2030 |
| 9 | Restored degraded priority forests | % of priority degraded forest area | 0% (2015) | 25% | 2030 |
| 10 | Installed renewable-energy capacity (PPA-backed) | MW | 0 MW (2015) | 100 MW | 2030 |
| 11 | Households using fuelwood/charcoal supplied with energy-efficient cookstoves | % of fuelwood/charcoal households | Baseline 2015 | 60% | 2030 |
| 12 | Carbon stocks in urban green corridors and tree planting | Gg $CO_2$eq/yr (sequestration) | 0 (2015) | 600 Gg $CO_2$eq/yr | 2030 |
| 13 | Adoption of low-emissions rice cultivation | hectares of irrigated/lowland rice | Baseline 2015 | 50,000 ha | 2030 |
| 14 | Operational landfill-gas recovery systems | number of facilities | 0 (2015) | ≥ 2 facilities | 2030 |

## 2. Definitions of Indicators (CTF Table III)

Table 2.4 (CTF Table III): Definitions of the Indicators Selected by Liberia

| No. | Indicator | Definition and Method of Calculation |
|---|---|---|
| 1 | Total national GHG emissions excluding LULUCF/FOLU | Sum of all anthropogenic emissions from the Energy, IPPU, Agriculture and Waste sectors, excluding net flux from Forestry and Other Land Use (FOLU). Calculated annually using the 2006 IPCC Guidelines (Tier 1) and AR5 GWPs. Reported in Gg $CO_2$eq/yr. |
| 2 | Sectoral GHG emissions | Annual GHG emissions for each IPCC sector reported in Chapter I, calculated as Activity Data × Emission Factor and aggregated using AR5 GWPs. Sectors: Energy (1A); IPPU (2 – currently NE); Agriculture (3); FOLU (3B/4); Waste (4/5). |
| 7 | National deforestation rate | Annual gross loss of forest cover (hectares per year) relative to the 2015 baseline. Computed from successive Land-Use change matrices using FDA forest-cover data and Global Forest Watch (GFW) cross-checks. |

| No. | Indicator | Definition and Method of Calculation |
|---|---|---|
| 8 | Annual area reforested | Annual hectares of land brought under tree cover through assisted natural regeneration, agroforestry and active planting (community and school programs), recorded by FDA and reported through the National REDD+ Strategy MRV system. |
| 10 | Installed renewable-energy capacity (PPA-backed) | Cumulative installed nameplate capacity (MW) of utility-scale renewable-energy generation backed by a Power Purchase Agreement (PPA) reaching financial close. Recorded by MME and the Liberia Electricity Regulatory Commission (LERC). |
| 11 | Households with energy-efficient cookstoves | Number of households reliant on fuelwood or charcoal that have been provided with an energy-efficient cookstove (improved cookstove rated at ≥30% efficiency improvement over traditional baseline), expressed as a percentage of all fuelwood/charcoal households per the most recent census. |
| 13 | Adoption of low-emissions rice cultivation | Cumulative hectares of rice cultivated under irrigated/lowland systems applying low-emissions practices (alternate wetting and drying, residue management) as recorded by the MoA National Agriculture Development Plan (2024–2030). |
| 14 | Landfill-gas recovery systems | Number of operational landfill-gas (LFG) collection and flaring/utilization systems at municipal solid-waste disposal sites within Liberia, as recorded by MIA in collaboration with city corporations. |

*Indicators 3, 4, 5, 6, 9 and 12 follow the same general definition pattern as Indicator 2 (sectoral GHG emissions) or are based on standard sectoral statistical conventions.*

## 3. Methodologies and Accounting Approaches (CTF Table IV)

The methodologies and accounting approaches applied for compiling Liberia's GHG inventory and tracking the indicators are summarized in Table 2.5 (CTF Table IV).

Table 2.5 (CTF Table IV): Methodologies and Accounting Approaches

| Methodological Element | Liberia's Approach |
|---|---|
| Inventory methodology | 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Tier 1 methodology, applied to all sectors. Tier 2 methodology applied for Solid Waste Disposal (5A) using country-specific population and waste-generation rate data. |
| GWPs | AR5 100-year GWPs: $CO_2$ = 1; $CH_4$ = 28; $N_2O$ = 265 (Decision 18/CMA.1, para 37). |
| Reference baseline (BAU) | Constructed using the Low Emissions Analysis Platform (LEAP) developed by the Stockholm Environment Institute. Driver assumptions include population growth, GDP growth, urbanization rates and sectoral activity-data trajectories. The BAU projection yields a 2035 economy-wide level of 55,507.41 Gg $CO_2$eq. |
| Approach for the LULUCF/FOLU sector | Land-based gross-net approach. Land categories: Forest Land, Cropland, Grassland, Wetland, Settlements, Other Land. Pools: Above-Ground Biomass, Below-Ground Biomass; Biomass Burning. $CO_2$ only reported for FOLU at Tier 1. |
| Treatment of natural disturbances | Liberia does not apply provisions for natural-disturbance exclusion. All emissions and removals are reported on a gross basis. |
| Use of cooperative approaches under Article 6 | None during the reporting period (2019-2022). No ITMOs authorized, transferred or applied. NA in CTF Tables. |
| Avoidance of double counting | Not applicable for the reporting period as Liberia is not currently engaged in cooperative approaches under Article 6. |

| Methodological Element | Liberia's Approach |
|---|---|
| QA/QC procedures | Tier 1 QA/QC procedures applied per the 2006 IPCC Guidelines, including: (i) data-source documentation; (ii) cross-checks of activity data against international datasets (FAOSTAT, IEA, World Bank, Global Forest Watch); (iii) recalculation verification using independently coded Python benchmarks; (iv) peer review by sectoral TWGs. Verified benchmarks (Gg $CO_2$eq, 2019-2022): Energy NE/957.01/926.55/1,044.18; Agriculture 517.12/517.04/517.24/521.56; Waste 142.88/150.05/144.10/143.85; FOLU −10.45/−6.35/−9.93/−1.08. |
| Uncertainty assessment | Tier 1 uncertainty assessment applied using IPCC default uncertainty ranges. Aggregate uncertainty in the national total estimated at approximately ±25%, with FOLU dominating uncertainty propagation. A more comprehensive uncertainty assessment is planned for BTR2. |
| Recalculations | Recalculations have been performed for the 2019-2022 inventory relative to the BUR1 (2014–2019) submission to: (i) align with AR5 GWPs in line with Decision 18/CMA.1 paragraph 37; (ii) incorporate Tier 2 method for Solid Waste Disposal; (iii) update activity data using the 2022 population and housing census; (iv) apply a unified land-use change matrix consistent with FAOSTAT and Global Forest Watch. |
| Methodological consistency with NDC | The same IPCC methods and AR5 GWPs are used for both the inventory and the NDC tracking. The BAU baseline was established using LEAP 2018 with subsequent harmonization against the 2019-2022 inventory. |
| Use of flexibility provisions | Liberia, as a Least Developed Country, applies the flexibility provisions of Decision 18/CMA.1 paragraph 6 in the following areas: (i) reporting of three direct GHGs ($CO_2$, $CH_4$, $N_2O$), with fluorinated gases reported as NE; (ii) Tier 1 methodology for most sectors; (iii) provisional reporting of IPPU (2) as Not Estimated (NE) due to limited industrial activity-data infrastructure; (iv) qualitative description of uncertainty and time-series consistency in this BTR1. |

## E. Summary of Most Recent National Greenhouse Gas Emissions and Removals

This section presents a summary of the most recent GHG emissions and removals data, consistent with the National Inventory Report (Chapter I) and following MPG paragraphs 71–73. The detailed methodology, activity data, emission factors and uncertainty discussion are provided in Chapter I.

### 1. National GHG Emissions by Sector and Year

Table 2.6: National GHG Emissions and Removals by Sector, 2019-2022 (Gg $CO_2$eq)

| Code | IPCC Sector | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|
| 1 | Energy | 1,139.57 | 957.01 | 968.44 | 1,044.18 |
| 2 | Industrial Processes and Product Use (IPPU) | NE | NE | NE | NE |
| 3 | Agriculture | 517.12 | 517.04 | 517.24 | 521.56 |
| 4 | Forestry and Other Land Use (FOLU) – Net flux | −10.45 | −6.35 | −9.93 | −1.08 |
| 5 | Waste | 142.88 | 150.05 | 144.10 | 143.85 |
| | National Total (excluding LULUCF/FOLU) | 1,799.57 | 1,624.11 | 1,629.78 | 1,709.59 |
| | National Total (including LULUCF/FOLU) | 1,789.12 | 1,617.76 | 1,619.85 | 1,708.51 |

*Notes: NE = Not Estimated. IPPU sub-categories 2A7 (Soda ash), 2C1 (Iron and steel), 2D1 (Lubricants), 2D2 (Paraffin wax) and 2F1 (Refrigeration/AC) are reported as NE in this BTR1 owing to insufficient activity data. Negative values for FOLU denote net removals (sinks). National totals may differ from BUR1 reported*

*figures owing to recalculations described in Chapter I and Section 2.4.3 above. Energy 2021 reflects an updated value (968.44 Gg $CO_2$eq) following recalculation of road-transport activity data*

## 2. National GHG Emissions by Gas

Table 2.7: National GHG Emissions by Gas, 2019-2022 (Gg $CO_2$eq)

| Gas | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|
| Carbon Dioxide ($CO_2$) – Fossil | 815.90 | 626.91 | 627.81 | 690.38 |
| Methane ($CH_4$) | 858.15 | 870.24 | 871.85 | 883.90 |
| Nitrous Oxide ($N_2O$) | 125.53 | 126.95 | 130.12 | 135.31 |
| HFCs | NE | NE | NE | NE |
| PFCs/$SF_6$/$NF_3$ | NO | NO | NO | NO |
| Total (excluding LULUCF/FOLU) | 1,799.57 | 1,624.11 | 1,629.78 | 1,709.59 |

*NE = Not Estimated. NO = Not Occurring. HFC-134a is recognized in Liberia's mitigation policy framework but is currently reported as NE pending implementation of the Refrigeration/AC activity-data collection program planned for BTR2.*

## 3. Trends and Drivers

Over the full reporting period, national emissions excluding LULUCF declined from 1,799.57 Gg $CO_2$eq in 2019 to a low of 1,624.11 Gg $CO_2$eq in 2020, then progressively recovered to 1,709.59 Gg $CO_2$eq by 2022. The 2020 dip reflects in part the macroeconomic and mobility impacts of the COVID-19 pandemic on road transport and industrial fuel demand. The Energy sector dominates the national profile, contributing 61 per cent of the 2022 total, followed by Agriculture (31 per cent) and Waste (8 per cent); IPPU is reported as Not Estimated. Energy-sector emissions fell from 1,139.57 Gg $CO_2$eq in 2019 to 957.01 Gg $CO_2$eq in 2020 (a 16 per cent decline), then rose to 968.44 Gg $CO_2$eq in 2021 and 1,044.18 Gg $CO_2$eq in 2022, principally driven by recovering road-transport fuel consumption (1A3b) and growing residential biomass use (1A4bi/1A4bii).

Agriculture remained broadly stable at approximately 517–522 Gg $CO_2$eq, dominated by enteric fermentation (3A) and rice cultivation (3C7). Waste emissions oscillated between 142.88 and 150.05 Gg $CO_2$eq, with municipal solid-waste disposal as the dominant sub-source. The FOLU sector remained a net sink throughout the period, but the magnitude of removals declined sharply from –10.45 Gg $CO_2$eq in 2019 to –1.08 Gg $CO_2$eq in 2022, reflecting reduced net forest cover gain and increased land conversion to cropland.

## 4. Per Capita and Emissions Intensity

Based on the 2022 census population of 5,250,187 and 2022 national emissions excluding LULUCF of 1,709.59 Gg $CO_2$eq, Liberia’s per-capita emissions in 2022 were approximately 0.326 t $CO_2$eq per person per year. This is among the lowest per-capita emission rates globally and reaffirms Liberia's negligible historical contribution to anthropogenic climate change.

## F. Structured Summary – Tracking Progress in Implementing and Achieving the NDC

In accordance with paragraphs 77 to 82 of the MPGs and the structured summary template adopted under Decision 5/CMA.3 (Annex II), Table 2.8 (CTF Table V) presents Liberia's structured summary of progress made in implementing and achieving the NDC under Article 4 of the Paris Agreement. As 2021 was the year of NDC 2.0 submission and the implementation period commenced in 2022, the period 2022 represents the first reporting year for Liberia. Implementation progress in subsequent years (2023–2030) will be tracked through successive BTRs.

Table 2.8 (CTF Table V): Structured Summary – Tracking Progress Made in Implementing and Achieving Liberia's NDC under Article 4

| No. | Indicator selected to track progress | Unit | Reference/ Baseline | Most recent value (2022) | Target level | Target year | Progress/status as of 2022 |
|---|---|---|---|---|---|---|---|
| 1 | Total national GHG emissions excluding LULUCF/FOLU | Gg $CO_2$eq/yr | BAU 2030 (LEAP) | 1,709.59 | 64% below BAU | 2030 | Inventory established for 2022 as the starting point; sector-level mitigation actions under preparation |
| 2 | Energy-sector GHG emissions (excl. Transport) | Gg $CO_2$eq/yr | BAU 2030 | 597 (est. excl. 1A3b) | 40.6% below BAU | 2030 | 1A1, 1A2, 1A4 sub-sectors compiled and verified for 2022; mitigation actions in PPA pipeline |
| 3 | Transport-sector GHG emissions (1A3b) | Gg $CO_2$eq/yr | BAU 2030 | 447.80 | 15.1% below BAU | 2030 | Activity-data verified; EV pilot program being scoped |
| 4 | Agriculture-sector GHG emissions | Gg $CO_2$eq/yr | BAU 2030 | 521.56 | 40% below BAU | 2030 | Stable 2020–2022; National Agriculture Development Plan 2024–2030 launched |
| 5 | Forestry/FOLU net GHG flux | Gg $CO_2$eq/yr | BAU 2030 | −1.08 | 40% below BAU | 2030 | Net sink throughout reporting period; magnitude declining – flag for action |
| 6 | Waste-sector GHG emissions | Gg $CO_2$eq/yr | BAU 2030 | 143.85 | 7.6% below BAU | 2030 | Tier 2 method applied 2022; landfill-gas pilots under design |
| 7 | National deforestation rate | % reduction vs 2015 | 2015 | TBD (FDA) | 50% reduction | 2030 | REDD+ baseline assessment ongoing |
| 8 | Annual area reforested | ha/yr (cum.) | 0 (2015) | TBD | 12,285 ha/yr (98,280 ha cum.) | 2030 | Community planting programmes in counties |

| No. | Indicator selected to track progress | Unit | Reference/ Baseline | Most recent value (2022) | Target level | Target year | Progress/status as of 2022 |
|---|---|---|---|---|---|---|---|
| 9 | Restored degraded priority forests | % area | 0 (2015) | TBD | 25% | 2030 | Pilot under FDA |
| 10 | Renewable-energy capacity (PPA) | MW | 0 (2015) | TBD (LERC) | 100 MW | 2030 | Mount Coffee II hydropower under feasibility |
| 11 | Households with energy-efficient cookstoves | % f.w./charcoal HHs | Baseline 2015 | TBD (LISGIS HH survey) | 60% | 2030 | Cookstove distribution piloted in Bong and Lofa |
| 12 | Urban carbon sequestration through tree planting | Gg $CO_2$eq/yr | 0 (2015) | TBD | 600 Gg $CO_2$eq/yr | 2030 | Urban greening pilot in Monrovia |
| 13 | Low-emissions rice cultivation | ha | Baseline 2015 | TBD (MoA) | 50,000 ha | 2030 | AWD demonstration farms established |
| 14 | Operational landfill-gas recovery systems | no. | 0 (2015) | 0 | ≥ 2 | 2030 | Pre-feasibility study under MIA |

*TBD = To be determined; baseline data collection ongoing for non-emissions-based indicators (Indicators 7–14) and will be reported in BTR2. Implementation effectively commenced in 2022; first full year of implementation tracking will be reported in BTR2 (covering 2023–2024).*

## G. Mitigation Policies, Measures, Actions and Plans

This section reports on Liberia's mitigation policies, measures, actions and plans, in accordance with paragraph 76 of the MPGs and using the structured table prescribed in Decision 5/CMA.3. Liberia's mitigation policies are integrated into the NDC 2.0/3.0 and the NDC Implementation Plan, and span all NDC sectors.

Table 2.9 (CTF Table V – PaMs): Mitigation Policies, Measures, Actions and Plans

| No. | Name and brief description | Sector | Gas | Type of instrument | Start year | Implementing entity | Expected GHG reduction (Gg $CO_2$eq) and status |
|---|---|---|---|---|---|---|---|
| E1 | Establish a private-investment enabling environment for renewable-energy PPAs (target 100 MW renewable capacity, 300 GWh/yr) | Energy | $CO_2$ | Economic/Regulatory | 2021 | MME, LERC, MFDP | Expected: 79.8 Gg $CO_2$eq/yr by 2030. Status: Under preparation |
| E2 | Distribute energy-efficient cookstoves to 60% of fuelwood/charcoal-using households | Energy/ AFOLU | $CO_2$, $CH_4$ | Programme | 2021 | MME, EPA, FDA | Expected: 588 Gg $CO_2$eq/yr by 2030. Status: County-level pilots ongoing |
| E3 | Phase out diesel-only generation and replace it with hybrid/PV mini-grids in counties | Energy | $CO_2$, $CH_4$, $N_2O$ | Capital investment | 2022 | MME, LERC, MIA | Expected: ~50 Gg $CO_2$eq/yr by 2030. Status: Mini-grid programme launched |

| No. | Name and brief description | Sector | Gas | Type of instrument | Start year | Implementing entity | Expected GHG reduction (Gg $CO_2$eq) and status |
|---|---|---|---|---|---|---|---|
| E4 | Develop large-scale solar PV plants (utility-scale) | Energy | $CO_2$ | Capital investment/ PPA | 2022 | MME, LERC, MFDP | Expected: ~50 Gg $CO_2$eq/yr by 2030. Status: Tender preparation |
| T1 | Reduce GHG emissions in the transport sector by 15.1% below BAU by 2030 | Transport | $CO_2$ | Mitigation target | 2021 | MoT, MPW, EPA | Status: Cross-cutting target; sector strategy under development |
| T2 | Pilot electric-vehicle introduction (focus on three-wheelers/kekehs) | Transport | $CO_2$ | Programme | 2022 | MoT, MFDP | Expected: 16.9 Gg $CO_2$eq/yr by 2030. Status: Feasibility study |
| T3 | Continuation of paved road upgrading and construction (improved fuel-efficiency) | Transport | $CO_2$ | Capital investment | 2018 | MPW, MoT | Status: Ongoing under PAPD |
| T4 | Sustainable urban transport policy with priority bus lanes (Monrovia) | Transport | $CO_2$ | Regulatory | 2023 | MoT, Monrovia City Corp. | Status: Policy drafting |
| A1 | Promote low-emissions rice cultivation (alternate wetting and drying; residue management) – 50,000 ha by 2030 | Agriculture | $CH_4$ | Programme/ Capital | 2021 | MoA, EPA | Expected: 19.6 Gg $CO_2$eq/yr by 2030. Status: Demonstration farms in Bong, Lofa |
| A2 | Reduce livestock emissions through improved feed and manure management (bio-digesters, composting) | Agriculture | $CH_4$, $N_2O$ | Programme | 2021 | MoA | Expected: 211 Gg $CO_2$eq/yr by 2030. Status: Pilot programme design |
| A3 | Promote conservation agriculture, integrated soil fertility management and agroforestry | Agriculture/FOLU | $CO_2$, $CH_4$, $N_2O$ | Programme | 2021 | MoA, FDA | Status: Field activities under National Agriculture Development Plan 2024–2030 |
| F1 | Reduce GHG emissions from forest conversion by 40% below BAU by 2030 | FOLU | $CO_2$ | Mitigation target | 2021 | FDA, EPA | Expected: 5,147 Gg $CO_2$eq/yr by 2030. Status: REDD+ enabling environment in place |
| F2 | Halve the national deforestation rate by 2030 (vs 2015 baseline) | FOLU | $CO_2$ | Regulatory/ Programme | 2021 | FDA, EPA | Status: REDD+ Strategy implementation |
| F3 | Reforest an average of 12,285 ha/yr (98,280 ha cumulative by 2030) | FOLU | $CO_2$ | Programme | 2021 | FDA, EPA | Expected: 1,013 Gg $CO_2$eq/yr by 2030. Status: Community and school planting |
| F4 | Restore 25% of priority degraded forests by 2030 | FOLU | $CO_2$ | Programme | 2022 | FDA | Status: Priority degraded-forest mapping ongoing |
| F5 | Conserve all High Conservation Value/High Carbon Stock (HCV/HCS) forests | FOLU | $CO_2$ | Regulatory | 2021 | FDA, EPA | Status: Implementation under REDD+ |

| No. | Name and brief description | Sector | Gas | Type of instrument | Start year | Implementing entity | Expected GHG reduction (Gg $CO_2$eq) and status |
|---|---|---|---|---|---|---|---|
| F6 | Establish 5 new Protected Areas | FOLU | $CO_2$ | Regulatory/ Capital | 2021 | FDA, EPA | Expected: ~210 Gg $CO_2$eq/yr by 2030. Status: PA proposal pipeline |
| F7 | Enhance urban carbon stocks through urban greening (600 Gg $CO_2$eq/yr by 2030) | FOLU/ Settlements | $CO_2$ | Programme | 2022 | EPA, Monrovia City Corp. | Status: Urban greening pilot |
| W1 | Implement landfill-gas (LFG) recovery system at municipal landfill(s) | Waste | $CH_4$ | Capital investment | 2022 | MIA, EPA | Expected: 7.6 Gg $CO_2$eq/yr by 2030. Status: Pre-feasibility |
| W2 | Develop wastewater-treatment options enabling methane recovery | Waste | $CH_4$ | Capital investment | 2022 | MIA, MoH | Expected: 0.64 Gg $CO_2$eq/yr by 2030. Status: Concept stage |
| W3 | Strengthen institutional and legal frameworks for waste management at national and municipal levels | Waste | $CH_4$ | Regulatory | 2022 | MIA, EPA | Status: Policy review underway |
| W4 | Public-awareness and capacity-building programs for proper waste management | Waste/ Health co-benefits | $CH_4$ | Programme | 2022 | MIA, MoH, EPA | Status: Ongoing |

## H. Projections of GHG Emissions and Removals

In line with paragraphs 91 to 101 of the MPGs and the special circumstances of Liberia as a Least Developed Country (Decision 18/CMA.1, paragraph 6), Liberia presents indicative projections of GHG emissions and removals to support tracking of NDC implementation. Projections were generated using the Low Emissions Analysis Platform (LEAP) for the Energy, Transport, Agriculture and Waste sectors, complemented by sector-specific modelling for Forestry/FOLU. The projection methodology, key assumptions and parameters are set out in Annex II of this Chapter.

### 1. BAU Projection

The BAU scenario projects the evolution of national GHG emissions in the absence of additional NDC mitigation actions, reflecting only currently implemented baseline policies. The BAU scenario yields a projected total of 55,507.41 Gg $CO_2$eq in 2035, dominated by the FOLU sector due to continuing forest conversion and the Energy sector due to projected fuel-import trajectories.

### 2. NDC Scenarios

Two NDC scenarios are reported alongside the BAU: the Unconditional scenario (10 per cent reduction below BAU, yielding approximately 5,551 Gg $CO_2$eq absolute reductions in 2035) and the Conditional scenario (an additional 54 per cent reduction conditional on international support, yielding approximately 29,974 Gg $CO_2$eq additional reductions). The aggregate 64 per cent reduction below BAU corresponds to an absolute emissions level of approximately 19,983 Gg $CO_2$eq in 2035.

Table 2.10: Summary of Projected Emissions and NDC Reduction Commitments by Sector (Gg $CO_2$eq, 2035)

| Sector | BAU 2035 | Base year | Commitment (%) | Target reduction (Gg $CO_2$eq) | Target year |
|---|---|---|---|---|---|
| Economy-wide (Total) | 55,507.41 | 2022 | 64% | 35,524.74 | 2030/2035 |
| of which: Unconditional | – | 2022 | 10% | 5,550.74 | 2030/2035 |
| of which: Conditional | – | 2022 | 54% | 29,973.99 | 2030/2035 |
| Sectoral level | | | | | |
| Agriculture | 2,753.92 | 2022 | 40.0% | 1,101.57 | 2030 |
| Forestry (FOLU) | 47,374.62 | 2022 | 40.0% | 18,949.85 | 2030 |
| Energy (excl. Transport) | 4,505.68 | 2022 | 40.6% | 1,829.31 | 2030 |
| Transport | – | 2022 | 15.1% | – | 2030 |
| Waste | 873.19 | 2022 | 7.6% | 66.36 | 2030 |

*Source: Liberia NDC 2.0 (2021) and NDC 3.0 (2025). Sectoral BAU projections are extrapolated from the 2018 LEAP baseline; recalibration of sectoral BAU using the recalculated 2019-2022 inventory is planned for BTR2.*

### 3. Sensitivity and Limitations

The projections are subject to substantial uncertainty arising from: (i) the limited time series for which inventory data are available (2014-2022); (ii) the significant gap between BAU forecasts and actual emissions in the most recent inventory year, particularly for the FOLU sector where the BAU 2035 projection (47,374.62 Gg $CO_2$eq) substantially exceeds the 2022 inventory value (–1.08 Gg $CO_2$eq, net sink); and (iii) macro-economic uncertainty regarding population, GDP and energy demand. Liberia plans to recalibrate the BAU using the recalculated 2019-2022 inventory and the 2022 census update for BTR2.

## I. Information on Cooperative Approaches under Article 6 of the Paris Agreement

In accordance with paragraphs 75(a)–(b) of the MPGs, Liberia confirms that during the reporting period 2019-2022:

- Liberia did not authorise, transfer or apply any Internationally Transferred Mitigation Outcomes (ITMOs) towards its NDC under Article 4 of the Paris Agreement;
- Liberia was not engaged in any cooperative approach under Article 6.2 (bilateral or plurilateral cooperative approaches) during the reporting period;
- Liberia had not submitted, hosted or transferred any Article 6.4 Emission Reductions (A6.4ERs) generated under the mechanism established by Article 6.4 of the Paris Agreement during the reporting period.

Accordingly, all CTF Table elements relating to ITMOs and A6.4ERs are reported as Not Applicable (NA). Liberia is, however, exploring potential participation in cooperative approaches under Article 6 (Articles 6.2 and 6.4) to mobilize additional climate finance for the conditional component of its NDC. Should such engagement materialize during a future reporting period, Liberia will report the corresponding information consistent with the requirements of Decisions 2/CMA.3 and 3/CMA.3 and the relevant CTF tables.

## J. Mitigation Co-Benefits Resulting from Adaptation Actions and Economic Diversification Plans

In accordance with paragraph 76(d) of the MPGs, Liberia reports the following mitigation co-benefits arising from adaptation actions and economic-diversification plans during the reporting period:

Table 2.11: Mitigation Co-benefits Resulting from Adaptation Actions and Diversification Plans

| Action/Plan | Primary objective | Mitigation co-benefit |
|---|---|---|
| Climate-smart agriculture | Adaptation Agriculture | Carbon sequestration in agricultural soils through conservation tillage; reduced $N_2O$ through balanced fertilizer use; reduced $CH_4$ from low-emissions rice. |
| Coastal-zone protection (mangrove restoration) | Adaptation Coastal | Significant $CO_2$ sequestration in coastal mangrove biomass and soils; reduced coastal-erosion-driven $CO_2$ emissions from soil disturbance. |
| Sustainable forest management & REDD+ | Adaptation Forestry | Major $CO_2$ sequestration through avoided deforestation, reforestation and forest restoration. |
| Watershed protection and reforestation of catchments | Adaptation Water | $CO_2$ sequestration in restored vegetation; reduced reliance on diesel pumping through improved baseflow regulation. |
| Renewable-energy electrification of remote/coastal communities | Adaptation Energy resilience | Direct $CO_2$ reduction by displacing diesel generation; resilience to fuel-supply disruptions. |

## K. Improvements Planned for Future Reporting

In line with the principle of continuous improvement (MPG paragraph 80), Liberia identifies the following priorities for BTR2 (covering 2023–2024) and beyond:

- Initiate compilation of the IPPU sector inventory, focusing on Refrigeration and Air Conditioning (2F1, HFC-134a), lubricants (2D1) and paraffin wax use (2D2), in collaboration with the Ministry of Commerce and Industry, the Liberia Revenue Authority and refrigeration trade associations.
- Strengthen FOLU activity data through full integration with the National Forest Monitoring System (NFMS), including remote-sensing-based gross deforestation, gross afforestation and degradation activity data.
- Recalibrate the BAU projection for all NDC sectors using the recalculated 2019-2022 inventory and the 2022 Population and Housing Census update.
- Implement Tier 2 methodology for Enteric Fermentation (3A) using country-specific feed-intake parameters and herd-structure data from the National Agriculture Development Plan.
- Develop a quantitative uncertainty assessment for all sectors using IPCC Tier 1 propagation methodology (Approach 1).
- Establish a dedicated GHG inventory database integrated with the EPA's MRV system to ensure time-series consistency across reporting cycles.
- Operationalise an inventory QA/QC plan with documented external peer review and recalculation-tracking procedures.

# III. INFORMATION RELATED TO CLIMATE CHANGE IMPACTS AND ADAPTATION

**Information related to climate change impacts and adaptation under Article 7 of the Paris Agreement**

## A. Executive Summary

This comprehensive chapter of the A-BTR details Liberia's national circumstances, institutional arrangements, and adaptation efforts in response to climate change. The country, located in West Africa's Upper Guinea Rainforest, faces significant climate vulnerabilities across multiple sectors. The chapter provides an in-depth analysis of Liberia's geographic, demographic, and infrastructural characteristics, highlighting how these factors influence its climate adaptation capacity.

Climate vulnerability and risk assessments reveal substantial challenges across key sectors. In agriculture, rising temperatures and erratic rainfall patterns threaten crop yields and food security. The fisheries sector, crucial for meeting a significant share of the country's animal protein needs, faces disruption due to changing ocean temperatures and precipitation patterns. The forestry sector, while maintaining over 40% of the Upper Guinea rainforest, experiences increased pest prevalence and reduced forest health due to climate impacts. Coastal zones face particular vulnerability to sea-level rise and erosion, affecting both infrastructure and livelihoods.

The institutional framework for climate adaptation in Liberia involves multiple stakeholders, with the Environmental Protection Agency (EPA) serving as the lead agency. The country has developed various policy instruments, including the National Adaptation Plan (2020-2030) and revised Nationally Determined Contribution (NDC), which outline specific adaptation targets and strategies. Implementation progress is evident through numerous projects across priority sectors, though challenges persist in monitoring and evaluation.

International cooperation plays a vital role in Liberia's adaptation efforts, with various partnerships supporting capacity building and technology transfer. The country has made significant strides in integrating gender considerations into its adaptation strategies, recognizing the disproportionate impact of climate change on women and vulnerable populations. However, gaps remain in technical capacity, financial resources, and institutional coordination.

Moving forward, Liberia's adaptation priorities focus on strengthening resilience in agriculture, fisheries, forestry, coastal zones, waste management, energy, and health sectors. The success of these efforts will depend on enhanced institutional capacity, improved monitoring and evaluation systems, and continued international support for implementation of adaptation measures.

## B. National Circumstances, Institutional Arrangements and Legal Frameworks related to Adaptation

## C. Introduction

This section of the Biennial Transparency Report and the Third National Communication (BTR1NC3) delves into Liberia's national circumstances in the context of climate change adaptation. Specifically, it explores three key thematic areas: (1) the country's geographic, demographic, and infrastructural factors influencing climate adaptation; (2) the institutional arrangements and roles of relevant national institutions in assessing and addressing climate change adaptation at sectoral and national levels; and (3) the legal frameworks, including national policies and international laws, that guide adaptation implementation in Liberia.

## D. Geography of Liberia

The Republic of Liberia is located in the Upper Guinea Rainforest on the West Coast of Africa. This region, which is among the world's most biologically diverse, was once covered by a continuous and dense tropical rainforest ranging from Guinea to Ghana (World Bank, 2021a). The Country lies at 6°30'N 9°30′W and 6.500°N 9.500°W and is bordered by Sierra Leone to the northwest, Guinea to the north, Côte d'Ivoire to the east, and the Atlantic Ocean to the south. Liberia covers an area of approximately 111,369 square kilometers (43,000 square miles). The country is characterized by mostly flat to rolling coastal plains, containing mangrove swamps and a few low mountains in the northeast. The highest point solely is the Wologizi Range which is 1,440 meters (4,720 ft) above sea level in the northwestern Liberia range of the West Africa Mountains and the Guinea Highlands (Bateman et al., 2000). Liberia has six principal river basins (Cavalla, Cestos, St. John, St. Paul, Lofa and Mano). The largest of these rivers is the Cavalla, 515 km (320 mi) long, found along the eastern side of the country. The country's watershed tends to move in a southwestern pattern towards the sea.

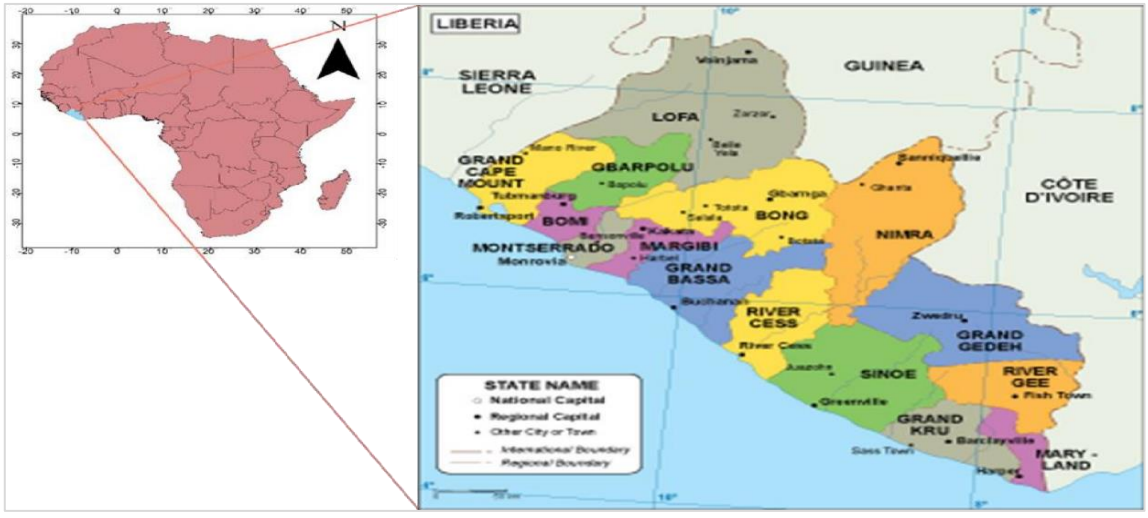



*Figure 11: Political Map of Liberia Source: BUR1, 2020*

## E. Bio-Physical Features

### 1. Forest

Liberia boasts a remarkable amount of forest cover. It holds the title of West Africa's most forested nation, containing a significant portion (43%) of the Upper Guinean Rainforest, a global haven for

biodiversity. As of 2015, forests blanketed a substantial 68% of Liberia's land area, translating to roughly 6.5 million hectares. Notably, this includes some areas dedicated to tree crops like rubber, oil palm, and cacao.

