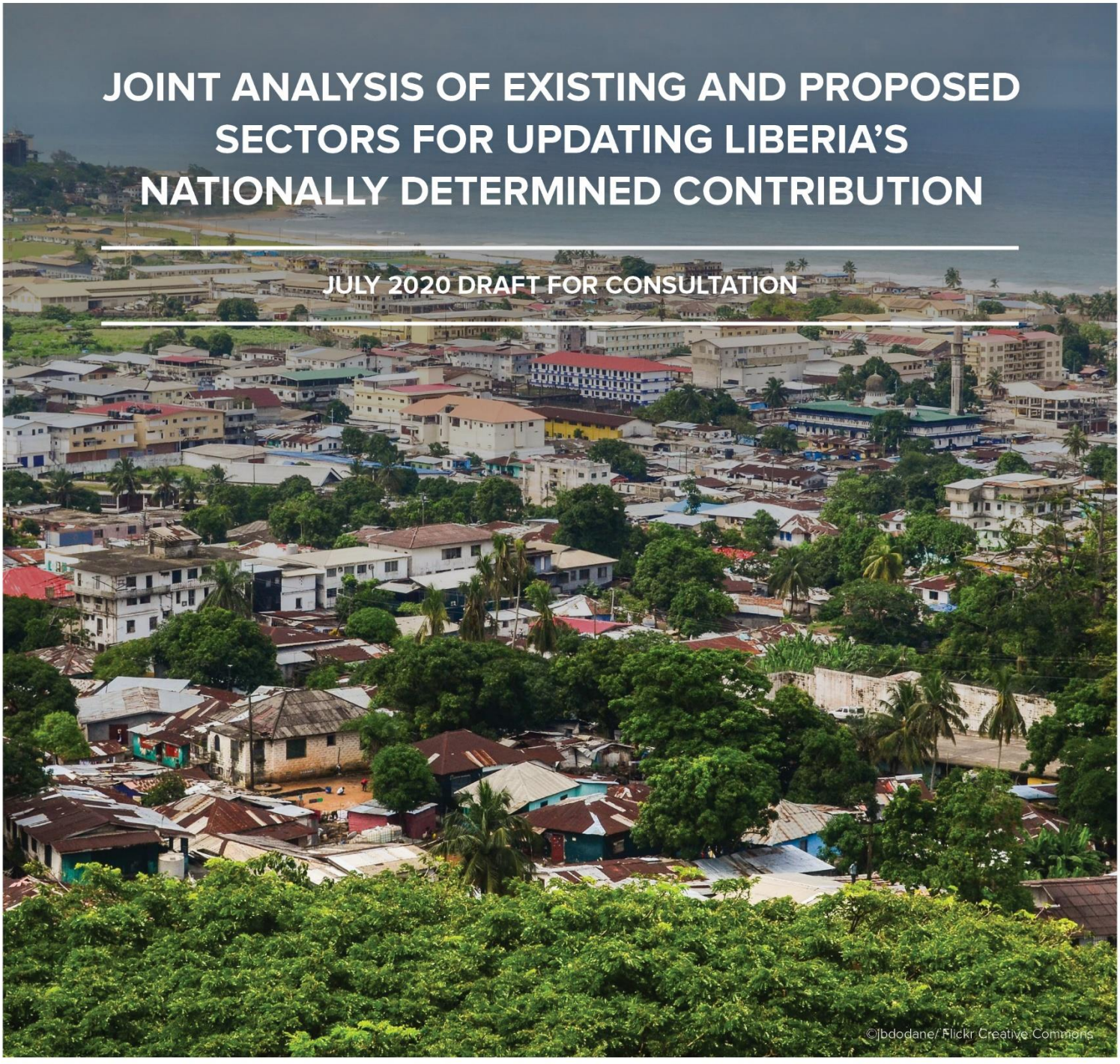
JOINT ANALYSIS OF EXISTING AND PROPOSED SECTORS FOR UPDATING LIBERIA'S NATIONALLY DETERMINED CONTRIBUTION

JULY 2020 DRAFT FOR CONSULTATION



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Executive Summary

Introduction

To support the Government of Liberia's Environmental Protection Agency (EPA) in its nationally determined contribution (NDC) update process, Conservation International (CI), EU-Liberia Climate Change Alliance+ and the United Nations Development Program (UNDP) prepared the following review of Liberia's 2015 NDC. The goal of this NDC review was to analyze the national context for each sector, understand existing progress and challenges since 2015, identify mitigation and adaptation opportunities, and prepare initial recommendations for consideration during the NDC update process, which is designed to take a consultative, whole-of-government approach. This review and all recommendations are intended as a starting point for technical expert input and consultation under the direction of the EPA. The outcomes of those participatory consultations will drive a whole-of-government and whole-of-society approach to ensure that updates to the NDC fully reflect Liberia's national priorities, circumstances, and ambition.

Summary of Liberia's 2015 NDC Commitments

The adoption of the Paris Agreement in December 2015 made vital progress toward meaningfully addressing climate change. Ambitious commitments and actions from countries, in line with national circumstances, are essential to ensure the success of the Agreement. The Government of Liberia has shown leadership in addressing climate change through an intended nationally determined contribution[1] (INDC) (now an NDC following Liberia's ratification of the Paris Agreement), which aims to reduce greenhouse gas emissions by 15% below business as usual levels by 2030 with a long-term goal of carbon neutrality by 2050 (see overview table of Liberia's greenhouse gas emissions by sector below). Liberia's 2015 NDC also highlights the crucial role of adaptation for ensuring the resilience of the country's communities and natural systems. Liberia has identified critical sectors and reinforced adaptation priority

[1] Registry of UNFCCC Intended Nationally Determined Contributions available at https://www4.unfccc.int/sites/submissions/indc/Submission%20Pages/submissions.aspx.

strategies and action through its forthcoming National Adaptation Plan implemented by UNDP with funding from the Green Climate Fund (GCF).

Table i.i. Liberia Greenhouse Gas (GHG) Emissions by Sector *(without LULUCF), 2000*

GHG Source and Sink Categories	Total Gg CO_2 Equiv.	Sector Share (%) (without LULUCF)
Energy	5,414	67.5
Industrial processes	NO	NO
Solvent and other product use	NE	NE
Agriculture	2,562	31.9
LULUCF	-96,811	
Waste	46	0.6
Other (please specify)	NO	NO
Total (without LULUCF)	8,022	100
Total (with LULUCF)	-88,789	
Note: LULUCF – Land use, land-use change and forestry		

Source: Adapted from Liberia's 2015 Nationally Determined Contribution.

Table i.ii. Summary of Liberia's 2015 NDC targets *(conditional on international support)*

Mitigation	Adaptation

• Mitigation target: Reduce greenhouse gas emissions by 15% below business as usual levels by 2030 with a long-term goal of carbon neutrality by 2050.
• Sectors covered: Energy (electricity and transport) and waste.
• Sector targets by 2030:
  ○ Improve of energy efficiency by 20% by replacing cook stoves with low thermal efficiency (5-10%) with higher efficiency (40%) stoves;
  ○ Increase renewable energy generation to 30% (from 26%);
  ○ Transition to 3.5% biofuel use in transport; and
  ○ Capture landfill gas to use for biogas and power generation.
• Proposed actions: NDC includes 16 actions to facilitate achievement of these targets.
	• Adaptation priority areas (as outlined in National Adaptation Programmes of Action):
	  ○ Enhance agricultural resilience to increasing rainfall variability;
	  ○ Build a national hydro-meteorological monitoring system; and
	  ○ Build coastal defense walls to reduce vulnerability of urban coastal areas.
	• Sectors covered: Agriculture, energy, health, forestry, coastal zone, fisheries, and transport/infrastructure.
	• Proposed actions: NDC includes 29 actions for short, medium and long-term adaptation.
	• NAP to achieve these targets is under development.

Source: Information from Liberia Initial Nationally Determined Contribution (2015).

Recommendations to Inform the Updated NDC

The current process to update Liberia's NDC is an opportunity to apply additional international and national information and guidance that has been agreed upon or made available since Liberia's 2015 INDC submission, as well as to align the updated NDC with long-term sectoral priorities.

The following recommendations detail specific points of consideration for the content of the updated NDC:

- *The structure and organization of the 2015 NDC provides a useful basis on which to prepare Liberia's updated NDC.*
- *Liberia should look to agreed guidance in the Paris Agreement and decision text, as we well as further guidance on the information and accounting[2] to inform the NDC update and national climate plans. Key topics covered by this guidance include:*
    - *Information: Reference point; Period of implementation; Scope and coverage; Planning processes; Assumptions and methodologies; Ambition; Contribution towards global goals of the Paris Agreement; and*
    - *Accounting: Approaches & metrics assessed by IPCC; Consistency between NDC communication & implementation; Inclusion of all categories of emissions and removals; Explanations of any excluded emissions.*
- *Update information based on analysis of existing sectors in the NDC to include updated strategies and plans, improved information, more specific targets or planned actions, or to raise the ambition of existing targets.*
- *Update information based on analysis of potential new sectors to be included in the updated NDC. This includes forests, green corridors, coasts, fisheries, and short-lived climate pollutants.*
- *Use IPCC guidelines to define emissions categories and describe assumptions and methodologies used to identify targets and actions across the NDC sectors.*
- *Provide consistent units throughout the NDC. For example, if GHG emissions are presented in Gg of CO_2eq, other targets and scenarios for action should use the same unit.*
- *Highlight relevant interlinkages for implementation across sectors in the revised NDC. Several important climate actions in Liberia require inputs and collaboration among multiple sectors through a nexus approach to ensure effective and complementary implementation, as well as to fully assess tradeoffs.*
- *Identify national capacity building and institutional arrangements that will form part of NDC implementation.*

[2] Summarized for brevity following Annex I and Annex II of UNFCCC decision 4/CMA.1. https://unfccc.int/sites/default/files/resource/cma2018_3_add1_advance.pdf.

- *Provide information on the coordination and alignment with other major national planning processes and goals, such as low-carbon development strategies, Sustainable Development Goals (SDGs), and other multilateral environmental agreements.*

Summary of Initial Recommendations by Sector

As part of this NDC review, the authors analyzed the following sectors for consideration to inform the NDC update process.

Energy	**Forests**
Waste	**Green Corridors**
Transport and Infrastructure	**Coastal Zones**
Short-lived Climate Pollutants	**Fisheries**
Agriculture	**Health**

The following initial recommendations are proposed for each sector during the process to update the NDC. All recommendations are intended as a starting point for technical expert input and consultation.

Energy Sector Recommendations for Consideration

1. Integrate targets and improved information from other policy plans and strategies.
2. Consider opportunities to add quantified and/or time bound goals and targets to the activities identified in the revised NDC.
3. Review and verify the energy sector scenarios in the 2015 NDC.
4. Consider communicating human development, environmental, or health co-benefits that may accompany energy sector targets.
5. Explicitly link energy sector actions in the NDC with associated forest sector outcomes.
6. Ensure that the appropriate institutional arrangements and governance are in place to ensure effective and efficient participation of the energy sector in national climate planning and action.
7. Consider linkages with climate goals across sectors and promote mainstreaming of climate objectives.
8. Take stock of progress made in implementing existing energy sector policies and the NDC. *[Linkages with other sectors]*
9. Consider linkages with national COVID response and recovery priorities as part of the update of NDC targets for this sector. *[Linkages with other sectors]*

Waste Sector Recommendations for Consideration

1. Clarify waste sector institutional roles, mandates, and legislation and highlight synergies and areas for institutional collaboration.

2. Promote awareness and education about waste management at all levels – national and subnational – including cities, local, and household levels.
3. Add further detail to the existing NDC goal to develop waste management infrastructure.
4. Enlist private sector support to invest in the waste management sector.
5. Formulate a strategy for advancing plans to capture methane gas emitted from landfills and convert it to energy.
6. Consider interlinkages with health, including adaptation targets for the health sector, under the NDC. *[Linkages with other sectors]*
7. Take stock of progress made in implementing existing waste sector policies and NDC activities. *[Linkages with other sectors]*
8. Consider linkages with national COVID response and recovery priorities as part of the update of NDC targets for this sector. *[Linkages with other sectors]*

Transport and Infrastructure Sectors Recommendations for Consideration

1. Set timelines and further specify existing targets.
2. Avoid conversion of forests and other natural ecosystems for biofuel production.
3. Implement controls on vehicle imports and set stricter fuel efficiency standards.
4. Include targets to promote water, rail, and air transport.
5. Enhance the public transport infrastructure target.
6. Include systems for rapid transportation in public transport services.
7. Consider options for green infrastructure.
8. Take stock of progress made in implementing existing transport and infrastructure sector policies and NDC activities. *[Linkages with other sectors]*
9. Consider linkages with national COVID response and recovery priorities as part of the update of NDC targets for this sector. *[Linkages with other sectors]*

Short-lived Climate Pollutants Recommendations for Consideration

- Pursue appropriate policies, actions, and mitigation measures for short-lived climate pollutants (SLCPs) identified through NDC consultations and technical expert inputs.