However, human-induced activities such as logging, small-scale mining, road construction, agriculture, and settlements have fragmented these once-continuous forests into isolated blocks (NPRSCC, 2018). Despite this fragmentation, Liberia's forests remain highly valuable for both biodiversity and the economy. They are home to numerous rare and endemic species, and the formal forestry sector contributes a significant share (10%) to the national income

Liberia 2018 National Forest Inventory described a forest as an area of land that has a canopy cover of at least 30 %, contains trees with a minimum of five meters (5m) height and covers a minimum of one (1) hectare of land. This definition includes shifting cultivation in its fallow phase but does not include land with predominant agriculture use such as oil palm and rubber.

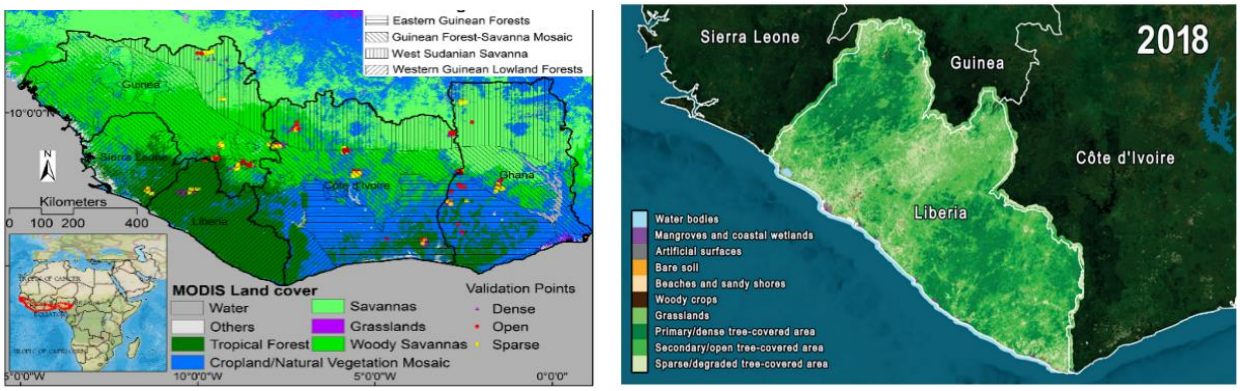



Figure 12: Forest Map of the Upper Guinea Rainforest and Liberia
*Source: WWF and SVS202*

## 2. Soil

The soil types across Liberia vary considerably depending on the region. The three main categories are sandy soils, clayey soils, and loamy soils. Sandy soils dominate the coastal regions and drain well due to their coarse texture, but they tend to be low in fertility and organic matter content. Clayey soils, found inland, have a finer texture and hold water more effectively, making them more fertile. Loamy soils, considered the most fertile, are a mix of sand, silt, and clay particles and are found in various regions. These soil types significantly influence agricultural adaptation practices in Liberia, as different crops and techniques are suited to each type. In 2023, the Government of Liberia, with technical support from the Food and Agriculture Organisation of the United Nations (FAO), developed the Liberia Soil Information System (LIBSIS). The Soil information system provides a comprehensive understanding of Liberia's soil resources for decision-making in the agriculture and forestry sectors.

## 3. Water

Liberia is well endowed with various water resources throughout the country. The major rivers are St. Paul, Lofa, Cavalla, St. John, Mano and Cestos (LISGIS, 2022). The country's water resources also include lakes, wetland and groundwater. Major rivers like the Cavalla, St. John, and St. Paul hold potential for hydropower development and agriculture production. However, low water flow in the St. Paul River hinders power generation at the Mount Coffee Dam, the main source of electricity for Monrovia[1]. Despite this challenge, Liberia ranks among African nations with the

[1] https://www.profor.info/sites/profor.info/files/Liberia-Forestry-Development-Authority-An-Institutional-Capacity-Assessment.pdf

highest per capita renewable water resources, boasting an estimated 71,000 cubic meters per person per year (FAO, 2005). While water is abundant, quality can be an issue in some areas due to pollution from mining, farming, and industrial activities[2]. Additionally, groundwater, the primary source of drinking water for over 70% of the population, often faces microbial contamination[3]. While access to basic drinking water services has improved, sanitation remains a critical issue, with only 18.2% of the population having access in 2020[4].

*Table 9: Main Rivers of Liberia*

| River Basin | Area in Sq Km | Area in Liberia (Sq Km) |
|---|---|---|
| St. Paul | 8,460 | 4,950 |
| Cestos | 4,850 | 3,900 |
| Lofa | 4,100 | 3,550 |
| St. John | 6,650 | 5,700 |
| Cavalla | 11,670 | 5,300 |
| Mano | 3,200 | 2,440 |

## F. Climate Profile

Between 1960 and 2006, mean annual temperature has increased by 0.8°C, at an average rate of 0.18°C per decade, while the mean annual rainfall over Liberia has decreased since 1960; however, it remains unclear if this is a long-term trend or due to the variability in rainfall for the region (World Bank, 2021).

### 1. Temperature

Situated in a tropical environment, Liberia experiences warm to hot temperatures throughout the year. The country has two main climatic systems, which include dry and rainy seasons. The rainy season typically occurs from May to October, with the heaviest rainfall between June and August. September is the wettest month, with a total rainfall of 375 mm, while February has the lowest, with 1 mm of rainfall. Due to its proximity to the Atlantic Ocean and dense forests, Liberia experiences high humidity levels, especially during the rainy season (World Bank, 2024). The dry season lasts from November to April (BUR 1, 2020). The weather is generally fair, whereas temperature varies from 23 °C to 33°C and is rarely below 21°C or above 34°C throughout the year, with an average monthly temperature falling between 24°C and 27°C.

The hottest months in the country are from February to April while August through December are the months with the lowest temperature (BUR 1, 2020). The average temperature of April is the highest during the year at 27.4 °C while December has the lowest average.

### 2. Rainfall

Liberia experiences significant rainfall, particularly during the rainy season. Annual rainfall totals vary across the country, with northern regions receiving an average of over 1,800 mm and coastal areas receiving over 2,800 mm annually. The African monsoon influences Liberia's rainfall patterns, although rain spells can occur even during the dry season, especially in the north. The coastal region, including Monrovia, receives particularly high rainfall, reaching 5,000 mm annually with peak rainfall in June and July. Liberia's warm and humid climate creates favorable conditions for tropical diseases like malaria. The country is also vulnerable to tropical storms, especially

[2] Primmer, R., & Sam, R. (2020). Biodiversity Sector Assessment. Social Impact, Inc

[3] Liberian Hydrological Service. Liberia River Basins 2016: Drainage Divisions and River Basin Boundaries; Monrovia, 2016.

[4] Climate Risk Profile: Liberia (2021): The World Bank Group

during the rainy season. Climate projections indicate an increase in average rainfall of 2-5% between 2010 and 2050 (EPA, 2013).

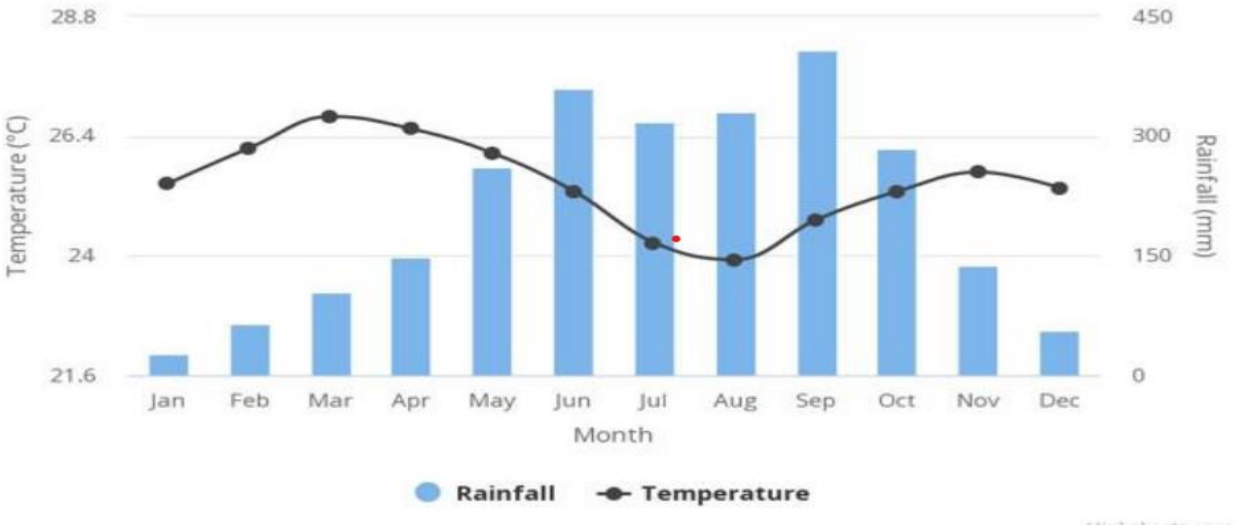



Figure 13: Average Annual Temperature (°C) and Precipitation (mm) (1991-2020)
*Source: (NAP, 2020-2030)*

## G. Demographics Characteristics

### 1. Population

The 2022 census conducted by Liberia Institute of Statistics and Geo-Information Services (LISGIS) puts Liberia's population at over 5.2 million an increase of 50. 4% when compared with the 2008 census result, which was over 3.5 million. Liberia has a population density of just 35 people per square kilometer, which ranks 180th in the world. Liberia has sixteen indigenous ethnic groups and several foreign minorities. Indigenous groups account for 95% of the population. A total of 5,148,113 (98.1%) of the population are citizens of Liberia, while foreigners (102,074) constitute about 2 % of the population.

The non-Liberians come from Asia, Lebanon, Europe, America, the surrounding border countries, and other West African countries. Guineans are the largest group (42.3%) of non-Liberians living in the country (102,074), followed by Ghanaians (14.3%), Nigerians (11.8%), Sierra Leoneans (11.0%), and Ivorians (5.2%).

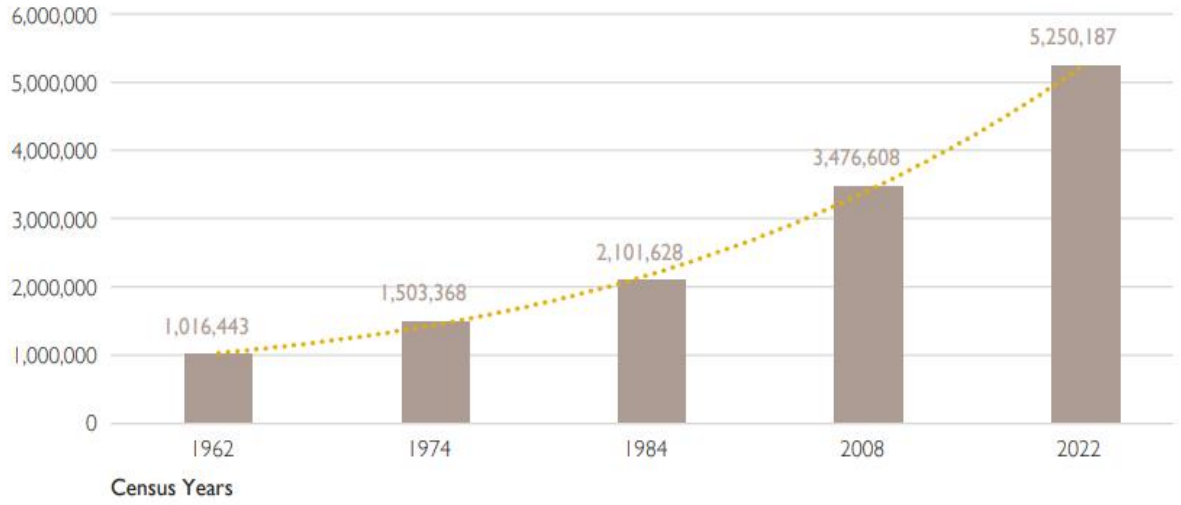



Figure 14: Population Change in Liberia 1962-2022
*Source: LIGIS, 2022*

## 2. A Population Distribution

The 2022 census results disaggregation by sex revealed that 50.4% (that is 2,644,027) of the people are male, while the female population accounts for 49.6% (that is 2,606,160). The country's national sex ratio stands at 101.5 males for every 100 females. The average household in Liberia is 4.4 persons, with a population density of 140 people per square mile. The male population is slightly higher than female by 0.4 % in Liberia.

The urban population is more than the rural population by 4.5 percentage points. The female population in the urban areas (50.8%) is higher than the male population (49.2%). In the rural areas, however, the population of males (51.7%) is more than the females (48.3%) by 3.4 percentage points.

The population under 18 years of age (2,176,918) is close to half (41.5%) of the total population, while the population in the 18-34 years old group (1,737,253) is about a third (33.1%). This translates to about three-quarters (74.6%) of the population being under 34 years of age. About 60 % of the population in Liberia is literate. This proportion is higher in urban (71.8%) than in rural (45.1%) areas, and higher among males (65.1%) than females (54.6%). The proportion of males (21.8%) who completed school is about one and a half (1.5) times that of females, and it is about three times higher (2.7 times) in the urban areas than in rural areas. The drop-out rate is higher in the rural areas (15.6%) than in the urban areas (13.0%).

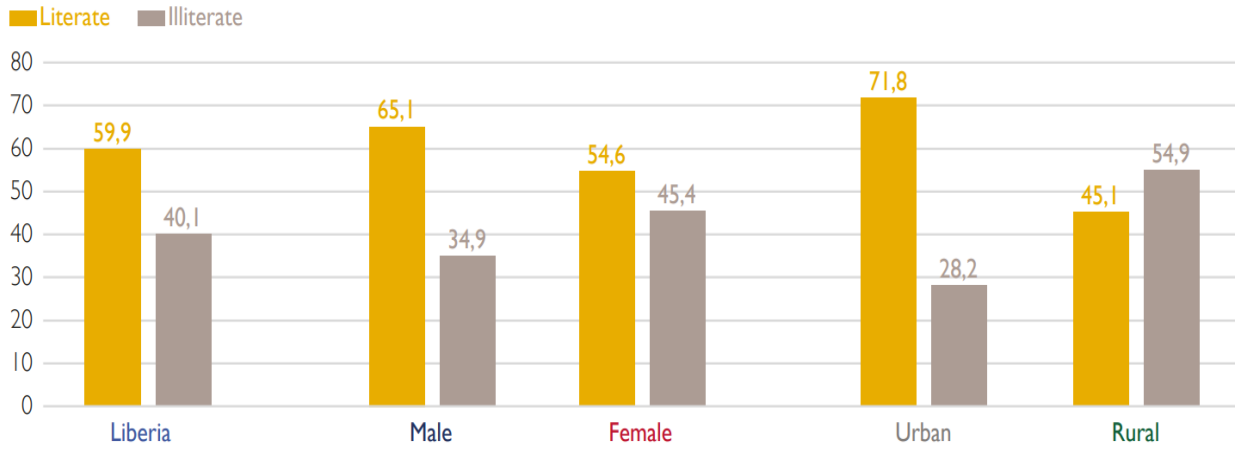



Figure 15: Percentage Distribution by Literacy, Sex, and Place of Residence
*Source (LISGIS, 2022)*

## 3. Socio-Economic Characteristics

Liberia is characterized as a low-income country with significant dependence on donor funding and diaspora remittances (WorldBank, 2018). The economy is predominantly agrarian, with agriculture serving as a major employer (African Development Bank, 2023). Key agricultural products include cash crops such as rubber, coffee, cocoa, and palm oil, while subsistence crops comprise rice, cassava, and vegetables. The agricultural sector's vulnerability to climate hazards is heightened by its rain-fed nature.

The poverty level remains substantial, with 35.4% of the population living below the international poverty line ($2.15 a day). Economic indicators show an unemployment rate of 4.1% in 2021, with GDP growth projections of 4.3% in 2023 and 4.8% in 2024, driven by expansion in mining, services, and agriculture sectors. The World Bank reports an economic expansion of 4.7% in 2023. The country's economic stability faces challenges from external factors, including the Russian invasion of Ukraine, which has led to increased commodity prices and fiscal constraints (AfDB, 2023). The fiscal deficit is expected to be 4.1% of GDP in 2023, with projections of stabilization at 4.0% in 2024.

Demographically, Liberia has a dependency ratio of 59 (2022), with higher ratios in rural areas (63:100) compared to urban areas (56:100). Economic activity is geographically concentrated, with Montserrado County accounting for one-third of the working population, while Bong, Lofa, and Nimba counties collectively represent another third. Overall economic participation among individuals aged 15 years or over stands at 26.4%.

## 4. Infrastructure Characteristics

## 5. Energy

Liberia's energy infrastructure primarily relies on electricity and petroleum products for economic activities and transportation. According to the 2022 National Census report, about a quarter of households predominantly use kerosene, electricity, and liquefied petroleum gas for lighting, cooking, and entertainment. Access to electricity remains limited, with only a small percentage of the population, particularly in urban areas (53.7%), having access. The main sources of electricity are public electricity grids, solar panels, and self-generation. Biomass, including charcoal and

wood, dominates energy consumption, accounting for over 80% of primary energy sources (World Bank, 2015).

In the capital city of Monrovia, only 6.7% of the population has access to electricity. Monrovia's grid is largely supplied by expensive diesel-fueled generation resources. Less than 23 MW of Liberia's on-grid installed generation operates daily and, therefore, larger facilities such as hotels, restaurants and office buildings self-generate electricity at their premises at levels estimated to be ten times greater than the existing installed generation capacity.

Liberia's energy sector faces several challenges, including limited access to electricity, reliance on fossil fuels and traditional biomass, and vulnerability to climate change. The country has worked to improve its energy infrastructure, with recent developments such as the rehabilitation of the Mount Coffee hydropower plant and increased electricity generation capacity to at least 80 MW (USAID, 2016).

However, the sector remains vulnerable to climate-related impacts, such as rising sea levels and changes in rainfall patterns. Addressing these challenges requires a multifaceted approach, including investments in climate-resilient energy infrastructure, promoting renewable energy sources, and implementing policies that reduce greenhouse gas emissions. By prioritizing these strategies, Liberia can ensure a sustainable and resilient energy future.

**6. Transport**

The Government of Liberia has outlined initiatives to improve the transport sector through its National Transport Master Plan, including road rehabilitation, development, and upgrading; expansion of public transport; enhancement of railway transport; and development of coastal shipping and air transport (GoL, 2012). By integrating climate-smart principles into this Master Plan, Liberia can enhance the resilience of its transport infrastructure and contribute to its transport development goals.

**7. Water**

Liberia has one of the highest rates of water resources per capita in Africa, however water quality and sanitation remain a significant problem, particularly for major urban zones such as the capital city, Monrovia (World Bank, 2022). Approximately 70% of the population has access to improved water sources, though Liberia has an abundant water supply (from both surface and groundwater). However, water quality remains poor in some areas due to mining (e.g. iron ore pollutants), farming (e.g. agrochemical runoff) and industrial activities (e.g. discharge from rubber processing)[5].

In rural areas, water is largely supplied from shallow wells whose levels fluctuate with rainfall variability, particularly during the dry season (December–April). Approximately 73% of the population has access to improved water sources; however, just 7% of rural populations and 29% of urban populations have access to improved sanitation facilities (EPA,2018).

In urban areas, intense precipitation is likely to impact the water infrastructure, as the increased volumes of water overwhelm sewer systems and water treatment plants. This could also lead to an increase in the amount of runoff into rivers and lakes, washing sediment, nutrients, pollutants, trash, animal waste, and other materials into water supplies, making them unusable, unsafe, or

[5] USAID, 2023, "WATER RESOURCES PROFILE SERIES: Liberia Water Resources Profile Overview

in need of water treatment and increasing the cost for water purification to supply potable water to communities[6].

### 8. Health

Liberia has one of the highest rates of diseases that are caused or exacerbated by environmental factors and will likely be intensified by climate change (WHO, 2018). The increase in rainfall, flooding and higher temperatures could increase the incidence of vector- and waterborne diseases such as cholera, malaria, diarrheal diseases, yellow fever and schistosomiasis. In Liberia, malaria is one of the leading causes of morbidity and mortality, and the number one cause of death for children under age five[7].

Dengue fever is already present in neighbouring Côte d'Ivoire and is likely to expand into Liberia as temperatures increase (WHO, 2018). Yellow fever is also likely to increase in wet weather; meningitis, prevalent in hot, dry months may expand in the country's inland zones. Respiratory diseases may be exacerbated by heat stress and inhalation of pollutants from stagnant air (WHO, 2018). While high temperature alone can be compensated for by evaporative cooling such as from transpiration, if the air is nearly saturated with moisture (humidity), then the cooling potential is reduced and the apparent temperature increases.

Liberia's health-care infrastructure requires a sustainable upgrade to support more systemic climate change resilience. There is a need to further strengthen the capacity of healthcare personnel to become fully aware of the relationship between climate change variability and health impacts. Over the years, there has been limited capacity in the context of health and climate change. Training and improving capacity in the sector can improve the level of knowledge and skills required to raise awareness of diseases related to climatic change impacts.

## H. Information on Adaptive Capacity

Liberia's adaptive capacity to climate change is fundamentally integrated into national and sectoral policy frameworks, though it faces challenges due to poverty rate distribution. The country's ability to adapt is heavily influenced by socio-economic and educational factors, varying significantly across regions and socioeconomic groups. Enhancement of adaptive capacity serves as a practical approach to managing climate variability and extremes, while simultaneously promoting sustainable development and reducing vulnerabilities. The youth population plays a crucial role in climate adaptation efforts through various initiatives including education, awareness, innovation, and policy advocacy. Their engagement is particularly significant as they bring fresh perspectives and energy to adaptation efforts, with a focus on job creation through adaptation components in the NDC and related climate instruments, which aims to reduce vulnerability and enhance adaptive capacity to climate shocks.

### 1. Climate Change Adaptation Challenges

Liberia faces significant climate change adaptation challenges due to its heavy dependence on climate-sensitive sectors for economic growth and development, making it highly vulnerable to climate change impacts (AfDB, 2023). The country experiences various climate hazards including erratic rainfall patterns, sea level rise, temperature increases, extreme coastal flooding, erosion, tropical storms, and increased dry spells (GoL, 2021). Additionally, there has been a notable increase in pests and diseases across the country, as evidenced by the 2023 pest invasion that affected hundreds of farms and smallholder farmers' livelihoods. According to the African

[6] https://washdata.org/data/household#!/table?geo0=country&geo1=LBR

[7] USAID (2017). Climate risks in food for peace geographies – Liberia. Climate Risk Profile. https://www.climatelinks.org/sites/default/files/asset/document/20170227_USAID%20ATLAS_Climate%20Risks%20in%20FFP%20Geographies_Liberia.pdf

Development Bank's (2022) Climate Vulnerability Index, Liberia ranks among the 10 most vulnerable countries to climate change impacts, with a vulnerability score of 0.606, placing it at 177th out of 181 countries.

While Liberia has developed various policy responses, including the National Adaptation Program of Action 2008, NAP 2020-2023, and Updated NDC, the country faces significant financial challenges. It requires an estimated US$490.6 million to achieve its climate change and green growth ambitions through 2025, with a current finance gap of 460 million dollars. The situation is further complicated by limited private sector funding and challenges in accessing finance, including insufficient financial incentives for private sector investment in adaptation and lack of de-risking opportunities for infrastructure investments (AfDB, 2023).

## 2. Institutional Arrangements and Governance Framework Relevant to Climate Change Adaptation

In Liberia, institutional arrangements in the context of adaptation to climate change involve collaboration and partnerships among relevant institutions and stakeholders to address the multifaceted challenges posed by climate hazards, risks, and impacts. Overall, it answers the question "who will do what" or "who is responsible for what" with regards to BTR & TNC preparation. It also focuses on reporting climate risk, impacts, and vulnerability assessment to the EPA for onward reporting to the UNFCCC under the Enhanced Transparency Framework (ETF) of the Paris Agreement. Liberia's national climate change adaptation policies and other related instruments are sector-based. For example, the revised NDC, NPRSCC, and NAP are all anchored on the relevant sectors of the Liberia economy. As such, a sector-based approach is adopted for the institutional arrangement for preparing the BTR and TNC.

### 3.1.8.1 Governance Framework

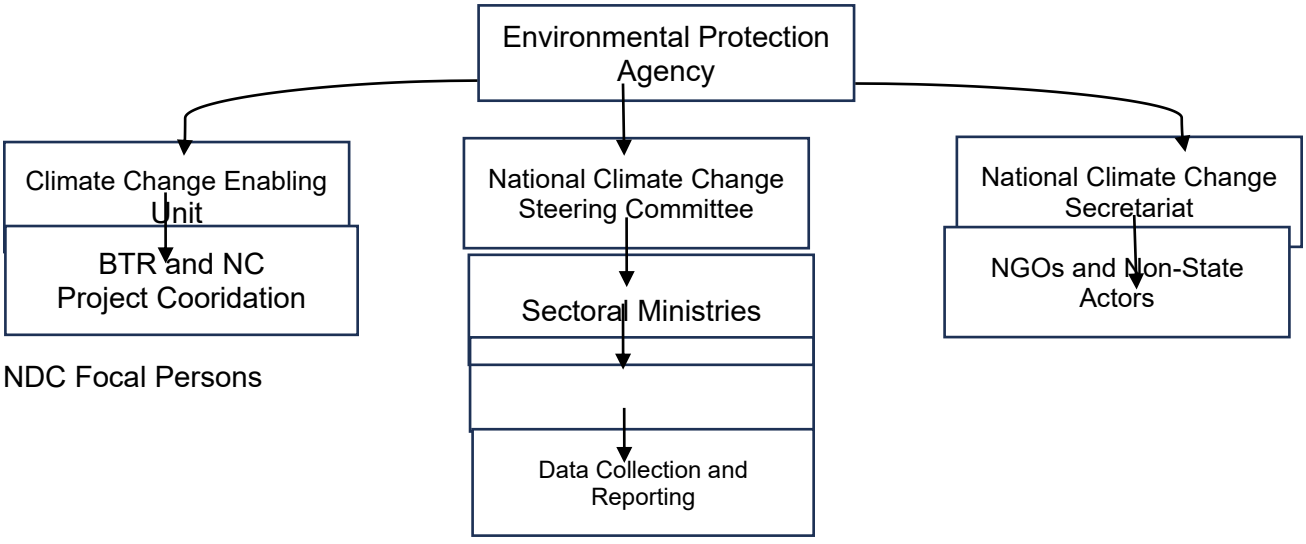



Figure 16 Institutional Arrangements and Governance Framework

Table 10: Institutional Arrangement, roles, and coordination mechanisms

| Institution | Roles and Responsibilities | Coordination Mechanism |
|---|---|---|
| Environmental Protection Agency (EPA) | - Overall coordination of climate change efforts<br>- Conduct climate impact assessments<br>- Develop adaptation strategies | - Hosts the CCEU, NCCSC, and NCCS<br>- Facilitates inter-ministerial and agency collaboration |
| Climate Change Enabling Unit (CCEU) | - Preparation and communication of BTR and NC<br>- Validation of climate reports | - Receives updates from BTR&NC project coordinator<br>- Engages with national stakeholders |
| National Climate Change Steering Committee (NCCSC) | - Inter-ministerial coordination<br>- Oversight of climate change strategies | - Organize regular meetings with ministry representatives<br>- Conflict resolution and alignment of initiatives |
| National Climate Change Secretariat (NCCS) | - Develop national climate change action plans<br>- Resource allocation and progress monitoring | - Liaison between government, international organisations, and civil society<br>- Facilitates knowledge sharing and collaboration |
| Sectoral Ministries and Agencies | - Develop sector-specific adaptation policies<br>- Implement adaptation measures | - Participation in NCCSC meetings<br>- Collaboration with NGOs and academic institutions |
| NDC Focal Person | - Data collection on climate risks and impacts<br>- Track performance of sectoral projects | - Quarterly reporting to central office<br>- Coordination with county-level offices |
| NGOs and Non-State Actors | - Implementation of adaptation projects<br>- Provid ground-level insights | - Quarterly reporting to County Offices<br>- Information sharing with relevant sectors |

## 3. Institutional Capacity Gaps and Proposed Capacity-Building Needs, Explicitly Linked to Adaptation Goals

The following institutional capacity gaps have been identified with regard to climate change Adaptation in Liberia during the period, and the following proposed capacity-building needs have been identified, explicitly linked to the country's adaptation goals detailed in the table 16 below.

Table 11: institutional capacity gaps and capacity-building needs

| Institution | Capacity Gap | Capacity Building Need | Link to Adaptation Goal |
|---|---|---|---|
| Environmental Protection Agency (EPA) | Limited technical expertise in advanced climate modeling | Training on downscaling climate models | Improve accuracy of local climate projections |
| Climate Change Enabling Unit (CCEU) | Insufficient data management systems | Implement robust data management and reporting tools | Enhance transparency and accuracy in BTR and NC reporting |
| Sectoral Ministries and Agencies | Lack of sector-specific vulnerability assessment skills | Workshops on sectoral vulnerability assessments | Develop targeted adaptation strategies for each sector |
| NDC Focal Persons | Inadequate monitoring and evaluation expertise | Training on M&E frameworks for adaptation projects | Improve tracking and reporting of adaptation outcomes |

| Institution | Capacity Gap | Capacity Building Need | Link to Adaptation Goal |
|---|---|---|---|
| NGOs and Non-State Actors | Limited understanding of national adaptation priorities | Regular briefings on national adaptation strategies | Align local projects with national adaptation plans |

## 4. Legal Policy Frameworks and Regulations Relevant to Adaptation Actions

The following legal policy frameworks and regulations have been developed to govern adaptation concerns in the country.

Table 12: Legal policy frameworks and regulations

| Policy/Framework | Year | Key Objectives/ Features |
|---|---|---|
| National Adaptation Plan (NAP) | 2020-2030 | • Comprehensive framework for climate resilience<br>• Enhances adaptive capacity across vulnerable sectors<br>• Focuses on agriculture, forestry, coastal zones, energy, waste management, and fisheries<br>• Promotes climate-smart agriculture and sustainable resource management |
| Revised NDC | 2021-2030 | • Targets 64% GHG reduction below BAU by 2030<br>• Includes 10% unconditional and 54% conditional reductions<br>• Covers 9 key sectors: agriculture, forests, coastal zones, fisheries, health, transport, industry, energy, and waste<br>• Incorporates urban green corridors initiatives |
| National Climate Change Policy (NPRSCC) | 2018 | • Provides comprehensive framework for climate response<br>• Supports adaptation and disaster risk management<br>• Integrates climate change into national planning processes<br>• Establishes coordination mechanisms at national, county, and district levels<br>• Includes capacity building and knowledge management components |
| Vision 2030 | Current | • Comprehensive development framework focusing on demography, economy, social structures, and governance<br>• Addresses environmental sustainability challenges<br>• Integrates climate adaptation strategies<br>• Promotes sustainable resource management<br>• Aims to protect biodiversity and natural resources |
| Environmental Protection and Management Law | 2002 | • Establishes legal framework for sustainable development<br>• Creates partnership between regulatory agencies<br>• Implements environmental protection measures<br>• Incorporates principles of sustainable development and polluter-pays<br>• Promotes public participation in environmental management |
| National Environmental Policy | 2003 | • Addresses human impact on environmental systems |

| Policy/Framework | Year | Key Objectives/ Features |
|---|---|---|
| | | • Balances economic development with resource management<br>• Focuses on improving physical environment and quality of life<br>• Promotes sustainable natural resource management<br>• Coordinates economic growth with environmental protection |
| National Disaster Management Policy | 2012 | • Establishes functional framework for disaster risk management<br>• Creates institutional structure for disaster response<br>• Integrates disaster risk reduction into development planning<br>• Strengthens emergency preparedness and response<br>• Promotes coordination between stakeholders |
| Land Rights Law | 2018 | • Establishes four categories of land rights (Public, Government, Customary, Private)<br>• Defines management framework for different land types<br>• Protects community land rights<br>• Promotes sustainable land management<br>• Establishes Liberia Land Authority oversight |
| National Gender Policy | 2019 | • Promotes gender equality in national development<br>• Mainstreams gender considerations in climate action<br>• Empowers women in decision-making processes<br>• Addresses climate change impacts on vulnerable groups<br>• Supports women's participation in agricultural and environmental sectors |

# I. Impacts, Risks and Vulnerabilities, as Appropriate; Adaptation Priorities and Barriers, Adaptation Strategies, Policies, Plans, Goals and Actions to Integrate Adaptation into National Policies and Strategies

## J. Introduction

Liberia is known as one of the wettest countries in the world with relatively consistently warm temperatures year-round. However, the two major seasons - the rainy season, wettest months (June-Sept) and the dry season, drier months (Dec-Apr)- vary by county. The annual total rainfall slowly decreases as one moves inland from the coast – 2,227.15 mm in coastal Maryland to 2,012.64 mm in Grand Gedeh. This variation depends on both the timing and intensity of the Intertropical Convergence Zone (ITCZ) and monsoon conditions (World Bank Group, 2024).

### 1. Approach to Climate Modelling

The modelling of climate scenarios uses a variety of methods to project the impacts of Climate change using General Circulation Model (GCM) Projections, which are inherently uncertain; therefore, high-resolution environmental data is required to improve and reduce model uncertainty. Using GCM projections will require the use of downscaling techniques, such as interpolation of GCM anomalies to include statistical modelling and regional dynamical climate

modelling, among others and which differ in accuracy, output resolution and computational requirements.

A delta method is used. The delta method, or delta change/change factor (DC) method, is a form of statistical Bias-correction downscaling technique that leverages the difference between future and current climate data. Using observation data with the outputs of 31 Coupled Model Intercomparison Project Phase 6 (CMIP6) models, we will be able to project three Shared Socio-economic pathways or storylines.

**2. Data Acquisition**

Observed, historical climate data: The Observed, historical climate data were collected and downloaded from CRUTS (Climatic Research Unit gridded Time Series) through the World Bank Climate data portal. CRUTS is the most widely used observational climate dataset (Eyring et al, 2016). Data is presented on a 0.5° latitude by 0.5° longitude grid over all land domains except Antarctica, with historical climate data from 1990 to 2020 (Harris et al, 2020). The Future climate data: Climate projection data used and collected on the World Bank Climate Change Knowledge Portal (or) CCKP is derived from both the CMIP5 and CMIP6 (Coupled Model Intercomparison Project, Phase 5 and Phase 6) collections. CMIP is a standard experimental framework for studying the output of coupled atmosphere-ocean general circulation models, as seen by World Climate Research. Modelled climate data is presented as a 1.0° latitude by 1.0° longitude grid, produced through a bilinear interpolation Program (Eyring et al, 2016).

**3. Delta Method Downscaling**

The delta method, or the DC approach used here, is a simple form of Bias-correction in which a change factor or 'delta' is derived from the GCM and then added onto the observations (historical climate data). A change factor is defined as the difference between the long-term (30-year) mean of a climate variable in the future and the historical period. This includes calculation of 30-year averages for present-day simulations and future period and calculation of anomalies as the absolute difference between future and present-day values in temperatures (minimum and maximum) and proportional differences in total precipitation (Harris, et al, 2020).

Using the historical data as time series from the CRUTS dataset, we thus calculated 30-year means as a baseline (2019-2022) for the variable. Next, we calculated the 30-year means for each SSP and future period (2023 – 2053). For the future period, we calculated the anomaly (delta change) with respect to the baseline climate for each variable and year. We used absolute differences for temperatures (eq.1), and for precipitation, we used the absolute value of the change relative to the baseline period(eq.2).

$$X_{DCi} = X_{OBSi} + \Delta X_{Ii} \quad \text{(eq.1)}$$

$$X_{DCi} = X_{OBSi} * (1 + \Delta X_{Ii}) \quad \text{(eq.2)}$$

where, $X_{OBSi}$ is the historical climate data from observations; $\Delta X_{Ii}$ is the interpolated anomaly (delta); and $X_{DCi}$ is the downscaled future climate of each GCM in the year i.