Agriculture Sector Recommendations for Consideration

1. Identify opportunities to mainstream climate goals in agricultural development plans and vice versa.
2. Consider opportunities to add quantified and/or time bound goals and targets to the adaptation activities identified for the revised NDC.
3. Underscore the co-benefits from adaptation actions in agriculture practices, including mitigation outcomes, as well as potential trade-offs. *[Linkages with other sectors]*

4. Improve data for specific GHG inventory categories and continue to increase technical and institutional capacities for monitoring, reporting, and verification (MRV) and GHG inventory development.
5. Address gender and youth considerations in training of institutional and local experts in agriculture sector planning, monitoring, and reporting.
6. Consider strengthening of climate services and early warning systems for farmers to build and strengthen resilience of the agriculture sector.
7. Take stock of progress made in implementing existing agriculture sector policies and the NDC. *[Linkages with other sectors]*
8. Consider linkages with national COVID response and recovery priorities as part of the update of NDC targets for this sector. *[Linkages with other sectors]*

Forest Sector Recommendations for Consideration

1. Consider estimating mitigation benefits of existing policies and targets in the forest sector.
2. Consider opportunities to add quantified and/or time bound goals and targets to the activities identified for the revised NDC.
3. Integrate improvements in data availability and reporting from the forest sector into the revision and update of the Nationally Determined Contribution.
4. Consider linkages with climate goals across sectors and promote mainstreaming of climate objectives.
5. Address gender considerations in training of institutional and local experts in forest sector planning, monitoring, and reporting.
6. Take stock of progress made in implementing existing forest sector policies and the NDC. *[Linkages with other sectors]*
7. Consider linkages with national COVID response and recovery priorities as part of the NDC update for this sector. *[Linkages with other sectors]*

Green Corridors Recommendations for Consideration

1. Establishment of a Local Environment Committee to identify areas at risk for environmental degradation and appropriate for establishing green corridors.
2. The EPA, in consultation with the relevant line Ministries, provides guidelines and measures necessary for establishing green corridors in urban areas.
3. Preparation of County Environmental Action Plans to identify areas targeted for afforestation or reforestation.
4. Capacity-building for the Ministry of Public Works, LISGIS, and Municipal Authorities.
5. Draft a National Zoning Act and produce a zoning map of 5 municipalities.
6. Promote green corridor connectivity with a focus on supporting healthy wildlife populations.
7. Consider linkages with national COVID response and recovery priorities as part of the update of NDC targets for this sector. *[Linkages with other sectors]*

Coastal Zones Recommendations for Consideration

1. Increase the specificity of coastal adaptation actions.
2. Prioritize green-grey infrastructure approaches to coastal resilience.
3. Connect the coastal zone adaptation actions to their mitigation co-benefits.
4. Consider linkages with climate goals across sectors and promote mainstreaming of climate objectives. *[Linkages with other sectors]*
5. Address gender considerations in training of institutional and local experts in coastal zone management and monitoring.
6. Take stock of progress made in implementing existing coastal sector policies and the NDC. *[Linkages with other sectors]*
7. Consider linkages with national COVID response and recovery priorities as part of the update of NDC targets for this sector. *[Linkages with other sectors]*

Fisheries Sector Recommendations for Consideration

1. Set timelines and further specify existing targets.
2. Enhance the target to broaden scope of research.
3. Define rules around allocation and fishing rights.
4. Support artisanal fisher communities.
5. Include a new target related to the conservation of mangroves.
6. Enhance the target to include sub-targets for aquaculture fisheries.
7. Improve regional cooperation.
8. Take stock of progress made in implementing existing fisheries sector policies and the NDC. *[Linkages with other sectors]*
9. Consider linkages with national COVID response and recovery priorities as part of the update of NDC targets for this sector. *[Linkages with other sectors]*

Health Sector Recommendations for Consideration

1. Identify interlinkages between climate change and health, and opportunities to mainstream climate goals in health sector development plans.
2. Consider opportunities to add quantified and/or time bound goals and targets to the activities identified for the revised NDC.
3. Identify linkages between delivery of both health and rural development programs to increase the effectiveness and efficiency across sectors.
4. Specify the health co-benefits of reducing emissions from black carbon as part of national climate action.
5. Take stock of progress made in implementing existing health sector policies and the NDC. *[Linkages with other sectors]*
6. Consider linkages with national COVID response and recovery priorities as part of the update of NDC targets for this sector. *[Linkages with other sectors]*

Linkages with Sustainable Development Priorities

Where appropriate, the review also identified interlinkages with related plans and processes, especially the Sustainable Development Goals (SDGs), as action on climate change and sustainable development overlap significantly, with a large potential for synergies, but also for competing outcomes if not planned appropriately. For example, low-emissions development and long-term poverty reduction can be achieved via the energy transitions outlined in SDG 7, the sustainable industrialization processes in SDG 9, and the transition to responsible consumption and resilient food systems in SDGs 2 and 12. Achieving climate adaptive and resilient development and reducing disaster risks is also envisioned in several SDGs, including 1, 9, 11, and 13. Similarly, climate action will ease the pathways toward achieving many of the SDGs, especially those related to reducing poverty and hunger, access to water, healthy terrestrial and ocean ecosystems, healthy livelihoods, and gender equality.[3] Furthermore, according to analysis conducted by CI, the ability of Liberia to achieve 44 of the 169 SDG targets is dependent upon its natural capital, including Liberia's physical environment and the ecosystem services it provides.[4] For this review, we identified key linkages between each sector and the SDGs, according to their targets and indicators, as shown in Figure i.i. below.

Figure i.i. Sustainable Development Goals relevant to each NDC sector.

The information in this review is not exhaustive and will be revised in line with government consultation and expert feedback.

[3] Climate and SDGs Synergy Conference. (2019) Outcome Summary - Global Conference on Strengthening Synergies between the Paris Agreement and the 2030 Agenda for Sustainable Development: Maximizing Co-Benefits by Linking Implementation across SDGs and Climate Action https://sustainabledevelopment.un.org/content/documents/22398Summary_document_Copenhagen_FINAL_for_website.pdf.

[4] Conservation International. (2017) Nature and the Sustainable Development Goals: Priority Linkages Summary for Liberia.

Next Steps

This review and all recommendations are intended as a starting point for technical expert input and consultation under the direction of EPA. The outcomes of those participatory consultations will drive a whole-of-government and whole-of-society approach to ensure that updates to the NDC fully reflect Liberia's national priorities, circumstances, and ambition.

Pictured: Participants of Liberia's UNFCCC Policy Training Workshop in Buchanan in November 2019, co-organized by the EPA, FDA, CI and UNDP.

Sector Highlight: Energy

National Sectoral Context

The energy sector is the primary source of GHG emissions in Liberia, comprising emissions from the burning of firewood, charcoal, palm oil, as well as fossil fuels, especially petroleum products. In 2000, the energy sector accounted for 67% of national GHG emissions. Currently, household energy use is dominated by biomass energy, which accounts for more than 90% of the energy used nationally, suggesting important linkages to energy and forests. In 2012, residential electricity access included only 10% of urban residents and 2% of rural residents through diesel-powered generators.[5] At that time, a small minority of Liberians had access to electricity through the state-owned Liberia Electricity Corporation (LEC), which was only operational in the capital city of Monrovia, operating on a combination of diesel fuel and hydropower from the Mt. Coffee dam.[6] The country projects significant growth in installed capacity to meet the goals for increased electricity access under the Agenda for Transformation and the 2018 Pro-Poor Agenda for Prosperity and Development. This growth was estimated at 10% up to 2020, and 3% from 2020 to 2028.[7] For example, in 2008, the generation capacity of LEC was 9.6 MW (diesel generation) nationally, with a customer base of 2,500 residents.[8] By 2010, installed LEC electric grid generation capacity in Liberia increased to approximately 22 MW distributed as follows: hydropower, 21%; thermal (HFO) capacity, 11%; thermal (diesel) 66% and thermal (gasoline) 2%. In comparison, pre-conflict installed electricity generation capacity, including the private sector, was about 412 MW.[9]

[5] Liberia Ministry of Justice. (2012) National Sustainable Development Report. https://sustainabledevelopment.un.org/content/documents/598liberiantreport.pdf.
[6] Liberia Ministry of Justice. (2012) National Sustainable Development Report. https://sustainabledevelopment.un.org/content/documents/598liberiantreport.pdf.
[7] Environmental Protection Agency of Liberia. (2013) Identification of Capacity Barriers, Gaps and Needs for Enabling Climate Change Mitigation Measures Under the Project: Management of Environmental Services and Financing for Sustainable Development.
[8] Liberia Ministry of Lands, Mines and Energy. (2009) A National Energy Policy and Agenda for Action and Economic and Social Development. http://www.moci.gov.lr/doc/National%20Energy%20Policy%202009.pdf.
[9] Liberia Ministry of Lands, Mines and Energy. (2009) A National Energy Policy and Agenda for Action and Economic and Social Development. http://www.moci.gov.lr/doc/National%20Energy%20Policy%202009.pdf.

Liberia's energy sector has made significant gains through the support of the West African Power Pool (WAPP) Project, through which access to renewable energy is being expanded across the country (Zwedru, Ganta, Kakata, Pleebo). These strides support the long-term effort of increasing the volume of electricity supply as well as achieving the renewable energy target in the 2015 NDC.[10] The goal of increasing access to renewable energy also contributes to the achievement of the Sustainable Development Goals (SDGs), in particular, SDG 7 - Affordable & Clean Energy, as well as SDG 12 - Responsible Consumption & Production, SDG 13 - Climate Action, and SDG 15 - Life on Land. These concurrent development and planning processes are not only sources of information, but also create opportunities to streamline planning, implementation, and reporting by aligning those processes with each other and ensuring coherence, and thus generating a greater economic impact.

Per the 2009 National Energy Policy, the Liberia Ministry of Mines and Energy (MME), through the Department of Energy (DoE) is tasked with defining and reviewing energy policy. The Energy Regulatory Board is responsible for licensing independent power producers and monitoring policy implementation by all operators, whether owned by the public sector, private sector, or local communities.[11] The Rural and Renewable Energy Agency (RREA) was established in 2009 to integrate energy into rural development planning; promote renewable energy technologies; facilitate delivery of energy services through rural energy service companies (RESCOs) and community initiatives; and facilitate funding of rural energy projects.

Under the 2013 EPA analysis, "Identification of capacity barriers, gaps and needs for enabling climate change mitigation measures under the project: management of environmental services and financing for sustainable development"[12] several energy projects were identified as potential Nationally Appropriate Mitigation Actions. One of these projects focused on reconstruction and expansion of the Yanhohun micro-hydro facility in Lofa country to power approximately 200 homes. Another solar project based on the World Bank's Sustainable Solar Market Packages (SSMP) approach was identified to distribute solar lanterns and solar home systems in Gbarnga and surrounding towns. The Lighting One Million Lives in Liberia project was also proposed to reduce GHG emissions by exchanging kerosene lanterns for solar lanterns, with a goal of reaching 200,000 rural households.

In 2015, the Liberia Electricity Policy established national priorities of encouraging efficient use of electricity resources, facilitating economic development, and promoting the development of renewable energy resources for electricity generation.[13]

[10] 2015 NDC target for the energy sector includes raising share of renewable energy to at least 30% of electricity production and 10% of overall energy consumption by 2030.

[11] Liberia Ministry of Lands, Mines and Energy. (2009) A National Energy Policy and Agenda for Action and Economic and Social Development. http://www.moci.gov.lr/doc/National%20Energy%20Policy%202009.pdf.

[12] Environmental Protection Agency. (2013) Identification of capacity barriers, gaps and needs for enabling climate change mitigation measures under the project: management of environmental services and financing for sustainable development. https://www.undp.org/content/dam/liberia/docs/docs/Liberia_NAMA_Study%202013.pdf.

[13] Republic of Liberia. (2015) An act to amend chapters 85 of the 1973 public authority law creating the Liberia Electricity Corporation and amendment thereto, to establish the 2015 Electricity Law of Liberia. https://www.rrealiberia.org/forest/doc_download/2015%20Electricity%20Law%20of%20Liberia.pdf/.

Existing NDC Targets

Table 1.1. Existing Mitigation Targets and Activities in 2015 NDC – Energy.

Mitigation Targets and Activities in 2015 NDC – Energy Sector		
Sectoral Quantitative Target (if applicable)	**Sub-targets and activities identified**	**Baseline information used for 2015 NDC target[14]**
10% reductions from the energy sector by 2030.	Improving energy efficiency by at least 20% by 2030	5,414 Gg CO_2e in 2000.
	Raising share of renewable energy to at least 30% of electrical production and 10% of overall energy consumption by 2030	
	Replacing cookstoves with low thermal efficiency (5-10%) with the higher-efficiency (40%) stoves	

Source: Information from Liberia Initial Nationally Determined Contribution (2015).[15]

Table 1.2. Existing Adaptation Targets and Activities in 2015 NDC – Energy.

Adaptation Targets and Activities in 2015 NDC – Energy Sector		
Sectoral Quantitative Target (if applicable)	**Sub-targets and activities identified**	**Baseline information used for 2015 NDC target**
Not stated.	Protection of water catchments around hydro-power sources such as the St. Paul River Basin	*Not stated.*
	Strengthening of transmission and distribution infrastructure for public utilities to ensure climate resilience (i.e., flooding)	

Source: Information from Liberia Initial Nationally Determined Contribution (2015).[16]

Existing Relevant Policies, Strategies and Plans

Relevant climate change and sectoral policies were reviewed in order to examine their targets and strategies for the energy sector. The most relevant and updated strategies and plans for climate action in the sector were the focus of this review process:

- ✓ National Policy and Response Strategy on Climate Change (2018);
- ✓ Rural Energy Strategy and Master Plan for Liberia until 2030 (2017);
- ✓ National Energy Efficiency Action Plan (2016);
- ✓ National Renewable Energy Action Plans (2015); and
- ✓ National Energy Policy: An Agenda for Action and Economic and Social Development (2009).

[14] Units in Gg can be converted to MT by dividing by 1,000. For example, 5,414 Gg CO_2e = 5.414 MT CO_2e.

[15] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC), emphasis added. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

[16] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC), emphasis added. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

In 2009, Liberia developed a National Energy Policy (NEPL), setting the framework for affordable access to modern energy services for all Liberians. The NEPL aims to make Liberia a carbon-neutral economy by 2050. This will entail promoting the use of renewable energy and leveraging biomass and water resources as a sources of carbon credits for energy development,[17] as well as promoting the use of renewable energy, such as solar and wind systems, in power plants and all large commercial facilities, such as supermarkets, hotels, restaurants, entertainment centers, hospitals, and large retail shops and stores.[18] Liberia's 2013 Initial National Communication (INC) reinforces the 2009 NEPL with long-term targets and scenario-based activities, which include GHG reductions, increased energy efficiency, and increased use of renewable energy through biomass electricity generation. The mitigation targets of Liberia's 2015 NDC are based on the energy sector analysis in the 2013 INC. The targets in other national strategies for the energy are not fully aligned among the different policies or are exclusive to particular sub-sector efforts (e.g. energy efficiency, rural energy), as can be noted in the selected targets summarized for each policy below. These selected policies are meant to provide a range of existing national targets for the NDC revision; they are not exhaustive. A more detailed analysis on progress of each of these policies is *excluded* here for brevity and should be addressed in sector-specific stakeholder consultation and working groups as part of EPA's NDC revision process.

Energy Sector Strategies from the National Policy and Response Strategy on Climate Change (2018):

Mitigation Strategies:

- Promote exploration of **renewable energy sources** and enhance the mix of renewable energy share in the national grid and off-grid.
- Put in place a system to **enhance off-grid power supply** to rural areas with additional objective of **reducing deforestation**.
- Promote diversification of energy sources.
- Identify, promote, and support the use of **energy-efficient and low carbon** as well as **green energy technologies and practices**, including the efficient use of domestic appliances.
- Put in place an **incentive mechanism** to strengthen the participation of private the sector in the production and use of clean energy through including public private partnership (PPP).
- Introduce **affordable waste-to-energy technologies** such as methane captured from urban waste dumps. Introduce and encourage **energy conservation practices** in various sectors.

Adaptation Strategies:

- Promote diversification of energy sources including **renewable energy sources**.
- Promote the development and use of **affordable energy-efficient technologies**.
- Promote and implement **energy plantation schemes** to minimize pressure on natural forest and reduce energy stress.
- Introduce and promote a system for **sustainable use of biomass energy**.
- Promote and support the development and utilization of **community-based off-grids/mini-grids**.

[17] Liberia Ministry of Justice. (2012) National Sustainable Development Report. https://sustainabledevelopment.un.org/content/documents/598liberiantreport.pdf.