## K. Liberia's Climate Overview

Looking at the recent three decades climatology (1991-2020, (2021) see Figure 19), Liberia experienced a mean annual temperature of 25.45°C. During the 1991-2020 period, the warmest month of March ranged from a minimum of 21.30°C to a maximum of 32.51°C, while the coolest month of August ranged from a minimum of 20.97°C to a maximum of 27.72°C.As opposed to the

dry season (June–July–Aug), when there is nearly complete cloud cover, rainy months have minimal cloud cover, resulting in relatively wider temperature spreads (Figure 20).

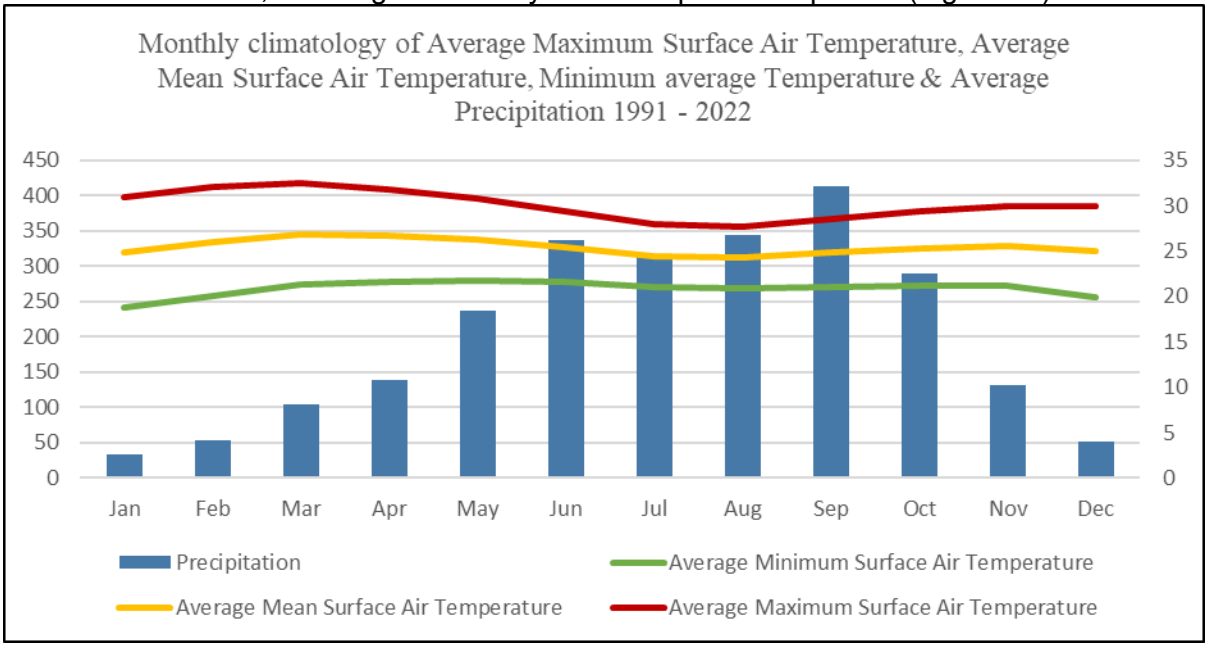



Figure 17: Monthly climatology of Average Maximum Surface Air Temperature 1991 – 2022

*(Source data: https://climateknowledgeportal.worldbank.org/*

## 1. Climate Projections

Climate projections for Liberia is projected for Temperature and Precipitation for the recent and next century used projected time periods: 2020 - 2039, 2040 - 2059, 2060 -2079 and 2080 - 2100 and Shared Socioeconomic Pathways (SSPs), which are meant to provide insight into future climates based on defined emissions, mitigation efforts and development pathways. SSP1-2.6, SSP2-4.5 and SSP3-7.0 projections are used for our modelling of temperature and Precipitation.

## 2. Temperature Variation

The Projected Average Mean Temperature in Degrees Celsius Nationwide using the reference period between 1950 and 2014 under Various Scenarios, as previously mentioned, varied and homogenously increases up to 2100 (Figure 21).

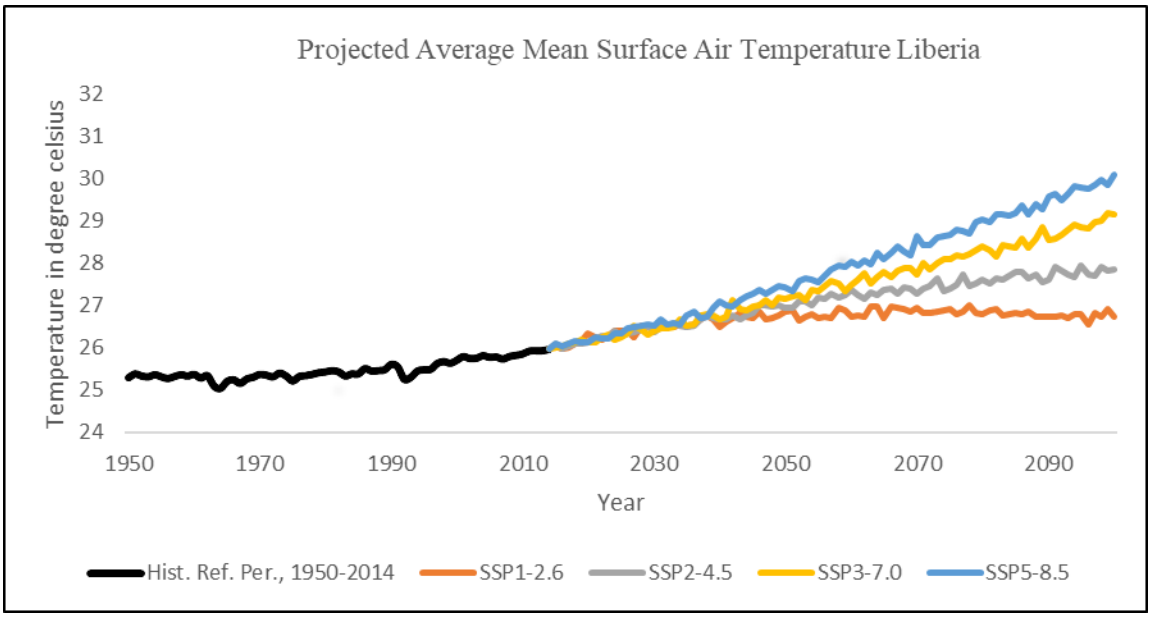



Figure 21: Average Projected Mean Surface Air Temperature for Liberia

As illustrated in Figure 21, SSP1-2.6 has the lowest annual mean temperature increase – an anomaly of 1°C by 2080–2099. Mean temperature rises by an anomaly of approximately 2°C by end of century under SSP2-4.5 and close to 3°C by end of century under SSP3-7.0, and a number of increasing tropical nights from 3 to 20 by the end of the century by 2099 (Table 18).

Table 13: Annual projected temperature across various time periods and scenarios for Liberia

| Description | SSP1-2.6 Project | | |
|---|---|---|---|
| | 2020 – 2039 | 2040-2050 | 2080-2099 |
| Annual Mean Temperature | 0.69°C (0.39°C, 0.99°C) | 0.98°C (0.54°C, 1.53°C) | 1.00°C (0.44°C, 1.78°C) |
| Tropical nights (number of night T-min >26°C) Annually | 2.87 (0.95, 6.68) | 5.93 (1.52, 15.44) | 6.08 (1.18, 23.37) |
| | **SSP2-4.5 Project** | | |
| | **2020 - 2039** | **2040-2050** | **2080-99** |
| Annual Mean Temperature | 0.69°C (0.38°C, 0.95°C) | 1.19°C (0.72°C, 1.76°C) | 1.96°C (1.19°C, 2.81°C) |
| Tropical nights (number of nights T-min >26°C) Annually | 2.94 (0.98, 6.47) | 8.66 (3.05, 20.35) | 29.70 (7.88, 77.82) |
| | **SSP3-7.0 Project** | | |
| | **2020 - 2039** | **2040-2050** | **2080-99** |
| Annual Mean Temperature | 0.67°C (0.38°C, 1.09°C) | 1.36°C (0.86°C, 2.10°C) | 2.85°C (1.91°C, 4.22°C) |

| Description | SSP1-2.6 Project | | |
|---|---|---|---|
| | 2020 – 2039 | 2040-2050 | 2080-2099 |
| Tropical nights (number of nights T-min >26°C) Annually | 2.57 (0.90, 7.45) | 11.98 (3.77, 33.32) | 91.14 (25.24, 233.08) |

The worsening mean temperature rises approximately 2°C and 3°C by the end-of-century under SSP2-4.5 and SSP3-7.0 respectively. Comparing number of high Heat Index days across these scenarios, number of high heat index days increases dramatically by 2080 - 2099 to nearly five months under SSP3-7.0 and less than two months under SSP2-4.5 and barely under SSP1-2.6. The annual number of tropical nights (T-min >26°C) experienced nationally by the end of the century increases much higher across all scenarios, especially SSP3-7.0. at the end of the century.

## 3. Precipitation Variation

The countrywide annual projected precipitation patterns under the three scenarios (SSP1-2.6, SSP2-4.5 and SSP3-7.0) show a high variation of precipitation across the three time periods: 2020-2039, 2040-2059, 2080-2099. These scenarios: SSP1-2.6 and SSP2-4.5 show an increasing precipitation across the end-of-century with decreasing precipitation under SSP3-7.0 and SSP5-8.5 (Figure 22).

As illustrated in figure 22 and Table 19, Precipitation intensity, as measured by the average largest 5-day cumulative precipitation annually, increases the most from the reference period by the end of the century (>20 mm) under SSP3-7.0. Whereas under SSP2-4.5 precipitation intensity increases across the century and decreased under SSP1-2.6.

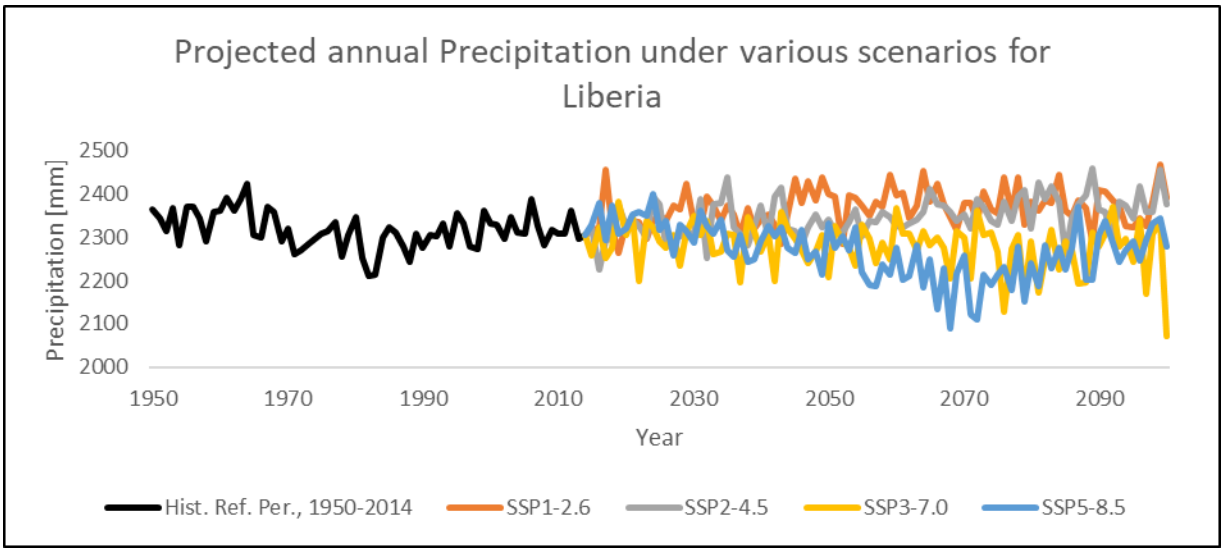



Figure 18: Projected annual Precipitation under various scenarios nationwide

Table 14: Average annual Precipitation across scenarios and time periods nationwide in Liberia

| Description | SSP1-2.6 Project | | |
|---|---|---|---|
| | **2020 - 2039** | **2040-2050** | **2080-2099** |
| Precipitation (mm) | 30.78 (−88.98, 156.70) | 43.40 (−70.77, 246.48) | 49.78 (−85.96, 253.34) |
| Average Largest 5-Day Cumulative Precipitation (mm) Annually | 3.23 (−54.63, 45.70) | 11.59 (−47.62, 60.55) | 9.69 (−53.23, 49.66) |
| | **SSP2-4.5 Project** | | |
| | **2020 - 2039** | **2040-2050** | **2080-99** |
| Precipitation (mm) | 3.78 (−89.08, 139.68) | 13.66 (−186.08, 234.75) | 48.98 (−150.42,385.48) |
| Average Largest 5-Day Cumulative Precipitation (mm) Annually | 4.36 (−52.80, 43.54) | 15.25 (−48.78, 61.01) | 18.60 (−47.17, 79.65) |
| | **SSP3-7.0 Project** | | |
| | **2020 - 2039** | **2040-2050** | **2080-99** |
| Precipitation (mm) | 218.16 (−212.05, 122.62) | 218.41 (−376.92, 230.00) | 236.33 (−530.80, 433.82) |
| Average Largest 5-Day Cumulative Precipitation (mm) Annually | 5.93 (−71.20, 60.98) | 16.28 (−71.64, 64.93) | 22.89 (−54.80, 83.03) |

## 4. Climate Vulnerability and Risk Assessment

### (Agriculture, Fisheries, and Forestry) Sectors

This section discusses climate vulnerability and risk assessment of three adaptation priority areas, including Agriculture, Fisheries, and Forestry sectors. The information contained in the assessment was informed by the results of a study published by Fobissie et al., (2019). The methodology used was based on the climate change vulnerability and risk concept as defined by the fifth assessment report (5AR) of the IPCC. (Figure 19: Illustration of the risk of climate-related impacts 23) below illustrates the interaction of both the climate system and the socioeconomic processes, including adaptation and mitigation, which are drivers of climate hazards, exposure and vulnerability. The key data collection tools and methods used for analysis include the Rapid Rural Appraisal (RRA), Multi-Criteria Analysis (MCA), Geographic Information Systems (GIS) software, Transect Walk and field observation via inclusive and participatory approaches etc.

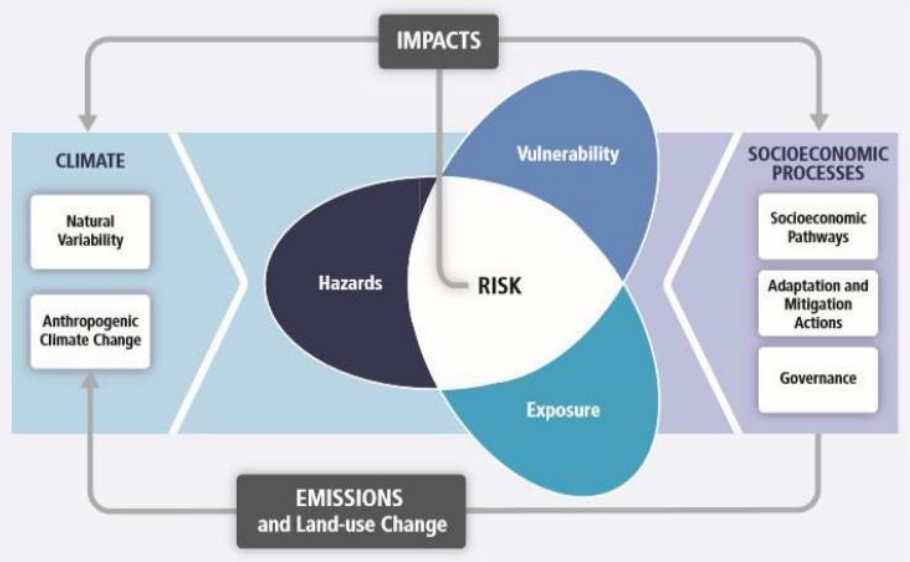



Figure 19: Illustration of the risk of climate-related impacts

Primary and secondary data were collected through desk review and analysis of past studies and reports. Key Informants interview focus group discussions with farmers, including technical and financial partners, were conducted for the three sectors. Key policy and technical documents relevant to the sectors were also reviewed and analyzed as secondary data. More details relating to the CVRA for the three (3) sectors can be found in the main CVRA report prepared by Fobissie et al and can be accessed via this link: https://fokabs.com/wp-content/uploads/2021/11/Climate-vulnerability-and-risk-assessment_Liberia_2019_final-report.pdf.

Despite the success of the CVRA for the aforementioned sectors (Agriculture, Fishery, and Forestry) sectors, the assessment had its fair share of limitations and challenges. Limited time and resources prevented the use of the Community-Based Risk Screening Tool – Adaptation and Livelihoods (CRiSTAL food security and CRiSTAL Forest) and the Climate Vulnerability and Capacity Analysis (CVCA) framework, which would have been more suitable when conducting community engagements. Subsequently, the CRVA and data collection methods were adapted into the RRA method. The CRVA also did not have adequate data to develop the vulnerability map of the fishery sector.

Regarding limitations, the CRVA focused mainly on the production side of the three sectors due to time and resource constraints. As a result, a more detail assessment that included both the production side as well as the climate vulnerability of the value chain in the three sectors could not be done. For instance, the vulnerability of the agriculture sector could have been assessed from a food-security perspective along the different value chains of selected produce like rice, cassava, cocoa and coffee. Notwithstanding, the findings for the sectors are explained respectively.

## 5. Agriculture Sector

The agricultural sector in Liberia faces significant climate-related challenges that affect both crop production and food security. Temperature changes have notably impacted agriculture in Nimba and Grand Gedeh Counties, where warmer temperatures and reduced cold periods are affecting yields of staple crops including maize, rice, rubber, and cassava.
According to Lobell et al, for every 1°C increase above 30°C temperature per day during maize growing season, there is a corresponding 1% reduction in yield each day under optimal rain fed

condition[8]. Climate factors are contributing to decreased plant productivity and increasing agricultural crop prices (EPA, 2018). The situation is particularly concerning for upland rice, Liberia's predominant cropping system, which is being significantly affected by changes in seasonal precipitation (Stanturf et al., 2013b). Food insecurity is widespread among rural households, with approximately 80% of the rural population being either moderately (41%) or highly vulnerable (40%) to food insecurity.

Livestock production has also been severely impacted by climate change, with livestock populations falling below 10% of national requirements due to extreme weather events including heat waves, floods, and droughts (Gaughan & Cawdell-Smith, 2015). These climate hazards, combined with animal diseases and vectors, are adversely affecting the livestock sector, which represents about 14% of national food and agricultural GDP (Zakary, 2007).

Rainfall pattern fluctuations are creating additional challenges for farmers. The Liberian Hydrological Service has observed that May and June, the main planting periods, are experiencing higher than expected rainfall. This excessive precipitation washes away seeds and sprouting plants, reducing farm productivity. The situation is exacerbated by intense temperature shifts during the mid-dry season, and the majority of farming households' vulnerability is heightened by their below-poverty-line status.The vulnerability of the agricultural sector to climate change in Liberia is presented in ***Error! Reference source not found.*** below.

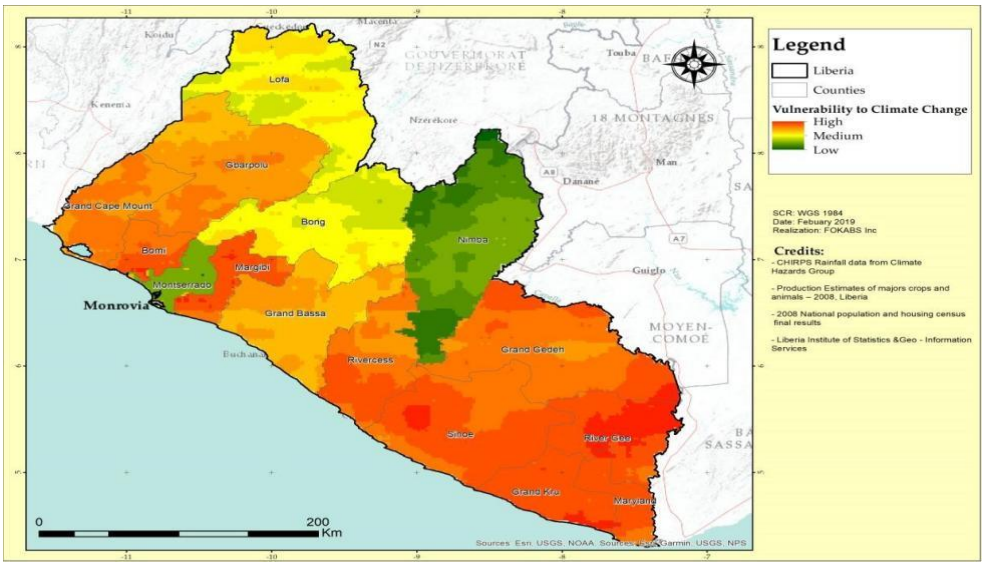



Figure 20 Vulnerability map of the agricultural sector to climate change

*(Fobissie et al., 2019)*

## 6. Fisheries Sector

Liberia's fishery sector is a crucial component of national food security and livelihoods, contributing 3.2% to GDP and providing 65% of the country's animal protein needs (FAO, 2007). The sector encompasses coastal marine fisheries, inland river and lake fisheries, and small-scale aquaculture, employing over 11,250 people (FAO, 2007). However, climate change poses

[8] Environmental Protection Agency (2018). National Policy and Response Strategy on Climate Change. http://www.epa.gov.lr/sites/default/files/National%20Policy%20and%20Response%20Strategy%20on%20Climate%20Change%20Final%20Document-min_0.pdf

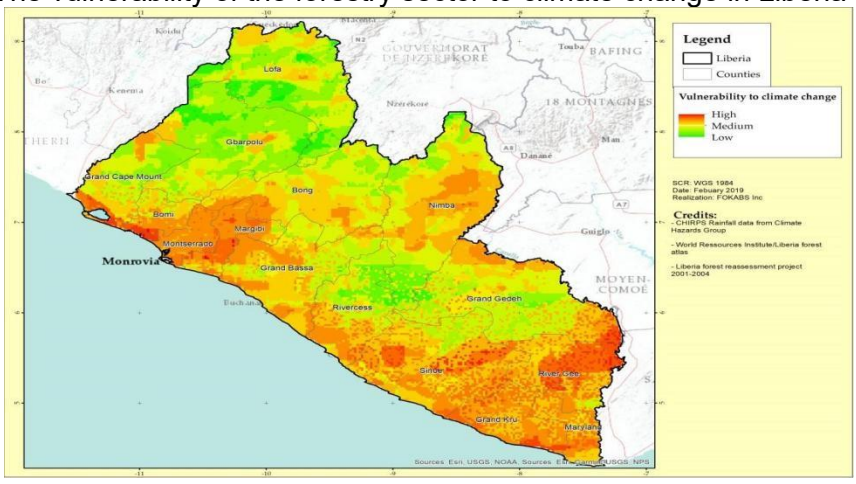
significant risks to the sector, with increasing temperatures disrupting production patterns and fish migration, while intense precipitation leads to reduced fishing days and income loss (EPA, 2018). Rising sea surface temperatures are causing reduced biodiversity and fish stocks through mortality, diminished reproduction, and migration to cooler waters, while changing rainfall patterns during dry seasons result in fish deaths and exposure to contaminated waters (USAID, 2017).

The impacts are particularly severe on inland fisheries, which are crucial for rural food security (Stanturf et al., 2013b). Climate-induced changes have led to multiple challenges including species extinction, migration of fish beyond accessible waters, and reduced fish production affecting both local consumption and export earnings. Brown tides[9] due to temperature increase has also destroyed fishing nets so badly to the extent that debris were seen on the beaches in Robertsport. Field assessments reveal that fishermen face challenges from sea-level rises, flooding, and coastal erosion. These impacts have significantly affected food security through reduced fish availability and productivity, leading to decreased local consumption and export capacity.

## 7. Forestry Sector

Over the years, Liberia has managed to maintained over 40 % of the Upper Guinea rain forest which serves as sources of revenue generation for the government and a source of livelihoods in the form of Non-timber Forest Products (NTFPs) for the communities in close proximity to it (FDA, 2000). Notwithstanding, the forest sector has experienced its shares of the impacts of climate change. According to the USAID (2017) report on climate risk profile of Liberia, the increase in temperatures is causing increase in pests and diseases and increase in the frequency of intense precipitation has led to decrease in forest cover and health due to increase rainfall and erosion and runoff because of root loss.

The CVRA gathered information on the current or prevailing vulnerability of the forest sector from respondents from Lofa-Zigidda, Bong county- Foekoleh, Nimba-Gbedyin Camp 3, Sinoe-Cherue's town, and Grand Gedeh-Zleh town. This included: increase temperatures which (i) causes snails to hide, (ii) causes lots of framire to die, (iii) leads to low flowering of plants and less seed-fruits in walnuts, (iv) leads to reduced yield of Garcina kola or bitter kola, and (v) reduction in yield of Xylopia (aethiopica-country-spot), Piptadeniastrum africanum-Dahoma, and Rattan. The vulnerability of the forestry sector to climate change in Liberia is presented in figure 25.




[9] USAID (2017). Liberia Fact Sheet. Climate Change Risk Profile. URL: https://www.climatelinks.org/sites/default/files/asset/document/2017_USAID%20ATLAS_Climate%20Risk%20Profile_Liberia.pdf

Figure 21: A vulnerability map of the forestry sector to climate change.
*(Fobissie et al., 2019)*

## 8. Climate Vulnerability and Risk Assessment for the Coastal Zone of Liberia

Liberia is confronted with major development challenges which are further exacerbated by climate change-amplified hazards such as coastal erosion and flooding. These hazards contribute to the vulnerability of the population. Liberia's coastline stretches for 579km, dominantly in a NW-SE direction (GoL, 2018). In terms of coastal geology, it is almost completely built from sand with infrequent crystalline outcrops.

Present-day coastline of Liberia exhibits both accretional and erosional features also influenced by coastal rivers. The effects of climate change induced sea level rise (SLR) alone (2.8 to 3.6mm/y from 1993 to 2010) may not be significant, however in combination with high tides (maximum astronomical high tide 1.38m), return period of high waves (2.95m for 50-year return period in rainy season), destructive energy of long distance originated swell waves and geological composition of the coastland (erosion prone sandy coast) makes Liberian coastal area highly vulnerable to climate change. Coastal population growth and coastal urbanization adds additional pressure on the coast by increasing the need for both economic activities and housing.

The CVRA for the Coastal Zone was conducted in 2019 under the NAP (Kalinski, 2019). The information contained in this section is extracted from the study's report. The framework of risk assessment embraces a constructive approach of combining the quantifications of severity of hazards with spatial analysis with respect to potential vulnerable regions on the coast, and can be seen in
*from IPE Global and Trumbic 2018 (Kalinski, 2019).* , while the model used is shown in *Figure 23: Model of Risk Assessment by UNESCO originally from Trumbic 2018* .

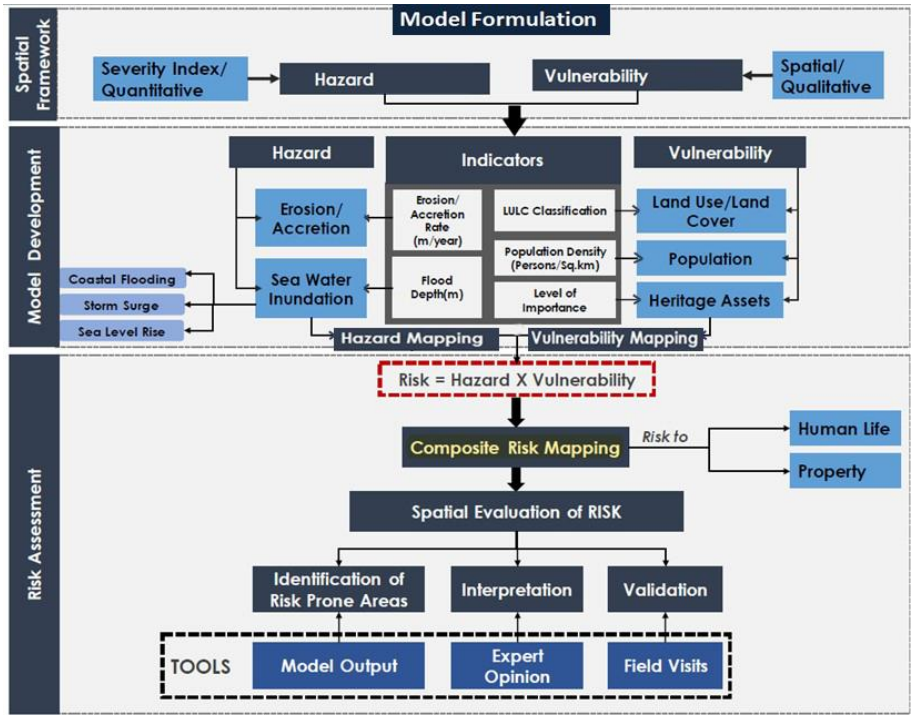



Figure 22 : General framework of Risk Assessment. Modified

*from IPE Global and Trumbic 2018 (Kalinski, 2019).*

The risk assessment was based on two sets of parameters: the hazards (coastal erosion and flooding); and the vulnerability (to the human population, property, and land within the study area) broken up into land use and land cover vulnerability, population vulnerability, and heritage vulnerability. Indexes were determined for each hazard and vulnerability category.

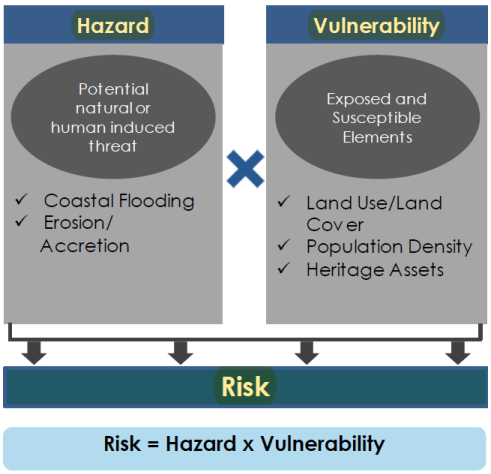



Figure 23: Model of Risk Assessment by UNESCO originally from Trumbic 2018

The study then calculated the cumulative hazard and vulnerability indices respectively, and then determined the composite risk index as the product of the combination of hazard parameters and the combination of vulnerability parameters (factoring in the consequence of their proximity to the coastline) via the formula below:

$$RI = (EHI + SHI)x(\frac{LVI + PVI + HVI}{D})$$

Where:

$RI = Risk\ Index$;

$EHI = Erosion/Accretion\ Hazard\ Index$ ;

$SHI = Sea\ water\ inundation\ Hazard\ Index$;

$LVI = Land\ use/Land\ cover\ Vulnerability\ Index$;

$PVI = Population\ Vulnerability\ Index$;

$HVI = Heritage\ Vulnerability\ Index$; and

$D = Distance\ from\ coastline$.

The coastal zone was defined as an area from coastal line (sea level), up to 25 meters above sea level (masl), which is more less 30km landward into the interior of the country, thus amounting to an area of approximately 16,400 km$^2$. The land vulnerability assessment was conducted for the landward side of the project area through nine coastal counties of Liberia (Grand Cape Mount, Bomi, Montserrado, Grand Bassa, Rivercess, Sinoe, Grand Kru, Maryland).

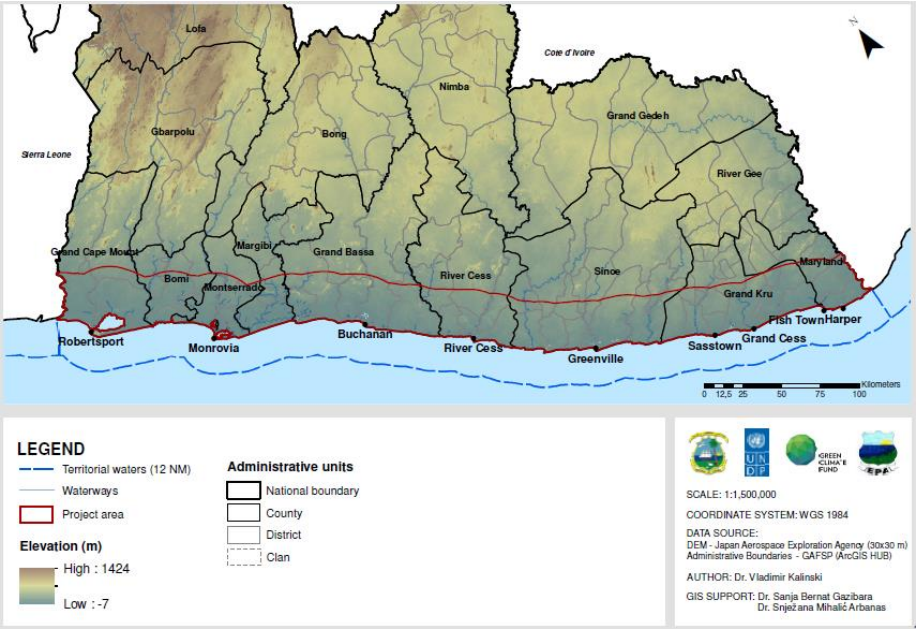



Figure 24: Project area spans over nine coastal counties and from coastal line up to 30km inland.

The erosion rate data is a result of several coastal processes on different time and spatial scales. The data used for this section was provided by (Luijendijk et al., 2018) in their study on the 'State of the World's Beaches'. The data used to calculate the sea water inundation index comprised of the following:

- Data for the 50-year maximum swell wave height and the highest astronomical tide were taken from the National Oceanic and Atmospheric Administration (NOAA)[10].
- The maximum flood level on roads were taken from documented flood level on road around Roberts International Airport area (Smell No Taste, Margibi County) and downtown Harper, Maryland County.
- The SLR value was obtained by taking the maximum SLR projected for 2100 by the IPCC in their 2013 summary for policy makers.
- The Digital Elevation Model (DEM) data used to create the elevation profile was retrieved from the Japan Aerospace Exploration Agency in 30m horizontal resolution and 1m vertical resolution.

To calculate the vulnerability index, land cover and land use maps were obtained from the Liberia Institute of Statistics and Geo-Information Services (LISGIS), and external sources were used in the study. LISGIS also provided the official and projected population data that was used in the study. Information on heritage sites was obtained from the Ministry of Information, Cultural Affairs and Tourism (MICAT).

## 9. Cumulative Hazard

Cumulative hazard represents the product of erosion/accretion hazard and coastal flooding hazard, or in other words, cumulative hazard is a combination of both hazards. If there was any insecurity about hazard levels while observing single hazard components (EHI, SHI), cumulative

[10] USAID (2017). Climate risks in food for peace geographies – Liberia. Climate Risk Profile. URL: https://www.climatelinks.org/sites/default/files/asset/document/20170227_USAID%20ATLAS_Climate%20Risks%20in%20FFP%20Geographies_Liberia.pdf

hazard results show that 6% of total project area, or almost 1,000 km$^2$ is prone to either medium or high hazard *(Figure 25: Left-Cumulative hazard shares. Cumulative hazard distribution per counties. 29)*.

Assessment per counties (*Figure 25: Left-Cumulative hazard shares. Cumulative hazard distribution per counties. 30*) shows similar distribution of medium and high hazard areas in values from 2 to 10%, with Montserrado and Margibi being counties with the highest cumulative hazard level, but others are closely following.