[18] Liberia Ministry of Lands, Mines and Energy. (2009) A National Energy Policy and Agenda for Action and Economic and Social Development. http://www.moci.gov.lr/doc/National%20Energy%20Policy%202009.pdf.

- Conserve **water catchments** for sustainable production of hydropower sources.
- Ensure the incorporation of **renewable and low carbon energy technology** promotion in sectorial and national development planning.

Source: National Policy and Response Strategy on Climate Change (2018). Emphasis added.

Selected targets from the Rural Energy Strategy and Master Plan for Liberia (2017):

Rural energy by 2030:

- Electrification rate for the population outside of Monrovia of 10% in 2020, 20% in 2025 and 35% in 2030, electrifying the largest cities and towns of the country first.
- More than 75% of all electricity generated from renewables by 2030 with 19% coming from other than large hydro: Mini-hydro, Solar and Biomass.
- Universal access to **affordable solar lamps, efficient appliances and cook stoves**.
- **Cooking gas available** in all county capitals and **efficiently produced charcoal** widespread across the country.

Source: Rural Energy Strategy and Master Plan for Liberia (2017). Emphasis added.

Selected targets from the National Energy Efficiency Action Plan (2016):

- **Implement efficiency measures** that free-up 1,054 MW of power generation capacity by 2030. At an average of 53 MW per year.
- Phase out inefficient incandescent lamps by 2018.
- **Reduce average losses in electricity distribution** from the current levels of 28-40% to the world level of 10% by 2024.

Source: National Energy Efficiency Action Plan (2016). Emphasis added.

Selected targets from the National Renewable Energy Action Plans (2015):

- The access targets for the share of Grid-Connected Renewable Energy compared to total power generation is targeted to be 16% in 2015, and will be significantly increased to 94% in 2020, 96% in 2025, and 95% in 2030.
- Following the 2009 NEPL, 10% emissions reduction in the sector by 2015.

Targets for Grid-connected Installed Capacity and Share of Renewable Energy					
	2010	2015	2020	2025	2030
Annual electricity generation (GWh)	190.00	242.49	309.49	395.00	504.13
of which is renewable generation (GWh) (*status quo*)	39.51	39.51	39.51	39.51	39.51
Scenario NREAP (*planned*)					
Additional hydropower generation (GWh)	-	-	1,9500.00	3,900.00	3,900.00
Additional wind generation (GWh)	-	-	0.16	0.31	0.31

Additional PV generation (GWh)	-	-	225.00	450.00	450.00
Additional renewable electricity generation (GWh)	-	-	**2,175.16**	**4,350.31**	**4,350.31**
Targets for Off-grid Applications					
	2010	**2015**	**2020**	**2025**	**2030**
Share of Rural Population Served with Off-Grid (mini-grids and stand-alone) Renewable Energy Electricity Services in %	**0.3%**	**-**	**34.5%**	**-**	**100%**

Source: Adapted from National Renewable Energy Action Plans (2015).

Selected targets from the National Energy Policy of Liberia (2009):

- Achieve a **carbon-neutral economy** for Liberia by 2050;
- Maximize energy efficiency and demand-side management (DSM) to **minimize the financial and environmental costs of energy development**;
- Improve energy efficiency;
- Raise the share of **renewable energy to 30%;** and
- Increase the level of **biofuels in transport fuel**.

Source: National Energy Policy of Liberia (2009). Emphasis added.

Selected targets from the Rural Energy Strategy and Master Plan for Liberia (2017):

By 2030:

- More than 75% of all electricity generated from renewables by 2030 with 19% coming from other than large hydro: Mini-hydro, Solar and Biomass.
- Universal access to **affordable solar lamps, efficient appliances and cook stoves**.
- **Cooking gas available** in all county capitals and efficiently produced charcoal widespread across the country.

Source: Rural Energy Strategy and Master Plan for Liberia until 2030 (2017). Emphasis added.

Selected targets from the Initial National Communication (2013):

Energy Subsector	Adaptation Option and Mitigation Measure Identified
Electricity	• Promote hydroelectricity • Promote energy efficiency and the use of renewable energy • Set emissions standards • Reduce losses in electricity supply streams
Residential, commercial, and institutional (RCI)	• Use of renewable energy sources, such as solar water heaters • Promote energy efficiency in appliances and building design • Switch to lower GHG emitting energy sources
Transport	• Switch from fossil to renewable fuel (solar, gas, biomass)
Industrial	• Use renewable energy • Promote low-carbon fuel for industrial boilers • Use more energy efficient and clean technology

Source: Initial National Communication (2013).

Review of NDC Targets

Data. The most recent source for national emissions information on the energy sector and climate change is the 2009 NEPL. The most *complete* source of estimated emissions for the energy sector is for the year 2000, as included in the 2015 NDC, as well as the World Bank analysis from 2011, "Options for the Development of Liberia's Energy Sector."[19] The energy sector data referenced in the 2015 NDC likely does not reflect Liberia's current emissions profile as of 2020 because of the significant growth of installed capacity since the 2000 estimated baseline emissions, as well as extensive efforts to advance rural electrification.

While the energy sector covers emissions from fuelwood, transportation, and electricity production, the lack of up-to-date information in the 2015 NDC is a significant gap. Emissions data for the sector are reported infrequently at the subsector level, and country-specific grid emission factors are not available due to the recent rebuilding of the electrical grid. Emissions and removals presented in the 2015 NDC are based on the 2013 INC, which employed the Revised 1996 IPCC Guidelines and the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000 (IPCC GPG). There are unexplained emissions discrepancies in the 2015 NDC between the energy sector baseline and the information used to create the emissions reduction scenario for the sector. The BAU scenario projection 2011 – 2030 is based on historical data taken from "Options for Development of Liberia's Energy Sector Report"[20] and projected scenarios developed under the 2013 INC. The 2013 INC energy data includes information from the Liberia Petroleum Refining Corporation, Liberia Electricity Corporation, National Energy Policy, Ministry of Transport, and others.

The Government of Liberia has undertaken efforts to develop improved and updated information in the preparation of a Second National Communication to the UNFCCC. Further, improved data from the Second National Communication, and from the ongoing GEF Capacity Building Initiative on Transparency (CBIT) project is expected to allow for the use of the 2006 IPCC guidelines in Liberia's National Greenhouse Gas Inventory.

Sources of emissions. Emissions from electricity production (energy industries) accounted for 20.6% of the emissions from the energy sector, despite providing a small proportion of the national energy demand. The relatively low emissions (1.9%) resulting from manufacturing industries and construction reflect the low production and contribution of this subsector to the national economy. Household energy use and residential electricity is not directly communicated in the national GHG inventory -- rather it is reflected through primary energy sources such as electricity production, and fuelwood or charcoal use, which are reported in the energy sector. It is relevant to note that emissions from transportation are also included as part of the energy sector, although this analysis provides a detailed consideration of Transportation in a following section. Table 1.3 below shows a summary of the 2000 statistics of energy-sector GHG emissions for Liberia.

[19] World Bank. (2011) Options for Development of Liberia's Energy Sector Report. http://documents1.worldbank.org/curated/en/436161468272715599/pdf/637350ESW0P11800ESW0pub010026011web.pdf.

[20] World Bank. (2011) Options for Development of Liberia's Energy Sector Report. http://documents1.worldbank.org/curated/en/436161468272715599/pdf/637350ESW0P11800ESW0pub010026011web.pdf.

Table 1.3. GHG emissions by category from the energy sector in 2000.[21]

Greenhouse Gas Source and Sink Categories	CO_2 (Gg)	CH_4 (Gg)	N_2O (Gg)	2000 Gg CO_2 eq.	Contribution to national total (%)	Category contribution to sector (%)
Energy	**3,571**	**1,533**	**310**	**5,414**	**67.5%**	
A. Energy Industries	1,117	0	0	1,117	13.9%	20.6%
B. Manufacturing Industries and construction	105	0	0	105	1.3%	1.9%
C. Transport (road vehicles)	2,152	21	0	2,173	27.1%	40.1%
D. Other sectors[22]	197	1,512	310	2,019	25.2%	37.3%

Source: Adapted from Liberia Initial National Communication (2013).[23]

As of 2010, the major sources of energy came from the use of biomass (> 90%) rather than electricity generation, as shown in Table 1.4 below.

Table 1.4. Primary Energy Consumption in Liberia by Fuel Type, 2010

Primary Energy Consumption by Fuel Type, 2010		
	GWh	**Percent**
Firewood	11,613	83.9%
Charcoal	1,316	9.5%
Petroleum Products	727	5.2%
Electricity Generation (fossil fuel)	150	1.1%
Others Generation (Hydro)	40	0.3%
Total	13,845	100.00%

Source: Adapted from NREAP (2015).[24]

Mitigation and Adaptation Opportunities for the Energy Sector

To be further elaborated in forthcoming analyses by the EU-Liberia Climate Change Alliance+ and technical consultations.

Liberia's energy sector is going through a process of reconstruction and decisions made now about fuel sources, energy generation, as well as transmission and distribution will have long-term effects on GHG emissions, depending on the energy investment "pathways" that are selected in the sector now. Liberia's low sunk costs in energy infrastructure can also be considered as an opportunity to "leapfrog" to low-

[21] To convert the values in Table 1.3 from Gigagrams (Gg) to Megatons (MT), divide each value by 1,000.
[22] "Other sectors" includes emissions from biomass, such as fuelwood, charcoal.
[23] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf.
[24] Republic of Liberia. (2016) National Renewable Energy Action Plans (NREAPs) Period 2015-2020/2030). https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_PANEE/Liberia_national_energy_efficiency_action_plan_neeap.pdf.

emissions energy technologies and electrification strategies (such as micro grids) that were not available or cost-effective until recently. Liberia's diversified approach to rural electrification, mini-grids, renewable energy sources, and efficient fuelwood use suggests a recognition of this opportunity, while also striving to meet the immediate development needs of the population.

Institutional Framework

The 2015 Electricity Law was signed by the President of Liberia, with the goal of expanding basic electricity services, and highlights the development of renewable energy resources as a key priority. The Liberia Electricity Corporation, the Rural and Renewable Energy Agency, and the Department of Energy, of the Ministry of Mines and Energy are working with development partners, investors, concessions and other stakeholders to plan, finance, and carry out the reconstruction and rehabilitation of key power infrastructure for centralized generation and decentralized rural power supply. Decisions on design and implementation for rural power infrastructure and power supply are to occur jointly, through an iterative process as part of the Rural Energy Strategy and Master Plan for Liberia.[25]

Table 1.5. Institutions and agencies with mandates on energy in Liberia.

Institution	Mandate
The Ministry of Mines, and Energy (MME)	• Administers all activities related to mineral, water and energy resource exploration, coordination and development in the Republic of Liberia.
Department of Energy (DoE)	• Under the MME, DoE is responsible to govern and oversee the management of the Nation's energy resources, as well as coordinate stakeholders' actions in the energy sector.
Liberia Electricity Corporation (LEC)	• Public utility entity with a mandate to produce and supply economic and reliable electric power to the entire nation, while maintaining financial viability. Includes responsibility for improving and expanding the system to meet future growth.
Rural and Renewable Energy Agency (RREA)	• Independent agency with the responsibility to facilitate and accelerate the economic transformation of rural Liberia by promoting the commercial development and supply of modern energy products and services to rural areas through the private sector and community initiatives with an emphasis, but not necessarily exclusive reliance, on locally available renewable resources.
Liberia Petroleum Refinery Corporation (LPRC)	• Public entity, wholly owned by the government, with the mandate to procure and supply quality petroleum and petroleum products to the Liberian market.

Costs and Investment Opportunities

The recent construction of the WAPP Côte d'Ivoire, Liberia, Sierra Leone, and Guinea transmission line and rehabilitation of the Mt. Coffee power station are examples of the scale of implementation and costs for implementation of renewable energy infrastructure. Mt. Coffee Hydro dam cost estimates were $320

[25] Rural and Renewable Energy Agency. (2016) Rural Energy Strategy and Master Plan for Liberia until 2030. https://gestoenergy.com/wp-content/uploads/2018/04/LIBERIA-RURAL-ENERGY-STRATEGY-AND-MASTER-PLAN.pdf.

million USD. The cost of about 364 km of 115 KV power transmission lines is put at $59 million USD, while that for about 576 km of distribution lines is put at about $32 million USD, excluding operations and maintenance.[26]

Among examples for rural energy investments, the Rural and Renewable Agency has rehabilitated a mini-hydro installation delivering 60 KW in Yandohum in Lofa County; contracted 2 MW hydro plant on Kaiha River, Lofa to benefit 50,000 homes and businesses, completed feasibility studies for three hydropower sites—Gbedin and Ya in Nimba, and Gee in River Gee; and distributed 31,000 solar lanterns/lamps and solar photovoltaic (PV) systems installed in 9 facilities in Lofa County. Opportunities for additional affordable energy investments exist for private providers.[27]

The following table details the short-, medium-, and long-term interventions to address climate change in the energy sector as outlined in the 2018 National Policy and Response Strategy on Climate Change.

Table 1.6. Action Plan for the Implementation of Strategic Interventions – Energy, Mining, Industry.

Sectoral and Cross-Sectoral Intervention for Adaptation Area: Energy					
Strategic Interventions	**Intervention Period** (Years 2017 to 2026)			**Estimated Cost** (Million USD)	**Implementing Agencies**
	(1-3) Short-term	(4-5) Mid-term	(6-10) Long-term		
Establish and promote a robust national program on solar energy (e.g. hybrid systems, installation of solar panel, promotion of solar street lighting, etc.) and other energy efficient lighting technologies.	X	X	X	3	RREA, EPA, MoFDP
Support the provision of energy efficient technologies such as energy efficient bulbs to provide power and lighting for schools and other public institutions as well as for households, as a means of enhancing or introducing energy efficient technologies.	X	X		1	RREA, LEC, MoPW, EPA, MoFDP,
Support the promotion and implementation of energy plantation schemes, targeted at minimizing the pressure on natural forest, and reduce energy stress.	X	X		3	FDA, MoA, EPA, MoFDP
Develop a system to regulate sustainable use of biomass energy.	X	X		0.1	RREA, FDA, MME, EPA, MoFDP
Promote and support the development and utilization of community-based off-grids/mini-grids.		X	X	12	RREA, LEC, EPA, MoFDP
Conservation and protection of water catchments, including around hydro-power and municipal water supply sources.	X	X	X	11	FDA, MME, EPA, MoFDP
Ensure and support the incorporation of renewable and low carbon energy technology promotion in sectorial and national development planning.	X	X	X	0.01	MME, FDA, NIC EPA, MoFDP
Sectoral and Cross-Sectoral Intervention for Mitigation: Energy					
Strategic Interventions	**Intervention Period** (Years 2017 to 2026)			**Estimated Cost** (Million USD)	**Implementing Agencies**

[26] Ministry of Planning and Economic Affairs. (2013) Republic of Liberia Agenda for Transformation: Steps for Liberia Rising 2013. https://www.undp.org/content/dam/liberia/docs/docs/Liberia%20Agenda%20for%20transformation.AfT.pdf.

[27] Sandikie. J. S., Ministry of Lands, Mines and Energy. (2015) National Renewable Energy Action Plans (NREAPs). http://www.se4all.ecreee.org/sites/default/files/national_renewable_energy_action_plans_nreap_-_liberia.pdf.

Promote exploration of renewable energy sources and enhance the mix of renewable energy share in the national grid and off-grid.	X	X	X	2	RREA, LEC, MME, MoFDP, EPA
Promote a system to enhance off-grid power supply to rural areas with additional objective of reducing deforestation.	X	X	X	20	RREA, FDA, MME, MoFDP, EPA
Identify, promote and support the use of energy efficient low carbon as well as green energy technologies and practices, including the efficient use of domestic appliances.	X	X	X	5	RREA, MME, MoFDP, EPA
Strengthen the participation of the private sector in the production and use of clean energy, including public private partnership (PPP).	X	X	X	2	MME, NIC, MoFDP, EPA, private entrepreneurs etc.
Design and implement urban waste dumps for methane capture in all major urban areas.		X	X	3	LEC, EPA, MME, Municpal, MoFDP, private entrepreneurs etc.

Sectoral and Cross-Sectoral Intervention for Adaptation: Mining

Strategic Interventions	Intervention Period (Years 2017 to 2026)			Estimated Cost (Million USD)	Implementing Agencies
	(1-3) Short-term	(4-5) Mid-term	(6-10) Long-term		
Mainstream climate change considerations into mining regulations and practices to promote the use of efficient, clean energy and the protection of biodiversity and other environmental resources.	X	X		0.25	MME, MoC, EPA, MoFDP
Put in place appropriate monitoring and evaluation system in the mining sector to ensure that climate considerations are incorporated from planning to implementation.	X			0.10	MME, EPA, MoFDP

Sectoral and Cross-Sectoral Intervention for Mitigation: Mining

Strategic Interventions	Intervention Period (Years 2017 to 2026)			Estimated Cost (Million USD)	Implementing Agencies
	(1-3) Short-term	(4-5) Mid-term	(6-10) Long-term		
Raise energy diversification, energy management, efficiency and cleaner production (green mining), which also uses environment friendly chemicals and practices in mining, through appropriate policies and investments in the sector.		X	X	1	LEC, EPA, MME, MoFDP
Exploring the mechanism for affordable and hybrid technologies in capturing and storing GHG so that the mining sector in Liberia will incorporate carbon management policies to be competitive in the world market.		X	X	5	LEC, MME, MoFDP, EPA

Sectoral and Cross-Sectoral Intervention for Adaptation: Industry

Strategic Interventions	Intervention Period (Years 2017 to 2026)			Estimated Cost (Million USD)	Implementing Agencies
	(1-3) Short-term	(4-5) Mid-term	(6-10) Long-term		
Put in place a system and procedure to mainstream climate change considerations into industrial planning and practices including the promotion of diversified and integrated energy sources, establishment of energy and industrial waste management systems, spatial planning for industrial	X	X		0.4	MME, MoPW, MoC, EPA, MoFDP

locations and zoning in the context of climate change, and the establishment of climate insurance scheme.					
Promote cottage industries that utilize sustainable small-scale energy technologies/installations in rural areas.	X	X	X	15	MME, MoC, RREA, EPA
Sectoral and Cross-Sectoral Intervention for Mitigation: Industry					
Strategic Interventions	**Intervention Period** (Years 2017 to 2026)			**Estimated Cost** (Million USD)	**Implementing Agencies**
	(1-3) Short-term	(4-5) Mid-term	(6-10) Long-term		
Promote and raise energy diversification, efficiency and cleaner production practices and technologies in industries through appropriate policies and investments.		X	X	2	LEC, RREA, MoCI, MME, EPA, MoFDP
Set up small power plants by capturing methane from waste dumps using CDM.		X	X	30	LEC, MLME, RREA, Municipal city Corporation (Municipal Authorities), Monrovia city Council (Municipal Authorities), EPA, MoFDP

Source: Adapted from National Policy and Response Strategy on Climate Change (2018).[28]

Agency abbreviations: DOE= Department of Energy; EPA= Environmental Protection Agency; LEC= Liberia Electric Corporation; RREA= Rural and Renewable Energy Agency; MoFDP= Ministry of Finance & Development Planning; MoCI= Ministry of Commerce & Industry; MME= Ministry of Mines and Energy; LEC= Liberia Electric Corporation; NIC= National Investment Commission, FDA= Forest Development Authority.

Policy Gaps and Challenges

Challenge: Linkages between NDC sectors. Liberia's primary energy source – fuel wood – is linked to the energy sector, as well as agriculture and sustainable land and forest use. This suggests an important coordinated planning is needed between the energy sector and the forest and agriculture sectors to optimize the outcome of interventions and minimize unintended impacts.

Challenge: Informality in the energy sector. Informality in the energy sector (i.e. unregulated production and provision of electricity and primary fuels), corruption, electricity theft, and vandalism undermine power transmission and distribution, as well as sustainability.[29]

Challenge: Lack of data availability. According to the INC, the lack of reliable activity data and disaggregated energy balances made it difficult to compile the complete and accurate GHG inventory and to conduct a quantitative assessment of mitigation options. Accurate disaggregated national energy balances should show the type and amount of energy consumed by each sector of the economy, making it possible to accurately determine the impact that each individual mitigation option can have on each sector, and collectively on the national GHG emissions.

[28] Liberia 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.

[29] Republic of Liberia. (2018) Pro-Poor Agenda for Prosperity and Development. https://www.theperspective.org/2018/Revised_PAPD.pdf.

Challenge: High energy costs. Failure to meet investment targets in the energy sector results in continued high energy costs. Liberia's electricity end-user cost of US$ 0.38 per KWh is one of the highest on the continent and extremely cost prohibitive to many citizens in the country. The high energy cost encourages continued use of biomass energy as a lower-cost alternative, driving forest degradation, and contributing significantly to GHG emissions. Further, this high cost creates a barrier for energy-intensive investments that would benefit the overall socio-economic development and provide climate resilient investment pathways.

Gap: Lack of monitoring and evaluation framework. The 2018 National Policy and Strategy on Climate Change outlines a monitoring and evaluation framework; however, the 2015 NDC lacks one. It is important to keep track of progress towards NDC targets. It is also crucial to implement robust monitoring, review, and reporting processes and systems that address mitigation, adaptation, and climate finance. The monitoring system should ensure that proactive and/or corrective steps can be taken as, and when needed, such that intended targets are met.

Sectoral Recommendations for Consideration

Preparation of energy sector recommendations to be led by the EU-Liberia Climate Change Alliance+ with inputs from a robust stakeholder input and consultation process. The below suggestions are proposed as a potential starting point for further examination.

Recommendation 1: Integrate targets and improved information from other policy plans and strategies.

As part of the NDC review and consultation process, strategies for development of the energy sector have been developed since the INDC was submitted in 2015, such as the Rural Electrification and Strategic Master Plan, National Renewable Energy Action Plans, National Policy and Response Strategy on Climate Change. Similarly, the Rural and Renewable Agency has made important gains since the INDC was submitted in 2015. These strategies and plans describe existing efforts, information, or targets for Liberia's sustainable energy transition that could be included in the revised NDC. Related improvements in the Natoinal GHG Inventory should be taken into consideration to reflect the enhanced ambition that these efforts entail.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the enhancement and integration of targets from other plans and strategies.

Recommendation 2: Consider opportunities to add quantified and/or time bound goals and targets to the activities identified in the revised NDC.

For consistency with previous UNFCCC communications, these targets and goals could build from the 2013 INC energy sector "adaptation options and mitigation measures," the 2015 NDC, and the 2018 Climate Strategy to develop more quantitative and time-bound goals.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the further specification and timelines for improved targets from the energy sector

Recommendation 3: Review and verify the energy sector scenarios in the 2015 NDC.

The energy sector mitigation scenarios in the 2015 NDC seem to be inconsistent with the sector-level emissions presented in Table i.i, suggesting much lower emissions from the energy sector starting in 2000. These sector-specific scenarios should be updated with information that is aligned with the National GHG Inventory, or further clarified. In addition, proper documentation of information on methodological approaches used for the energy sector scenarios should be ensured. This includes energy sector specific assumptions, methodologies and approaches consistent with IPCC guidance.

Emissions and removals presented in the 2015 NDC are based on the 2013 INC, which employed the Revised 1996 IPCC Guidelines and the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000 (IPCC GPG). The technical review and update of the NDC could include updating the values of key parameters in energy used in the baseline scenario calculation and rectify errors and inconsistencies by updating baseline to reflect the improved emissions inventories (e.g. to apply the latest IPCC guidelines). Clear baseline and mitigation scenarios will be developed taking into consideration the data generated through the Second National Communication, National Adaptation Plan, and the CBIT project. The sector-specific data and other socio-economic parameters will also have to be taken into consideration.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of this recommendation

Recommendation 4: Consider communicating human development, environmental, or health co-benefits that may accompany energy sector targets.

Many of the actions identified in the energy sector have efficiency gains and/or carry additional development co-benefits, such as improved health from switching to cleaner burning fuels. Signaling these co-benefits under conditional targets may be useful for attracting further support. For example, under rural electrification, the Rural Electrification and Strategic Master Plan sets clear targets, identifies least-cost projects and technologies, and investments needed to increase renewable energy access for rural areas and populations. These include mini and small hydropower, as well as solar technologies. Scaling up these investments can have positive implications for the development and expansion of development corridors, as well as for agricultural value chains.[30] Rural electrification or improved cookstoves also have gender-specific health co-benefits for sustainable development that should be part of such an analysis. Emissions reductions from these potential investment opportunities should be quantified to better signal the climate benefits.

[30] Republic of Liberia. (2018) Pro-Poor Agenda for Prosperity and Development. https://www.theperspective.org/2018/Revised_PAPD.pdf.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of conditional targets associated with co-benefits that may accompany energy sector emission targets.

Recommendation 5: Explicitly link energy sector actions in the NDC with associated LULUCF outcomes.

Liberia is providing a global service for emission reductions with its Land-use, Land-use Change, & Forestry (LULUCF) carbon sink. The climate benefit could be even greater if gross LULUCF emissions are addressed through reduced deforestation and degradation, and there may also be opportunities for increasing the sink through actions to promote forest regeneration. Reducing Emissions from Deforestation and Forest Degradation (REDD+) is one tool for achieving these additional climate benefits. LULUCF was not specifically included in the NDC mitigation targets, but forests are implicitly connected to the mitigation activity that seeks to distribute more efficient cook stoves, which will reduce pressure on forest resources. These efforts could have significant benefits in the land sector considering that "close to 95% of the 1.5 million people in Monrovia use charcoal for cooking and heating," according to the 2013 Initial National Communication for Liberia. Therefore, even though LULUCF is outside of the NDC targets, fulfillment of these existing targets could increase the carbon sink/decrease gross LULUCF emissions. Explicitly linking actions in the NDC to LULUCF benefits could present an opportunity for increased financial resources via REDD+ and incentivize maintenance or enhancement of the sink and reduction of gross LULUCF emissions.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of this recommendation to link energy sector actions from the NDC with LULUCF outcomes.

Recommendation 6: Ensure that the appropriate institutional arrangements and governance are in place to ensure effective and efficient participation of the energy sector in national climate planning and action.

Given the importance of this sector and the diversity of public stakeholders involved in the energy sector and relevant subsectors, the governance and institutional arrangements needed to ensure effective planning, implementation, and monitoring should be discussed to ensure alignment between goal setting, program support, and implementation, as well as to mainstream existing climate-related policies with the aim to reduce GHG emissions. Energy financing and private sector involvement in the energy sector, including de-risking of private sector investment, are also important areas to strengthen alignment.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of a target that addresses the need for a comprehensive energy sector governance and legal framework reform.

Recommendation 7: Consider linkages with climate goals across sectors and promote mainstreaming of climate objectives.

Recognizing the synergies between climate actions in different sectors can increase multi-sector benefits of individual climate actions. For example, there are key linkages between the forestry, agriculture, coastal zones, urbanization and energy sections of Liberia's NDC as well as the 2018 National Policy and Response Strategy on Climate Change. The forthcoming Technical Report on Mainstreaming Climate Change Considerations into the Relevant Sector Specific Development Programs, Policies, Strategies and Management Plans in Liberia, supported by United Nations Development Programme, provides proposed steps for mainstreaming climate actions in each step of the policy cycle—from policy formulation, review and planning to resource allocation, programming and implementation. This document will serve as an important resource for mainstreaming climate actions across all sectors, including the energy sector.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of a target that includes the mainstreaming of climate actions across all sectors.

Recommendation 8: Take stock of progress made in *implementing* existing energy sector policies and the NDC. *[Linkages with other sectors]*

In the process of reviewing and updating the NDC, it is critical to take stock of progress made toward implementing existing sectoral and climate change targets and plans. The revised NDC should be informed by experiences, challenges, and lessons learned from implementing current targets and plans in the energy sector. The stakeholder consultation process should identify any changes in national circumstances, political priorities, development priorities, and efforts to achieve SDGs (including progress made toward relevant sectoral SDG targets), which can help identify new opportunities and synergies to pursue emissions reduction strategies within the context of national priorities. The work done by EPA under the ongoing second national communication can provide a useful input into this stocktaking process.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders could contribute to identify new opportunities for mitigation strategies.

Recommendation 9: Consider linkages with national COVID response and recovery priorities as part of the update of NDC targets for this sector. *[Linkages with other sectors]*

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of this recommendation.

Sector Highlight: Waste

National Sectoral Context

In 1986, preceding the conflict period in Liberia, approximately 85% of Monrovia's waste was collected for disposal. Other counties throughout the country, including Buchanan, Gbarnga, Greenville, Harper, Kakata and Robertsport, also had "relatively-developed waste collection and disposal systems."[31] However, by 2000, in the post-conflict period, this figure had decreased significantly to about 20-30%. Much of the existing waste management infrastructure had been lost and waste collection services ceased in many areas, leading to an increase in alternative solid waste disposal methods, including burning or burying waste in communities or dumping in wetlands for land reclamation.[32] The issue of waste management has been a serious challenge in Liberia, particularly in Montserrado County, which hosts about half of the country's population in the capital city, Monrovia. The city was initially built for approximately five hundred thousand people, but has grown to over 1.4 million inhabitants, owing mainly to urban sprawl.[33] This exponential population growth has had a cascading effect on solid waste generation and management in the city. Many other urban cities across the country are also confronted with similar issues.