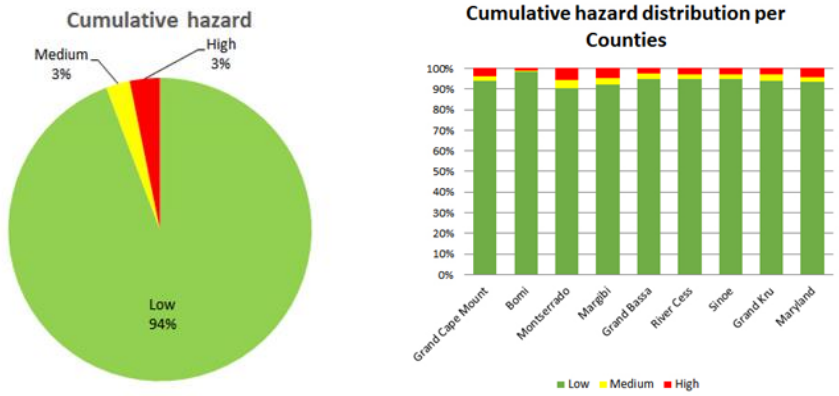



Figure 25: Left-Cumulative hazard shares. Cumulative hazard distribution per counties.

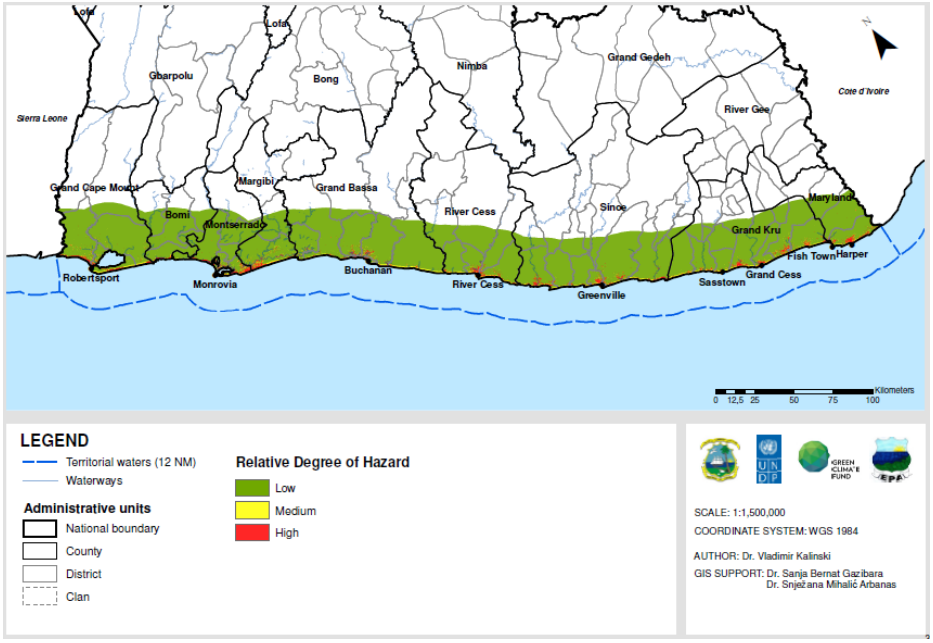



Figure 26: Cumulative hazard map (Kalinski, 2019).

## 10. Composite Vulnerability

Composite vulnerability represents the product of Land use-Land cover vulnerability, Population vulnerability and Heritage vulnerability, and it is inversely proportional to distance from the coastline. Composite vulnerability of the project area exhibits relatively high shares of medium and high vulnerability, 10% and 7%, respectively of the entire project area (*Figure 27: Composite vulnerability of the project area. Composite vulnerability per counties.* ). The highest contributors to such division are certainly Land use/Land cover vulnerabilities and heritage vulnerabilities, while population vulnerability, due to low population density, has contributed with a lesser share.

Considering composite vulnerability per counties (*Figure 27: Composite vulnerability of the project area. Composite vulnerability per counties.* ), the highest composite vulnerabilities can be observed in three northern counties: Grand Cape Mount County due to valuable heritage sites and agriculture; Montserrado County as a result of all three elements of vulnerability (population density is high, agricultural land and heritage sites) and similarly Margibi county.

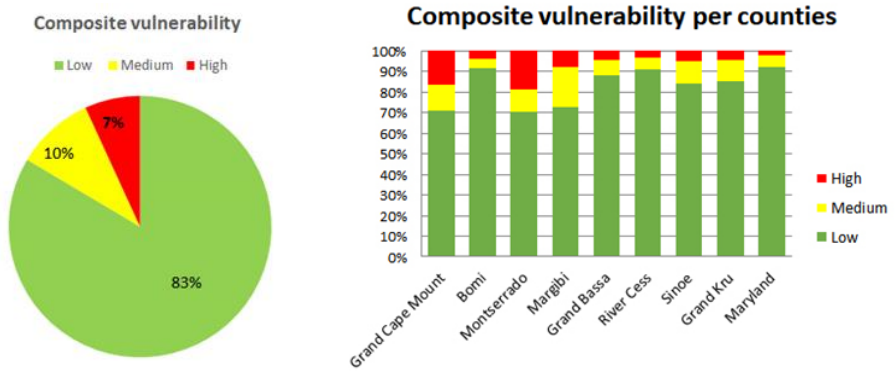



Figure 27: Composite vulnerability of the project area. Composite vulnerability per counties.

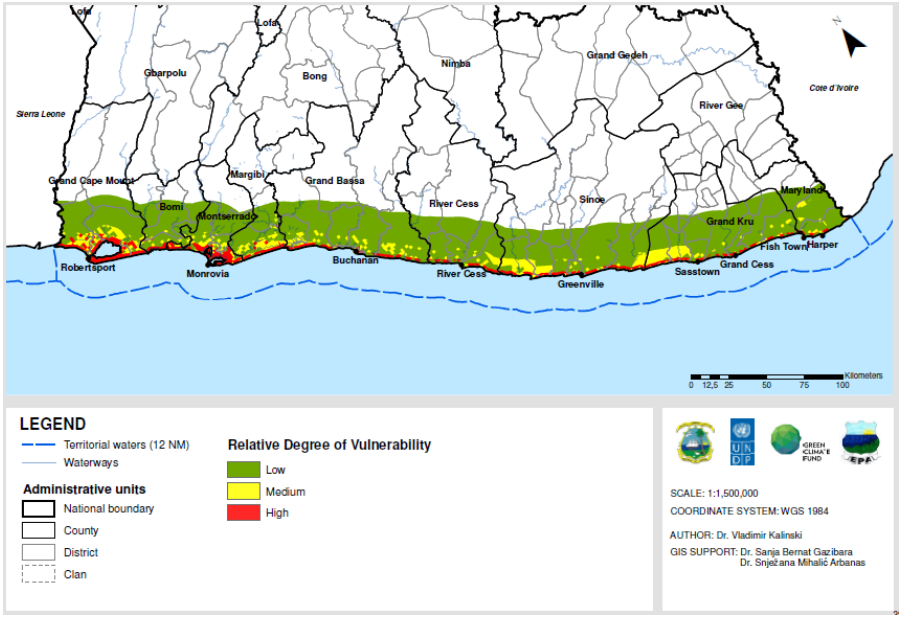



Figure 28: Composite Vulnerability Map (Kalinski, 2019).

## 11. Composite Risk Assessment

The spatial analysis of hazard and vulnerability led to the assessment of overall composite risk for the entire coastal project area. A combination of the hazards – stating severity of impact and the vulnerability status gives clear picture of the "risk zones" which would need priority attention in coastal project planning and management.

Computation of composite risk reveals that around 2,568 square kilometers, which is 16% of the project area, faces the highest level of relative risk, very high (***Error! Reference source not found.***) of getting affected by the coastal hazards and is vulnerable to them, majority of which are in the northern counties of the project area (Montserrado, Grand Cape Mount, and Margibi, **Error! Reference source not found.**). Another 31% of the project area falls under high risk, which is

almost equally distributed (around 30% value) among all counties, with the exception of Margibi County, which has a significantly higher share (50%) of high composite risk. Significant medium risk share (49%) is characterizing Sinoe County. If only high and very high risks are considered, the topmost levels of composite risk can be found in Margibi County, followed by Montserrado and then Grand Cape Mount counties.

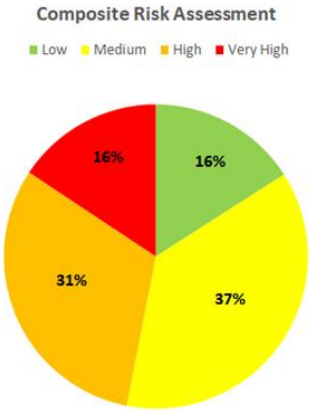



Figure 29 Composite risk shares of project area.

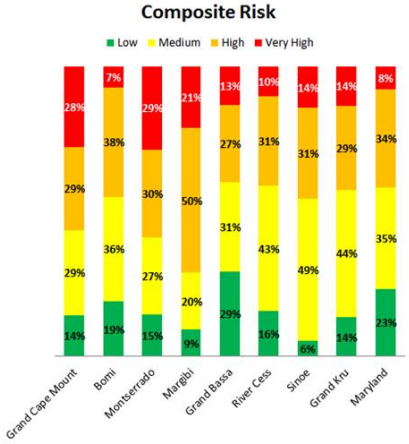



Figure 30 Distribution of composite risk shares across counties

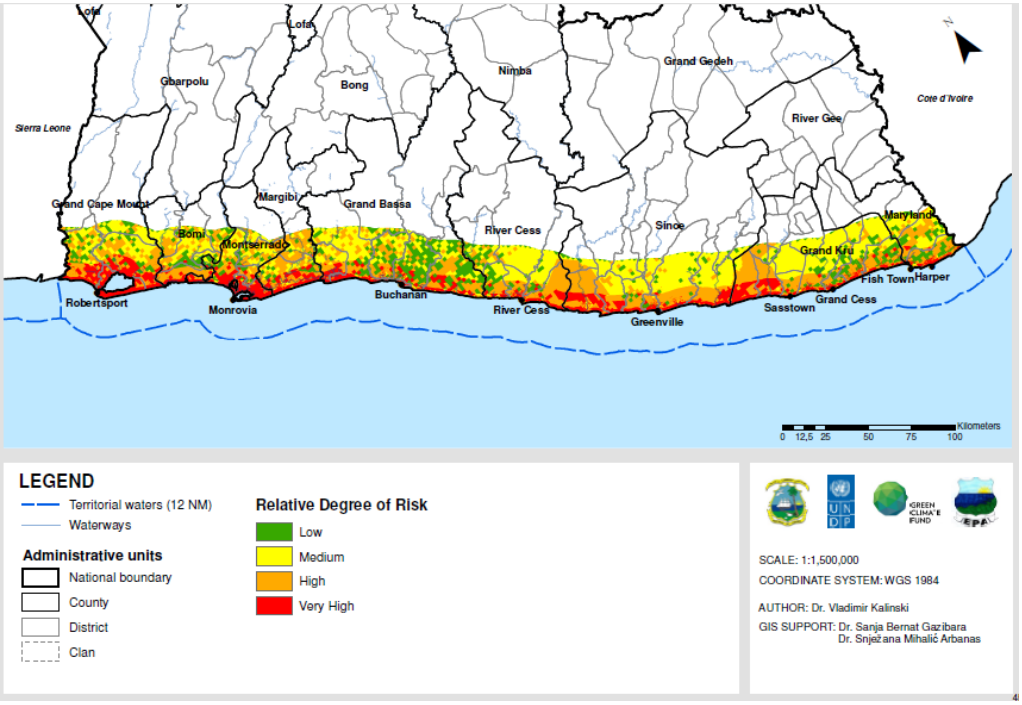



Figure 31 Composite Risk Map (Kalinski, 2019)

## 12. Climate Vulnerability and Risk Assessment for the Waste Management and Energy Sectors of Liberia

This sub-section presents CVRA for the waste and energy sectors. It was informed by a study done in 2020 on two of Liberia's climate-sensitive sectors: Waste Management and Energy (Foday, 2020). It utilized a more qualitative research approach. Primary and secondary qualitative data were gathered via a desk review, including conducting a literature review of relevant published and unpublished documents. This was followed by stakeholder consultations via key informant interviews and focus group discussions. With the information gathered through the aforementioned processes, the assessment analysed climate change and its impacts on Liberia's waste and energy sectors using GIS, which was also used to prepare the vulnerability maps for both sectors. (***Error! Reference source not found.***6*)* shows the conceptual framework used for the study, and illustrates the interaction of both natural climate variability and anthropogenic climate triggering vulnerability and risk, adapted from IPCC and modified for use during the CVRA.

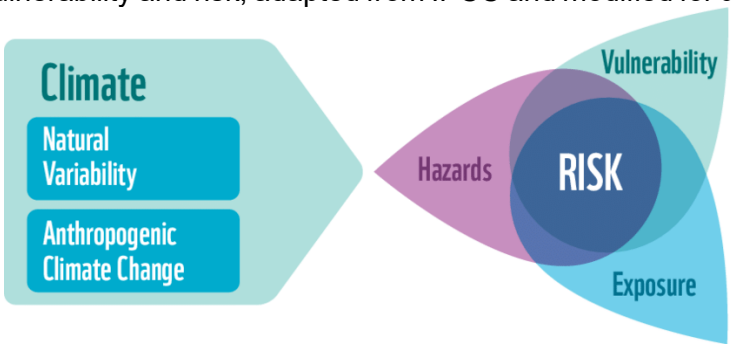



Figure 32 Conceptual framework used for the study (Foday, 2020).

The study encountered major challenges. As a result of limited time and resource constraints for fieldwork, the assessment was carried out in Montserrado County, specifically in the City of Monrovia. Regarding the two (2) sectors under discussion, Monrovia is an ideal representation of Liberia – from a worst-case scenario perspective. This is because the city faces high population density, poor waste management issues, high energy demands and challenges, and high predicted vulnerability to climate change as compared to the rest of the 14 counties. There was also a lack of cooperation from some stakeholders and community members.

## 13. Waste Management

Liberia's waste management sector faces significant vulnerabilities to climate change due to inadequate infrastructure, poor regulation, and limited capacity. Climate projections indicate increased risks from sea-level rise, higher temperatures, and intense precipitation, particularly affecting coastal areas where most of the population resides. These changes threaten waste management and sewage facilities, increasing the risk of water-borne diseases in densely populated communities. Evidence of these impacts is visible in coastal communities like West Point, New Kru Town, and PHP in Monrovia, where infrastructural damage from coastal erosion and flooding has led to problematic practices such as using municipal solid waste for land reclamation. Furthermore, the IPCC (2014b) identifies the waste sector as both vulnerable to and a potential driver of climate change through greenhouse gas emissions from landfills, highlighting the critical need for integrated climate-responsive waste management strategies.

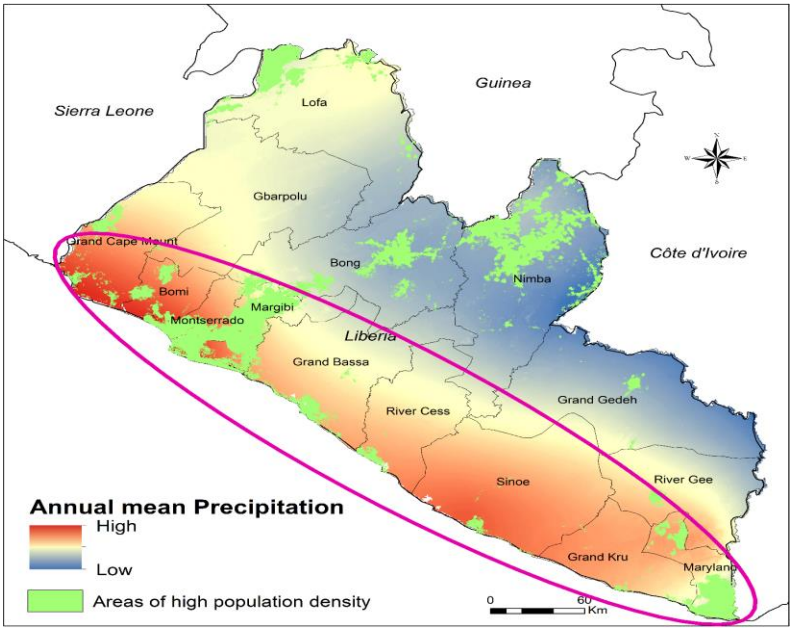



Figure 33 High pop. density areas with high vulnerability to climate change in the waste sector.

*Pink ellipsoid shows coastal towns with high population density prone to increased precipitation (Foday, 2020)*

## 14. Energy

Liberia's energy sector is heavily dependent on biomass, with approximately 95% (World Bank, 2019) of the population relying on firewood and charcoal for cooking and heating, and palm oil for

lighting (EPA, 2020b). As of 2008, electricity access was extremely limited, with only 2% rural and 10% urban population having access through diesel generation (Republic of Liberia, 2008). While the country possesses significant renewable energy potential, including a theoretical hydropower capacity of 4,478 MW from its six major rivers (Mano, Saint Paul, Lofa, Saint John, Cestos, and Cavalla), which drain over 60% of the country's area, the sector remains highly vulnerable to climate change impacts (Kannah, 2019) (ECREEE, 2017) (*Figure 38*).

Key climate vulnerabilities in the energy sector according to Fobissie et al., (2019) include: increased peak electricity demands due to rising temperatures, particularly in urban areas like Monrovia; potential reduction in hydropower generation capacity due to drought conditions, especially in climate hot zones where major rivers originate; impacts on wind and solar potential due to changes in cloud cover, temperature, and pressure patterns; and infrastructure damage from severe weather events affecting transmission lines and power poles. However, there is a positive outlook regarding river discharge, which is expected to increase by 5-10% in the future.

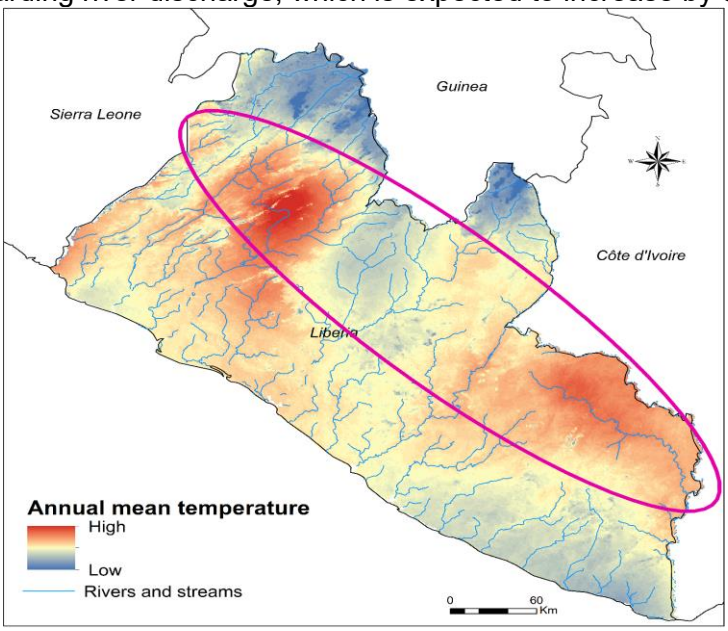



Figure 34 High vulnerability and risk to climate change in the energy sector

*Pink ellipsoid shows inland areas prone to increased temperatures, also corresponding to the origin of major rivers in the country that are used or identified to be used or identified to be used to generate hydro-electric power (Foday, 2020).*

## 15. Climate Vulnerability and Risk Assessment for the Health Sector of Liberia

Climate change has become a major public health threat globally (World Health Organisation, 2023). It impacts human health both directly and indirectly. The health impacts of climate change are primarily found in VBDs, diarrheal diseases, mental illness, malnutrition, cardiorespiratory diseases, and allergies (Watts et al., 2017). According to IPCC's fifth assessment report (AR5), climate change is likely to exacerbate already existing health problems and bring additional impacts on human health causing an increased burden of diseases, and premature deaths (IPCC, 2014a). Furthermore, the adverse impacts of climate change are amplified by factors such as poverty, diseases, and high population density (IPCC, 2023).

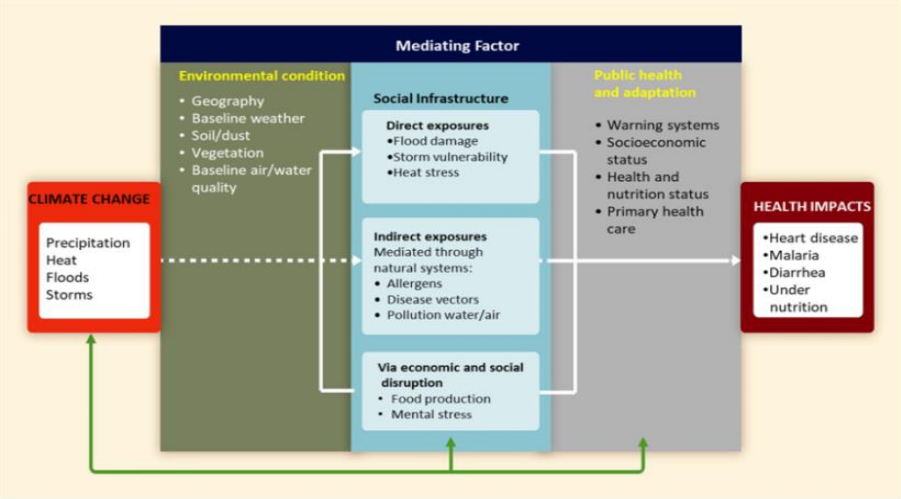



Figure 35: Climate change and health impacts (Dr. Joshi & Dr. Harmon, 2021) (IPCC, 2014b)

Over the years, Liberia has been observing variations in temperature, rainfall, and other extreme weather events. These variations have profound impacts on the seasonal and spatial distribution of Vector-borne diseases and Water-borne diseases (VBDs, WBDs), cardio-respiratory diseases, and malnutrition. As a result, there is an increased reporting of disease cases, disease outbreaks, and emerging and re-emerging diseases in different locations and periods (USAID, 2017).

For context, in Liberia, malaria, respiratory illnesses, diarrhea, tuberculosis, sexually transmitted diseases, worms, skin diseases, malnutrition and anaemia are the most common causes of ill health. Malaria accounts for over 40% of out-patient service attendance and up to 18% of inpatient deaths. Diarrhea diseases in Liberia are the second leading cause of morbidity and mortality (EPA, 2013b).

The CVRA for the health sector was done in 2021 and assessed the climate change vulnerability and risk in the 15 counties of Liberia. A mixed assessment approach was used for climate change risk assessment in health as seen in . The assessment followed the IPCC's vulnerability and risk conceptual framework – defined in its fifth assessment report (IPCC, 2014a), as shown in .

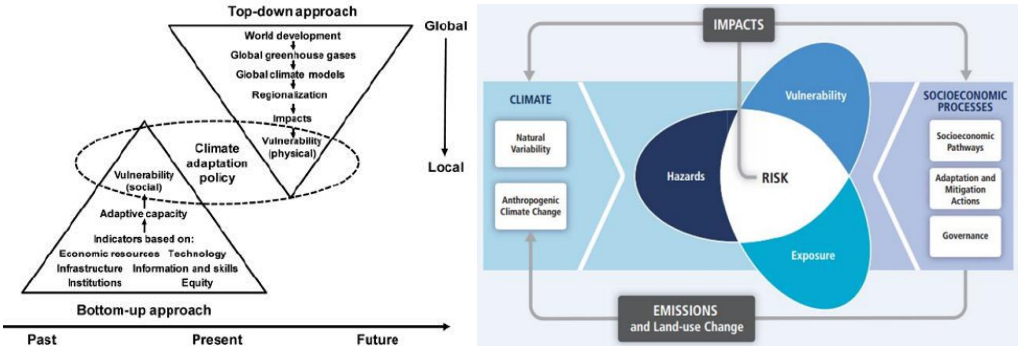



Figure 36 Top-down and bottom-up approaches to inform climate adaptation policy.

Based on the proposed framework of the CVRA, the methodological steps shown in *(Dr. Joshi & Dr. Harmon, 2021).* were utilized to assess hazards, climate vulnerability and risk in the health sector of Liberia. Both quantitative and qualitative data were used for the assessment. The annual data was based on both temporal and spatial extension in counties. The temporal period for climate-sensitive health outcomes was between 2016 to 2020. The remaining sections describe the hazards facing the health sector and the sector's vulnerability – broken up into exposure and sensitivity.

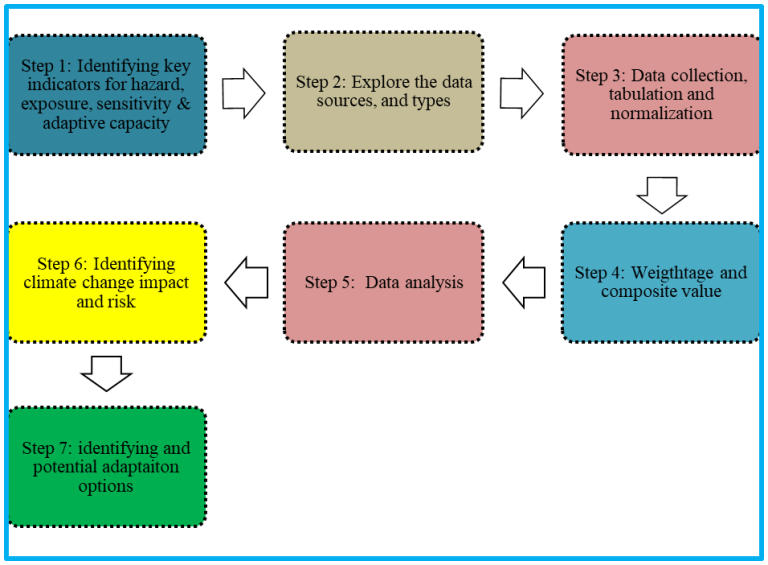



Figure 37: Steps on vulnerability and risk assessments and identifying adaptation options *(Dr. Joshi & Dr. Harmon, 2021).*

## 16. Hazards

Several hazards are affecting Liberia. The most common hazards are epidemics, floods, tropical storms, domestic fire, tidal abnormalities, coastal erosion, and dry spell. Windstorm, flood, coastal erosion, and house fire are four major hazards prevailing in Liberia in terms of the frequency of occurrence (NDMA, 2020). In Liberia, climate change, together with other natural and human-made health stressors, influences human health and diseases in numerous ways. For example, increased flooding and extreme events will also increase the contamination levels of rivers and farms from human waste that brings the increased incidence of water-borne diseases (EPA, 2013b).

In the CRVA, four temperatures-related and four precipitations-related climate extreme events were used to assess the human health risk of climate change in Liberia. The county-specific average climate extreme indices of 2019 and 2020 calculated in this study are given in *Figure 38: Extreme climate indices on health in Liberia (Dr. Joshi & Dr. Harmon, 2021).* .

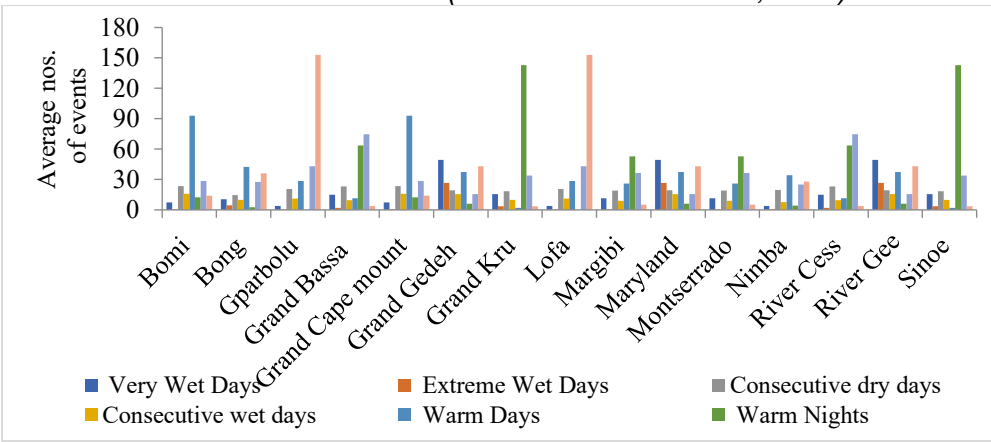



Figure 38: Extreme climate indices on health in Liberia (Dr. Joshi & Dr. Harmon, 2021).

The baseline hazard analysis (*Figure 39: Liberia health hazard (baseline). )* showed that Maryland, Grand Cape Mount, and Lofa Counties have a very high hazard risk, while Margibi, Bong, Nimba, Sinoe, and Grand Kru Counties have a very low hazard risk.


Figure 39: Liberia health hazard (baseline).

It was also observed that most communities in Liberia are hotspots of flood, landslide and coastal erosion, which are major hazards in Liberia. In coastal areas, flooding is associated with a high risk of disease outbreaks (such as cholera, diarrhea, and malaria), food insecurity, drowning, and injuries, damage of dwellings, and even deaths (IFRC, 2021). Flooding across the Country in 2019 directly affected more than 60,000 people (Kalinski, 2019).

## 17. Vulnerability (exposure)

For exposure to vulnerability, it was observed that the total number of healthcare infrastructures such as hospitals, Primary health Care (PHC) level-1 clinics, PHC level-2 clinics, including infrastructures such as water pump indoor and outdoor, public tap, closed well and open well were included in exposure indicators. The index analysis depicts that the highest exposure index value is found in Montserrado, and the lowest index values are found in Gbarpolu, Bomi, Rivercess, Grand Kru and River Gee counties. The exposure rank analysis revealed that Montserrado has very high exposure while Nimba has high exposure.

The distribution of exposure rank index over counties is given in *Figure 40: Distribution of exposure index by county, Liberia (Dr. Joshi & Dr. Harmon, 2021).* .


Figure 40: Distribution of exposure index by county, Liberia (Dr. Joshi & Dr. Harmon, 2021).

Counties with very high exposure have a larger population, a higher number of households, health centers, hospitals, PHC clinics, and a higher number of water infrastructures such as indoor and outdoor pumps, public taps and closed and open wells. The population and both types of infrastructures and services are exposed to climate hazards.

## 18. Vulnerability (sensitivity)

The sensitivity indicators used in the assessment of this study were population (male, female, under 5 years, above 60 years, rural and urban), the population affected from flood, windstorm and coastal erosion, malaria cases including malaria during pregnancy and, under five years, malaria deaths/100,000 population, elephantiasis with lymphoedema, cholera, bronchiolitis, asthma, Respiratory Tract Infection (RTI), pneumonia, hypertension, heart disease, stroke, malnutrition, access to limited drinking water services, unimproved sanitation facility, absolute poverty, number of houses with mud, stick and brick wall, houses made of from tarpaulin, bamboo leaves and thatch, and water infrastructures in rural and urban settings.

The analysis shows that sensitivity varies with demographic characteristics, settlement types, geographical locations, and socio-structural differences. The indexes depict that Montserrado has the highest, and Gbarpolu, Rivercess, Sinoe, Grand Gedeh, River Gee and Grand Kru have the lowest sensitivity score rank (45).


Figure 41: Distribution of sensitivity rank by county of Liberia (Dr. Joshi & Dr. Harmon, 2021).

The county with very high sensitivity, such as Montserrado, has a higher population of males and females under five and in urban areas. Nimba has a higher proportion of residents living in rural areas. Montserrado has higher cases of malaria (including clinically confirmed malaria and malaria in pregnancy), elephantiasis, schistosomiasis, typhoid including enteric fever, diarrheal diseases including cholera, bronchiolitis, Acute Respiratory Infection (ARI), pneumonia, heart diseases and malnutrition, from the Liberia IDSR Epidemiology Bulletin, which covers data from 2016 to 2017.

Montserrado has higher cases of under-five malaria deaths in every 100,000 population, including asthma, hypertension and stroke. The county also has a higher population affected by floods and coastal erosion, while Nimba has a higher population affected by windstorms. The number of houses made from reed, bamboo, grass & mat, and bamboo leaves is higher in Rural Montserrado (LISGIS, 2022). Montserrado has more water infrastructure in rural areas. The groups most vulnerable to climate risks are those that live in coastal areas and whose livelihoods consist of fishing, farming and low-level trading.

## 19. Adaptation Priorities and Barriers

This section focuses on climate change adaptation priority areas of Liberia, and the barriers to implementing adaptation actions/strategies within those areas.

## 20. Priority Areas for Climate Change Adaptation

Vulnerability and adaptation assessments – as summarized in the ***Error! Reference source not found.*** chapter, have revealed that Liberia is faced with climate change and variability, leading to extreme events, which negatively impact key sectors that have already been mentioned in the section on the ***Error! Reference source not found.*** and shown in Table 20.

Table 15: Priority areas for climate change adaptation and cross-cutting sectors in the NAP.

| No. | NAP's Adaptation Priorities | Water resources | Biodiversity |
|---|---|---|---|
| 1 | Agriculture | Water resources | Biodiversity |
| 2 | Fisheries | Water resources | Biodiversity |
| 3 | Forestry | Water resources | Biodiversity |
| 4 | Coastal areas | Water resources | Biodiversity |
| 5 | Waste management | Water resources | Biodiversity |

| | | | |
|---|---|---|---|
| 6 | Energy | Water resources | Biodiversity |
| 7 | Health | Water resources | Biodiversity |

Additionally, analysis of the adaptation strategies used the adaptation policy framework (APF) of Liberia, which recognized four (4) principles that provide the basis from which integrated actions to adapt to climate change were developed. They are as follows:

1. Adaptation to short-term climate variability and extreme events serves as a starting point for reducing vulnerability to longer-term climate change;
2. Adaptation must occur at different levels in society, including the local level;
3. Adaptation policy and measures must be assessed in a development context; and
4. The adaptation strategy and the stakeholder process by which it is implemented must be given equal importance.

Based on this framework and the elements of adaptation strategy, key additional sectors, including cross-sectorial initiatives, were identified, and their corresponding adaptation policy and strategies formulated, even though the CVRAs did not capture them explicitly.

## 21. Adaptation Strategies, Policies, Plans, Goals and Actions to Integrate Adaptation into National Policies and Strategies

Based on the above-mentioned areas listed in Table 15: Priority areas for climate change adaptation and cross-cutting sectors in the NAP. , adaptation targets, actions, and policy measures were agreed upon in the 2021 revision of Liberia's Updated Nationally Determined Contribution (NDC) to the Paris Agreement (EPA, 2021), updating the actions in the 2015 NDC that were captured in the National Adaptation Plan of Liberia for the 2020-2030 period. The adaptation goals and strategies were however extracted from the NPRSCC and updated in the NAP. These strategies, goals, actions, challenges, gaps, and barriers are presented in the Table 22 per priority adaptation area.