The absence of well-engineered landfills in Monrovia and other major cities across the country makes waste management a challenge. As a result, current proper waste disposal activities are carried out at a small number of transfer stations, while most waste is inappropriately disposed of in open fields, wetlands, marketplaces, and along roadsides in most communities. Waste is collected from the primary sources (homes, businesses, hotels, etc.) by Community Based Enterprises (CBEs)/Small and Medium Enterprises (SMEs) for a little fee to be transported to holding centers or transfer stations. Presently, there are two waste transfer stations in Montserrado County: (1) the Stockton Creek Station – which services communities north of Monrovia (e.g., Gardnersville) and (2) the Fiamah Station – which services

[31] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf.
[32] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf.
[33] Liberia Institute of Statistics and Geo-Information Services (LISGIS). (2008) Population and Housing Census. https://www.lisgis.net/pg_img/NPHC%202008%20Final%20Report.pdf.

communities in Monrovia. There is also a temporary holding center used by Paynesville City Corporation (PCC), which services the Paynesville area. From these transfer stations, the wastes are transferred to Whein Town Sanitary Landfill, which is shared by Monrovia and Paynesville municipalities and is rapidly approaching its holding capacity. Since 2017, the government has embarked on the Cheesemanburg Landfill Urban Sanitation (CLUS) Project funded by World Bank. The construction of the proposed new landfill will help further strengthen the Solid Waste Management (SWM) sector and enhance waste collection and disposal as a way of providing a cleaner and healthier environment, in Brewerville, Tubmanburg, and the Township of Cheesemanburg.

Climate projections for Liberia predict increased sea level rise, increased temperatures, and increased frequency of intense precipitation (e.g., along the coast), which hosts most of the country's population. These drastic changes in climatic conditions would impact the already limited waste management sector. For example, sea level rise will lead to increased coastal flooding and likely damage to the already dilapidated waste management and sewage facilities. For instance, densely populated communities, such as West Point, New Kru Town, and PHP in Monrovia, have all experienced severe infrastructural damages caused by coastal erosion and flooding in the last decade.

Based on the estimated emissions for 2000, the waste sector accounted for approximately 0.6% of Liberia's national greenhouse gas emissions, with a significant contribution (91.7%) coming from methane emissions from solid waste disposal. The remaining 8.3% is attributed to domestic and commercial wastewater handling.[34] In addition to opportunities for GHG mitigation, addressing emissions from the waste sector in Liberia's NDC will contribute to the achievement of the Sustainable Development Goals (SDGs), especially, SDG 6 - Clean Water & Sanitation, SDG 11 - Sustainable Cities & Communities, SDG 12 - Responsible Consumption & Production, and SDG 13 - Climate Action.

The Liberia Environmental Protection Agency is responsible for environmental issues related to waste management in the country. This includes monitoring, supervision, and preparing relevant guidance. However, there are several other national ministries, agencies, and subnational entities involved in specific aspects of the waste management process.

Existing NDC Targets

There are three recognized waste management systems in Liberia: solid-waste disposal on land, industrial and domestic wastewater handling, and incineration. Liberia's NDC focuses on solid waste disposal on land, with four sub-targets.

[34] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf.

Table 2.1 Existing Mitigation Targets and Activities in 2015 NDC – Waste.

Mitigation Targets and Activities in 2015 NDC – Waste Sector		
Sectoral Quantitative Target (if applicable)	**Sub-targets and activities identified**	**Baseline information used for 2015 NDC target**
316,000 tCO_2e (Mitigation Scenario 4: Monrovia Landfill Gas Plant)	Strengthen institutional and individual capacity for waste management.	In 2000, the waste sector accounted for 0.6% of Liberia's total CO_2e emissions.
	Develop waste management infrastructure.	
	Implement and strengthen policy that promotes private investment in waste management.	
	Capture methane gas emitted from landfills and used for fueling vehicles, cooking at home or generation of power.	

Source: Information from Liberia Initial Nationally Determined Contribution (2015).[35]

Table 2.2. Existing Adaptation Targets and Activities in 2015 NDC – Waste.

Adaptation Targets and Activities in 2015 NDC – Waste Sector		
Sectoral Quantitative Target (if applicable)	**Sub-targets and activities identified**	**Baseline information used for 2015 NDC target**
Not stated.	*Adaptation activities from the waste sector are not included in Liberia's 2015 NDC.*	*Not stated.*

Source: Information from Liberia Initial Nationally Determined Contribution (2015).[36]

The NDC also refers to methane mitigation targets, such as "landfill recovery, waste incineration with energy recovery, composting of organic waste, controlled wastewater treatment, and recycling and waste minimization."[37]

Existing Relevant Policies, Strategies and Plans

Relevant climate change and sectoral policies were reviewed in order to examine their targets and strategies for the waste sector. The most relevant and updated strategies and plans for climate action in the sector were the focus of this review process:

- ✓ National Policy and Response Strategy on Climate Change (August 2018).

In 2018, the National Policy and Response Strategy on Climate Change presented seven targets related to climate mitigation in the waste sector. These proposed activities built on the sectoral goals outlined in the

[35] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC), emphasis added. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

[36] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC), emphasis added. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

[37] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC), emphasis added. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

2015 NDC, with the ultimate objective of developing and implementing "a comprehensive waste management strategy that includes the development of environmentally sustainable landfills, recovery and use of methane emissions for energy generation, and instituting programs at the community and national level for recycling, reducing, and reusing waste."[38]

Waste Sector Strategies from the National Policy and Response Strategy on Climate Change (2018):

Mitigation Strategies:

- Strengthen capacity at the community and institutional level for **integrated waste management.**
- Identify and promote the use of **energy-efficient technologies** and measures in the waste sector.
- Develop an **integrated waste management strategy** and system for all types of waste, assigning priority for prevention of waste generation with nationally appropriate and **low greenhouse gas emission technologies** that are well managed and compatible **with methane recovery, capture and use for power generation.**
- Promote private public partnership and other ventures that **attract financing for infrastructure investments in the waste sector**.
- Design and implement a system to **turn urban waste to inputs for agricultural production through composting of waste** for use in food security programs in urban (urban agriculture) and rural areas.
- Identify and develop **Clean Development Mechanism (CDM) and Nationally Appropriate Mitigation Action (NAMA) projects** in the solid waste and waste water sector.
- Expand **equitable access to environmentally-friendly and sustainable waste management and sewerage systems** – including for the poorest and most vulnerable communities.

Source: National Policy and Response Strategy on Climate Change (2018). Emphasis added.

Review of NDC Targets

Data. The waste sector data for 2000 was derived from a national municipal solid waste inventory survey undertaken in 2004 by the Monrovia City Corporation and UNICEF for the period 1995–2006. The survey covered four municipalities in Monrovia, with about 90% coverage. The data included limited information on waste composition.[39] Other ongoing process related to the Second National Communication and EU-Liberia Climate Change Alliance+ are expected to produce data of relevance to the sector.

[38] Liberia 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.

[39] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf.

Sources of emissions. In 2000, the waste sector accounted for approximately 0.6% of Liberia's national greenhouse gas emissions, with a significant contribution (91.7%) coming from methane emissions from solid waste disposal. The remaining 8.3% is attributed to domestic and commercial wastewater handling.[40]

Table 2.3. GHG emissions by category from the waste sector.[41]

Greenhouse Gas Source and Sink Categories	CO_2 (Gg)	CH_4 (Gg)	N_2O (Gg)	2000 CH_4 Gg CO_2e	Contribution to national total (%)	Category contribution to sector (%)
Waste		**2.18**	**NE**	**45.82**	**0.6%**	
A. Solid waste disposal on land		2.00		42.00	0.5%	91.7%
B. Wastewater handling		0.18	NE	3.82	0.0%	8.3%
C. Waste incineration				NE	0.0%	0.0%
D. Other (please specify)		NO	NO			

Source: Adapted from Liberia Initial National Communication (2013).[42]

Mitigation and Adaptation Opportunities for the Waste Sector

To be further elaborated in forthcoming analyses by the EU-Liberia Climate Change Alliance+ and technical consultations.

Institutional Framework

Several ministries and agencies have mandates related to the waste sector in Liberia, which is outlined in Table 2.4 below. The Liberia Environmental Protection Agency is responsible for environmental issues related to waste management in the country. This includes monitoring, supervision, and preparing relevant guidance. However, there are several other national ministries, agencies, and subnational entities involved in specific aspects of the waste management process.

The municipalities have been granted, by the Public Health Law of 1975 (which remains valid), the responsibility of ensuring clean and sanitary environmental conditions on the territory under their respective jurisdictions. They are responsible for sanitation activities, including the cleaning, collection, and disposal of generated solid waste.[43]

[40] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf.
[41] To convert the values in Table 2.3 from Gigagrams (Gg) to Megatons (MT), divide each value by 1,000.
[42] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf.
[43] United Nations Environment Programme. (2007) Assessment of Solid Waste Management in Liberia. https://www.unenvironment.org/resources/report/assessment-solid-waste-management-liberia

Table 2.4. Institutions and agencies with mandates on waste in Liberia.

Institution	Mandate
Environmental Protection Agency (EPA)	• Responsible for tackling environmental issues and waste management services, coordination, monitoring and supervision of waste management projects. Consult with relevant stakeholders on all activities relating to the protection of the environment and sustainable use of natural resources. • Setting up national guidelines for solid waste management in Liberia, environmental quality standards and ensuring compliance with pollution control. • Providing guidelines for the preparation of environmental impact assessments (EIAs), audits/ inspections and environmental licenses/permits for healthcare waste treatment plants.
Ministry of Health and Social Welfare (MHSW)	• Assess the environmental health of the population, thereby conducting sanitary inspections to evaluate compliance in line with the Public Health Law of Liberia. (Environmental & Occupational Health Department)
Ministry of Public Works (MPW)	• Installation of infrastructure for waste management delivery services, i.e., waste collection to transfer stations and the construction of sanitary landfills.
Ministry of Mines and Energy (MME)	• Evaluating urban sanitation projects. • Providing guidance for engineered landfill sites for the disposal of nonhazardous waste generated from Healthcare facilities.
Monrovia City Corporation (MCC)	• Responsible for carrying out city ordinances, management of municipal wastes, recreation, public education and awareness and provision of services in environmental health and sanitation.
National Environment Policy Council	• Responsible for policy making regarding the environment. It also set priorities for national goals and objectives for the protection of the environment • Promote co-operation among Line Ministries, local authorities, the private sector, non-governmental organizations engaged in environmental protection programs and the public

Source: Adapted from David Jr, V et al. (2019)[44]

Cost and Investment Opportunities

The 2018 National Policy and Response Strategy on Climate Change included an "Action Plan and Resource Mobilization Plan," which outlines specific activities for undertaking climate action in each sector between 2017-2026. Table 2.5 below includes information regarding the activities, estimated costs and relevant government implementing agencies, as outlined in the 2018 Resource Mobilization Plan.[45]

[44] David V.E., Wenchao J, Mmereki D, John Y, Feno H (2016) Healthcare Waste Management Practices in Liberia: An Investigative Case Study. Int J Waste Resour 6: 235. doi:10.4172/2252-5211.1000235. Quoted in David, V.E. et al. (2019) "Solid Waste Management in Monrovia, Liberia: Implications for Sustainable Development" Article in Journal of Solid Waste Technology and Management. DOI: 10.5276/JSWTM.2019.102.

[45] Liberia 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.

Table 2.5. Action Plan for the Implementation of Strategic Interventions – Waste.

Sectoral and Cross-Sectoral Intervention Area: Waste Management					
Strategic Interventions	**Intervention Period** (Years 2017 to 2026)			**Estimated Cost** (Million USD)	**Implementing Agencies**
	(1-3) Short-term	(4-5) Mid-term	(6-10) Long-term		
Strengthen capacity at the community and institutional level for integrated waste management	X	X		30	Municipal authorities, MoH, MoFDP, EPA, or city corporations
Develop an integrated waste management strategy and system for all types of waste, assigning priority for prevention of waste generation with nationally appropriate low greenhouse gas emission technologies that are well managed and compatible with methane capture and use for electricity generation	X	X		10	LEC, MME, MUNICIPAL AUTHORITIES, MoFDP, EPA, other city corporations, Universities and Colleges
Promote private public partnership (PPP) and other ventures that attract financing for infrastructure investments in the waste sector	X	X	X	1	NIC, MoPW, MICAT, MoFDP, EPA
Design and implement a system to turn urban waste into input for agricultural production through composting of waste for use in food security programs in the urban (urban agriculture) and rural areas	X	X		35	MoA, MoFDP, EPA, city corporations
Develop landfills for all major cities and use CDM and NAMAs to develop projects for methane recovery and for power generation in landfills	X	X	X	100	MME, Municipal City Corporation (MUNICIPAL AUTHORITIES), Monrovia City Council (MUNICIPAL AUTHORITIES), MoFDP, EPA

Source: Adapted from National Policy and Response Strategy on Climate Change (2018).[46]
Agency abbreviations: EPA = Environmental Protection Agency; LEC = Liberia Electric Corporation; MICAT = Ministry of Information Culture Affairs & Tourism; MoA = Ministry of Agriculture; MoFDP = Ministry of Finance & Development Planning; MoH = Ministry of Health; MME = Ministry of Mines and Energy; MoPW = Ministry of Public Works; NIC = National Investment Commission

Policy Gaps and Challenges

Challenge: Absence of an integrated waste management policy and strategy. The absence of an overarching integrated waste management policy and strategy presents a challenge for management and coordination in the sector. Such a policy and/or strategy will provide clear vision and direction for waste management and can also help mobilize donor partners and private capital. A coherent strategy for waste management, revenue collection, and incentivizing assistance from the government is crucial for strengthening the sector, demonstrating national commitment toward waste management, and incentivizing private sector investments.

[46] Liberia 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.

There is further uncertainty about the handling of electronic waste, with quantities rapidly increasing in the country. Policies or concrete measures for handling electronic waste are currently lacking. Similarly, special treatment of medical waste, particularly single-use non-recyclable materials (such as plastic gloves, masks, gowns, beddings etc.), during Ebola and COVID-19 outbreaks, need to be considered and addressed.

Challenge: Limited data availability. The lack of reliable available data in the waste sector presents a challenge. The waste-sector data for 2000 was derived from a national municipal solid waste inventory survey undertaken in 2004 by the Monrovia City Corporation and UNICEF for the period 1995–2006. The survey covered four municipalities in Monrovia with about 90% coverage. The data included limited information on waste composition.[47]

Data availability is a major challenge for climate action in this sector. The challenge makes it difficult to justify the mitigation potential of the sector, and yet it has a huge potential and enormous co-benefits ranging from air quality, pollution, economy, and health. The absence or limitation of data makes it difficult to compile accurate GHG inventory information, conduct a quantitative assessment of mitigation options, and eventually package the option as Clean Development Mechanism (CDM) or Nationally Appropriate Mitigation Action (NAMA) project.

Challenge: Complex and overlapping institutional mandates. The Liberia Environmental Protection Agency is a national leader on the provision of waste management services within the country. Despite significant advances on national coordination and waste management implementation, some ministries and agencies have overlapping mandates related to the waste sector in Liberia (see Table 2.4 above). This is further complicated by the overlapping responsibilities between agencies at the national and subnational level. “On the one hand, the EPA, the MHSW, and the municipalities all have a monitoring role, and on the other hand the MME and the MPW have responsibility for preparing engineered landfill sites. In general, four government ministries oversee the water supply and sanitation (WSS) sector.”[48] Local governments outside Monrovia have limited capacity to manage solid waste or coordinate with national agencies, which presents additional challenges.

Sectoral Recommendations for Consideration

Preparation of waste sector recommendations to be led by the EU-Liberia Climate Change Alliance+ with inputs from a robust stakeholder input and consultation process. The below suggestions are proposed as a potential starting point for further examination.

The targets for the waste sector as outlined in the NDC cover the most pressing needs to support Liberia’s climate and sustainable development goals. The recommendations below are focused on refining and

[47] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf.
[48] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf.

elaborating these goals to make them more specific and tangible. These refined targets may belong as part of the revised NDC or in a detailed implementation plan.

Recommendation 1: Clarify waste sector institutional roles, mandates, and legislation and highlight synergies and areas for institutional collaboration.

This recommendation proposes an elaboration of an existing target under Liberia's NDC to "Strengthen institutional … capacity for waste management." As described in the Challenges section above, several ministries and agencies have overlapping mandates related to the waste sector in Liberia. According to Initial National Communication, "[l]ack of coordination between and lack of clear roles or functions for the relevant waste-management agencies: Ministry of Public Works (MPW), the MCC, the EPA" is a key barrier. This continues to the subnational scale where "[w]eak institutional capacity of local government agencies and city and town councils due to low priority accorded to waste management." [49] This is also an opportunity to highlight synergies and areas for institutional collaboration.

This can be done through the formulation of a national waste policy and strategy. The process of developing such an instrument has already been started, but it must be finalized and validated. The appropriate handling of electronic waste and hospital waste should also be considered in the context of COVID-19 and should be addressed in a national waste policy and strategy. Relevant legislation should be reviewed, including relevant incentives or disincentives, to ensure sectoral harmonization.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of an improved coordination mechanism at the national and subnational levels.

Recommendation 2: Promote awareness and education about waste management at all levels – national and subnational – including cities, local, and household levels.

This recommendation proposes an elaboration of an existing target under Liberia's NDC to "strengthen … individual capacity for waste management." In 2007, a United Nations Environment Programme report, "Assessment of Solid Waste Management in Liberia," identified education and awareness building as a key step for improving waste management in the country:

> One of the key factors necessary to ensure the success of the sustainable waste management initiatives, as advocated by this paper, is the involvement of the civil society. This would mean enhancing the communities' contribution to the operational processes; strengthen educational programmes on waste-heath related issues at school, and examining the proper role of women within the waste management sector.[50]

As part of an enhanced NDC or a detailed implementation plan, this goal should be accompanied by specific education strategies and a proposal for implementation, including a focus on "the environmental

[49] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf.
[50] United Nations Environment Programme. (2007) Assessment of Solid Waste Management in Liberia. https://www.unenvironment.org/resources/report/assessment-solid-waste-management-liberia.

and societal benefits of waste reduction and recycling, composting options, and reduce the stigma attached to waste-management services."[51] It is important that this effort considers the need for awareness on how to appropriately manage all types of waste—electronic, construction, agricultural, medical, radioactive, household, gaseous, liquid, etc.—for each relevant audience. There may also be an opportunity to explore community-based waste management approaches, such as sorting recyclables.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to a strategy for engaging and educating different segments of the Liberian public ensuring women and youth involvement.

Recommendation 3: Add further detail to the existing NDC goal to develop waste management infrastructure.

This recommendation proposes an elaboration of an existing target under Liberia's NDC to "[d]evelop waste management infrastructure." This goal could encompass a broad set of activities. The revised NDC and implementation plan would benefit from additional detail on what is intended.

For example, the 2018 National Policy and Response Strategy on Climate Change proposed to "[p]ursue the development and implementation of a comprehensive waste management strategy that includes the development of environmentally sustainable landfills, recovery and use of methane emissions for energy generation, and instituting programs at the community and national level for recycling, reduce and reuse of waste."[52] Waste management "infrastructure" could include the implementation of relevant environmentally friendly technologies; coordination structures, waste processing protocols, guidance, and systems; composting and recycling facilities; and selection and development of landfill sites, etc.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of a strategy for improving waste management infrastructure, considering both national and subnational infrastructure needs.

Recommendation 4: Enlist private sector support to invest in the waste management sector.

This recommendation proposes an elaboration of an existing target under Liberia's NDC to "implement and strengthen policy that promotes private investment in waste management." In 2007, United Nations Environment Programme prepared an Assessment of Solid Waste Management in Liberia, which included specific recommendations for engaging the private sector in the waste management sector in Liberia:

> …[I]n many countries of the world, including Africa, the privatization of waste management services is often seen as the only viable option, and potentially offers higher quality of service at competitive prices, allowing the government sector to focus on the roles of monitoring and enforcement of services. On this matter, the African Development Bank's guidelines for waste management state that private enterprises may play a role in vastly improving solid waste

[51] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf.
[52] Liberia 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.

management services in Africa. However, it should be noted that compared to developed-country models, the African models require greater involvement of the communities in the process. Community Based Organizations (CBOs) may play a role in providing solid waste management services from pre-collection to recycling and composting.

…

The implementation of cost-recovery measures by municipalities through user-fees and local taxes, in parallel with the establishment of subcontracting partnerships with the private sector could be a promising solution for Liberia. However, this would require empowering the municipalities and the EPA in their monitoring and enforcement role, through appropriate training of staff and provision of appropriate resources.

To explore further the option of privatization of waste management services feasibility studies would need to be undertaken, including the review of possible cost-recovery mechanisms. Preliminary investigations by the UNEP team indicate that waste generators would generally be prepared to pay an appropriate fee for waste collection services.[53]

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of a strategy for engaging the private sector in improving and investing in the waste management sector.

Recommendation 5: Formulate a strategy for advancing plans to capture methane gas emitted from landfills and convert it to energy.

The existing NDC goal to "Capture methane gas emitted from landfills and used for fueling vehicles, cooking at home or generation of power" is the most directly linked to the delivery of emission reductions from the waste sector. According to the NDC, "Based on these calculations, it is assumed that most of this methane gas can be captured and either used to fuel vehicles on biogas or can be piped in for use in a power generation facility. Doing either can reduce emissions by roughly 90%."[54] The formulation of a strategy should focus on building the facilities to capture methane gas emitted from landfills and convert to energy, as well as other relevant opportunities, such as the feasibility of liquid and gaseous waste treatment.

This goal requires the most technical and financial inputs. As identified under the National Policy and Response Strategy on Climate Change, a CDM or NAMA project could provide investment for a landfill gas capture plant.[55] The formulation of a strategy should cover capacity, technology and finance needs and how to address them.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of a strategy for building the facilities to capture methane gas emitted from landfills and convert to energy, as well as the feasibility of liquid and gaseous waste treatment.

[53] United Nations Environment Programme. (2007) Assessment of Solid Waste Management in Liberia. https://www.unenvironment.org/resources/report/assessment-solid-waste-management-liberia.

[54] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC). https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

[55] Liberia 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.

Recommendation 6: Consider interlinkages with health, including adaptation targets for the health sector, under the NDC. ***[Linkages with other sectors]***

The appropriate handling of electronic waste and hospital waste are important considerations in the context of COVID-19 and should be addressed in the relevant sections of the NDC revision. This also links to the air pollutants analysis under the short-lived climate pollutants section in terms of ensuring health co-benefits.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of this recommendation.

Recommendation 7: Take stock of progress made in *implementing* existing waste sector policies and NDC activities. ***[Linkages with other sectors]***

In the process of reviewing and updating the NDC, it is critical to take stock of progress made toward implementing existing sectoral and climate change targets and plans. The revised NDC should be informed by experiences, challenges, and lessons learned from implementing current targets and plans in the waste sector. The stakeholder consultation process should identify any changes in national circumstances, political priorities, development priorities, and efforts to achieve the Sustainable Development Goals (SDGs) (including progress made toward relevant sectoral SDG targets), which can help identify new opportunities and synergies to pursue emissions reduction strategies within the context of national priorities. The work done by EPA under the ongoing second national communication can provide a useful input into this stocktaking process.

Recommendation 8: Consider linkages with national COVID response and recovery priorities as part of the update of NDC targets for this sector. ***[Linkages with other sectors]***

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of this recommendation.

Sector Highlight: Transport & Infrastructure

National Sectoral Context

Liberia's transport sector is characterized by the existence of inefficient and poorly maintained vehicles; about 90% of the imported vehicles have been used before and the majority have 10 years of use when they are first imported to the country.[56] This situation is aggravated by the exclusive use of low-quality fuel (low grade diesel and mixed petroleum), all of which is imported.[57] In terms of transport infrastructure, roads have been severely affected by the 15-year civil war in the country, leaving them in very poor condition; only 6.2% of the road network is paved and 45% of households have access to a road within 5km throughout all the seasons, which also has a negative impact on livelihoods and access to health and other facilities, especially during rainy seasons.[58] All of these factors contribute to the emissions from the transportation sector, specifically from road vehicles.

Liberia's GHG inventory includes transport as one of the main emitting sectors within the energy sector, accounting for a total of 40.1% of the total GHG emissions from energy.[59] GHG emissions from transport are increasing and have doubled since 1986, now accounting for 27.1% of the national total GHG emissions (contributing with CO_2 and CH_4 emissions).[60] In addition to GHG mitigation opportunities, addressing emissions from transport and infrastructure in Liberia's NDC will contribute to the achievement of the Sustainable Development Goals (SDGs), especially, SDG 9 - Industry, Innovation & Infrastructure, SDG 11 - Sustainable Cities & Communities, SDG 13 - Climate Action, and SDG 15 - Life on Land.

[56] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf Pg. 55.
[57] Republic of Liberia. (2016) National Renewable Energy Action Plans (NREAPs) Period 2015-2020/2030). https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_PANEE/Liberia_national_energy_efficiency_action_plan_neeap.pdf.
[58] Republic of Liberia. (2012) National Sustainable Development Report.
[59] Republic of Liberia. (2016) National Renewable Energy Action Plans (NREAPs) Period 2015-2020/2030). https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_PANEE/Liberia_national_energy_efficiency_action_plan_neeap.pdf.
[60] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf Pg. 52-55.

The Ministry of Transport (MoT) is the main agency responsible for road transportation services and regulating the use of transport infrastructure.[61] Meanwhile, the Ministry of Public Works (MoPW) is the entity in charge of road infrastructure (planning, designing, constructing, and maintenance), enforcement of safety standards for transport services and urban planning.[62] The EPA is responsible for ensuring that fossil fuels comply with environmental safety standards and that environmental impact studies are undertaken before construction of any infrastructure. Other entities with responsibilities in this sector include the Liberia Civil Aviation Authority (LCAA), which oversees the regulation and promotion of civil aviation and its safe development,[63] and the National Port Authority (NPA), which oversees public ports in Liberia, among other responsibilities.[64]

Existing NDC Targets

Table 3.1. Existing Mitigation Targets and Activities in 2015 NDC – Transport and Infrastructure.

Mitigation Targets and Activities in 2015 NDC –Transport/Infrastructure Sector		
Sectoral Quantitative Target (if applicable)	**Sub-targets and activities identified**	**Baseline information used for 2015 NDC target**
Not stated.	5% Biofuel use in transport - leading to a 40% reduction in GHG emissions resulting from palm biodiesel use (over fossil fuel) by 2030.	In 2000, transport accounted for 40.1% of the total GHG emissions from the energy sector and 27.1% of Liberia´s National GHG emissions.
	Mainstream climate change into existing transport management plan to strengthen emission control.	
	Strengthen institutional capacity for developing strategies for integrated transport services; developing technical and safety standards and the enforcement of policies including emission control.	
	Improve the quality and reliability of transport infrastructure and services	
	Develop emissions reductions and tracking system of pollutants from vehicles.	

Source: Information from Liberia Intended Nationally Determined Contribution (2015). [65]

[61] Ministry of Transport and Ministry of Public works. (2012) National Transport Master Plan of Liberia. http://mot.gov.lr/doc/Cap_4.pdf.
[62] Ministry of Transport and Ministry of Public works. (2012) National Transport Master Plan of Liberia. http://mot.gov.lr/doc/Cap_4.pdf
[63] Civil Authority Aviation Act (2006). http://lcaa.gov.lr/statutory-authority/.
[64] National Port Authority of Liberia. (2018) Overview of the authority. http://www.npaliberia.com/corporate/overview/.
[65] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC), emphasis added. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

Table 3.2. Existing Adaptation Targets and Activities in 2015 NDC – Transport and Infrastructure.

Adaptation Targets and Activities in 2015 NDC – Transport/Infrastructure Sector		
Sectoral Quantitative Target (if applicable)	**Sub-targets and activities identified**	**Baseline information used for 2015 NDC target**
Not stated.	Implement and reinforce design standards and planning codes for roads and other infrastructure to cope with flooding, sea level rise and windstorm.	*Not stated.*
	Strengthen early warning systems and evacuation planning for intense rainfall events and floods.	
	Install signs high above the ground that can alert pedestrians and motorists of unsafe zones, such as low-lying areas.	
	Maintain and upgrade roads with appropriate drainage systems to cope with flooding.	
	Improve and enhance public transport services	

Source: Information from Liberia Initial Nationally Determined Contribution (2015).[66]

Existing Relevant Policies, Strategies and Plans

The climate change related policies that include references to the transportation sector were reviewed in order to examine their targets and strategies for the transport and infrastructure sector. The most relevant and updated strategies and plans for climate action in the sector were the focus of this review process:

- ✓ National Policy and Response Strategy on Climate Change (August 2018);
- ✓ Pro-Poor Agenda for Prosperity and Development (PAPD) (September 2018);
- ✓ National Renewable Energy Action Plans (NREAPs), (2015) Period 2015-2020/2030; and
- ✓ Liberia National Communication (2013).

The full text from the National Transport Master Plan (2012) and its update (2018) were not available for our review, but should be considered in the expert review and consultation process. The Liberia National Adaptation Programme of Action (NAPA) (2008) was reviewed, but it provided no specific targets or strategies for the transport and infrastructure sector.