Table 16: Adaptation strategies, policies, plans, goals and actions

| **Table 8a: Adaptation strategies, policies, plans, goals and actions**<br><br>**Agriculture** | | | |
|---|---|---|---|
| Adaptation | | | |
| Goal | Strategies | Adaptation Actions and Policy Measures | Challenges, gaps, and barriers to adaptation |
| The aim of an adaptation program for the agriculture sector is to foster a secure environment for decision-making on the part of farmers and public policy managers faced with climatic uncertainties through efficient access to information, technologies, and production processes to establish sustainable production systems. | • Strengthen the capacity of the Ministry of Agriculture, including training of experts, logistics, and use of technology for the management of the sector.<br>• Improve the effectiveness of pest, disease, and weed management practices through the broader use of integrated pest and pathogen management development and varieties and species resistant to pests and diseases and improving quarantine capabilities and monitoring programmes.<br>• Assess crops vulnerability and suitability (cropping pattern) for different Agroecological zones.<br>• Enhance climate-proof agro-infrastructural systems that strengthen the capacity of local farmers to increase productivity.<br>• Support communities in livestock and crop sectors by inventorying and disseminating indigenous knowledge, establishing and/or strengthening insurance schemes, early warning, early action system, vaccination campaign, disease control, etc., to cope with the stress based on climate variability.<br>• Develop and introduce a diverse range of integrated Soil fertility management | • Increase training and capacity building of farmers and agricultural extension agents to implement climate adaptation actions in the agriculture ands livestock sectors, especially by increasing support for education and training on agricultural climate risks and adaptation solutions for vulnerable groups<br>○ Establish 100 farmer field schools and train 5,000 farmers in climate-resilient agricultural and livestock practices by 2025 (Linked to Mitigation target)<br>○ Train 150 agricultural extension agents per year to support implementation of climate-resilient agricultural and livestock practices, with 45 agents receiving additional support for increased implementation with vulnerable groups by 2025 (Linked to Mitigation target)<br>○ Roll out a “Women in Agriculture” program with 4 training sessions per year (with at least 45 women trained per year) to support implementation of climate-resilient agricultural and livestock practices and increase women’s access to agricultural inputs and labor-saving devices by 2025<br>• Increase finance for agriculture and livestock diversification by $3,000,000 dollars by 2025.<br>• Strengthen the Environmental Knowledge Management System platform to increase the integration of local and indigenous knowledge of climate-resilient agricultural and livestock practices by 2025. | • Awareness<br>• Capacity building<br>• Technology<br>• Research |

| **Table 8a: Adaptation strategies, policies, plans, goals and actions**<br><br>**Agriculture** | | | |
|---|---|---|---|
| | (SFM), water harvesting, and conservation techniques to farmers as a sustainable means of improving soil fertility, intensifying agricultural production, and coping with extreme conditions (aridity, waterlogging, flood, etc.)<br>• Strengthen the Central Agricultural Research Institute (CARI) capacity for research development of climate smart agriculture initiates in Liberia, including the setting up of seed banks and soil management, crop diversification, immigration, improved livestock breeds, etc.<br>• Develop and implement agriculture technologies and methodologies, including hydrological technology models and scenarios for planning and ensure its promotion through agricultural programmes by considering social-economic and gender differences.<br>• Develop climate-resilient crops, promote drought – resistant, flood-tolerant, and establishing gene bank of climate-resilient varieties of indigenous food crops (NDC, 2015)<br>• Develop and support coping strategies such as irrigation infrastructure, intercropping, aquaculture, climate-resilient plant varieties to support the farming system and encourage farmers to engage in them.<br>• Promote the development of sustainable livestock programmes for farmers, including grazing management systems. Livelihood diversification (bee harvesting, rabbit, guinea fowl, and indigenous | • Establish or strengthen crop and livestock insurance systems by 2025<br>• Strengthen agricultural climate services and early warning systems by 2025.<br>• Develop national dietary guidelines to support climate-resilient, food secure livelihoods by 2025 (Linked to Health sector)<br>• Establish a national research institution focusing on new climate smart seed varieties and improving livestock breeding by 2030 | |

| **Table 8a: Adaptation strategies, policies, plans, goals and actions**<br><br>**Agriculture** | | | |
|---|---|---|---|
| | poultry) and breeding animals to adapt to climate change.<br>• Develop a communication strategy to increase farmers' awareness of climate change and strengthen the coordination of existing structures and institutions available to help them adapt to its impact. | | |

Table 8b: Fisheries

| **Adaptation** | | | |
|---|---|---|---|
| Goal | Strategies | Adaptation Actions and Policy Measures | Challenges, gaps, and barriers to adaptation |
| To reduce climate-induced changes in the ecosystems that support the fisheries sector. | • Strengthen the capacity of the Bureau of National Fisheries, including staffing and logistics for research monitoring and enforcement.<br>• Invest in and support artisanal fishing communities, including training, fishing gear, and alternative livelihoods.<br>• Set up robust monitoring, reporting, and verification system that captures and reports timely and accurate changes in the stock of productivity and pressure on fisheries; and implement adaptive management practices for managing the sector.<br>• Support research to fully understand pressures on fisheries related to climate change impacts and identify appropriate measures, including diversification of livelihood portfolio of fishery-dependent communities.<br>• Identify, map, and protect areas valuable for fisheries (e.g., deep pools in river systems that serve as spawning areas), including the setting up of marine protected areas.<br>• Support the establishment of a system to reduce external stressors on fisheries by instituting changes in a vessel or gear types as well as | • Identify endangered and vulnerable fish species, map the areas valuable for their protection, and work with fishery communities to create multiple-use conservation areas and/or Marine Protected Areas to improve their ability to survive the impacts of climate change (link with coastal zones sector)<br>• Strengthen the capacity of the National Fisheries and Aquaculture Authority, including manpower development, logistics, and training in adaptive management; research funding; and set up a robust monitoring, reporting and verification system that captures and reports in a timely and accurate manner changes in the stock of productivity and pressure in fisheries, including climate-related impacts<br>○ Increase funding by $1.5 million dollars per year for research on climate-related pressures on fisheries and appropriate climate adaptation solutions in the fisheries sector, including on alternative approaches to the traditional way of using mangroves for smoking fish by 2030 – Conditional on international support<br>○ Implement 20 trainings (2 per year) for fishery managers to learn and implement adaptive management practices by 2030 | • Capacity building<br>• Technology |

| Adaptation | | | |
|---|---|---|---|
| | instituting actions and regulatory measures to reduce land-based sources of pollution (e.g., agricultural, and urban runoff) and destructive fishing practices (e.g., fishing with explosives and poisons).<br>• Integrate fisheries fully into climate change adaptation and food security policies at the national level (draft and enact where non-existent) to ensure incorporation into broader development planning.<br>• Support the diversification of the livelihood portfolio of fishery-dependent communities.<br>• Support the establishment of early warning systems to identify probable threats and risks related to fisheries.<br>• Support the establishment of improved information and communication networks for decision making and planning and between fishing communities to support information sharing about potential shocks in the system.<br>• Establish a monitoring system for fishery management and climate change<br>• Establish a surveillance system to promote a smart fishery system (NAPA, 2008)<br>• Promote sustainable fishing practices and policies Regulate fishing practices to prevent overexploitation and fishing in restricted areas (NAPA, 2008) Conduct capacity building among the sector | • Invest in marine store and tracking systems for artisanal fisher communities, including the provision of training, fishing gears and alternative livelihoods.<br>○ Conduct 1 training per year with artisanal fishers, fishmongers, and fish processors, especially women, on sustainable fishery and fish handling practices by 2030<br>• Integrate fisheries fully into climate change adaptation and food security policies at the national level by 2025 (Link to Agriculture and Health sectors)<br>• Develop and implement climate smart fishery management systems to enhance the adaptive capacity and resilience of fisher communities, including technical support and backstopping for artisanal fishing cooperatives and extension services by 2030<br>• Increase capacity building of women involved in marketing & smoking of fish and wider community engagement to promote conservation of mangroves (e.g., introduce alternative approaches to smoking fish) by 2025 (Link to Forest sector)<br>• Strengthen effective early warning systems to identify probable threats and risks related to fisheries by 2025<br>• Establish a fisheries program at the University of Liberia by 2025<br>• Establish five (5) artisanal fish landing and processing centers in the Mesurado basin by 2025<br>• Develop an awareness program in schools within coastal counties to promote climate-smart fisheries and mangrove conservation by 2025<br>• Support the establishment of improved information and communication networks among and between fishing communities by launching information, education and communication campaigns and conducting public awareness on fisheries policy and education on threats and risks in the sector by 2025<br>• Setup an inter-ministerial national task force to reduce both land- and water-based sources of pollution (e.g., agricultural, and urban runoff; boat effluent) and | |

| Adaptation | | | |
|---|---|---|---|
| | | destructive fishing practices (e.g., fishing with explosives and poisons) by 2025<br>• Improve national systems for monitoring and tracking fishing vessels by 2030<br>• Reduce threats from illegal, unreported, and unregulated (IUU) fishing by purchasing necessary equipment, launching coordinated surveillance, and monitoring operations, and launching public communications campaigns about the risks and impacts of IUU fishing by 2030 | |

Table 8c: Forestry

| Adaptation | | | |
|---|---|---|---|
| Goal | Strategies | Adaptation Actions and Policy Measures | Challenges, gaps, and barriers to adaptation |
| To reduce risk and climate change vulnerabilities of the sector implementing strategies | • Strengthen the capacity of the FDA, including training of experts and logistics for forest management<br>• Implement sustainable and, where applicable alternative livelihood initiatives for forest-dependent communities; to enable them to become less reliant on forest resources;<br>• Promote community forest activities beyond timber extraction as a management tool for sustainable forest using indigenous species and knowledge.<br>• Establish a comprehensive monitoring system for forest resources by building on existing systems (including non-timber forest products) to detect changes in the conditions of the ecosystem services provided by forests.<br>• Implement reforestation and afforestation activities in degraded areas, increase rural income, and improve biodiversity richness, including wild fauna. | • Develop training, capacity building, and strategic communications plans for forestry authorities and forest communities to implement climate adaptation actions in the forest sector, especially by increasing support for education and training on climate risks and adaptation solutions for vulnerable groups<br>• Conduct 20 trainings with forestry authorities and forest-dependent communities on climate-related risks, adaptation solutions and adaptive forest management practices, with strategic messaging for communities about incentives and opportunities to enhance their resiliency to climate change at the household and community level by 2025 (Linked to Mitigation target)<br>• Encourage sustainable fuelwood/charcoal production with alternative domestic energy options by 2025 (Link to Health sector)<br>• Implement an effective benefit-sharing mechanism for forest communities by 2030<br>• Increase funding for research on adaptive forest management solutions by 2025 | • Capacity building<br>• Technology<br>• Finance |

| Adaptation | | | |
|---|---|---|---|
| | • Identify and map for proper management of water catchment areas in forests that are valuable to communities.<br>• Promote the consolidation of protected area network by considering landscape approach, ensuring that it consists of a large spectrum of forest types across various environmental gradients and enhance connectivity between habitats.<br>• Establish and/or strengthen coordination mechanisms with other line ministries and agencies that might implement activities that affect forest and wildlife and ensure that the principle of sustainable forest and wildlife management is mainstreamed in national and sectoral policies and programmes.<br>• Enforce regulations related to illegal hunting to eliminate poaching and implement an environmental 'Code of/ethics in the wildlife sector.<br>• Develop and implement a communication strategy to increase the awareness of relevant stakeholders, particularly forest-dependent communities, about the impact of climate change and how they can adapt to these changes | • Develop an adaptive forestry management and conservation plan to prevent poaching, anthropogenic forest fire, land conversion, invasive species, and diseases, including training/capacity building by 2030 | |

Table 8d: Coastal Areas

| **Adaptation** | | | |
|---|---|---|---|
| Goal | Strategies | Adaptation Actions and Policy Measures | Challenges, gaps, and barriers to adaptation |
| The development of the strategic plan for the sector to reduce the risk and vulnerability of climate change impacts the coastal sector and disseminate information on the climate change process around the sector. | • Develop and implement coastal zone policy, design, and management plan<br>• Assess and build the capacity of agencies and managers responsible for managing coastal adaptive capacity in the sector.<br>• Develop an integrated management plan for coastal zone management as well as an early warning system that includes training and capacity development for coastal management and monitoring<br>• Promote and implement disaster risk management in general (especially disaster preparedness).<br>• Support the rehabilitation and protection of wetlands and mangroves, including awareness and education of their host communities.<br>• Develop and implement a program for climate-proofing new investments in infrastructure (roads, sewers, water supplies, and other infrastructure) in coastal settlements and rural areas to protect continuous access to livelihoods, health care, and education.<br>• Design and implement a strategic communication action plan to inform and educate people about changes and challenges associated with coastal areas related to climate change and how they can adapt to cope with these changes and challenges.<br>• Construct sea walls or revetment | • Develop training, capacity building, and strategic communications plans for coastal managers and communities to implement coastal adaptation actions, especially by increasing support for education and training on climate risks and adaptation solutions for vulnerable groups<br>• Conduct 22 training sessions with coastal managers and communities on climate-related risks, adaptation solutions, adaptive coastal management practices, and climate-smart infrastructure development, with strategic messaging for communities about incentives and opportunities to enhance their resiliency to climate change at the household and community level by 2025<br>• Develop a strategic communications plan to educate and disseminate adaptation actions via awareness programmes, establishment of research & innovation centers within coastal communities, development of multi-stakeholder platforms for information sharing with regular/timely updates etc. by 2025<br>• Invest in coastal zone monitoring equipment for data collection, research, and management purposes by 2030<br>• Develop and support coastal and marine research project proposals, initiatives, and activities, and increase funding for research on adaptive coastal management solutions and access to research opportunities by 2030 | • Capacity building<br>• Information dissemination (awareness)<br>• Technology |

Table 8e: Waste Management

| Adaptation | | | |
|---|---|---|---|
| Goal | Strategies | Adaptation Actions and Policy Measures | Challenges, gaps, and barriers to adaptation |
| To reduce climate change vulnerability and risk factors relating to the emission of greenhouse gases from waste disposal. | • Strengthen capacity at the community and institutional level for integrated waste management.<br>• Develop an integrated waste management strategy and system for all types of waste, assigning priority to prevent waste generation with nationally appropriate low greenhouse gas emission technologies that are well managed and compatible with methane capture and use for electricity generation.<br>• Promote private-public partnership (PPP) and other ventures that attract financing for infrastructure investments in the waste sector.<br>• Design and implement a system to run urban waste into input for agricultural production through composting waste for use in food security programmes in the urban (urban agriculture) and rural areas.<br>• Develop landfills for all major cities and use the Clean Development Mechanism (CDM) and Nationally Appropriate Mitigation Actions (NAMAs)to develop methane recovery and power generation projects in landfills. | • Provide technical/logistical support for<br>○ Reduce risk of waste bags sitting at the curbside for too long and being carried away into streets or waterways by heavy rainfall, heavy wind or landslides or snow by implementing frequent collection at scheduled times (based on extreme weather forecasts)<br>○ Avoid insects, pests (as well as risk of waste bags being carried away by extreme events) by a proper scheduling collection (Link to Health sector).<br>○ Ensure waste transfer stations, disposal sites and storage areas are elevated and safe from floods, for example avoiding flood plains (low-lying near rivers or coastal areas) and develop adaptation plans for established sites located in flood areas (Link to Coastal zones sector).<br>• Strengthening of the institutional and legal situation at national and municipal levels by 2025.<br>• Include in the sectoral strategies and policies at the national level climate adaptation strategies and policies. | • Technology<br>• Capacity Building<br>• Finance<br>• Research |

Table 8f: Energy

| Adaptation | | | |
|---|---|---|---|
| Goal | Strategies | Adaptation Actions and Policy Measures | Challenges, gaps, and barriers to adaptation |
| The strategy will reduce the risk and vulnerability of climate change impacts on the energy sector, thereby sustaining energy production. | • Establish and promote a robust national program on solar energy (e.g., hybrid systems, installation of solar panels, promotion of solar street lighting, etc.) and other energy-efficient lighting technologies. | • Improve the policy making capacity with better cross sector coordination and implementation with focus low carbon enabling investments<br>○ Include mainstreaming activities to improve the energy sector strategies | • Capacity building<br>• Research<br>• Technology |

| Adaptation | | | |
|---|---|---|---|
| | • Support the provision of energy-efficient technologies such as energy-efficient bulbs to provide power and lighting for schools and other public institutions and households as a means of enhancing or introducing energy-efficient technologies.<br>• Support the promotion and implementation of energy plantation schemes to minimize natural forest pressure and reduce energy stress.<br>• Develop a system to regulate the sustainable use of biomass energy.<br>• Promote and support the development and utilization of community-based off-grid/mini-grids.<br>• Conservation and protection of water catchments, including around hydro-power and municipal water supply sources.<br>• Prevent sedimentation that could hinder the production of energy in hydroelectric facilities<br>• Enhance implementation of an energy generation mix plan that increases the resilience of the current and future energy systems to the impacts of future climate variability and change.<br>• Establish Protection of water catchment around hydropower sources | and policies at the national level with climate adaptation strategies and policies<br>• Support the implementation of a full de-regulation of the electricity sector (into independent transmission, distribution, and generator subsectors) with accurate costs, and tariffs<br>• Improve the adaptation capacity of the most vulnerable since access to reliable and affordable electricity provides social and economic development | • Financing |

Table 8g: Health

| Adaptation | | | |
|---|---|---|---|
| Goal | Strategies | Adaptation Actions and Policy Measures | Challenges, gaps, and barriers to adaptation |
| Strengthen the capacity of the health infrastructure and systems to achieve the objectives of the National Health and Social Welfare Policy and Plan, the Public Health Law and the SDGs 3 (good health) in the face of climate change and its risks. | • Integrate climate change considerations into existing health policies and strategies, taking into account gender-differentiated impacts and responses.<br>• Strengthen the integrated disease surveillance response systems and the emergency preparedness to prevent, mitigate, and respond to climate induced epidemics.<br>• Strengthen preventive measures to restrict preventable disease transmission.<br>• Develop early warning systems for climate-driven infectious diseases.<br>• Improve community-level health care and the dissemination of information on changing health risks to enhance the response to climate-related diseases.<br>• Increase access to safe water in order to improve disease vector control10.<br>• Conduct research on health vulnerability and impact, and develop scenarios to facilitate adequate planning.<br>• In a low carbon action, promote the use of water filters that provide access to clean water while reducing demand for firewood used to boil water and therefore slowing deforestation.<br>• Conduct periodic health Impact assessments on proposed mitigation and adaptation | • Establish 425 community health clubs to improve community-level health care and disseminate information on changing health risks to enhance the response to climate-related diseases by 2030<br>• Increase funding by $500,000 per year for research on climate-health nexus, including on the increased health vulnerabilities caused by climate change, the temporal, spatial and spectral aspects of meteorological data needed for healthcare purposes, and on the quality, level, and detail of healthcare data required for disease modelling to develop adequate response measures by 2030<br>• Promote household and community-level adoption of practices that improve air quality, improve water safety and reduce the risk of disease transmission, while also reducing fuelwood use, such as water filters and improved cookstoves (Link to Forest and Agriculture sectors)<br>• Conduct 40 training sessions on health risks of using firewood and other climate-related health risks by 2030 (Link to Forest sector)<br>• Provide at least 170 water safety and purification kits to rural communities by 2030<br>• Develop climate health hazards risk mapping and area-based scenario planning for responding to climate health hazards and improve disease surveillance systems, preparedness and response capacity for the health consequences of climate change (e.g., heat-related illness, infectious diseases, malnutrition, natural disasters, mental health, forced migration, chronic disease) by 2025<br>• Mobilize and sustain financial resources for national level engagement of the health sector that ensures project implementation by 2025 | • Non-climate resilient health system<br>• Underperforming service delivery regarding climate-sensitive diseases<br>• Capacity enhancement<br>• Limited scope of vulnerability and risk assessment<br>• Investment in research and evidence generation<br>• Data gaps in health, infrastructure, water, sanitation and hygiene<br>• Data gaps in meteorology and hydrology; insufficient inter-sectoral collaboration |

| Adaptation | | | |
|---|---|---|---|
| | strategies to determine impacts on vulnerable populations and cumulative health impacts. | | |

## 22. Adaptation Challenges, Barriers, and Gaps

The NAP process developed sectoral and thematic strategies for each of the six (6) climate-sensitive sectors. However, significant bottlenecks or adaptation barriers identified from the context of climate risk management were as follows:

- Information and knowledge gaps relating to exposure and sensitivity of human, productive, and infrastructure systems to climate change;
- Identification and spacing of the potential impacts of climate change on Liberian national territory; and
- Decentralized dissemination of climate data and information in plainly understandable language.

## 23. Domestic Priorities and Progress Towards Those Priorities

The actions proposed in the NAP are meant to complement or upscale adaptation actions ongoing through various projects and the program being implemented by the nation and county governments, civil society, private sector, and academia; and not duplicate ongoing efforts.
Priority area-specific gaps which the strategies stipulated in the NAP are expected to address can be seen in *Table 22*.

Table 17: Gaps identified that may inhibit adaptation processes

| No. | Adaptation Priority Area | Gaps |
|---|---|---|
| **1** | Agriculture sector | • Awareness<br>• Capacity building<br>• Technology<br>• Research |
| **2** | Fisheries sector | • Capacity building<br>• Technology |
| **3** | Forestry sector | • Capacity building<br>• Technology<br>• Finance |
| **4** | Coastal Zone sector | • Capacity building<br>• Information dissemination (awareness)<br>• Technology |
| **5** | Waste Management sector | • Technology<br>• Capacity Building<br>• Finance<br>• Research |
| **6** | Energy sector | • Capacity building<br>• Research<br>• Technology<br>• Financing |

| No. | Adaptation Priority Area | Gaps |
|---|---|---|
| **7** | Health sector | • Non-climate resilient health system<br>• Underperforming service delivery regarding climate-sensitive diseases<br>• Capacity enhancement<br>• Limited scope of vulnerability and risk assessment<br>• Investment in research and evidence generation<br>• Data gaps in health, infrastructure, water, sanitation and hygiene<br>• Data gaps in meteorology and hydrology; insufficient inter-sectoral collaboration |

# L. Progress on Implementation of Adaptation Actions; Effectiveness of Adaptation Actions; Monitoring and Evaluation of Adaptation Actions and Processes

### 3.3 Introduction

This section provides a summary account of the progress made with regards to the implementation efforts from 2019-2022 with regards to national adaptation actions, plans, goals, needs, strategies and measures, policy frameworks (e.g. national adaptation plans & NDC), and other relevant information as appropriate. In this regard, Liberia's most recent climate change documents, the First Adaptation Communication (ADCOM, 2021), the SNC (2021), the NAP (2020-2030), and the revised NDC (2021) have identified "Agriculture, Forestry, Coastal zones, Fisheries and Health" as the key national priority sectors for climate change adaptation. As such, the national implementation adaptation plan efforts focused on the identified five key adaptation sectors.

**1. Implementation of Adaptation Actions and the Effectiveness of These Actions**

Liberia has identified and continues to implement several adaptation efforts and initiatives to address the severe impacts of climate change. These impacts are disrupting livelihood activities, destroying unique ecosystems, destabilizing socio-economic activities, and accelerating environmental degradation. Additional adaptation efforts and initiatives are documented in Liberia's First Adaptation Communication to the UNFCCC (AdCom, 2021). Table 10 describes the implementation of different adaptation actions in the country and further details the effectiveness of these actions.

Table 18: Implementation of Projects/ programs for adaptation actions

| Agriculture Sector | | | |
|---|---|---|---|
| **Project title** | | **Description and relation to climate change adaptation** | **Project circle & status** |
| 1 | Smallholder Agriculture Development for Food and Nutrition Security (SADFONS) | The objective of the SADFONS is to improve food and nutrition security and reduce the poverty of targeted rural populations in Liberia.<br>1. Support to enhancing smallholder agricultural productivity and market access;<br>2. Institutional Strengthening and Capacity Building;<br>3. Project management and coordination;<br>Implemented by the ministry of Agriculture, the project is a 100% grant of $ 9.08 Million USD from the<br>Global Agriculture and Food Security Program (GAFSP), African Development Bank (AfDB) and the Government of Liberia.<br>Targeted beneficiaries: 41,174 Household (30,000 = children school going age; female = 4,469 and male = 6,705). | 2021 to 2026: ongoing |
| 2 | Rural Economic Transformation Project (RETRAP) | Object of the RETRAP is to improve productivity and market access for smallholder farmers and agri-enterprises for selected value chains in project participating counties.<br>1. Improve the enabling environment for agricultural development;<br>2. Competitiveness and market access through Productive Alliances<br>3. Farm to Market Roads and Logistics Centers<br>4. Support Food Security<br>Implemented by the ministry of Agriculture, the project is a 100% loan of $ 85 Million USD from the World Bank, International Development Association.<br>Targeted beneficiaries: 60, 000 household; (30,000 females; 30,000 male) | 2021 to 2026: ongoing |
| 3 | Building Climate Resilience Project (BCRP) | Objective of the BCRP is to promote agriculture as a business for enhanced income and poverty reduction.<br>1. Climate-proofed Agriculture Production and post-harvest combined with Livelihood Diversification;<br>2. Climate Resilient Rural Infrastructure;<br>3. Institutional Capacity Development<br>Implemented by the ministry of Agriculture, the BCRP is a 100% Grant of $8.8 Million USD from the International Fund for Agriculture Development and Adaptation Fund.<br>Targeted beneficiaries: 25, 000 (female = 10,000; male = 15, 000). | 2019 to 2026: ongoing |
| 4 | Smallholder Agriculture Transformation and Agribusiness Revitalization Project (STAR-P) | The project development objective is to increase agricultural productivity and promote commercialization of smallholder farmers through productive linkages between the farmers and the private agribusiness firms in selected value chains of Liberia.<br>1. Institutional Capacity Building and Strengthening the Enabling; Environment for Farmers, State and non-state Actors;<br>2. Enhancing Productivity and Competitiveness; | 2019 to 2029: ongoing |

| Agriculture Sector | | | |
|---|---|---|---|
| | | 3. Project Management, Monitoring and Evaluation, Citizen Engagement and Contingency Emergency;<br>Implemented by the ministry of Agriculture, the project is a 100% loan of $25 Million USD. | |
| 5 | VOSIEDA Climate Smart Agriculture for Resilience and Livelihood Support | This project is aimed at facilitating climate-smart agriculture techniques that empower smallholder farmers, mainly women, and youths, to employ sustainable and regenerative farming practices in rural Liberia. The overall project goal is to strengthen rural communities' resilience to climate change impact through small-scale agricultural practices that promotes sustainable productivity and reduced agricultural sector greenhouse gas (GHG) emissions. The objectives are:<br>1. Increase agricultural productivity and income of smallholders in a sustainable way;<br>2. Reduce agriculture based GHG emissions;<br>3. To promote adaptation to farming practices that are climate resilient and climate friendly;<br>4. To increase knowledge and awareness of rural farmers on triple win principle of farming methods productivity, resilience, and reduced emissions in Liberia;<br>5. Contribute to reduced incidence of rural poverty amongst the most vulnerable populations to climate change.<br>Implemented by "Volunteers for Sustainable Development in Africa" (VOSIEDA), the project is a 100% grant of $1.8 Million USD from the government and people of Sweden.<br>Targeted beneficiaries: A total of 34 farmer groups, comprising 2,040 individual farmers, were set up across four (4) political districts in Nimba County. This represents a total of 8,160 households, taking an average household size of 4 people. A total of 70 farmer groups are to be set up as per the project plan. | 2022 to 2026: ongoing |
| 6 | Smallholder Agricultural Productivity Enhancement and Commercialization Project (SAPEC) | The SAPEC was a GAFSP finances $46.5 million project to enhance the income of smallholder farmers, particularly women, and youth, through sustainable land expansion and land improvement, increased market access, and strengthened institutional capacities. SAPEC aims to transform Liberia's agriculture sector, which is dominated by traditional subsistence farming systems and is characterized by labor-intensive shifting cultivation and low technologies that result in low productivity.<br>As of December 2020, the project has reached 151,312 people and 43 producer-based organisations in total. Specifically, SAPEC has provided 18,040 hectares of land with improved production support; 36,844 smallholders with productivity enhancement support, 55,266 people with improved nutrition services and products, 37,055 people with direct employment, and 3,519 people with capacity building support. The project also has constructed or rehabilitated 163 kilometers of roads and nine post-harvest facilities. Further, in the last six months of 2020, the project's Sustainable Crop Production Intensification component rehabilitated 290 hectares of lowlands and constructed seven head dams; more than 140 diversion boxes are ongoing. | 2010 to 2020: Completed |

| | | | |
|---|---|---|---|
| **Agriculture Sector** | | | |
| 7 | Building Climate Resilience Project (BCRP) | Funded by the IFAD's & Adaptation Fund of US$8.84 million grant; the BCRP is being executed by the Ministry of Agriculture and supervised by the International Fund for Agricultural Development (IFAD). The project aims at promoting agriculture as a business for enhanced incomes and reduced rural poverty in Bong County of Liberia.<br>Beneficiaries: 25,000 beneficiaries including 10,000 rice producers, 10,000 cocoa producers and 5,000 smallholder farmers from other enterprises of which at least 40% will be women and 40% young people.<br>Project Components:<br>1. Climate-Proofed Agricultural Production and Post-Harvest Combined with Livelihood Diversification;<br>2. Climate Resilient Rural Infrastructure;<br>3. Institutional Capacity Development and Policy Engagement; and<br>4. Project Coordination and Management | 2019 to 2026: ongoing |
| 8 | Tree Crop Extension Project 1 (TCEP-1) | Executed by the Ministry of Agriculture and supervised by the International Fund for Agricultural Development.<br>Project Location: Nimba County Liberia<br>Project Cost: US$30.70 million by IFAD loan of US$13 million and US$9 million - IFAD 2 next allocation (71.8%)<br>Objective of the TCEP-1: To improve incomes and climate change resilience of smallholder cocoa producers, particularly women-headed households, youths and FBOs Target Beneficiaries 11,000 beneficiaries including 8,000 smallholder cocoa producers who are members of kuu groups and FFS; 2,400 farmers to benefit from access to roads, input supply and market linkages and 600 farmers who will benefit as a result of job creation along the value chain.<br>Project Components 1. Revitalization of Cocoa Plantation 2. Rehabilitation and Maintenance of Farm-to-Market Roads 3. Service Provision for Value Chain Development 4. Project Coordination, Management and M&E | 2017-2023: completed |
| **Coastal zone sector** | | | |
| No. | **Project title** | **Description and relation to climate change adaptation** | **Project circle & status** |
| 1 | Monrovia Metropolitan Climate Resilience Project (MMCRP) | The objective is to enhance coastal protection, foster improved coastal management and present local communities with diversified climate-resilient livelihoods. The project will build the long-term climate resilience of coastal communities in Liberia by both addressing immediate adaptation priorities and creating an enabling environment for up-scaling coastal adaptation initiatives to other parts of Monrovia and Liberia. The interventions of the project are in three inter-related focus areas: i) coastal protection; ii) coastal management; and iii) diversified climate-resilient livelihoods. | 2021 to 2027: ongoing |

| Agriculture Sector | | | |
|---|---|---|---|
| | | The project will address one of the most urgent adaptation needs in Monrovia by constructing a 1050 meters rock revetment to protect "West Point" against coastal erosion and storms. From an infrastructural perspective, the project will protect and build the climate resilience of approximately 10,800 people in West Point and avoid damages of up to USD 47 million.<br>Output 1: Protection of coastal communities and infrastructure at West Point against erosion caused by sea-level rise and increasingly frequent high-intensity storms.<br>Output 2: Institutional capacity building and policy support for the implementation of Integrated Coastal Zone Management across Liberia.<br>Output 3: Protecting mangroves and strengthening gender- and climate-sensitive livelihoods to build local climate resilience in Monrovia.<br>Implemented by the EPA through the UNDP, the MMCRP is funded by the GCF and the Government of Liberia Co-finance.<br>The project will directly benefit approximately 250,000 people through coastal defense, enhanced livelihoods, and improved protection of mangrove ecosystems. In addition, the project will indirectly benefit approximately 1 million people through the adoption of a transformative, climate risk-informed Integrated Coastal Zone Management approach for Liberia, with the first phase of implementation focused on the Monrovia Metropolitan Area. | |
| 2 | Enhancing Resilience of Vulnerable Coastal Communities in Sinoe County of Liberia (ERVCCS) | The ERVCCS aims at Enhancing the Resilience of Vulnerable Coastal Communities in Sinoe County of Liberia. The project interventions include<br>1) Strengthening Institutional Capacity for Climate Change Adaptation Planning,<br>2) Supporting Innovative Technologies for Climate Information and Communication Management,<br>3) Introducing Hybrid Adaptation Solutions, and<br>4) Supporting Resilient Livelihood Diversification through Training and Improved Access to Finance.<br>Executed by the EPA, the project is financed by a GEF Trust Fund grant and co-financed by UNDP and the Government of Liberia (GoL).<br>The majority of the above interventions will target all coastal counties in Liberia. In contrast, hybrid adaptation interventions will be explicitly implemented in Sinoe County, one of the country's most vulnerable coastal counties. | 2022 to 2028: ongoing |
| 3 | Building Resilience to Flooding and Coastal Erosion in Liberia | This project seeks to restore the dignity and enhance the safety of communities mostly at risk of floods and coastal erosion in Liberia. Specifically, this project will equip the National Disaster Management Agency (NDMA) of Liberia with vehicles, ICT Equipment and other logistics to effectively respond to disasters in Liberia.<br>1. Equip the National Disaster Management Agency (NDMA) of Liberia with vehicles, ICT Equipment and other logistics to effectively respond to disasters in Liberia.<br>2. Enhance the effectiveness and sustainability of NDMA's National Early Warning & Emergency Operation Center (NEWEOC)<br>Implemented by UNOPS, the project is a 100% grant of $1,891,138.00 USD being financed by the government and people of Japan. | 2022 to 2023: completed |
| **Fishery sector** | | | |

| Agriculture Sector | | | |
|---|---|---|---|
| No. | **Project title** | **Description and relation to climate change adaptation** | **Project circle & status** |
| 1 | Liberia Sustainable Management of Fisheries Project (LSMFP) | The objective is to improve fisheries management and enhance livelihood and income for government and targeted beneficiaries.<br>1. improving governance and management reforms, developing human and institutional capacity, and improving policies, strategies, institutional and legal frameworks;<br>2. supporting activities that aim at increasing the national value addition provided by the fisheries sector;<br>3. supporting marine sustainable fisheries production;<br>The LSMFP is implemented by the Bureau of National Fisheries and financed by the International Development Association at the amount of $ 22.8 Million USD with 56% Grant and 44% Loan.<br>Project targeted beneficiaries:<br>1. Training Females;<br>2. Training fish farmers;<br>3. Women-owned new businesses supported;<br>4. NaFAA staff trained in fisheries management; | 2020 to 2026: ongoing |
| 2 | Integrated Rice-fish Farming: A Research and Extension Development Based Initiative to Improve Food Security and Nutrition in Liberia | To enhance the development of rice and fish value for improved food, nutrition, and economic security through targeted research and extension CARI/MOA/NaFAA in Liberia. Financed by the European Union, the project is a 100% grant of $406,248.00 USD.<br>Targeted beneficiaries: Fish farmers | 2020 to 2023: Completed |
| 3 | Long Term Assistance to the National Aquaculture and Fisheries Authority of Liberia | The objective is to improve sectoral governance and fisheries management in Liberia.<br>1. To build capacity at NaFAA so that it can fulfil its role as regulator, supervisor and coordinating agency;<br>2. To provide technical assistance for the development and effective implementation of national and international rules, regulations and policies<br>Financed by the European Union, the project is a 100% grant of $704,968.37 USD. | 2019 to 2022 |
| 4 | Liberia Sustainable Management of Fisheries Project (LSMFP) | Approved by the World Bank in 2021, the project is funded by the International Development Association (IDA) and includes US$20 million grant and US$20 million credit. The project will improve conditions for fishermen and women, increase value addition for export, help address the economic vulnerability of the Liberian economy to climate change, and reduce vulnerability of food security. The LSMFP will support the establishment of an industrial and an artisanal fish landing site at the Mesurado Pier in Monrovia, and other artisanal landing sites in Margibi, Maryland, Grand Bassa, Sinoe and Grand Kru counties. | 2020 - present: ongoing |
| **5** | The Project for Procurement of Solar Powered Freezers and Other Equipment for Fishing Industry in 3 Communities of Montserrado County | The objective of the project is:<br>o improve effective, low-impact fishing and fish-handling practices among fishers and fish rocessers in targeted communities<br>o increase safety among fishers in targeted communities | 2021 (1 year): completed |

| Agriculture Sector | | | |
|---|---|---|---|
| | | Funded by the Government and people of Japan, the project amount is $85,818.00 USD; a 100% grant.<br>The targeted beneficiaries are Fishermen and Fishmongers. | |
| **Forestry Sector** | | | |
| **No.** | **Project title** | **Description and relation to climate change adaptation** | **Project circle & status** |
| **1** | UNDP/FAO Community-Based Forestry and Protected Area Management (CBFM) | The Program aimed at strengthening management of community forests and protected areas in Liberia though improved governance of community forest management; Capacity building of forest regulatory institutions; and to promote sustainable livelihood incentives forest dependent communities.<br>1. Livelihood options for communities are made climate-resilient through diversification, enterprise development;<br>2. Strengthened institutional and community capacity, and regulatory framework for community forest management.<br>Implemented by UNDP and FAO, the project is financed by the government and people of Sweden with the amount of $7,550,676.66 USD.<br>Project target: Promote social equity by supporting women-led initiatives and enhance women participation in decision making and land-use activities. | 2022 to 2026: Ongoing |
| **2** | Liberia Forestry Training Institute (FTI) Capacity Building | The Objective of the project is to build natural resources management capacity in Liberia through:<br>1. Institutional strengthening;<br>2.Teacher training and curriculum development.<br>Implemented by the United States Forest Service, the project is funded by the Global Agriculture and Food Security Program (GAFSP), African Development Bank (AfDB) and the Government of Liberia with the amount of $268,072.00 USD grant.<br>Project target: Train teachers in natural resource management. | 2016 to 2022: completed |
| **3** | Liberia Forest Sector Project (2016-2023). | The project aimed at strengthening forest conservation and building capacity for the establishment of 30% forest cover reserve for adaptation and mitigation. The project provides opportunities for sustainable charcoal production and sustainable forest management. Aimed at increasing the ability of forest-dependent communities and forest ecosystems to adapt to the impacts of climate change. | 2016 to 2023: completed |
| **4** | The Liberia Forest Program | The Liberia Forest Program is being implemented to enhance the rubber sector through technical and financial support. The program offers long-term financing to smallholder rubber farmers for replanting and renovating aging rubber plantations. It also provides technical assistance focused on adopting agronomic best practices, promoting environmental sustainability, and improving climate change adaptation. In 2017, the Central Bank of Liberia reported that rubber is a major contributor to state revenues, accounting for 17.5% of total exports. Commercial rubber farms employ an estimated 30,000 people, while up to 60,000 smallholder households are involved in rubber tree cultivation. | 2017 to Present: Ongoing |

| Agriculture Sector | | | |
|---|---|---|---|
| **Health Sector** | | | |
| **No.** | **Project title** | **Description and relation to climate change adaptation** | **Project circle & status** |
| 1 | Liberia Health Systems Strengthening Project (2013- 2018). | The project has an estimated budget of USD 5 million from the Health Result Innovation Trust Fund and USD 10 million from the International Development Association. | 2013 to 2018: Completed |
| 2 | Post-Ebola health system strengthening and epidemic prevention (2016 to 2020). | Post-Ebola health system strengthening and epidemic prevention (2016 to 2020). The general resilience of the system has been enhanced and the specific aspects of emergency care and disease control have been increasingly strengthened. | 2016 to 2020: completed |

## 2. Implementation of Adaptation Actions Identified in Liberia's Adaptation Communications (adcom, 2021)

This section summarizes in Table 19, the implementation of adaptation actions identified in past and current adaptation communications. The first & second National Communications, and Liberia's first Adaptation Communication to the UNFCCC were considered for the reporting purpose.

Table 19: Implementation of adaptation actions identified in the National Communications NC

| Adaptation actions/ efforts/ projects | Implementation progress |
|---|---|
| Environmental Studies Master's Degree Program at the University of Liberia (UL). | This Master's Degree Program is currently ongoing and has graduated its first batch of student (2023-2024) who have satisfactorily completed the required courses as outlined for the program.<br><br>Environmental Studies Master's Degree Programs at the University of Liberia (UL). The University of Liberia, supported by the UNDP's NAP project, established a Master's Degree Program in Environmental Studies, including Climate Change. The establishment of this master's degree program is a major achievement for Liberia, a country that lacks adequate climate change expertise. The Environmental Studies curriculum is designed to offer a Master of Arts (MA) and a Master of Science (MSc) in various disciplines in environmental studies. The MSc and MA stress the importance of understanding the interrelationships between the humanities, social sciences, climate change, and natural science engineering, agriculture, and forestry disciplines. A more detailed account of this program is provided in chapter 9.2 of Liberia's SNC. |
| Liberia's Agricultural Sector Investment Plan | Identified in Liberia's second national communication (SNC, 2021), the LASIP phase I: 2011 - 2015 and LASIP phase II: 2018 -2022 is intended to be a public-private partnership (PPPs) in which investment growth for the export sectors will be spearheaded by the private sector, while the public sector will concentrate in promoting small farmer growth and development. The LASIP I & II have been updated to Liberia National Agriculture Development Plan (2024-2030). Liberia's new National Agriculture Development Plan (NADP) 2024-2030 is a comprehensive blueprint aimed at transforming the agricultural sector to achieve food self-sufficiency and sustainable development. Launched in July 2024, the NADP builds on the successes and lessons learned from the Liberia Agriculture Sector Investment Plans (LASIP I & II). The NADP focuses on strategic investments in agricultural infrastructure, technology, and research to transition from traditional subsistence farming to large-scale, mechanized agriculture. Key components include enhancing productivity through modern farming techniques, improving market access, and promoting climate-smart agriculture to increase resilience against climate change. The plan also emphasizes empowering youth and women, fostering public-private partnerships, and ensuring policy coherence to create an enabling environment for agricultural growth (NADP, 2024-2030). LASIP I & II laid the groundwork by focusing on food security, infrastructure development, and capacity building. The NADP expands on these foundations by incorporating advanced technologies, fostering innovation, and aligning with global climate goals to ensure long-term agricultural sustainability and economic growth. |
| Technology Needs Assessment (TNA), Liberia | Identified in Liberia's 1st Adaptation communication, the aim of the TNA process is to assist Liberia to identify and analyze priority technology needs, which can form the basis for a portfolio of Environmentally Sound Technology (EST) projects and programmes to facilitate the adoption, transfer and diffusion of said technologies. |

| Adaptation actions/ efforts/ projects | Implementation progress |
|---|---|
| | For adaptation, the TNA identified adaptation technologies in two sectors, Agriculture and Coastal zones, listed below:<br>▪ Agriculture: Value addition to agriculture products, improved storage (drying and freezing of agriculture products), integrated soil fertility management, crop diversification and new varieties, irrigation, ecological pest management and mixed farming.<br>▪ Coastal Zone: Integrated coastal zone management, flood early warning systems, rock revetments, groynes, seawalls, beach nourishment, planting of coconut trees along beaches, coastal wetland protection, and restoration of coastal vegetation (coconut trees, almond trees, mangroves, etc.).<br><br>As prioritized from the TNA process, currently the "R*ock revetments"* that were prioritized as technologies for the coastal zone sector are to be implemented/ constructed under the *Monrovia Metropolitan Climate Resilient Project (MMCRP)* in West-Point, 1050 m revetment; and also, the *Enhancing the resilience of vulnerable coastal communities in Sinoe County* of Liberia, 1500m revetment. |
| Monrovia Metropolitan Climate Resilient Project (MMCRP) | As identified in Liberia's 1st adaptation communication (AdCom, 2021) to have been implemented, the Monrovia Metropolitan Climate Resilience Project (MMCRP) is currently ongoing and has made significant progress. The MMCRP was launched in 2021 with funding from the Green Climate Fund through the UNDP and is being implement by the EPA, aims to protect Liberia's coastal communities from the impacts of climate change. The project focuses on constructing coastal defense structures, such as rock revetments, to mitigate sea-level rise and high-intensity storms, particularly in the vulnerable West Point area. It also promotes Integrated Coastal Zone Management (ICZM) to enhance institutional capacity and policy support, while protecting mangroves and strengthening climate-resilient livelihoods. By addressing immediate adaptation needs and fostering long-term resilience, the MMCRP benefits approximately 250,000 people directly and indirectly supports around one million people in the Monrovia Metropolitan Area. |
| Smallholder Agriculture Transformation and Agribusiness Revitalization Project (STARP) of Liberia: | Identified in the second national communication as an adaptation effort, the Smallholder Agriculture Transformation and Agribusiness Revitalization Project (STAR-P) in Liberia is funded by the World Bank with $25 million. It aims to enhance the livelihoods and food security of smallholder farmers by increasing agricultural productivity and commercialization. The project focuses on the rice, oil palm, and horticulture value chains, and involves strengthening institutional capacities, promoting climate-resilient agricultural practices, and fostering private sector engagement. Initially covering five counties, STAR-P has expanded to all 15 counties, targeting 38,000 smallholder farmers, with at least 30% being women, to ensure sustainable agricultural development and market access (SNC, 2021). |
| Liberia National Adaptation Plan 2020 -2030 | Identified in Liberia's 1st Adaptation Communication (AdCom, 2021) to the UNFCCC, the purpose of the National Adaptation Plan 2020 -2030 is to provide an overall framework to guide Liberia in developing, coordinating and implementing its National Adaptation Plan. The NAP process also outlines the alignment between existing national, regional, and international policies and legal frameworks.<br>The objectives of this NAP process are to:<br>-Provide a framework and procedures for sharing of information of scientific, technical, and traditional knowledge on climate change risk management; and develop capacity-building measures;<br>-Coordinate sectors (including both public and private sector stakeholders), institutions, and universities on climate change risk management using awareness with a focus on the improvement of climate risk management actions; and |

| Adaptation actions/ efforts/ projects | Implementation progress |
|---|---|
| | -Encourage participation from sector stakeholders and line agencies responsible for key sectors to identify and propose measures to promote adaptation to reduce climate change risk. |
| Health Sector project | Identified in Liberia's SNC, Liberia has set a target of becoming a middle-income country by 2030 (Republic of Liberia, 2012), and the health and social welfare of the population is critically important in achieving this goal (Ministry of Health and Social Welfare, 2007). The UNDP, in partnership with the EPA, has recently initiated a climate vulnerability assessment for the health sector of Liberia which is expected to provide and update information on climate risk and vulnerability on the health sector. As such, several studies by the Ministry of Health (MoH) and the National Public Health Institute of Liberia (NPHIL) have confirm the correlation between temperature and precipitation patterns and malaria, cholera, dysentery, giardiasis, amebiasis, and typhoid fever which are diseases that afflict thousands throughout the country.<br>To address these issues, the following adaptation measures have been implemented to cope with health outbreaks.<br>1. Identifying and disinfecting stagnant water sources that are breeding grounds for insects;<br>2. Promoting hygiene and sanitation education and awareness in the country, including clinical interventions and community health education programmes;<br>Strengthening the Roll Back Malaria program and providing a range of herbal treatments. |
| Liberia Climate Change Assessment (2013) | Identified in the second national communication, Liberia Climate Change Assessment (2013) is a project implemented by the United States Agency for International Development USAID-Liberia Mission to assist the Government of Liberia to develop climate data. In an effort, the project assessed and developed a climate data and future climate projections for the country. The project presented the level of coastal vulnerability identified in the coastal zone of Liberia from climate change impacts and recommended sustainable intervention. The result of this assessment for the coastal zone is an asset to be used by stakeholders to solicit funding from climate change donors in order to implement coastal adaptation or mitigation measures. |
| Knowing Your Environment (KYE) | As identified in the second national communication, the Knowing Your Environment (KYE) program was established in 2015 by the planning and policy department of the Environmental Protection Agency of Liberia (EPA). The KYE is currently ongoing/ being implemented. It is an environmental knowledge and information sharing program aimed at promoting climate change knowledge sharing amount the staffs of the EPA to adequately enable them to efficiently diffuse climate change knowledge in vulnerable communities. The KYE program activities are designed to directly engage an affected or vulnerable community "face-to-face" once a week (every Wednesday) to disseminate and educate climate residents about some important environmental regulations, adaptation/mitigation measures. It also creates the medium to build synergies which enable environmental experts to share climate change knowledge in addressing specific problems affecting the environment. |
| Liberia Sustainable Management of Fisheries Project (LSMFP). | As identified in the 1st Adaptation communication (AdCom), the *Sustainable Management of Fisheries Project (LSMFP)* is currently being implemented (2024). The *LSMFP* Approved by the World Bank in 2021, the project is funded by the International Development Association (IDA) and includes US$20 million grant and US$20 million credit. The project will improve conditions for fishermen and women, increase value addition for export, help address the economic vulnerability of the Liberian economy to climate change, and reduce vulnerability of food security. The LSMFP will support the establishment of an industrial and an artisanal fish landing site at the Mesurado Pier in Monrovia, and other artisanal landing sites in Margibi, Maryland, Grand Bassa, Sinoe and Grand Kru counties. |

| Adaptation actions/ efforts/ projects | Implementation progress |
|---|---|
| Climate Saturday | As identified in the second national communication (SNC), the Climate Saturday is currently being implemented and has been successful for more than four (4) years. The Climate Saturday is run by the Action for Climate Empowerment focal point of the EPA. The program is considered as a decentralization of climate change discussion from governmental/institutional level to a community/household level.<br>The aim of this program is to buttress national efforts aim at promoting initiatives to enhance action to combat climate change at the national level by taking discussions that borders on climate change to local community dwellers in local languages. This is a monthly exercise which has been successful in Montserrado county, Margibi Country, Bomi, Grand Bassa County, River Cess County, Bong County, Cape Mount County and Nimba County. |

## 3. Implementation of Adaptation Actions Identified in the NDCs

The NDC provides specific targets and frameworks for each of the key national adaptation sectors (Agriculture, Coastal zone, Health, Fishery and forestry). These key principles and targets are also aligned with the National Adaptation Plan (NAP) and other national climate change adaptation documents. As such, the development and implementation of adaptation projects /programmes are aligned with these principles and frameworks in order to achieve the national adaptation targets and plans. In alignment with Liberia's climate commitments as outlined in the revised NDC and NAP, the country has initiated several implementation steps following the 2021 launch of its National Adaptation Plan.

This section provides a summary account of some identified adaptation actions/ projects that are being implemented. The below listed projects/ actions were selected because they are aligned with the NDC's adaptation frameworks and targets as per the specific adaptation sector.

Table 20: Implementation of adaptation actions identified in the adaptation section of NDC

| Adaptation Project/ Action | Implementation Progress |
|---|---|
| Liberia's Blue Ocean Programme (BOP)- 2019-2026 | As identified in the revised NDC, this project is aligned with the coastal zone target of coastal management/ protection and sustainability.<br>Liberia's Blue Ocean Programme (BOP) 2019-2026, supported by Conservation International and funded by Sweden, aims to promote the sustainable management of Liberia's coastal and marine ecosystems. The project focuses on conservation and restoration efforts to protect biodiversity, alleviate poverty, and enhance resilience to climate change. Key activities include conducting a national mangrove inventory, establishing community mangrove management committees, and providing alternative livelihoods for coastal communities. The BOP also addresses marine pollution and supports sustainable small-scale fisheries, contributing to the overall goal of fostering a blue economy in Liberia[11]. |
| The Monrovia Metropolitan Climate Resilient Project (MMCRP) | This project is aligned with the NDC's coastal zone target implementation of green and gray coastal protection measures.<br>The Monrovia Metropolitan Climate Resilience Project (MMCRP), launched in 2021 with funding from the Green Climate Fund with support from the UNDP, aims to protect Liberia's coastal communities from the impacts of climate change. The project focuses on constructing coastal defense structures, such as rock revetments, to mitigate sea-level rise and high-intensity storms, particularly in the vulnerable West Point area. It also promotes Integrated Coastal Zone Management (ICZM) to enhance institutional capacity and policy support, while protecting |

[11] Lobell et al looked at the Nonlinear heat effects on African maize as evidenced by historical yield trials (Lobell et al., 2011).

| Adaptation Project/ Action | Implementation Progress |
|---|---|
| | mangroves and strengthening climate-resilient livelihoods. By addressing immediate adaptation needs and fostering long-term resilience, the MMCRP benefits approximately 250,000 people directly and indirectly supports around one million people in the Monrovia Metropolitan Area[12]. |
| Enhancing the resilience of vulnerable coastal communities in Sinoe County of Liberia | This project is aligned with the NDC's coastal zone target implementation of green and gray coastal protection measures and sustainability.<br>The Global Environmental Facility (GEF) approved the sum of US$20.4 million of the adaptation project to be jointly implemented by the Government of Liberia and UNDP. The project aims to address the effects of sea erosion on the livelihoods, assets and entire ecosystems of over 16,000 people in coastal communities in Sinoe County. The project is mainly implemented in Greenville, but extends some soft services like provision of micro-finance, value addition, and sustainable agriculture to other coastal counties[13]. |
| Increasing Smallholders' productivity and strengthening resilience for adaptation through climate smart agricultural practices for integrated and sustainable agri-food system. | This project is aligned with the NDC's Agriculture sector target that promotes capacity building, improved food security, sustainable and resilient agricultural.<br>With Technical support from the Least Developed Expert Group (LEG) at two NAP Writing Meetings held in Nairobi, Kenya (2022) and Moroni, Comoros (2023), Liberia was able to finalize the project. The project aims to enhance the productivity and resilience of smallholder farmers by promoting climate-smart agriculture (CSA). This initiative focuses on implementing sustainable farming techniques, such as drought-resistant crop varieties, efficient water management, and soil conservation practices, to adapt to climate change impacts. By integrating CSA practices, the project seeks to improve food security, increase farm incomes, and build the capacity of smallholders to withstand climate-related shocks, thereby contributing to a more sustainable and resilient agricultural sector in Liberia. |

## 4. Steps Taken to Formulate, Implement, Publish and Update National and Regional Programmes, Strategies and Measures, Policy Frameworks

Liberia acknowledges the current and future threats of climate change and has initiated several measures to address these challenges that directly and indirectly impact the country's socio-economic and environmental progress. Key initiatives include ratifying the UNFCCC, the Kyoto Protocol, and the Paris Agreement. Liberia also reports to the UNFCCC through its Nationally Determined Contributions, National Communications, and the first Adaptation Communication. Additionally, the country has prepared various climate change plans and strategies, such as the NAPA, the NAP, and the National Policy and Response Strategy on Climate Change (AdCom, 2021).

According to the EPA (2020), Liberia formulated its National Adaptation Programme of Action (NAPA) with technical support and funding from the Global Environment Facility (GEF) and United Nations Environment Programme (UNEP). The NAPA's preparation was guided by existing strategies and policies, including the National Reconstruction and Development Plan (NRDP), the National Biodiversity Strategy and Action Plan (NBSAP), and Sustainable Development Goals (SDGs—formerly the Millennium Development Goals).

[12] Brown (and red) tides can occur when certain algae species reach high concentrations, or "blooms," that discolor water. Some of these algae species can harm some marine life under certain conditions. Brown tides can reduce water transparency to less than a foot in some cases, affecting seagrass by limiting light penetration in the water column (EPA, 2020).

[13] Source: with changes;

The NAPA process identified several urgent adaptation needs, including (1) agricultural adaptation, (2) national meteorological and hydrological monitoring, and (3) coastal defense. Building on these projects, the country initiated the National Adaptation Plan (NAP) process in 2010 through the Environmental Protection Agency (EPA) and the United Nations Development Programme (UNDP). This initiative aimed to address pressing climate-related issues and human capacity needs. The NAP process in Liberia was designed to reduce climate change vulnerability, strengthen institutional coordination for adaptation, and expand the existing knowledge base to scale up adaptation efforts. The NAP will be in effect for ten years (2020–2030), with ongoing monitoring and evaluation. Around 2029, this first implementation period will be reviewed, and a new framework will be developed to guide the period from 2031–2040 (NAP, 2020-2030).

The revision of Liberia's Nationally Determined Contribution (NDC) began with a comprehensive analysis of existing and proposed sectors, assessing mitigation and adaptation measures and opportunities. The NDC was then developed through stakeholder consultation, technical analysis of all sectors, sectoral reports, NDC costing and cost-benefit analysis, and workshop outcomes. This revision builds upon key national planning documents, including Liberia's first NDC (2015-2020), the National Climate Change and Response Strategy (2018), Second National Communication, State of the Environment Reports, and the first Biennial Update Report.
In its revised NDC, Liberia commits to reducing its economy-wide greenhouse gas emissions by 64% below the projected business-as-usual (BAU) level by 2030. This target comprises:

- An unconditional 10% reduction below BAU, with emissions of 11,187 Gg $CO_2e$ in 2030.
- An additional 54% reduction, conditional upon international support, leading to emissions of 4,537 Gg $CO_2e$ in 2030.

Liberia is currently developing its next NDC, due for submission in 2025. This aligns with the Paris Agreement's requirement that countries update their NDCs every 5 years, reflecting their highest possible ambition in addressing climate change. As a Party to the Agreement, Liberia aims to make fair and ambitious contributions to emissions reduction, setting short-, medium-, and long-term targets in its revised NDC. The country has also expanded its commitment by including two additional sectors—Fishery and Coastal Zone—that were absent from the 2015 NDC. The ongoing development of NDC 3.0 will likely build upon the progress made in the 2021 revision while incorporating new insights from current climate assessments and policy developments.

The Initial National Communication (INC), submitted in 2013, established a baseline assessment of Liberia's climate change situation. It included an inventory of greenhouse gas emissions, vulnerability assessments, and proposed mitigation and adaptation strategies. The Second National Communication (SNC), submitted in 2021, built upon the INC, offering updated information on emissions, climate impacts, and progress in implementing climate actions. The SNC is mandated by Article 12 of the Convention and follows COP 8 Guidelines for National Communications for Non-Annex 1 Parties (Decision 17/CP.8). It not only fulfils reporting requirements but also raises awareness about climate change issues in Liberia. Liberia's SNC provides a comprehensive overview of the country's climate change initiatives, including:

- Climate change vulnerability and adaptation assessment
- National greenhouse gas inventory
- Greenhouse gas mitigation assessment
- Climate change technology transfer
- Development assessment and capacity building to address climate change-related impacts

Liberia is expected to submit its Third National Communication (TNC) in 2025. The TNC will likely offer an updated assessment of the country's climate change situation, incorporating findings from Liberia's Revised Nationally Determined Contribution (NDC) and other relevant climate change initiatives (SNC, 2021).

In November 2021, Liberia submitted its First National Adaptation Communication (1st AdCom) to the United Nations Framework Convention on Climate Change (UNFCCC). This document outlines Liberia's efforts to address climate change impacts, highlighting the country's commitment to protecting its people, property, and environment. The AdCom details Liberia's national development plans and policies, including the National Adaptation Plan (NAP) and Nationally Determined Contribution (NDC). It also showcases Liberia's participation in international climate agreements and efforts to strengthen adaptation capacity through initiatives like the Capacity Building Initiative for Transparency (CBIT).

The AdCom provides a comprehensive overview of Liberia's climate vulnerability, risks, and adaptation priorities. It also outlines implementation needs, recent actions, and future goals for key sectors such as agriculture, coastal zones, health, forestry, and fisheries. While acknowledging challenges like limited funding and expertise, Liberia remains committed to advancing adaptation actions and achieving its climate targets (AdCom, 2021).

## 5. Coordination Activities, Changes in Regulations, Policies and Planning

An essential step in addressing the impacts of climate change adaptation actions involves having a functioning institutional structure to coordinate climate change initiatives across all sectors at the national and sub-national levels. However, the current governance structures on climate change and institutional arrangements (NPRSCC, 2018) are critical to providing the NAP process's governance. Therefore, the institutional arrangement of the NPRSCC (2018) adopted to implement the NAP Process is of two categories: (1) National Level (horizontal coordination) and (2) subnational level (vertical coordination) (NAP, 2020-2030).

## 6. Horizontal Coordination

The National Level or horizontal arrangement includes line ministries and agencies, the EPA, National Climate Change Secretariat (NCCS), and National Climate Change Steering Committee (NCCSC). Table 26 shows the roles of the horizontal arrangement in the coordination and implementation of the NAP process;

*Table 21: Institutional arrangements and coordination activities*

| National Institution | Coordination/implementation roles |
|---|---|
| NCCSC | - Validate (bi-annual) and secure government support for the implementation of the NAP Process<br>- Supervise and provide the leadership for the overall coordination and activities of the NAP Process<br>- Report bi-annual on the progress of the NAP Process to the President of the Republic of Liberia and Head of Standing Committees on Environment and Natural Resources of the Houses of Senate and Representative, respectively<br>- Engage cabinet and the legislature to secure funding for the implementation of the NAP Process |
| EPA | -The EPA shall be the led agency on the implementation of the NAP Process<br>- Coordinate the NAP Process consultation with the Ministry of Transport (MoT), Forestry Development Authority (FDA), Ministry of Gender, Children and Social Protection (MoGCSP), Ministry of Mines and Energy (MME), Ministry of Agriculture (MoA), and other relevant sectoral institutions |

| National Institution | Coordination/implementation roles |
|---|---|
| | - Work with a local organisation to establish the vertical integration that reports to the EPA monthly |
| NCCS | - Track the progress on the implementation NAP Process<br>- Serve as liaison between the NCCSC and the EPA and various working groups on the implementation of the NAP Process<br>- Engage in appropriate programmes to strengthen national capacity during the NAP Process<br>- Collaborate with an international organisation, academic institutions, and experts to implement the NAP Process<br>- Maintain full records of the proceedings of the Climate Change Steering Committee. |

## 7. Vertical Coordination

The Sub-national or Vertical integration is driven by recognition of sub-national diversity in vulnerability to climate change, as well as the important role played by sub-national authorities and local organisations in advancing adaptation. The sub-national are institutions, systems, and processes at a level below the national level, including the local level. The subnational relative to Liberia is Local Government and Local Organisation. The local organisations are Non-governmental Organisations, Civil Service Organisations, and Private Sectors operating in Liberia. The NAP stresses the importance of vertical integration since it links to the decentralization process and highlights the need to integrate climate change adaptation into national and sub-national structures, including developing district development plans. Information sharing and capacity building is critical for successful vertical integration and is planned by the EPA (NAP, 2020-2030).

In collaboration with the Environmental Protection Agency, the Ministry of Internal Affairs plays the lead role in coordinating with the government's subnational levels. The EPA is expected to provide experts that will work with the communities at the district and village community. The subnational level is then divided into committees at the district and village of community. The implementation of adaptation strategies projects should be at the subnational (districts/villages). Through the NAPAs, Liberia integrates climate change concerns into several activities, including the National development planning from the perspective of finance and planning, the vulnerability of Liberia climate change on the agriculture, fisheries, forest, health, energy, and the coastal areas The NAPs implementation also led the government through the EPA to develop progressive policies and planning on climate change. Some of the policy documents include the National Planning Framework and the National Climate Change Policy. In addition, part of the NAPs activities include capacity building, and the University of Liberia Master Program in Environmental Studies and Climate Change to educate Liberians on adaptation assessments (NAP, 2020-2030).

## 8. Monitoring and Evaluation of Adaptation Actions and Processes

Currently, there is no established national Monitoring and Evaluation (M&E) system for adaptation under the NAP and the NDC. The lack of a national M&E system for climate change adaptation was reported in Liberia's Adaptation communication (AdCom, 2021) to the UNFCCC. To establish an M&E system for climate change adaptation, a proposed framework of a monitoring, evaluation, and learning (MEL) system for Liberia's National Adaptation Plan (NAP) 2020–2030 has been developed through a technical report (https://napglobalnetwork.org/resource/note-monitoring-evaluation-learning-liberia-adaptation-plan/). The MEL system will be aligned with Liberia's NAP process and will help to track the progress of implementation on prioritized actions set in the NAP.

The proposed framework was informed by best practices and input gained through consultations with stakeholders from national and county governments, civil society organisations, and the private sector. Additionally, the proposed MEL framework for Liberia is guided by international policies and frameworks, including the United Nations Framework Convention on Climate Change (UNFCCC), and its 2015 Paris Agreement. Liberia submitted her NAP and revised NDC in 2021. The revised NDC also calls for a climate change measurement and reporting system that builds on existing structures and includes adaptation through tracking climate finance, climate impacts, and climate change actions. Presented in the table below, Liberia's NAP outlines a four-step approach to MEL of the NAP.

*Table 22: The four (4) steps for the MEL of the NAP*

| **Steps** | **Indicative activities — to be led by the EPA** |
|---|---|
| 1. Monitoring the NAP | • Identify areas of the NAP that will be monitored through qualitative and quantitative performance measures to determine progress made toward the NAP's objectives.<br>• Define metrics for documenting progress for the areas identified for monitoring. Concerning evaluation, determine the means for measuring and communicating levels of effectiveness and assessing gaps.<br>• Collect information on the metrics throughout the NAP process. |
| 2. Reviewing the NAP process to assess progress, effectiveness, and gaps – Evaluation | • Compile and synthesize information from new assessments and emerging science, as well as the results and outcomes from adaptation activities being implemented, to support the review and updating of the NAP.<br>• Revise the NAP using evaluation information and metrics. |
| 3. Iteratively updating the NAP – Learning | • Update the NAP based on the information collected.<br>• Work toward aligning the NAP updates with relevant national development plans. |
| 4. Reporting on progress and effectiveness, and carrying out outreach on the NAP | • Disseminate the NAP document.<br>• Provide information in national communications on the progress and effectiveness of the NAP. |

**Source:** Adapted from Government of Liberia. (2021). Liberia National Adaptation Plan 2020-2030, p. 101. https://unfccc.int/documents/424116

Regarding the technical report, the institutional arrangements for the MEL system will build on the coordination and management structures set out in Liberia's NAP and NDC. The EPA will lead the establishment and operationalization of the MEL system for adaptation. At the sub-national level, the EPA will work with county authorities and local organisations responsible for adaptation planning, implementation, monitoring and evaluation to operationalize the MEL system for adaptation.

Communication of adaptation progress, results, and lessons learnt will form an integral part of the MEL system. The EPA will need to establish processes to analyze the adaptation data and prepare the required national and international reports, including those required under the UNFCCC and its Paris Agreement, such as the AdCom and assessments of progress toward the Global Goal on Adaptation. In addition, the data and information will be used to update Liberia's NDC and NAP and provide input to the annual reports on the environment and climate change. Moving forward, the EPA will require financial support from both the national government and international organisations to operationalize the MEL system. According to the technical report, the main recommendations to move forward to establish the MEL system are to:

- Establish a single, coordinated system for MEL and reporting on climate change adaptation.
- Establish methods for tracking progress, identifying achievements, and evaluating the results of the adaptation process, and make any changes that might be necessary. Establish mechanisms to facilitate the review and analysis of adaptation data.
- Provide adequate human resources and build MEL capacity in the coordinating and implementing agencies to enable the MEL system for adaptation to operate effectively.
- Encourage dialogue and debate among stakeholders to create a common understanding of the significance of a MEL system for climate change adaptation and the need for effective coordination of the system at the sectoral, national, and sub-national levels.
- Scale up efforts to integrate learning from the MEL system for adaptation into government policies, strategies, and plans in order to facilitate implementation of the NAP process and add value to ongoing development initiatives.

The proposal is for Liberia's adaptation MEL system to be established over 3 years. The suggested next steps to be implemented over the next 3 years include the following: institutional arrangements, data collection, management and review; and communication and reporting.

## 9. Information related to Averting, Minimizing and Addressing Loss and Damage Associated with Climate Change Impacts

Under the Paris Agreement's Enhanced Transparency Framework (ETF, Article 13) and the Warsaw International Mechanism for Loss and Damage (WIM), Liberia, as a Least Developed Country (LDC), is encouraged to report on efforts to avert, minimize, and address loss and damage (L&D) associated with climate change impacts, focusing on cooperative and facilitative approaches to enhance understanding, action, and support.

Liberia faces significant climate risks, including sea-level rise (0.1 - 0.2m observed by 2020, projected to worsen), coastal erosion, flooding, and droughts, impacting agriculture (70% of livelihoods), fisheries, and coastal communities. Progress is drawn from Liberia's updated NDC (2021), National Adaptation Plan (NAP, 2020 - 2030). During the reporting period, Liberia has received funding not specifically targeted at addressing loss and damage (L&D), but as a broader adaptation effort that help reduce associated climate change impacts. These funds align with the Paris Agreement's emphasis on adaptation finance (Article 7) supporting vulnerability reduction in climate-sensitive sectors like agriculture, coastal zones, and disaster resilience. As a Least Developed Country (LDC), Liberia can access these funding through mechanisms like the Green Climate Fund (GCF), Global Environment Facility (GEF), Adaptation Fund, and bilateral/multilateral partners.

Funding focuses on building resilience to projected risks such as sea-level rise (threatening 230,000 people and US$250 million in land loss), flooding, droughts, and erosion, which exacerbate economic and non-economic L&D. However, disbursements have been partial highlighting gaps in scaling up. While adaptation funding supports resilience-building, it is insufficient for addressing residual L&D impacts that persist despite mitigation and adaptation (Republic of Liberia, 2021). The Paris Agreement (Article 8) recognizes L&D as distinct, requiring specific financial mechanisms to address economic losses and non-economic losses (e.g. cultural heritage, biodiversity) (UNDP Liberia, 2022). Adaptation funding focuses on averting and minimizing risks through proactive measures like climate-smart agriculture (Global Environment Facility, 2024).

L&D funding is needed for irreversible impacts, such as rebuilding after floods or compensating displaced communities, which adaptation cannot prevent. This fund aims to provide dedicated finance for vulnerable countries. Liberia's access to this fund has been limited (no disbursements by 2024), necessitating a tailored national mechanism (UNDP Liberia, 2022).Liberia's L&D efforts are fragmented across the EPA, National Disaster Management Agency (NDMA), and sector ministries, leading to inefficiencies in coordination, reporting, and fund allocation. For example, the NDMA handles disaster response in Liberia, while the EPA manages climate data, but no single body integrates L&D strategy, funding, and monitoring in the Country.

## M. Cooperation, Good Practices, Experience and Lessons Learned

### 1. Cooperation

This section gives account of Liberia's efforts in recognizing, participating and upholding regional and international climate change cooperation that support adaptation and mitigation regarding good practices, experience, and lessons learned.

Liberia recognizes the current and future threats of climate change and has undertaken several initiatives to address the many direct threats that impact the country's socio-economic and environmental progress and its people. Key among some of the initiatives to address the threats of climate change to the country are, the upholding of the UNFCCC, the ratification of Kyoto Protocol and the Paris Agreement; reporting to the UNFCCC through Liberia's National Communications and AdComs; and the preparation of a number of climate change plans and strategies including the NAPA, the NAP, and the National Policy and Response Strategy on Climate Change. In 2015, Liberia committed to the attainment of the Sustainable Development Goals (SDGs), and has made a significant progress and several efforts in this regard. Liberia has aligned its National Policy and Response Strategy on climate change with Agenda 2030 of the SDGs.

In so doing, Liberia is party to more than ten multilateral environmental agreements which include but are not limited to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); the Cartagena Protocol on Biosafety; the Ramsar Convention on Wetlands of International Importance; the Convention on Migratory Species (CMS); and the Montreal Protocol on Ozone Depleting Substances. Liberia's efforts under the two other Rio Conventions, the United Nations Convention on Biological Diversity (CBD) and the UN Convention to Combat Desertification/ Land Degradation (UNCCD), are closely aligned with Liberia's adaptation priorities. (SNC, 2021) and (AdCom, 2021). Additional regional and international cooperation that can attest to Liberia's efforts in addressing climate change also include but not limited to the following:

- The EU-Liberia Climate Change Alliance + CRIS number: ENV/2016/39639 financed under Development Cooperation Instrument;
- Climate change/REDD (2014): Liberia and Norway entered into a partnership to improve forest governance, strengthen law enforcement, and support efforts in reducing greenhouse gas emissions from deforestation and forest degradation in Liberia;
- The Ecowas Centre for Renewable Energy and Energy Efficiency (ECREE);
- Liberia signed the Sendai Framework for Disaster Risk Reduction (SFDRR) and developed a National Action Plan for Disaster Risk Reduction: 2016 to 2021. The mission of the action plan is "to apply and effectively implement all legal and institutional frameworks and innovative technological approaches to reduce national and local community vulnerabilities and disaster risks within the context of sustainable development".