In 2018, the National Policy and Response Strategy on Climate Change (NPRS) presented eight targets related to climate mitigation and seven related to adaptation in the transport sector. These proposed activities built on the goals outlined in the 2015 NDC with the ultimate objective of "Build[ing] the future of Liberia´s transport system and associated infrastructure on a low carbon emitting basis" and "Ensur[ing] the development of an efficient, effective and affordable transportation system that is resilient to the

[66] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC), emphasis added. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

possible shocks of climate change and which contributes to the sustainable development of the country."[67] From the infrastructure sector, the NPRS presented six targets related to climate adaptation. These built on the 2015 NDC with the objective of "Ensur[ing] that infrastructure is 'climate-proof.'"[68]

Transport Sector Strategies from the National Policy and Response Strategy on Climate Change (2018):

Mitigation Strategies:

- Enhance and **promote the use of mass transport systems** in major cities using, for example, buses.
- Promote the use of **non-motorized transport means** such as bicycles.
- Construct **new road infrastructure** and **rehabilitate the existing ones** to gradually avoid traffic congestion.
- **Integrate urban and regional planning approach to the national planning** in order to optimize location of facilities, so as to reduce travel time and cost.
- Introduce and gradually enhance the blending of domestically produces biofuels with fossil fuel to substitute imported fossil fuels for cars with **domestically produced biodiesel and bioethanol.**
- Introduce and strengthen control on the importation of used cars and **stricter fuel efficiency standards.**
- Provide fiscal and regulatory investment incentives to make water, rail and air transport in Liberia gradually develop and become safer and more accessible.
- Avail or put in place a system to encourage the availability of public transport for tourist destinations.

Adaptation Strategies:

- Ensure the **mainstreaming of climate change considerations** in the national transport policies and programs.
- Establish and gradually **improving systems for rapid transportation**.
- Promote the use of **mass transport facilities**.
- Put in place a system for **proper urban transport planning** to facilitate efficient and **low GHG modes of transportation**.
- Promote **multiple modes in public transport** to include water and rail.
- Promote the use of **non-motorized transport** like bicycle.
- Promote **fuel switch in transport facilities**.

Infrastructure Sector Strategies from the National Policy and Response Strategy on Climate Change (2018):

[67] Liberia 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

[68] Liberia 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

Adaptation Strategies:

- Ensure **climate resilience in the infrastructure sector**, including improved use of weather and climate information in infrastructure planning and development, and research to identify and design materials that enhance the resilience of infrastructure.
- Amidst the increasing wave of sea erosion along the coast, higher tides and more frequent storm surge events, there is a need to **redesign the coastal highways, bridges, sewer and water infrastructure** so that they are made **resilient**.
- Regulations and codes should be revised or developed where necessary to **account for climate change impacts.** Major infrastructure projects such as roads, airports and sea ports should be subjected to **climate risk screening** as part of the planning process.
- Reduce damage to infrastructure and the environment, and lessen the risk to human health and wellbeing by developing land-use policies and emergency response measures that **account for sea-level rise when planning and building infrastructure**.
- **Regulate development** in coastal areas; **prevent construction** in areas of known vulnerability, and **protect coastlines at critical sites** in order to mitigate the risk to coastal communities.
- Employ significant investment in building coastal protection including **eco-based solutions** (planting of trees) and hard structures (groynes, revetments, etc.) in coastal cities like Monrovia, Buchanan, Robertsport, Greenville, Harper, Cestos and Grandcess.
- As a last resort, relocate communities that are at extreme risks due to flooding and coastal erosion.

Source: National Policy and Response Strategy on Climate Change (2018). Emphasis added.

Transport Infrastructure Strategies from the Pro Poor Agenda for Prosperity and Development (PAPD) (2018):

- By 2023 Liberia will have a **more expansive national road network** reducing the cost of transport and doing business, supporting the generation of decent employment opportunities, and transforming the living conditions of the poor and the vulnerable through better access to social services.
- **Alternative water transport opportunities** will also be pursued.
- A road authority will be fully implemented.
- A more **effective road maintenance system** will be established.
- High Level National Target: By 2023- 517 km roads connecting all county capitals, 260km of urban roads, 237.1km secondary road constructed and paved; constructed material testing facilities in 5 regions; 6,184.7km of primary, secondary and urban roads maintained; zoning laws standardized and enforced.
- By 2023, the government aims to have a stronger and more competitive **air and sea transport system** supporting economic transformation and job creation.
- The government will construct new and rehabilitate existing air and sea infrastructure.

Source: Pro Poor Agenda for Prosperity and Development (PAPD) (2018). Emphasis added.

Transport Sector Mitigation Strategies from the Initial National Communication (2013):

- Continue to **improve the public transport system**.
- Equip the police force with the resources to enforce laws and regulations.
- Put in place a **traffic management plan**.
- Ensure **integrated land-use and transport planning.**
- Establish a **road improvement program**.
- Create a **driver awareness campaign** for efficient use of vehicles.

Source: Initial National Communication (2013). Emphasis added.

National Renewable Energy Action Plans (NREAPs) (2015):

- Promotion of **biodiesel and ethanol substitution** in the transport sector is a measure planned for 2016-2030.

Source: National Renewable Energy Action Plans (NREAPs) (2015). Emphasis added.

Review of NDC Targets

Data. According to the Initial National Communication, the national inventory baseline is the year 2000 since it has the most accurate activity data for the country, the revised 1996 IPCC Guidelines and the guidelines in IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000 (IPCC GPG) were used in order to prepare this inventory.[69]

Sources of emissions. In 2000, transport was one of the main emitting sectors within the energy sector; accounting for a total of 40.1% of the total GHG emissions from energy.[70] There is no information for the emissions from sub-sectors from transport, hence reducing the accuracy, completeness, and consistency of this accounting. The national GHG inventory plays a critical role in assessing the potential of mitigation options, because it is the starting point for making baseline projections. Thus, the more accurate, complete and consistent the GHG inventory is, the better the results of the mitigation assessment can be.

Table 3.3. GHG emissions by category from the transport sector.[71]

Greenhouse Gas Source and Sink Categories	CO_2 (Gg)	CH_4 (Gg)	N_2O (Gg)	2000 CH_4 Gg CO_2e	Contribution to national total (%)	Category contribution to sector (%)
Energy	**3,571**	**1,533**	**310**	**5,414**	**67.5%**	
A. Fuel Combustion (by sector)						
1. Energy Industries	1,117	0	0	1,117	13.9%	20.6%

[69] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf Pg. 6, 50.

[70] Republic of Liberia. (2016) National Renewable Energy Action Plans (NREAPs) Period 2015-2020/2030). https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_PANEE/Liberia_national_energy_efficiency_action_plan_neeap.pdf.

[71] To convert the values in Table 3.3 from Gigagrams (Gg) to Megatons (MT), divide each value by 1,000.

2. Manufacturing Industries and construction	105	0	0	105	1.3%	1.9%
3. Transport (road vehicles)	**2,152**	**21**	**0**	**2,173**	**27.1%**	**40.1%**
4. Other sectors	197	1,512	310	2,019	25.2%	37.3%

Source: Adapted from Liberia Initial National Communication (2013).[72]

Mitigation and Adaptation Opportunities for the Transport and Infrastructure Sector

To be further elaborated in forthcoming analyses by the EU-Liberia Climate Change Alliance+ and technical consultations.

Institutional Framework

Several ministries and agencies have mandates related to the transport and infrastructure sector in Liberia, which is outlined in Table 3.4 below. The Ministry of Transport and Ministry of Public Works have the core responsibilities in this area. There also are specific public authorities for ports and civil aviation in Liberia.

Table 3.4. Institutions and agencies with mandates on transport and infrastructure in Liberia.

Institution	Mandate
Ministry of Transport (MoT)	• Road transportation services (including regulations, plans and policies for road, rail, sea, and air transport services). • Regulating the use of transport infrastructure and the use of inland waterways and rivers as well as the use of ships flying the Liberian Flag for domestic and foreign commerce. • Enforcing service and safety standards for transport services.
Ministry of Public Works (MoPW)	• Road infrastructure, including planning, designing, constructing and maintenance of public infrastructure (roads, bridges and public buildings) • Urban planning.
Liberia Civil Aviation Authority (LCAA)	• Provide regulation and promotion of civil aviation and its safe development.
National Port Authority (NPA)	• Manages, plans, and builds all public ports in Liberia.
Liberia Maritime Authority	• Manages commercial activities within the maritime domain of Liberia.
Environmental Protection Agency (EPA)	• Monitor and ensure that all materials used, including designs and plans, meet existing environmental standards.

[72] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf.

	• Environmental Impact Assessments must be conducted, and a permit should be obtained before any construction or maintenance of infrastructures is undertaken.

Source: Adapted from information available in the National Transport Master Plan of Liberia (2012) [73], Civil Authority Aviation Act (2006) [74], National Port Authority of Liberia (2018) [75,76]

Cost and Investment Opportunities

The 2018 National Policy and Response Strategy on Climate Change included an "Action Plan and Resource Mobilization Plan," which outlines specific activities for undertaking climate action in each sector between 2017-2026. Table 3.5 below includes information regarding the activities, estimated costs and relevant government implementing agencies, as outlined in the 2018 Resource Mobilization Plan.[77]

Table 3.5. Action Plan for the Implementation of Strategic Interventions – Transport and Infrastructure.

Sectoral and Cross-Sectoral Intervention for Mitigation: Transport					
Strategic Interventions	**Intervention Period** (Years 2017 to 2026)			**Estimated Cost** (Million USD)	**Implementing Agencies**
	(1-3) Short-term	(4-5) Mid-term	(6-10) Long-term		
Enhance and promote the use of mass transport systems in major cities using, for example, buses.	X	X	X	20	MoT, NTA, MoFDP, EPA
Construct new road infrastructure and rehabilitate the existing ones to gradually avoid traffic congestion.	X	X	X	500	MoT, MoPW, MME, (Liberian Land Authority), EPA, MoFDP
Integrate urban and regional planning approach to the national planning in order to optimize location of facilities, so as to reduce travel time and cost.	X	X		2	MoT, MoIA, Liberian Land Authority, MoFDP, EPA
Introduce and gradually enhance the blending of domestically produces biofuels with fossil fuel to substitute imported fossil fuels for cars with domestically produced biodiesel and bioethanol.		X	X	20	MoT, MME, RREA, MoA, FDA, MoFDP, EPA
Strengthen the control on the importation of used cars and stricter fuel efficiency standards	X	X		1	MoT, EPA, LRA, MoCI, NPA, MoFDP, EPA
Provide fiscal and regulatory investment incentives to make water, rail and air transport in Liberia gradually develop and become safer and more accessible.		X	X	50	MoT, NIC, MICAT, MoCI, LRA, MoFDP, EPA
Sectoral and Cross-Sectoral Intervention for Adaptation: Transport					
Strategic Interventions	**Intervention Period** (Years 2017 to 2026)				

[73] Ministry of Transport and Ministry of Public works. (2012) National Transport Master Plan of Liberia. http://mot.gov.lr/doc/Cap_4.pdf.
[74] Civil Authority Aviation Act (2006). http://lcaa.gov.lr/statutory-authority/.
[75] National Port Authority of Liberia. (2018) Overview of the authority. http://www.npaliberia.com/corporate/overview/.
[76] Liberia Maritime Authority.(2019) Brief History http://www.lima.gov.lr/index.php/lima/history.html.
[77] Liberia 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.

	(1-3) Short-term	(4-5) Mid-term	(6-10) Long-term	Estimated Cost (Million USD)	Implementing Agencies
Mainstreaming climate change considerations into transport sector planning to promote sustainable transportation system in the country	X	X	X	0.25	MoT, MoFDP, EPA
Establish and gradually improve systems for mass and rapid transportation	X	X	X	3	MoT, MoPW, MoJ, MoFDP, EPA
Put in place a system for proper urban transport planning to facilitate efficient and low GHG modes of transportation		X	X	0.5	Mot, MoPW, MoFDP, EPA
Promote the expansion of multiple modes in public transport to include water and rail and non-motorized transport like bicycle.		X	X	50	MoT, MoPW, LMA, MoFDP, EPA
Sectoral and Cross-Sectoral Intervention for Adaptation: Infrastructure					
Strategic Interventions	**Intervention Period** (Years 2017 to 2026)			**Estimated Cost** (Million USD)	**Implementing Agencies**
	(1-3) Short-term	(4-5) Mid-term	(6-10) Long-term		
Mainstream climate change considerations into infrastructure planning, design, emergency preparedness and response	X	X	X	0.2	MPW, MOT, NDMA, EPA, MoFDP
Implement and reinforce land-use policies; design standards and planning codes for roads and other infrastructure to cope with flooding, sea level rise and windstorm	X	X	X	0.2	MoPW, MoT, MME, MoJ, LLA, EPA, MoFDP
Regulate development in coastal areas; prevent construction in areas of known vulnerability and protect coastlines at critical sites in order to mitigate the risk to coastal communities.	X	X		1	MoPW, MoT, MME, MoIA, NDMA, EPA, MoFDP
Employ significant investment in building coastal protection including eco-based solutions (planting of trees) and hard structures (groynes, revetments, etc.) in coastal cities like Monrovia, Buchanan, Robertsport, Greenville, Harper, Cestos and Grandcess.	X	X	X	250	MoPW, MME, MoA, NDMA, MoIA, MoFDP, EPA

Source: Adapted from National Policy and Response Strategy on Climate Change (2018).[78]

Agency abbreviations: EPA= Environmental Protection Agency; MOT= Ministry of Transport; MoPW/MPW= Ministry of Public Works; MoFDP= Ministry of Finance & Development Planning, MME= Ministry of Mines and Energy; LLA= Liberia Land Authority; NDMA= National Disaster Management Agency; MoJ= Ministry of Justice; LMA= Liberia Maritime Authority ; RREA= Rural and Renewable Energy Agency, NTA = National Transit Authority, MoA= Ministry of Agriculture; MICAT= Ministry of Information, Cultural Affairs & Tourism

Policy Gaps and Challenges

Challenge: Lack of information divided into sub-sectors. The available information on emissions from the transport sector has not been segregated to provide a detail on which subsectors account for the main emissions from transport, which could make it challenging to assess the potential of specific activities for this sector.

[78] Liberia 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.

Challenge: Lack of sufficient investment. According to the National Sustainable Development Report (2012), more investment is required in the transport sector and infrastructure, since a mass transport system and well-maintained roads are essential for a transition to a green economy, as well as for improved livelihoods in the population.[79] From the information set forth in the National Policy and Response Strategy on Climate Change, the necessary improvements in transport and infrastructure could require more than $800 million USD in investment for the adaptation and mitigation measures it entails.

Even though mitigation in the transportation sector requires capital-intensive investments in infrastructure development, there are several non-capital-intensive options (such as improved transportation management, linking multi-mode transport options, non-motorized transport, optimal scheduling, capacity development and awareness building, etc.) that can be considered. Often the GEF plays a critical role in mobilizing and directing capital investments in infrastructure through support for such non-capital-intensive options aimed at reducing GHG emissions.[80]

Gap: Domestic aviation and shipping have not been included. According to the Initial National Communication: "The transport sector is divided into three main subsectors: i) Road, transport, and railways for passenger and freight transport, ii) Domestic sea transport for passengers and freight using schooners, and iii) Civil aviation."[81] However, the inventory only covers road vehicles within the transport sector.