- Climate and Clean Air Coalition (CCAC): In 2014, Liberia became partner to the Climate and Clean Air Coalition (CCAC) with the goal of taking national action to reduce short-lived climate pollutants from diesel fuel methane, tropospheric ozone and other fine particulate matters that have impacts on health, agriculture and the climate.

These initiatives are all aimed at achieving the country's commitments to addressing climate change and its related impacts.

## 2. Good Practices That Promote Adaptation Actions in Liberia

With the help of partners, the government of Liberia has developed some key national networks, platforms, programmes and groups in an effort to increase awareness and promote information and knowledge sharing that will enhance coordination among institutions at all levels. Additional initiatives regarding climate change knowledge and information sharing that can be added to those listed in the Adaptation Communication, (AdCom, 2021) and the National Adaptation Plan (NAP, 2021) include but not limited to:

### 1. Good Practices as it relates to Science, Planning, and Policies for Adaptation

Liberia has undertaken several initiatives to share information, good practices, experiences, and lessons learned in the realm of climate adaptation, aligning with Article 7 of the Paris Agreement, which emphasizes enhancing adaptive capacity through knowledge exchange, capacity building, and cooperative actions. Some of these efforts focus on science (e.g. vulnerability assessments and climate data), planning (e.g. institutional coordination and sectoral strategies), and policies (e.g. mainstreaming adaptation into national frameworks like the National Policy and Response Strategy on Climate Change (NPRSCC, 2018)).

A key mechanism is the National Adaptation Plan (NAP) 2020–2030, which provides a framework and procedures for sharing scientific, technical, and traditional knowledge on climate change risks. This includes disseminating data on climatic projections using global climate models (GCMs) and downscaled information for priority sectors such as agriculture, coastal zones, fisheries, forestry, energy, and waste management. The NAP integrates lessons from past assessments, such as the 2019 vulnerability studies on agriculture, fisheries, and forestry, to inform evidence-based planning and policy updates. Experiences from the National Adaptation Programme of Action (NAPA, 2008) highlight good practices like scaling up coastal defense and agricultural adaptation projects, while noting challenges in budget constraints and scope, leading to recommendations for stronger donor coordination and private sector engagement.

Complementing the NAP is the **Liberia's National Adaptation Plan Communication Strategy (2024)**, developed with support from the NAP Global Network and the Government of Ireland. This strategy advances NAP implementation by raising awareness, facilitating stakeholder engagement, enhancing knowledge and capacity, fostering partnerships, and incorporating monitoring, evaluation, and learning (MEL). It draws from an inception workshop in August 2023, involving 50 participants from government, UNDP, FAO, NGOs, CSOs, youth, women, private sector, and media, where lessons learned emphasized broader consultations for messaging, simplified communications in local languages, and leveraging youth and media for wider reach. The strategy includes tailored messages on sector-specific adaptation (e.g. climate-smart agriculture, mangrove protection for coastal zones) and cross-cutting themes like gender mainstreaming, aligned with the National Gender Policy (2009) and SDG 5. Communication channels encompass radio public service announcements, talk shows, social media (e.g. Facebook, Instagram), community meetings, town crier announcements, billboards, mobile apps for early warnings, photo essays, and short videos. A rollout plan for 2024–2025 budgets

approximately USD 490,000 for activities like regional trainings, national dialogues, and gender-sensitive MEL to track impact through indicators such as media reach and stakeholder feedback. The **Environmental Knowledge Management System (EKMS)**, launched with UNDP support under the UNCCD project, serves as an online repository for climate data, vulnerability assessments, and adaptation knowledge products. It facilitates sharing among researchers, policymakers, NGOs, and networks at national, regional, and international levels, supporting NAP reporting and scientific collaboration. Good practices from EKMS include synchronizing climate information for real-time access, which has informed policy mainstreaming in sectors like water resources and biodiversity.

Ongoing programs further promote sharing: Climate Saturday (2021- ongoing), run by the EPA's Action for Climate Empowerment focal point, uses local languages for community discussions on adaptation science and planning; Talk the Environment (2021–2022), a weekly radio show hosted experts to discuss climate-smart practices and policy innovations; and Knowing Your Environment (KYE), which shares environmental and climate knowledge to build awareness. These build on experiences from the Strengthening Liberia's Climate Information and Services Project, which responds to NAPA priorities by securing and transferring critical technologies for climate-resilient development, including early warning systems and data sharing platforms.

**2. Good Practices, Experience, and Lessons Learned Related to Policy Innovation and Pilot and Demonstration Projects**

Liberia has actively pursued policy innovation and pilot and demonstration projects to enhance its climate adaptation efforts, aligning with the Paris Agreement's emphasis on strengthening adaptive capacity through innovative approaches and practical implementation (Article 7). These initiatives facilitate the sharing of information, good practices, experiences, and lessons learned, contributing to national and sectoral resilience.

One notable policy innovation is the National Adaptation Plan (NAP) 2020–2030, which introduces a flexible framework for integrating adaptation into sectoral policies and fosters innovation through pilot projects. The NAP includes the Climate-Smart Agriculture Pilot Project in Lofa County, launched in 2021 with support from the Food and Agriculture Organization (FAO). This project demonstrates drought-resistant crop varieties and water harvesting techniques, sharing lessons on scalability and farmer adoption rates with the Ministry of Agriculture and rural cooperatives. Experiences highlight the need for gender-sensitive training, as women farmers showed higher engagement when provided with tailored extension services, influencing policy adjustments in the National Agriculture Policy (2023).

Another pilot initiative is the Coastal Resilience Demonstration Project in Grand Cape Mount, implemented since 2020 with funding from the Green Climate Fund (GCF) and technical support from UNDP. This project tests mangrove restoration and sea wall construction to combat erosion and sea-level rise, sharing data on cost-effectiveness and community participation with the Environmental Protection Agency (EPA) and coastal communities. Good practices include participatory design, which increased local buy-in, while lessons learned emphasize the importance of integrating early warning systems, prompting the EPA to propose a national coastal monitoring policy in 2024.

The Renewable Energy Microgrid Pilot in rural Nimba County, supported by the African Development Bank (AfDB) and launched in 2022, demonstrates solar-powered microgrids to enhance energy resilience against climate variability. This project shares technical specifications and socio-economic impacts with the Rural and Renewable Energy Agency (RREA), informing

the National Energy Policy revision (2023). Experiences indicate that community ownership models improve sustainability, a lesson integrated into policy recommendations for decentralized energy solutions.

**3. Good Practices, Experience, and Lessons Learned Related to the Integration of Adaptation Actions into Planning at Different Levels**

Liberia has made concerted efforts to integrate adaptation actions into planning at national, sub-national, and local levels, aligning with Article 7 of the Paris Agreement, which encourages enhancing adaptive capacity through integrated planning and cooperation. These efforts involve sharing information, good practices, experiences, and lessons learned across various governance tiers to build climate resilience.

At the national level, the National Adaptation Plan (NAP) 2020–2030 serves as a cornerstone for integrating adaptation into planning. Developed by the Environmental Protection Agency (EPA) with support from UNDP and the Global Environment Facility (GEF), the NAP embeds adaptation actions into sectoral policies such as the National Agriculture Policy, National Forestry Policy, and National Energy Policy. The NAP process, initiated in 2010 and formalized in 2021, shares best practices like the inclusion of climate risk assessments in the revised Nationally Determined Contribution (NDC, 2021), which sets targets for reducing greenhouse gas emissions by 64% below business-as-usual levels by 2030. Experiences from the NAP's development highlight the importance of stakeholder consultations, with lessons learned emphasizing the need for stronger coordination among line ministries, as documented in the NAP's institutional arrangement section. These insights are shared through annual EPA reports and the Environmental Knowledge Management System (EKMS), ensuring policy alignment with national development plans like the National Reconstruction and Development Plan.

At the sub-national level, the NAP advocates for vertical integration, recognizing regional climate vulnerabilities. The Sub-National Adaptation Planning Framework, outlined in the NAP, involves county authorities and local organizations in integrating adaptation into district development plans. A notable example is the Lofa County Climate Resilience Plan (2022), developed with FAO support, which integrates climate-smart agriculture and water management into local planning. Good practices include participatory mapping exercises that engage community leaders, while lessons learned indicate the need for capacity building at county levels, as capacity gaps were identified in the 2024 stakeholder assessment. This information is shared via regional workshops and the EPA's coordination with the Ministry of Internal Affairs, enhancing sub-national policy coherence.

At the local level, the Community-Based Adaptation (CBA) Program, launched in 2021 with GCF funding, integrates adaptation into village-level planning in coastal and rural areas like Grand Cape Mount. This program demonstrates flood-resistant housing and mangrove restoration, sharing experiences through community meetings and mobile app-based early warning systems. Good practices include leveraging traditional knowledge, such as indigenous flood management techniques, while lessons learned highlight challenges in funding continuity, prompting advocacy for local climate budgets. These insights are fed into the NAP's Monitoring, Evaluation, and Learning (MEL) Framework, proposed in 2023, which tracks integration progress through indicators like the number of adapted community plans.

The National Climate Change Steering Committee (NCCSC) facilitates cross-level integration by coordinating the NAP process, sharing policy innovations like the National Disaster Management Policy (2012) with sub-national actors.

**4. Good Practices, Experience, and Lessons Learned Related to Cooperation to Share Information and Strengthen Science, Institutions, and Adaptation**

Liberia has actively engaged in cooperative efforts to share information and strengthen science, institutions, and adaptation, aligning with Article 7 of the Paris Agreement, which emphasizes international and regional collaboration to enhance adaptive capacity. These initiatives involve partnerships with global, regional, and local stakeholders to advance climate resilience through knowledge exchange, institutional capacity building, and scientific development.

At the international level, Liberia's ratification of the United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol, and Paris Agreement has facilitated cooperation to share climate information. The First Adaptation Communication (AdCom, 2021) to the UNFCCC details vulnerability assessments and adaptation priorities, sharing data with global partners to strengthen science. The Capacity Building Initiative for Transparency (CBIT), supported by the Global Environment Facility (GEF), enhances institutional capacity by training EPA staff in reporting under the Enhanced Transparency Framework (ETF), with good practices like standardized data collection shared via UNFCCC workshops. Lessons learned, such as the need for sustained funding, are documented in the AdCom and inform future cooperation strategies.

The EU-Liberia Climate Change Alliance, financed under the Development Cooperation Instrument, fosters cooperation with European partners to strengthen science and institutions. This alliance supports climate modeling and policy development, sharing downscaled GCM projections (e.g. CMIP6 data) with the EPA and academic institutions like the University of Liberia. Good practices include joint research on climate impacts, while lessons learned about data accessibility gaps are integrated into the Environmental Knowledge Management System (EKMS) for broader use.

The ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREE) partnership enhances regional cooperation by sharing renewable energy technologies and institutional frameworks with Liberia's Rural and Renewable Energy Agency (RREA). Pilot projects, like the Nimba County microgrid (2022), share technical expertise, with lessons learned about community ownership models strengthening national energy policies. This cooperation also supports adaptation by integrating climate-resilient infrastructure planning.

At the sub-regional level, Liberia's participation in the Sendai Framework for Disaster Risk Reduction (SFDRR) National Action Plan (2016 - 2021) involves cooperation with West African neighbors to share early warning system technologies and institutional strategies. Experiences from flood response pilots in Grand Cape Mount are shared via regional forums, with good practices like community training programmes noted, while lessons on coordination gaps inform the National Disaster Management Policy (2012) updates.

The Climate and Clean Air Coalition (CCAC), joined in 2014, promotes cooperation to reduce short-lived climate pollutants, sharing scientific research on health and agriculture impacts with Liberian institutions. Good practices include pilot projects on clean cooking technologies, while lessons learned about scaling challenges are fed into the NAP 2020–2030, enhancing adaptation strategies.

The UNDP-supported Strengthening Liberia's Climate Information and Services Project collaborates with international experts to improve meteorological data, sharing advanced modeling techniques with the Liberia Institute of Statistics and Geo-Information Services (LISGIS). Institutional capacity is bolstered through training, with experiences like real-time data

dissemination shaping the NAP's MEL Framework (2023), which emphasizes cooperative learning. These efforts are coordinated through the National Climate Change Steering Committee (NCCSC), which shares outcomes via the EKMS and annual reports, ensuring lessons like the need for gender-inclusive science (from the 2019 UNDP gender study) strengthen institutional frameworks.

**5. Strengthening Scientific Research and Knowledge Related to Climate, Including Research and Systematic Observation and Early Warning Systems, to Inform Climate Services and Decision-Making**

Liberia has made significant strides in strengthening scientific research and knowledge on climate issues, aligning with Article 7 of the Paris Agreement. These efforts focus on improving climate data collection, analysis, and dissemination to support early warning systems (EWS), climate services, and informed decision-making across sectors. Information, good practices, experiences, and lessons learned are shared through national communications to the UNFCCC, regional partnerships, and platforms like the Environmental Knowledge Management System (EKMS), ensuring accessibility for policymakers, communities, and international stakeholders.
Key initiatives include:

**i. Strengthening Liberia's Climate Information and Services Project (Completed):** Funded by the Global Environment Facility (GEF) and implemented by the United Nations Development Programme (UNDP) in collaboration with the Environmental Protection Agency (EPA) and the Ministry of Transport's Meteorology Department, this project enhances systematic observation by rehabilitating and expanding hydro-meteorological stations nationwide. It has improved data collection on temperature, precipitation, and extreme weather events, enabling better climate forecasting and EWS for floods and droughts. Good practices include integrating satellite data with ground-based observations for real-time monitoring, which has been shared through UNDP regional workshops in West Africa. Experiences highlight challenges in maintaining rural stations due to infrastructure limitations, with lessons learned emphasizing community training programs where over 200 locals have been trained since 2020 to ensure sustainability. These insights have informed updates to Liberia's National Adaptation Plan (NAP, 2020–2030) and are disseminated via the EKMS, supporting decision-making in agriculture and disaster risk reduction.

**ii. Early Warnings for All (EW4All) Initiative (launched July 2024):** As the first West African nation to launch this UN-led program, supported by the Climate Risk and Early Warning Systems (CREWS) initiative, Liberia is establishing a multi-hazard EWS to protect vulnerable populations from hydrological and meteorological risks by 2027. Coordinated by the EPA, National Disaster Management Agency (NDMA), and partners like the Liberian Red Cross Society (via a five-year MoU), it integrates research on climate projections (using CMIP6 models and delta method downscaling) with mobile alerts and community radio broadcasts. Good practices involve gender-inclusive vulnerability mapping, shared through ECOWAS forums, while lessons learned from pilot implementations in coastal counties (e.g. Grand Cape Mount) underscore the need for redundant communication channels during power outages. Progress reports are submitted to the UNFCCC, aiding global knowledge exchange on EWS in low-capacity settings.

iii. Global Basic Observing Network (GBON) National Contribution Plan (2024): Under the World Meteorological Organisation (WMO), this plan builds on the National Adaptation Programme of Action (NAPA, 2008) to upgrade Liberia's hydro-meteorological network for systematic climate observation. It includes installing automated weather stations and training meteorologists, enhancing data accuracy for climate services like seasonal forecasts. Experiences from initial

deployments reveal integration challenges with existing systems, with lessons learned promoting open-source data platforms for interoperability shared via WMO regional training sessions. This supports decision-making in health (e.g., tracking climate-related diseases) and is referenced in Liberia's revised Nationally Determined Contribution (NDC 3.0, 2021), which commits to establishing an EWS for climate-health threats.

**iv. Research Collaborations and Data Sharing Platforms:** Through the EU-Liberia Climate Change Alliance (ongoing), funded under the EU Development Cooperation Instrument, Liberia conducts joint research on climate impacts using General Circulation Models (GCMs) and shares findings via the EKMS, an online repository launched in 2018 with UNDP support. This platform hosts vulnerability assessments, climate projections, and EWS data, accessible to researchers and communities. Good practices include synchronizing data with international portals like the World Bank Climate Change Knowledge Portal, while lessons learned from user feedback (e.g. 2023 EKMS review) stress the importance of local language translations for broader uptake. These efforts are documented in Liberia's Second National Communication (SNC, 2021) and Adaptation Communication (AdCom, 2021) to the UNFCCC, fostering international cooperation and informing policies like the National Policy and Response Strategy on Climate Change (NPRSCC, 2018)

# N. Information related to Climate Change Impacts and Adaptation under Article 7 of the Paris Agreement

### Introduction

Liberia's commitment to addressing climate change and enhancing its adaptive capacity is evident in its recent efforts to assess and improve its climate resilience. This section highlights critical aspects of Liberia's adaptation journey, including sector-specific capacity building needs, technology transfer requirements, and the integration of gender and vulnerable populations' considerations in climate change adaptation strategies, based on a comprehensive stakeholder assessment conducted in August 2024.

### 1. Capacity Building Needs and Technology Transfer for Climate Adaptation

In 2024, a comprehensive capacity gap assessment was conducted across priority adaptation sectors, revealing critical needs in capacity building and technology transfer. The assessment identified sector-specific requirements essential for enhancing the country's adaptive capacity and improving the Adaptation reporting efforts under the Enhanced Transparency Framework (ETF).

Table 23: Capacity-building needs and technology transfer requirements for key sectors

| Sector | Capacity Building Needs | Technology Transfer Requirement |
|---|---|---|
| Agriculture | Training in climate-resilient farming techniques, crop diversification, water management, and vulnerability assessment methodologies. | Climate-smart irrigation systems, drought-resistant seed varieties, precision farming tools, and GIS mapping technologies for agricultural areas. |
| Fisheries | Training on collecting fish catch data, methods for acquiring data on different fish species in coastal and inland water bodies, and analyzing climate vulnerability data specific to fisheries. | Advanced systems for monitoring ocean temperature and salinity, sustainable aquaculture technologies, and early warning systems for extreme weather events affecting fishing communities. |
| Forestry | Training on methodologies for conducting climate vulnerability assessments specific to the forest sector, and skills to collect, analyze, and interpret data relevant to forest cover change. | Advanced remote sensing technologies for forest monitoring, sustainable forest management tools, and fire management systems. |

| Sector | Capacity Building Needs | Technology Transfer Requirement |
|---|---|---|
| Energy | Training on developing climate scenarios for current and future climate change impacts, grid modernization, and renewable energy integration. | Smart grid technologies, energy-efficient systems, and software tools (e.g., LEAP, MATLAB) for energy system modeling and vulnerability assessment. |
| Coastal Management | Training on integrated coastal zone management (ICZM), including driving forces, land-sea interactions, and the scope of ICZM programs. | Coastal monitoring and erosion control systems, sea-level rise prediction models, and GIS mapping tools for visualizing climate hazards along Liberia's coastline. |

This capacity needs assessment underscored the urgent need for comprehensive capacity enhancing across Liberia's adaptation sectors. By addressing these needs, Liberia can significantly enhance its ability to implement effective climate adaptation strategies, contributing to the goals of the Paris Agreement and improving the country's overall climate resilience.

## 2. Gender Integration in Climate Change Adaptation

Gender-related issues play a crucial role in Liberia's climate change adaptation strategies, as outlined in the Liberia National Gender Policy of 2009). This policy recognizes the disproportionate impact of climate change on women and girls, particularly in rural areas where they are often responsible for agricultural activities and household resource management. Climate change exacerbates existing gender inequalities, making it imperative to integrate gender considerations into adaptation planning and implementation. Liberia has taken steps to integrate gender considerations and address the needs of vulnerable populations in its climate change adaptation plans and implementation.

Table 24: Gender-Sensitive and Inclusive Adaptation Initiatives

| Initiatives | Description | Target Group |
|---|---|---|
| Climate-Resilient Agriculture Program | Women-led community-based projects focusing on drought-resistant crops and water-efficient farming techniques | Women Farmers |
| Coastal Youth Engagement | Training programs in mangrove restoration and sustainable fishing practices | Youth in coastal areas |
| Adaptation Fund Allocation | Mandate that at least 40% of funds benefit women-led or women-focused initiatives | Women-led organizations |
| Inclusive Early Warning Systems | Multi-lingual, multi-format alert systems designed to reach remote communities and people with disabilities | Vulnerable populations |
| Gender Responsive Water Management | Community-based water management projects addressing women's specific needs in water-scarce areas | Women in rural areas |

To track progress in gender integration and inclusivity, Liberia would have to incorporate the following indicators in Table 30 into its adaptation monitoring framework, aligned with the National Gender Policy:

Table 25: Gender-Specific Adaptation Indicators

| Indicator | Target | Alignment with National Gender Policy |
|---|---|---|
| Percentage of adaptation funds allocated to initiatives primarily benefiting women | 40% by 2026 | Addresses gender inequality and promotes women's economic empowerment |
| Number of women and youth trained in climate-resilient livelihood strategies | 10,000 by 2025 | Focuses on reducing socio-cultural discrimination and improving literacy among women |
| Representation of women and vulnerable groups in local and national climate change decision-making bodies | 50% representation by 2027 | Promotes women's leadership and participation in governance |
| Reduction in time spent by women and girls collecting water in climate-vulnerable areas | 30% reduction by 2028 | Addresses gender-based disparities in resource access and time poverty |
| Number of gender-responsive climate adaptation plans developed at county level | All 15 counties by 2026 | Ensures gender mainstreaming in local climate policies |

These initiatives and indicators demonstrate Liberia's commitment to integrating gender considerations into its climate change adaptation strategies, as per MPG recommendations. They address the unique vulnerabilities of women, youth, and other marginalized groups, while also promoting their active participation in climate resilience efforts. The National Adaptation Plan (NAP) process further reinforces this commitment by:

- Conducting gender-specific vulnerability assessments, as evidenced by the 2019 UNDP-supported study on gender and social impacts of climate change
- Aligning with international commitments such as CEDAW and SDG 5 on Gender Equality
- Implementing gender-responsive monitoring and evaluation systems to ensure gender is adequately reflected in all climate change adaptation plans, programmes, and projects.

By prioritizing gender integration and inclusivity in its adaptation strategies, Liberia aims to address the disproportionate impacts of climate change on vulnerable populations while promoting gender equality and social equity in its climate resilience efforts.

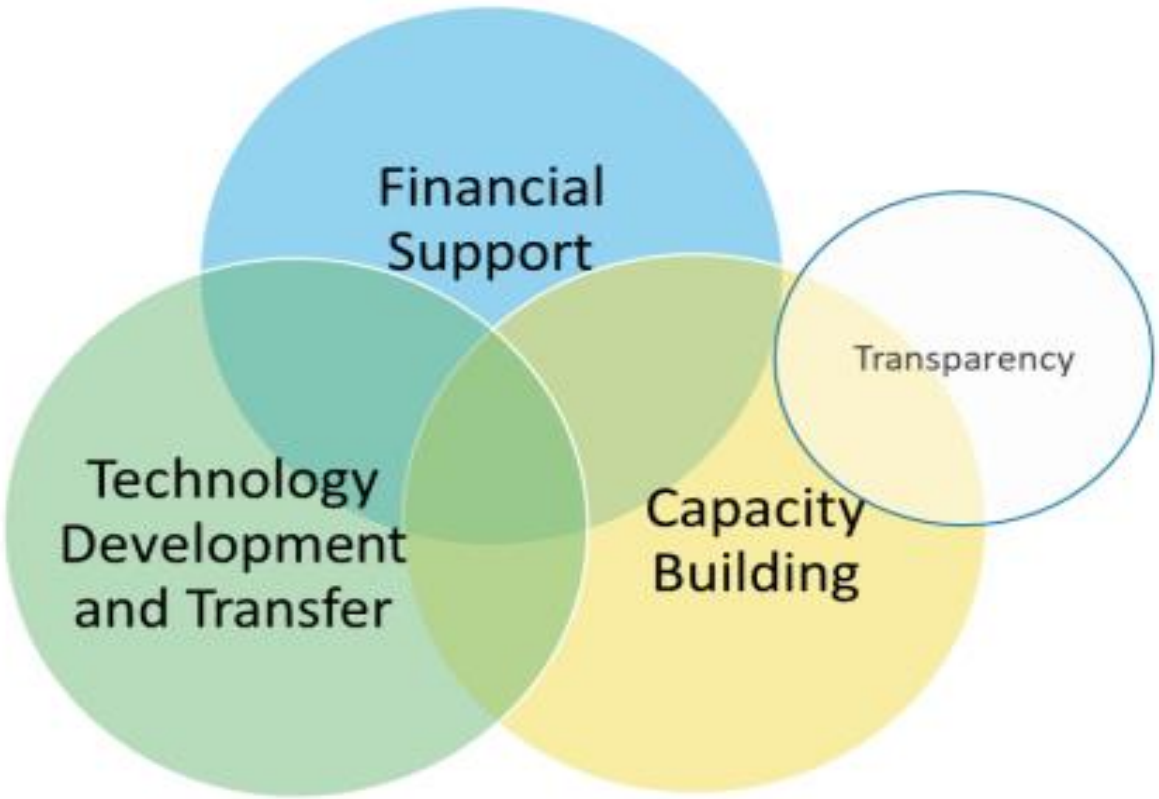
## 3. Adaptation Gaps and Capacity Needs

Capacity-building needs in the context of gender and climate change adaptation are significant to Liberia's adaptation. There is a pressing need to enhance women's participation in decision-making processes related to climate change adaptation at all levels, from local communities to national policy-making. This includes providing training and education on climate-resilient agricultural practices, sustainable resource management, and alternative livelihood strategies. Additionally, efforts should be made to increase women's access to climate information, early warning systems, and adaptive technologies to enhance their resilience to climate impacts.

Research plays a vital role in understanding and addressing the gendered impacts of climate change in Liberia. There is a need for more gender-disaggregated data and analysis to inform evidence-based policy-making and adaptation strategies. Research should focus on understanding the specific vulnerabilities and adaptive capacities of women and men in different sectors and regions of Liberia. Furthermore, studies should explore traditional knowledge and practices that can contribute to climate resilience, with a particular emphasis on women's roles in environmental conservation and sustainable resource management. Such research is crucial in developing targeted and effective gender-responsive adaptation measures for Liberia.

# IV. INFORMATION ON FINANCIAL, TECHNOLOGY DEVELOPMENT AND TRANSFER AND CAPACITY-BUILDING SUPPORT

**Information on financial, technology development and transfer and capacity-building support needed and received under the Paris Agreement**



## A. National Circumstances, Institutional Arrangements and Country-Driven Strategies

This section includes a summary of Liberia's national circumstances with respect to climate change for the purpose of this chapter. Liberia's national circumstances are described in detail in chapter 4 of the country's National Adaptation Plan (NAP, 2020-2030). In addition, chapter 1 of Liberia's Second National Communication (SNC, 2021) to the UNFCCC provides a narrative description of the national circumstances in regard to climate change, including national geography, system and structure of governance, population, weather and climate, and economic profile. 1.1 National circumstances Liberia is situated on the West Coast of Africa and is bounded by longitude 7° 18' to 11° 30' West and latitude 4° 20' to 8° 30' North. The country covers an area of 111,370 square km with a coastal belt about 570 km in length, extending 149 km inward. The country is bordered by Guinea on the North, Côte d'Ivoire on the East, Sierra Leone on the West and the Atlantic Ocean on the south (EPA, 2021c).

According to Liberia's Institute of Statistics and Geo-Information Services (LISGIS) 2008 census, the population of the country was 3.48 million. Liberia's estimated population in 2018 was 4,809,768 (LISGIS, 2021). Liberia's NAP 2020-2030 explains that the climate of Liberia is predominantly equatorial with four distinct elevation zones: the coastal belt, the rolling hills, the plateaus and the northern highlands. Generally, Liberia experiences two seasons due to the movement of the inter-tropical convergence zone: a wet season which usually falls between May and November and a dry season which runs between December and April during which time the dry and dusty harmattan winds blow off the Sahara Desert. As an exception, the southernmost parts of the country receive rainfall almost throughout the year. The average annual precipitation for Liberia is 2,500 mm, but there are some regional variations.

Liberia's NAP explains that average rainfall is higher in coastal areas where it exceeds 3,000 mm annually and decreases towards the country's interior. In Monrovia, for example, precipitation reaches 5,000 mm per year, with maximum amounts in June and July when nearly 1,000 mm of rain falls each month, with decreases in the month of August (EPA, 2013). The country's mean annual precipitation has decreased since 1960. From 1961 to 2016, the country's mean monthly precipitation varied from 27 mm in January to 400 mm in September. Temperatures in Liberia are highly influenced by the seasons. Nationally, temperatures during the rainy season are relatively low because of near-complete cloud cover, and slight diurnal variation occurs. From 1970 to 1999, temperatures typically ranged from 24 °C to 25 °C during the wet season and 24 °C to 27 °C during the dry season.

National temperature information collected from the Robert International Airport weather station between 2009 and 2012 showed a variation in temperature from 23 °C to 33 °C annually. Liberia's NAP includes projections of future trends for temperature and precipitation that show that Liberia will continue to be affected by changing climatic conditions. Global Climate Modeling data indicates that the mean annual temperature is projected to increase by 1.8 °C between 2040 and 2059. The RCP 8.5 (high greenhouse gas emissions scenario) projects 44 additional hot days with temperatures above 35 °C by mid-century, while the daily maximum temperatures are projected to increase by 1 °C to 2 °C. The number of hot nights is also expected to increase by 37 nights by mid-century, meaning that 89% of all nights will be hot, and by 49 nights by the end of the century, meaning that 95% of all nights will be hot. Average temperatures are estimated to increase by 1.54 °C in 2050 and 1.90 °C in 2080, thus warming Monrovia during the dry season by 1.30 °C by 2050 and by 1.85 °C by 2080 during the wet season.

Nimba is projected to warm by an average temperature of 1.50 °C by 2050 and 2.13 °C by 2080 during the dry season. The southeastern region, especially the Sapo National Park, is projected to warm slightly, with an estimated average increase of 1.44 °C by 2050 and 1.95 °C by 2080 during the dry season; and an increase of 1.29 °C by 2050 and 1.73 °C by 2080 in the wet season. Liberia's NAP indicates that the Regional Climate Models (RCMs) were used to project Liberia's climate from 2010 to 2050, and the mean air temperature is expected to increase by 0.4 °C to 1.3 °C. Furthermore, the EPA (2013) estimated that the average increase in temperature in the 2020s would be 0.6 °C; and temperature would increase by a cumulative total of 1.3 °C by the middle of the 21st century (EPA, 2018).

In order to properly implement and coordinate climate change initiatives across all sectors at both national and sub-national levels, various institutions play a role in the planning and implementation of climate change activities in the country, as illustrated in Figure 46. A brief description is included below, and more detailed information about Liberia's institutional arrangements for climate change is available in chapter 1.6 of Liberia's SNC. The National Climate Change Steering Committee (NCCSC) is responsible for overall climate change activities in Liberia. The NCCSC is the overarching institutional structure which has the mandate to coordinate and supervise the implementation of the climate change policy. Established by the President in October 2010, the committee is chaired by the Minister of Finance and Development Planning (MFDP), and its 16 members provide high-level policy coordination and oversight.

While current impacts of climate change are indicative of how it might negatively affect Liberia, the general trend in the increase in climate-related natural disasters indicates that failing to take measures to prepare for and respond to climate change impacts will be costly in social, economic, ecological and environmental terms. An important step in being ready to address the impacts of climate change, either through adaptive or mitigate actions, involves having a functioning institutional structure to coordinate climate change initiatives across all sectors at the national and sub-national levels.

However, current governance structures and institutional arrangements are inadequate for facing the inherent challenges of addressing climate change. An effective institutional arrangement must, therefore, seek to establish the political basis through which social, economic, ecological and environmental vulnerabilities associated with climate-related risks are addressed. Consequently, the arrangement designed for implementation of the climate change policy focuses on enhancing risk management for extreme events such as coastal erosion, flood, pest infestation, disease outbreak, and reduced agricultural productivity. This is done by considering the appropriate institutional arrangements and regulatory frameworks that might be effectively developed to meet the challenges associated with climate change.

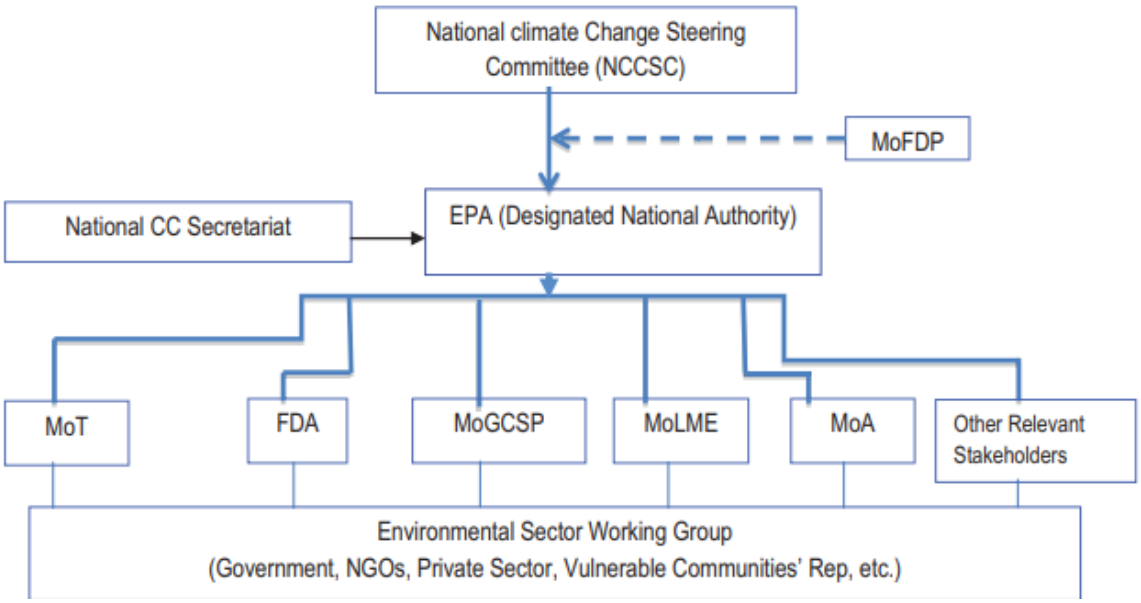



*Figure 42 Instructional Arrangement*

Source: National Climate Change Policy and Response Strategy of Liberia

Financial support is critical for Liberia to implement its NDC effectively. The country requires funding for various initiatives, including renewable energy projects, reforestation programmes, and capacity-building measures to enhance local governance structures for environmental management. According to recent reports, Liberia has received financial assistance through international mechanisms such as the Green Climate Fund (GCF) and through bilateral agreements with countries like Germany and Norway. However, the scale of funding remains insufficient for the comprehensive implementation of climate strategies.

## 1. Technology Development and Transfer

In the Paris Agreement, transparency under Article 13 is key to fulfilling reporting obligations. Technology transfer is another essential component for Liberia's climate action under the Paris Agreement. The country seeks access to advanced technologies that can improve agricultural productivity while minimising environmental impact.

Between 2017 and 2022, significant efforts have been made by Liberia to facilitate technology transfer initiatives which align with the local needs and capabilities. Amongst them include: An invocation hub established at the University of Liberia. It is a state-of-the-art Center of Innovation called UNIPoDs for students and faculty alike. The Centre of Innovation includes high-tech computer hardware, applications, a digital centre, an equipped computer laboratory, a corps of qualified and competent trainers and personnel to transfer the requisite skills to students and enhance faculty knowledge of the platform.

Through the Global Environment Facility and UNEP DTU Partnership, Liberia completed its Technology Needs Assessment and Technology Action Plans, identifying and prioritizing climate technologies in the energy and coastal adaptation sectors, and developing project concepts for implementation (UNFCCC, 2019; Wilson, 2021).

Technical assistance was provided through the Climate Technology Centre and Network to strengthen national capacity for technology planning and urban resilience, while the World Bank's Liberia Renewable Energy Access Project supported the deployment and diffusion of renewable energy technologies (World Bank, 2024).

The updated Nationally Determined Contribution (Republic of Liberia, 2021) integrates technology transfer and capacity-building priorities and outlines measures to track technology support received. Though, information on technology support received remains partial, with ongoing efforts to enhance national systems for monitoring, reporting, and verifying support for technology development and transfer in line with the Enhanced Transparency Framework (UNFCCC, 2022).

Support received through the CTCN and multilateral partners has enhanced national technical and institutional capacities, promoted knowledge exchange, and strengthened Liberia's ability to plan, adapt, and implement context-appropriate climate technologies. Most support to Liberia has focused on the demonstration, deployment, and diffusion stages, particularly in renewable energy and coastal adaptation technologies, with limited engagement in early-stage research and development (World Bank, 2024; UNFCCC, 2022).

**2. Capacity-Building Support**

Article 11 of the Paris Agreement- "Capacity Building" mentions that capacity building should be country-driven, based on and responsive to national needs, and foster country ownership of Parties, in particular, for developing country Parties and those that are particularly vulnerable to the adverse effects of climate change, such as small island developing States, to take effective climate change action, including, inter alia, to implement adaptation and mitigation actions, and should facilitate technology development, dissemination and deployment, access to climate finance, relevant aspects of education, training and public awareness, and the transparent, timely and accurate communication of information. During the reporting period under review (2017-2022) Liberia received several capacity building support including:

- Through funding support from the Green Climate Fund (GCF) to Liberia as part of country's National Adaptation Plans (NAP) process, in 2019 a graduate and undergraduate programme was established at the University of Liberia to offer students tertiary degrees in Environmental Science, Climate Change and Biodiversity
- As part of a 1.3 million USD grant from the Global Environment Facility, the Government of Liberia through the Environmental Protection Agency of Liberia and Conservation International implemented the Capacity Building Initiative for Transparency (CBIT);
- Liberia received capacity-building support from the Initiative for Climate Action Transparency (ICAT). ICAT supported Liberia to assess GHG and sustainable development impacts of mitigation policies, review NDC targets and develop tools and indicators to track the NDC progress in the transport, waste and energy sectors;
- Liberia also entered an agreement with the Greenhouse Gas Management Institute (GHGMI) to provide capacity building support to Liberian experts on greenhouse gas inventory reporting;
- The Least Development Countries University Consortium has also provided and continues to provide support to the University of Liberia, including other tertiary institutions in Liberia;
- The University of Liberia, through bilateral support from the Government of Canada, has provided long-term capacity-building opportunities for Liberian students to acquire specialized post-graduate certificates and diploma in climate action.

Table 26 key Initiatives, national policies, strategies and frameworks

| National Strategy/Policy | Description and relation to finance, technology Development and Transfer and Capacity Building |
|---|---|
| **Liberia's Revised Nationally Determined Contribution, 2021** | The NDC shows that Liberia recognizes the current and future threats of climate change. The document describes some efforts and initiatives that have been undertaken by Liberia to address climate change threats. The revised NDC includes climate change adaptation targets for eight sectors: Agriculture, Forests, Coastal zones, Fisheries, Health, Transport, Energy and Waste; as well as crosscutting targets for urban green corridors. In the revised NDC, Liberia commits to reducing its economy-wide greenhouse gas emissions by 64% below the projected business-as-usual level by 2030, through a combination of the following: unconditional greenhouse gas reductions of 10% below business-as-usual, resulting in an absolute emissions level of 11,187Gg $CO_2$ e in 2030; with an additional 54% reduction conditional upon international support, which would result in an absolute emissions level of 4,537Gg $CO_2$ e in 2030. The NDC outlines a national system for monitoring and evaluation (M&E) for adaptation actions, and measurement, reporting, and verification (MRV) for mitigation actions. It states the policy and institutional arrangements for NDC implementation, includes an analysis of the co-benefits of adaptation and mitigation, and highlights the direct and indirect investment needed to implement the NDC. EPA. (2021). Liberia's Revised Nationally Determined Contribution. Submitted to the UNFCCC on August 4, 2021. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/ Liberia%20First/Liberia's%20Updated%20NDC_RL_FINAL%20(002).pdf |
| **Liberia National Adaptation Plan 2020 -2030** | The purpose of the document is to provide an overall framework to guide Liberia in developing, coordinating and implementing its National Adaptation Plan. The NAP process will implement a sectoral-based approach to climate change adaptation planning in Liberia, with adaptation priorities identified for crucial sectors such as agriculture, forestry, energy, fisheries, coastal zones and waste management. The NAP process also outlines the alignment between existing national, regional, and international policies and legal frameworks. The objectives of this NAP process are to: -Provide a framework and procedures for sharing of information of scientific, technical, and traditional knowledge on climate change risk management; and develop capacity-building measures; -Coordinate sectors (including both public and private sector stakeholders), institutions, and universities on climate change risk management using awareness with a focus on the improvement of climate risk management actions; and -Encourage participation from sector stakeholders and line agencies responsible for key sectors to identify and propose measures to promote adaptation to reduce climate change risk. EPA. (2021). Liberia National Adaptation Plan 2020-2030. |
| **Liberia's Second National Communication (SNC) the UNFCCC, 2021** | The SNC is a reporting activity that is required by Article 12 of the Convention and based on COP 8 Guidelines for National Communications for Non-Annex 1 Parties (Decision 17/CP.8). The SNC also enhances general awareness and knowledge on climate change related issues in Liberia. Liberia's Second National Communication gives an account of many climate change adaptation and mitigation initiatives and efforts undertaken in the country. Liberia's SNC includes: climate change vulnerability and adaptation assessment, national greenhouse gas inventory, greenhouse gas mitigation assessment, climate change technology transfer, and development assessment and capacity building to address climate change-related impacts. EPA. (2021). Liberia's Second National Communication to the UNFCCC. https://unfccc.int/sites/default/files/resource/SNC.pdf |
| **Pro-Poor Agenda for Prosperity and Development (PAPD) 2018- 2023** | The PAPD is a five-year national development plan aimed at addressing the basic needs of Liberians for income security, better access to basic services and greater opportunities for self-improvement in an enabling environment that is inclusive and stable. Its long-term goal is to raise the per capita income levels and economic status of Liberia to a middle-income country, as outlined under the Vision 2030 framework. The PAPD aligns with the African Union Agenda 2063 and Sustainable Development Goals (SDGs) across all three sustainability dimensions: economic, social and environmental with a special emphasis on human development and peace. Ministry of Finance and Development Planning. (2018). Pro-Poor Agenda for Prosperity and Development (2018-2023). https://globalnaps.org/wp- |

| National Strategy/Policy | Description and relation to finance, technology Development and Transfer and Capacity Building |
|---|---|
| | content/uploads/2019/01/liberia-nationaldevelopment-agenda-pro-poor-agenda.pdf |
| **National Policy and Response Strategy on Climate Change (NPRSCC), 2018** | The policy and strategy document ensures that climate change adaptation and mitigation issues are mainstreamed at the policy level and in key sectorial and cross-sectorial development efforts. The NPRSCC includes concrete policies and measures in specific areas on climate change adaptation and mitigation, actions, resource mobilization plans, and an M&E framework. EPA. (2018). National Policy and Response Strategy on Climate Change. https://epa.gov.lr/content/national-policy-and-response-strategy-climate-change |
| **Technology Needs Assessment Report Liberia, Technology Action and Barrier Analysis** | The Assessment, Action Plan and barrier analysis are a set of activities that identify and analyze climate change mitigation and adaptation technology https://tech-action.unepccc.org/country/liberia/ |
| **Capacity Building Initiative for Transparency** | The goal is to increase awareness and communicate the successes about efforts toward achieving the transparency elements of the UNFCCC. The CBIT project sort to strengthen the institutional and technical capacities of developing countries to meet the enhanced transparency requirements in the Paris Agreement https://climate-transparency-platform.org/cbit-projects/building-and-strengthening-liberias-national-capacity-implement-transparency-elements |
| **Monitoring, Evaluation and Learning Framework for National Climate Change Adaptation** | The MEL system will be aligned with Liberia's NAP process and will help to track the progress of implementation on prioritized actions set in the National Adaptation Plans-NAP. liberia-MEL-system-brief-final-final.pdf |

## B. Findings from National Assessment on the Institutional Arrangement

The national assessment regarding institutional arrangements for reporting support needed and received, as well as resource mobilization related to Articles 9-11, is a critical evaluation aimed at understanding how effectively countries are implementing their commitments under international agreements. Articles 9-11 often pertain to obligations around environmental protection, sustainable development, or similar frameworks depending on the specific treaty or agreement being referenced (reference specifics; GEF, Adaptation Funds, LDC funds, establishment of climate desk at the MFDP, establishment of a climate desk at CBL, etc). The national assessment involved a comprehensive review of existing institutional frameworks, stakeholder engagement, data collection methods, and analysis of reporting mechanisms. This took into account:

- Stakeholder Identification: Identifying key stakeholders involved in resource mobilization and support reporting, including government agencies, NGOs, and international organisations;

- **Data Collection:** Gathering quantitative and qualitative data on resources mobilized (financial, technical assistance) and needs identified by various sectors;
- **Analysis of Reporting Mechanisms**: Evaluating how information is reported at national levels versus international obligations. This includes assessing transparency, accountability, and accessibility of reports;
- **Evaluation of Institutional Capacity:** Assessing whether existing institutions have the capacity to manage resources effectively and report accurately on needs and support received.

**Findings from the Assessment**

- **Institutional Frameworks:** The assessment generally revealed that Liberia has an established institutional framework that align with Articles 9-11; however, gaps do exist in coordination among different agencies responsible for implementation such as the Ministry of Agriculture, Ministry of Mines and Energy, Forestry Development Authority, Ministry of Internal Affairs, Ministry of Commerce and Industry, National Fisheries and Aquaculture Authority, etc.
- **Reporting Practices**: Liberia continues to struggle with consistent reporting due to varying definitions of what constitutes 'support' or 'needs.' This inconsistency has led to challenges in resource mobilization efforts;
- **Resource Mobilization Challenges**: The assessment showed that there are significant challenges in mobilizing adequate resources due to economic constraints or lack of political will. In most instances Liberia tends to report high needs but receive limited external support.

## 1. Description of Underlying Assumptions Made, Definitions and the Adopted Methodologies

The underlying assumptions regarding financial, technology development and transfer, and capacity-building support under the Paris Agreement for Liberia include:

**Commitment to Climate Goals**: It is assumed that Liberia is committed to achieving its Nationally Determined Contributions (NDCs) as outlined in its climate action plans (be more specific about the commitments made so far concerning reducing GHG and target set, implementation plan developed, and financing strategy, etc). This includes reducing greenhouse gas emissions and enhancing resilience to climate impacts;

**International Cooperation:** The assumption is that there will be ongoing international cooperation among countries, particularly developed nations providing support to developing nations like Liberia in terms of finance, technology transfer, and capacity building (provide specific information on financing mechanisms mentioned above and technology transfer intervention outlined in the TNA, etc;

**Availability of Resources:** It is assumed that sufficient financial resources will be mobilized from both public and private sectors globally to meet the needs identified in Liberia's climate strategies;

Cap**acity for Implementation:** There is an assumption that local institutions have or will develop the necessary capacity to effectively implement projects funded through international support (reference specific capacity building intervention and their implementation impacts).

**a. Definitions**

- Financial Support: Refers to funding provided by developed countries or international organisations aimed at helping Liberia achieve its climate goals. This can include grants, loans, or investments specifically earmarked for climate-related projects;
- **Technology Development and Transfer:** This involves the process of developing new technologies or adapting existing ones that can help mitigate climate change effects or enhance adaptation strategies. It also encompasses transferring these technologies from developed countries to Liberia;
- **Capacity-Building Support:** This refers to efforts aimed at strengthening the skills, competencies, and abilities of individuals and institutions in Liberia so they can effectively engage in climate action initiatives.

**b. Adopted Methodologies**

The methodologies adopted for assessing the financial needs and capacities under the Paris Agreement include:

- **Needs Assessment Reports:** These reports are prepared by national authorities in collaboration with international partners to identify specific financial requirements for implementing NDCs;

- **Stakeholder Engagement Processes:** Engaging various stakeholders, including government agencies, civil society organisations, private sector actors, and communities, helps ensure that the methodologies reflect diverse perspectives on needs and priorities;

- **Monitoring & Evaluation Frameworks:** Establishing frameworks allows for tracking progress on received support versus what was needed. This includes indicators related to financial flows, technology uptake rates, and capacity improvements over time;

- **Partnership Models:** Collaborations with international organisations such as the United Nations Framework Convention on Climate Change (UNFCCC), Global Environment Facility (GEF), Green Climate Fund (GCF), etc., are crucial for leveraging additional resources.

**c. Financial Needs Identified**

Liberia has identified significant financial needs associated with various sectors impacted by climate change, including agriculture, forestry, energy production, water resources management, health systems strengthening, infrastructure development, etc. The country's Nationally Determined Contributions (NDC 2.0, 2021) outlined specific targets which require substantial investments. The full implementation of Liberia's Climate Change Actions was put at $491 million through 2025. It is important to note that a substantial portion of the proposed financing, about 82% lean towards mitigation efforts, while a smaller fraction addresses adaptation needs.

d. **Technology Development Needs**

The Technology Needs Assessment (TNA) conducted for Liberia outlines the country's specific technology development needs from 2017 to 2022. This assessment is crucial for identifying the technologies that can help Liberia reduce greenhouse gas emissions and adapt to climate change, while also aligning with national sustainable development objectives.

**Key Areas Identified in the TNA**

- **Agriculture and Food Security**

The TNA emphasizes the need for improved agricultural technologies to enhance food security. This includes adopting climate-resilient crop varieties, efficient irrigation systems, and sustainable farming practices. By integrating these technologies, Liberia can mitigate the impacts of extreme weather events on food production.

- **Energy Sector Development**

A significant focus is placed on renewable energy technologies, particularly solar and wind energy. The TNA identifies the necessity for expanding access to electricity in rural areas through sustainable energy solutions. This aligns with Liberia's goal of achieving universal access to modern energy services.

- **Water Resource Management**

Technologies that improve water management are critical due to the vulnerabilities associated with climate change. The TNA highlights the need for efficient water conservation techniques and infrastructure improvements to ensure reliable access to clean water.

**Infrastructure Resilience**

The assessment points out that infrastructure development must incorporate climate resilience measures. This includes using advanced materials and construction techniques that can withstand extreme weather conditions, thereby protecting communities and economic activities.

- **Health Sector Technologies**

Enhancing health care delivery through telemedicine and mobile health applications is another area identified in the TNA. These technologies can improve access to health services, especially in remote areas, thus contributing to better health outcomes.

- **Education Technology**

The TNA recognizes the importance of integrating information and communication technologies (ICT) into education systems. This includes developing e-learning platforms and improving digital literacy among both students and teachers to foster a knowledge-based economy.

- **Disaster Risk Reduction Technologies**

Given Liberia's susceptibility to natural disasters, there is a need for technologies that enhance disaster preparedness and response capabilities. This encompasses early warning systems and data management tools that can help mitigate risks associated with climate change.

**e. Capacity-Building Requirements**

Liberia's capacity building requirements from 2017 to 2022, particularly in the context of its Biennial Transparency Report (BTR) and National Climate Change circumstances, are critical for

enhancing the country's ability to meet its commitments under the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement. The need for capacity building arises from Liberia's vulnerabilities to climate change, its low readiness levels, and the necessity for effective implementation of climate policies.

**Key Areas for Capacity Building**

**Data Collection and Management:**

Liberia requires improved systems for collecting, managing, and analyzing climate-related data. This includes establishing robust databases that track greenhouse gas emissions, climate impacts, and adaptation measures.

Enhanced monitoring systems will enable better reporting on progress towards national targets and compliance with international obligations.

**Technical Expertise Development:**

There is a pressing need to develop technical expertise within government agencies responsible for climate policy implementation. Training programmes should focus on areas such as climate science, environmental management, and sustainable development practices.

Collaborations with international organisations can facilitate knowledge transfer and skill development.

**Institutional Strengthening:**

Strengthening institutions like the Environmental Protection Agency (EPA) is essential for effective governance of climate change initiatives. This includes enhancing their regulatory frameworks and operational capacities.

Establishing clear roles and responsibilities among various stakeholders involved in climate action will improve coordination efforts.

**Public Awareness and Engagement:**

Raising public awareness about climate change impacts and adaptation strategies is vital. Capacity building efforts should include community engagement programmes that educate citizens on sustainable practices.

Involving local communities in decision-making processes can enhance resilience at the grassroots level.

**Financial Management Skills:**

Developing skills related to financial management is crucial for effectively utilizing international funding sources such as the Green Climate Fund (GCF). This includes training on project proposal writing, budgeting, and financial reporting.

Ensuring transparency in financial transactions will build trust with international partners.

**Policy Formulation and Implementation:**

Capacity building should also focus on enhancing policy formulation processes to ensure they are evidence-based and aligned with national development goals.

Training policymakers in adaptive management techniques will help them respond effectively to changing climatic conditions.

## 2. Least Developed Countries University Consortium and How Liberia Can Leverage on Capacity Building Efforts

The Least Developed Countries Universities Consortium on Climate Change (LUCCC) is a collaborative network aimed at enhancing research capacity and expertise in climate change among universities in the least developed countries (LDCs). This initiative was established to foster South-South collaboration, enabling universities from LDCs to share knowledge, develop common research projects, and implement training programs focused on climate change

adaptation. The consortium emphasizes community-based adaptation strategies, which are crucial for vulnerable regions like Liberia.

**Capacity Building Needs in Liberia**
Liberia faces significant challenges related to climate change, including rising sea levels, increased flooding, and erosion that threaten coastal communities. The country has been working towards building its capacity to address these issues through various initiatives. However, there remains a pressing need for enhanced local expertise and institutional frameworks to effectively manage climate risks.

**Current Capacity Building Initiatives**
**National Adaptation Plans:** Liberia has formulated its National Adaptation Plans (NAPs) to address its vulnerabilities to climate change. These plans require robust implementation strategies supported by trained personnel who understand both local contexts and global best practices.

**Collaborative Programs:** Various international organizations have partnered with local institutions to create tailored capacity-building programs that focus on urban management, waste management, and water provision. These programs aim to equip local officials with the necessary skills to manage resources sustainably.

**Community Engagement:** Engaging local communities in climate action is essential for effective adaptation strategies. Training programs that involve grassroots participation can empower communities to take ownership of their adaptation efforts.

**Role of LUCCC in Facilitating Capacity Building**
The LUCCC can play a pivotal role in addressing Liberia's capacity building needs through several mechanisms:

**1. Knowledge Sharing and Research Collaboration**
LUCCC facilitates knowledge exchange between universities across LDCs, allowing Liberian institutions to benefit from shared experiences and research findings related to climate change adaptation. This collaboration can lead to the development of localized solutions that are culturally relevant and context-specific.

**2. Training Programs Focused on Local Contexts**
By leveraging its network, LUCCC can help design training programs that are specifically tailored for Liberia's unique environmental challenges. These programs can cover topics such as sustainable agriculture practices, coastal management techniques, and disaster risk reduction strategies.

**3. Strengthening Institutional Frameworks**
LUCCC can assist in strengthening the institutional frameworks within Liberia by providing technical support and resources needed for effective policy implementation related to climate change adaptation. This includes enhancing the capabilities of government agencies responsible for environmental management.

**4. Promoting Community-Based Adaptation Strategies**

The consortium emphasizes community-based approaches which align well with Liberia's needs for grassroots involvement in climate action. By supporting initiatives that engage local populations in decision-making processes, LUCCC can help ensure that adaptation measures are more effective and sustainable.

**5. Accessing Funding Opportunities**

LUCCC can also facilitate access to funding opportunities from international donors by helping Liberian universities develop competitive proposals for climate-related projects. This financial support is crucial for implementing capacity-building initiatives effectively.

## C. Financial Support Received and Needed to Implement the Article 9

Article 9 of the Paris Agreement emphasizes the importance of financial support for developing countries, including Liberia, to mitigate and adapt to climate change. It establishes a framework for developed countries to provide financial resources, with a goal of mobilizing $100 billion per year by 2020 and continuing through 2025. This funding is essential for implementing climate action plans that align with national commitments under the agreement.

### 1. Financial Support Received by Liberia

Between 2019 and 2022, the average total climate finance flow to Liberia was US$ 112 million, lower by 39 percent than what was reported in Liberia's Climate Focus Report (CFR, 2022). Public sources account for 84 percent of the total flow and private funds account for 16 percent. Multilateral development financial institutions account for 39 percent of the public climate finance flows, government accounts for 33 percent and multilateral climate funds account for 19 percent.

The revised Nationally Determined Contribution (NDC) estimates that achieving the country's climate change goals between 2023 and 2025 will require US$ 490 million, which translates to US$ 163.3 million annually. However, Liberia currently receives less than 0.0038 percent of total climate finance flows to Africa, which total US$ 112 million annually, well below the relative size of the economy in the continent (0.1 percent of total GDP). This means that the climate finance gap in Liberia is US$ 51.3 million. Of the total amount needed, US$ 400.6 million dollars will be required to achieve Liberia's mitigation targets, whilst US$ 89.9 million dollars will be required to achieve its adaptation targets

Between 2017- 2022, Liberia has received various forms of financial support aimed at addressing climate change. The country has benefited from international funding mechanisms such as:

| No | Source of Funding Received | Area of Intervention | Amount Received to 2023 |
|---|---|---|---|
| 1 | Green Climate Fund | Enhancing resilience and reducing emissions. | 30 million |
| 2 | Global Environment Facility | biodiversity conservation and sustainable land management | $20 million. |
| 3 | Bilateral Aid | forest conservation efforts in Liberia | $150 million |
| 4 | Multilateral Development Banks | climate resilience and adaptation strategies | $ 50 million |

Overall, while these figures indicate some level of financial support received by Liberia, they still fall short when compared to the comprehensive needs outlined in its Nationally Determined Contributions (NDCs) under the Paris Agreement.

## 2. Financial Support Needed by Liberia

To effectively implement Article 9 and achieve its Nationally Determined Contributions- NDCs, Liberia requires substantial additional funding. Estimates suggest that:

**Total Funding Needs:** According to various assessments conducted by environmental organizations and governmental bodies, it is estimated that Liberia will need between $300 million to $500 million annually until 2030 to adequately address both mitigation and adaptation measures related to climate change (reference the document stating figures).

**Specific Areas of Need:**

- **Adaptation Projects:** Significant investment is needed in areas such as agriculture (to enhance food security), infrastructure development (to withstand extreme weather events), and health systems (to manage climate-related health risks);
- **Mitigation Efforts:** Investments are required for renewable energy projects (such as solar and hydropower) and reforestation initiatives aimed at reducing greenhouse gas emissions;
- **Capacity Building:** Funds are also necessary for training local communities and government officials on sustainable practices and effective implementation of climate policies.

Despite these needs being clearly articulated, challenges remain in securing adequate financing due to factors such as bureaucratic hurdles, lack of project readiness, limited access to international funds, and competing priorities within donor countries. In summary, while Liberia has received some financial support towards implementing Article 9 of the Paris Agreement, there remains a significant gap between what has been received and what is needed for comprehensive action against climate change.

## 3. Technological Support Received and Needs under the Article 10 of the Paris Agreement

Article 10 of the Paris Agreement emphasizes the importance of technology development and transfer to support developing countries in their efforts to mitigate climate change and adapt to its impacts. This article recognizes that access to technology is crucial for these nations, particularly in achieving their Nationally Determined Contributions (NDCs) and enhancing resilience against climate-related challenges. Liberia, as a developing country, has received various forms of technological support aimed at addressing climate change. The following points summarize the key areas where Liberia has benefited from technological assistance:

- **Capacity Building Initiatives:** Various international organisations, including the United Nations Development Programme (UNDP) and the Global Environment Facility (GEF), have provided training programmes aimed at enhancing local capacities in climate change adaptation and mitigation technologies;
- **Renewable Energy Projects:** Liberia has engaged in projects focused on renewable energy, particularly solar energy. For instance, initiatives supported by international

donors have led to the installation of solar panels in rural areas, providing electricity to communities that previously lacked access;

- **Forest Management Technologies:** Given Liberia's rich biodiversity and significant forest cover, there have been efforts to implement sustainable forest management practices. Technological support has included satellite monitoring systems for deforestation tracking and community-based forestry management tools.
- **Climate Resilience Programs**: The government has received technical assistance for developing climate resilience strategies, which include agricultural technologies that promote sustainable farming practices and enhance food security;
- **Partnerships with NGOs:** Non-governmental organizations have played a vital role in providing technological support through innovative solutions tailored to local contexts, such as water purification systems and efficient cooking stoves.

Despite receiving some technological support, Liberia still faces significant challenges that necessitate further assistance under Article 10 of the Paris Agreement:

- **Advanced Climate Modeling Tools**: There is a need for sophisticated climate modeling software that can help predict future climate scenarios specific to Liberia's geographical context. This would aid in better planning and resource allocation for adaptation measures;

- **Infrastructure Development Technologies**: In Liberia, there is an urgent need for technologies that can improve infrastructure resilience against extreme weather events, including flood-resistant construction techniques;

- **Access to Financial Resources for Technology Transfer**: While some funding mechanisms exist, there is a pressing need for more accessible financial resources specifically earmarked for technology transfer initiatives that align with national priorities;

- **Research and Development Capacity:** Strengthening local research institutions is critical for fostering innovation tailored to Liberia's unique environmental challenges. This includes investment in education and training programs focused on environmental science and engineering;

- **Integration of local and traditional Knowledge with Modern Technologies**: There is a recognized need for integrating indigenous knowledge systems with modern scientific approaches to create more effective solutions tailored to local conditions;

- **Monitoring and Evaluation Systems**: Developing robust monitoring frameworks will enable better assessment of technology implementation outcomes, ensuring accountability and continuous improvement in strategies employed;

- **Collaboration with Private Sector Entities**: Engaging private sector players who specialize in green technologies can facilitate knowledge transfer and investment into sustainable projects within Liberia.

## 4. Information on Capacity-Building Support Received and Needed under Article 11 of the Paris Agreement (reference Existing Support Received and Ongoing During the Reporting Period)

Article 11 of the Paris Agreement emphasizes the importance of capacity-building support for developing countries, including Liberia, to enhance their ability to implement climate change mitigation and adaptation strategies. This article recognizes that developing nations often face significant challenges in building the necessary institutional frameworks, technical expertise, and financial resources required for effective climate action.

As of now, Liberia has received various forms of capacity-building support aimed at enhancing its climate resilience and reducing greenhouse gas emissions. Key initiatives include:

**Technical Assistance:** International organizations such as the United Nations Development Programme (UNDP), the NDC Partnership, Conservation International and the European Union have provided technical assistance to help Liberia develop its Nationally Determined Contributions (NDCs) under the Paris Agreement. This includes training workshops for government officials on climate policy formulation and implementation. Technical support has also been received from the National Adaptation Plans Global Network to strengthen the capacity of sector experts on National Adaptation Plans implementation in Liberia;

**Financial Support**: The Green Climate Fund (GCF) and Global Environmental Facility have allocated funds to Liberia for projects aimed at improving agricultural practices, forest conservation, and renewable energy development. These projects are designed to build local capacities while also addressing immediate environmental concerns;

**Bilateral Support:** Providing technical and policy support to strengthen climate MRV systems in Liberia with funding from the Government of Canada through NovaSphere, a Canadian Corporation

**Partnerships with NGOs:** Non-governmental organizations (NGOs) have played a crucial role in capacity building by implementing community-based programs that educate local populations about sustainable practices. For instance, initiatives focused on reforestation and sustainable agriculture have been supported by international NGOs;

**Regional Cooperation:** Liberia has engaged in regional partnerships through organizations like Economic Community of West African States (ECOWAS), African Union (AU) which facilitates knowledge sharing and collaborative projects among member states to address common climate challenges.

Despite these efforts, there remains a significant need for further capacity-building support in several areas:

- **Enhanced Technical Expertise:** There is a critical need for more specialized training programs that focus on advanced climate science, data analysis, and modeling techniques. This would enable local experts to better assess vulnerabilities and design effective adaptation strategies;

- **Infrastructure Development**: Investment in infrastructure is essential for implementing climate resilience measures effectively. Capacity-building efforts should include training on project management and infrastructure maintenance to ensure sustainability;

- **Policy Frameworks:** Developing comprehensive policy frameworks that integrate climate considerations into national development plans is vital. Support is needed in drafting policies that align with international standards while being contextually relevant to Liberia's unique challenges;

- **Monitoring and Evaluation Systems**: Establishing robust monitoring and evaluation systems will help track progress towards achieving NDC targets and other climate-related goals. Training in these areas will enhance accountability and transparency in reporting;

- **Community Engagement Strategies:** Building local capacities requires engaging communities effectively in decision-making processes related to climate action. Training programs focused on participatory approaches can empower local stakeholders;

- **Access to Financial Resources**: While some funding has been received, there is an ongoing need for access to additional financial resources from international donors or through innovative financing mechanisms such as green bonds or carbon credits;

- **Research and Development Initiatives**: Encouraging research into localized solutions for climate adaptation can significantly benefit Liberia's approach to tackling climate change impacts effectively.

## 5. Information on Support Needed and Received by Liberia for the Implementation of Article 13 of the Paris Agreement and Transparency-related Activities Including Capacity-Building

Article 13 of the Paris Agreement establishes a framework for transparency and accountability in climate action. It requires countries to provide information on their greenhouse gas emissions, progress towards their Nationally Determined Contributions (NDCs), and support received or needed for climate action. For Liberia, this means enhancing its capacity to monitor, report, and verify (MRV) its climate actions effectively.

Liberia has been working towards establishing a robust transparency framework as mandated by Article 13. The country has developed its National Adaptation Plan (NAP) and is in the process of updating its NDCs. However, significant challenges remain in terms of data collection, analysis, and reporting capabilities. The need for technical assistance and capacity-building initiatives is critical for Liberia to fulfill its obligations under the Paris Agreement.

## 6. Support Received by Liberia Reference Policy Documents That Relates to This Section

- International Partnerships: Liberia has received support from various international organisations such as the United Nations Development Programme (UNDP), World Bank, African Development Bank, and bilateral partners like Germany and Norway. These partnerships have focused on enhancing Liberia's institutional capacities for climate reporting;
- Capacity-Building Initiatives: Specific programmes aimed at building local expertise in Measurement, Reporting and Verification- MRV systems have and continue to been implemented through the Capacity Building Initiative for Transparency Project support funded by the Global Environment Facility. For instance, training workshops have been organized to educate government officials on data collection methodologies and reporting

standards. Additionally, the ongoing bilateral support from the Government of Canada to strengthen MRVs systems in West Africa of which Liberia, Ghana, Togo and the Gambia are benefitting;

- **NDC Tracking and Policy Impact Assessment:** The Initiative for Climate Action Transparency (ICAT) supported Liberia to assess GHG and sustainable development impacts of mitigation policies, review NDC targets and develop tools and indicators to track the NDC progress in the transport, waste and energy sectors.
- **Financial Assistance**: Financial resources have been allocated through mechanisms like the Green Climate Fund (GCF). Liberia has submitted funding proposals aimed at strengthening its climate resilience and transparency systems;
- **Technical Support**: Technical assistance has also been provided through several national projects that aim to improve data management systems related to environmental statistics and greenhouse gas inventories.

**7. Support Needed by Liberia Reference Policy Documents That Relates to This Section**

**Enhanced Data Collection Systems**: To meet transparency requirements effectively, Liberia needs advanced data collection tools and methodologies that can ensure accurate tracking of emissions and climate actions;

**Institutional Strengthening**: There is a pressing need for institutional frameworks that can facilitate inter-agency collaboration in climate reporting processes;

**Long-term Financial Support**: Sustained financial investment is crucial for maintaining ongoing capacity-building efforts and ensuring that infrastructure for MRV remains functional over time;

**Public Awareness Campaigns**: Increasing public awareness about climate change issues will help garner broader support for national initiatives aimed at achieving transparency goals under the Paris Agreement;

**Regional Collaboration**: Engaging with neighboring countries to share best practices through peer-to-peer learning in transparency-related activities could enhance regional cooperation in addressing common challenges related to climate change.

**8. Chapter with Information on Financial Support, Technology Development and Transfer, and Capacity- Building Support Needed and Received, Including for Transparency-related Activities; and Support Eventually Provided and Mobilized**

Liberia has been actively seeking financial support to implement its commitments under the Paris Agreement. Liberia has received funding from various international sources, including the Green Climate Fund (GCF), bilateral aid from countries like Norway and Germany, and support from multilateral organizations such as the World Bank.

The total amount of financial support mobilized for climate-related projects in Liberia is estimated to be in the range of hundreds of millions of dollars. However, there remains a substantial gap between the funding needed for effective climate action and what has been received. According to reports by the United Nations Framework Convention on Climate Change (UNFCCC), Liberia requires an estimated $1 billion annually to meet its climate goals effectively.

**a. Technology Development and Transfer**

Technology development and transfer are critical components for Liberia's ability to mitigate climate change impacts and adapt to new environmental realities. The country has engaged with

various international partners to facilitate technology transfer in renewable energy, sustainable agriculture, and forest management.

For instance, initiatives supported by organizations such as the United Nations Development Programme (UNDP) have focused on enhancing solar energy technologies in rural areas. Additionally, partnerships with NGOs have aimed at improving agricultural practices through innovative techniques that increase resilience against climate variability.
Despite these efforts, there is still a pressing need for more advanced technologies tailored specifically for Liberia's unique ecological and socio-economic conditions. This includes not only renewable energy technologies but also systems for monitoring emissions and assessing climate risks.

**b. Capacity-Building Support**

Capacity-building is essential for ensuring that local institutions can effectively implement climate policies aligned with the Paris Agreement. Various programs have been initiated to strengthen institutional frameworks at both national and local levels.

The Government of Liberia has collaborated with international agencies to conduct training workshops aimed at enhancing skills related to climate finance management, project implementation, and stakeholder engagement. For example, initiatives funded by GCF have provided training sessions for government officials on how to develop bankable projects that can attract further investment.
However, challenges remain regarding human resource capacity within governmental bodies tasked with environmental governance. Continuous investment in education and training is necessary to build a robust workforce capable of addressing complex climate issues.

**c. Transparency-Related Activities**

Transparency is a key principle under the Paris Agreement that ensures accountability among nations regarding their climate actions. Liberia has made strides towards enhancing transparency through improved data collection methods related to greenhouse gas emissions and reporting mechanisms.

The establishment of a Nationally Determined Contribution (NDC) registry is one such effort aimed at tracking progress towards meeting its targets under the Paris Agreement. Furthermore, partnerships with international organisations have facilitated technical assistance in developing monitoring frameworks that align with global standards.

Despite these advancements, there are still gaps in data availability and quality which hinder comprehensive reporting on progress made towards achieving NDCs.

In summary, while Liberia has made significant strides in mobilizing financial resources, technology development, capacity-building support, and transparency-related activities necessary for achieving its commitments under the Paris Agreement, substantial challenges remain. The need for increased funding continues alongside demands for advanced technologies tailored specifically for local contexts as well as enhanced capacity within institutions responsible for implementing climate policies.

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