GHG emissions from road vehicles and civil aviation are projected to keep increasing in the next years; specifically, CO_2 emissions are expected to increase from 19,842 Gg (equivalent to 19.842 MT) in 2020 to 32,321 Gg (equivalent to 32.321 MT) in the year 2038.[82] The domestic shipping fleet should be of special relevance when accounting for emissions from this sector, since Liberia has the second biggest shipping fleet (in tonnage) globally, due to open policies that draw foreign vessels to its ports.[83] Emissions and targets from the domestic aviation and shipping sector could be included in the revised NDC in order to help strengthen the targets and increase its ambition.

Sectoral Recommendations for Consideration

Preparation of transport sector recommendations to be led by the EU-Liberia Climate Change Alliance+ with inputs from a robust stakeholder input and consultation process. The below suggestions are proposed as a potential starting point for further examination.

[79] Republic of Liberia. (2012) National Sustainable Development Report. https://sustainabledevelopment.un.org/content/documents/598liberiantreport.pdf.
[80] Dalkman et al. (2010) Advancing Sustainable Low-Carbon Transport Through the GEF.
[81] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf Pg. 64.
[82] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf. Pg. 66.
[83] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf Pg 44.

The NDC targets for the transport and infrastructure sector cover the most pressing needs to support Liberia's climate and sustainable development goals. The recommendations below are focused on refining and elaborating these goals to make them more specific and tangible. These refined targets may belong as part of the revised NDC or in a detailed implementation plan.

Recommendation 1: Set timelines and further specify existing targets.

The NDC has laid out mitigation and adaptation targets for the transport sector. However, only one of the targets has a timeline for implementation; therefore, we recommend that the remaining targets include a timeline to ensure that these measures and targets are enforced. On the other hand, several of these targets, both for mitigation and adaptation, are broad and could use further specification about activities and scope.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the further specification and timelines for improved targets from the transport sector.

Recommendation 2: Avoid conversion of forests and other natural ecosystems for biofuel production.

Regarding the sub-target for 5% biofuel use in transport, the NDC explains that "oil palm trees used for this will be wild or grown by large farms or through subsistence farming," under the assumption that everything is produced sustainably. However, the NDC also recognizes the need for further analysis to quantify life cycle GHG emissions from palm oil biofuel production in Liberia. Furthermore, the Liberia Forest Reference Level estimates that the palm oil industry is likely to have a negative impact on forest cover and is likely to drive national GHG emissions. Thus, it is essential that a refined biofuel target, activities, and scope be based on international best practice methodologies for determining life cycle GHG emissions and for sustainable biofuel production, be specific about how implementation will safeguard food security and avoid conversion of forests and other natural ecosystems, and be based on best-available data for Liberia. Due to the interlinkages with the agriculture and forestry sectors, enhanced coordination is recommended to align sector-specific plans for the palm oil industry and biofuel targets.

Recommendation 3: Implement controls on vehicle imports and set stricter fuel efficiency standards.

Controls on fuel efficiency for imported used cars together with stricter fuel efficiency standards for existing vehicles could be considered for inclusion in the NDC review process.[84] These mitigation strategies are already a part of the NPRS and could be used to enhance the NDC targets for the transport sector by tackling emissions from the old fleets that currently use low-quality fuel and have not specifically been addressed in the NDC targets. Some of the co-benefits from the implementation of these measures include improved air quality and other positive health impacts. As with other targets, a timeline for these activities should be included in the NDC.

[84] Liberia 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.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of required controls and stricter standards.

Recommendation 4: Include targets to promote water, rail, and air transport.

The "provision of fiscal and regulatory investment incentives to make water, rail, and air transport in Liberia gradually develop and become safer and more accessible"[85] has been set as a mitigation strategy by the NPRS and could be included in the NDC mitigation targets, since, so far, these are mainly focused on road transportation. The Pro-Poor Agenda has already set a target for this: "By 2023, the government aims to have a stronger and more competitive air and sea transport system supporting economic transformation and job creation." It also provides that "The government will construct new and rehabilitate existing air and sea infrastructure."[86] As with other targets, further specification and intermediate timelines should be included.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of an improved target that includes the promotion of water, rail and air transport systems.

Recommendation 5: Enhance the public transport infrastructure target.

The existing mitigation sub-target in the NDC to improve the quality and reliability of transport infrastructure and services could be further specified with the timeline set by the Pro-Poor Agenda, which states that "By 2023 Liberia will have a more expansive national road network reducing the cost of transport and doing business (...)."[87] As part of this target, the agenda also provides a more specific timeline "By 2023- 517 km roads connecting all county capitals, 260km of urban roads, 237.1km secondary road constructed and paved; constructed material testing facilities in 5 regions; 6,184.7km of primary, secondary and urban roads maintained; zoning laws standardized and enforced."[88] These timelines and activities could enhance the target set forth as part of the NDC.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of a target that further specifies the enhancement of public transport infrastructure.

Recommendation 6: Include systems for rapid transportation in public transport services.

The current target in the NDC sets forth the improvement and enhancement of public transport services as adaptation targets. Considering the strategies already established in the NPRS, this target could be

[85] Liberia 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.

[86] Republic of Liberia. (2018) Pro-Poor Agenda for Prosperity and Development (PAPD). http://liberianconsulatega.com/wp-content/uploads/2017/07/PAPD-Pro-Poor-Agenda-for-Prosperity-and-Development.pdf.

[87] Republic of Liberia. (2018) Pro-Poor Agenda for Prosperity and Development (PAPD). http://liberianconsulatega.com/wp-content/uploads/2017/07/PAPD-Pro-Poor-Agenda-for-Prosperity-and-Development.pdf.

[88] Republic of Liberia. (2018) Pro-Poor Agenda for Prosperity and Development (PAPD). http://liberianconsulatega.com/wp-content/uploads/2017/07/PAPD-Pro-Poor-Agenda-for-Prosperity-and-Development.pdf.

further specified to include the creation of "systems for rapid transportation and promoting the use of mass transport facilities."[89] In deciding which system to implement for this purpose, electric vehicles or others that are low in GHG emissions could be prioritized. All targets should include specific timelines and implementation actions.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of a specific target for improved public transport services.

Recommendation 7: Consider options for green infrastructure.

Specifically, for infrastructure, the NPRS has included investing in "building coastal protection including eco-based solutions (planting of trees) and hard structures (groynes, revetments, etc.) in coastal cities"[90] as an adaptation target. This strategy could be included as a new adaptation target in the NDC, since it would have the potential to protect the roads in coastal cities and provide co-benefits from the inclusion of natural climate solutions.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of a specific target for green infrastructure.

Recommendation 8: Take stock of progress made in *implementing* existing transport and infrastructure sector policies and NDC activities. *[Linkages with other sectors]*

In the process of reviewing and updating the NDC, it is critical to take stock of progress made toward implementing existing sectoral and climate change targets and plans. The revised NDC should be informed by experiences, challenges, and lessons learned from implementing current targets and plans in the transport and infrastructure sector. The stakeholder consultation process should identify any changes in national circumstances, political priorities, development priorities, and efforts to achieve the Sustainable Development Goals (SDGs) (including progress made toward relevant sectoral SDG targets), which can help identify new opportunities and synergies to pursue emissions reduction strategies within the context of national priorities. The work done by EPA under the ongoing Second National Communication can provide a useful input into this stocktaking process.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of this recommendation.

Recommendation 9: Consider linkages with national COVID response and recovery priorities as part of the update of NDC targets for this sector. *[Linkages with other sectors]*

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of this recommendation.

[89] Liberia 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.

[90] Liberia 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.


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Sector Highlight: Short-Lived Climate Pollutants

National Sectoral Context

As a signatory to the Paris Climate Agreement, Liberia developed and submitted its Intended Nationally Determined Contribution (INDC) in 2015. In 2018, the country ratified the Paris Agreement with commitments to revise and resubmit its INDC. Liberia's NDC presents the roadmap for reducing Greenhouse Gases (GHG) in Liberia: total national GHG emissions, excluding LULUCF, were estimated to be 8,022 Gg of CO_2 equivalent (equivalent to 8.022 MT) for the year 2000. The energy sector contributes about 67.5% of the national total, followed by the agriculture sector at 31.9%, and the waste sector at 0.6%. Liberia's mitigation target is to reduce GHG emissions in the energy sector by 10% by 2030, by implementing four mitigation actions.

As the country moves to revise its NDC in 2020, the Government of Liberia, under UNDP Climate Promise, intends to further enhance ambition by including short-lived climate pollutants (SLCP) – which include black carbon, hydrofluorocarbons (HFCs), tropospheric ozone, and methane, among others – as new gases in the revised NDC, particularly those used in refrigeration and air conditioning (A/C) systems, as well as in relation to waste management. Addressing SLCPs in climate action plans can also contribute to the achievement of the Sustainable Development Goals (SDGs), especially, SDG 6 - Clean Water & Sanitation, SDG 7 - Affordable & Clean Energy, SDG 9 - Industry, Innovation & Infrastructure, and SDG 13 - Climate Action.

The Government of Liberia ratified the Montreal Protocol in 1996 with commitment to phase out ozone depleting substances (ODS). The government reported a consumption of 4.51 ozone depleting potential (ODP) tonnes of HCFC in 2013 and estimated a consumption of 4.20 ODP tonnes in 2014. The declining trend in HCFC-22 consumption was attributed to couple of measures implemented by the government: enforcement of the ODS regulations, including seizure of fake or contaminated refrigerants and imposition of fines on violators of the ODS regulations; training in better refrigeration servicing practices focused on

reducing HCFC emissions; availability of alternative refrigerants and their use in air-conditioning units; and nationwide ozone protection awareness initiatives.

On 27 March 2014, Liberia joined the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (CCAC), which seeks to catalyze rapid reductions in SLCPs to protect human health, agriculture and the environment. The action to join the Coalition was influenced by the country's recognition of the extent to which reducing SLCPs can contribute to national and global environmental sustainability through mitigation efforts in the several sectors (waste, agriculture, energy, transport, refrigeration and air-conditioning etc.).

The national SLCP Coordination Unit was formally established in Liberia in August 2015 with the responsibility of executing Climate & Clean Air Coalition activities in the country, with a National Advisory Board and Steering Committee. A national communication strategy on SLCP mitigation and resources mobilization document was developed.

The Liberia Environmental Protection Agency (EPA) seeks to fully integrate SLCPs into the national climate change portfolio and support the development of a national air quality regulation using Liberia Forest Sector Project (LFSP) resources from the Norwegian Government. The country also wishes to develop a national SLCP plan.

Existing NDC Targets

Table 4.1. Existing Mitigation Targets and Activities in 2015 NDC – Short-lived Climate Pollutants.

Mitigation Targets and Activities in 2015 NDC – SLCP Sector		
Sectoral Quantitative Target (if applicable)	**Sub-targets and activities identified**	**Baseline information used for 2015 NDC target**
Not stated.	*No mention of targets for reducing emission of SLCP.*	*Not stated.*

Source: Information from Liberia Intended Nationally Determined Contribution (2015).[91]

Table 4.2. Existing Adaptation Targets and Activities in 2015 NDC – Short-lived Climate Pollutants.

Adaptation Targets and Activities in 2015 NDC – SLCP Sector		
Sectoral Quantitative Target (if applicable)	**Sub-targets and activities identified**	**Baseline information used for 2015 NDC target**
Not stated.	*No mention of adaptation targets for SLCP.*	*Not stated.*

Source: Information from Liberia Intended Nationally Determined Contribution (2015).[92]

While the current NDC does not set mitigation targets for SLCP, there are related targets for the energy and waste sectors as follows: reducing GHG emissions in the energy sector to 10% by 2030 (Replacing

[91] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC), emphasis added. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

[92] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC), emphasis added. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

cookstoves with low thermal efficiency (5-10%) with the higher-efficiency (40%) stoves); and mitigating emissions through the Monrovia Landfill Gas Plant by 316,000 tCO_2e. The baseline energy emission was estimated at 5,414 Gg CO_2e (equivalent to 5.414 MT CO_2e), while emissions from the waste sector was estimated at 0.6% of Liberia's total CO_2e emissions for the year 2000.

Existing Relevant Policies, Strategies and Plans

Relevant climate change and sectoral policies were reviewed in order to examine their targets and strategies for the SLCP sector. The most relevant and updated strategies and plans for climate action in the sector were the focus of this review process:

- ✓ National Policy and Response Strategy on Climate Change (August 2018);
- ✓ Liberia National Trade Policy 2014-2019-import Licensing System.

According to the National Policy and Response Strategy on Climate Change (NPRS), the Government of Liberia considers the energy and waste sectors to have strategic mitigation options, especially because the reliance on biomass for fuel is unsustainable; biomass used for cooking fuel creates indoor pollution that harms health at the household level, while charcoal production and fuelwood collection drive deforestation and forest degradation, as well as GHG emissions. Although the NPRS does not mention SLCPs, it supports the reduction of SLCPs as GHGs that both have a warming effect on climate and produce dangerous air pollution with detrimental impacts on human health.

The Government of Liberia has an import licensing system that is operated by an inter-agency committee comprising the Liberia Revenue Authority (Bureau of Customs and Excise), the Ministry of Commerce and Industry, the Ministry of Justice and the EPA that regulates the import of climate-polluting substances.

Mitigation and Adaptation Opportunities for the SCLP Sector

To be further elaborated following the conduct of analysis of quantitative data available on baseline and mitigation potential of adding SLCP in the revised NDC

Costs and Investment Opportunities

The development cost for implementing measures propose to mitigate emissions from SLCP will be estimated following feasibility studies.

Policy Gaps and Challenges

Challenge: Lack of clear national strategies for SLCPs. Addressing SLCPs is not embedded into ministerial/ sectoral plans, policies and programs. Concrete effort is needed for raising awareness both at the high level and with broad stakeholders with efforts to mainstream SLCPs in sectoral and national plans. There is also a need to develop an SLCP National Action Plan.

Challenge: Limited institutional and human resource capacity on SLCPs. The EPA's SLCP unit needs to build capacity for planning, inventory and data management, including the use of the Low Emissions Analysis Platform (LEAP) and other relevant software, as well as on improving coordination with other agencies.

Challenge: Lack of an SLCP emission inventory. There is a need to develop an SLCP inventory, which is aligned with existing data from the energy and forest sectors on fuelwood emissions, as well as linked to and updated with the national GHG inventory. Similarly, there is a need to establish a research committee, consisting of universities and research centers, to compile information to improve emission inventories and identify main emissions sources in the industry and transport sectors. This committee could provide support to city managers on decisions related to climate and air quality.

Challenge: Limited awareness about SLCPs, including their impacts on health. There is a need to raise broad stakeholder awareness, including communication to policy makers, public services, and the broader public to convince stakeholders of the importance of addressing SLCPs, as well as to mobilize the private sector and financing. Stakeholders should be educated about the links between SLCPs and health, development, climate, and the environment, as these are of interest to most decision makers, especially due to the national number of premature deaths from outdoor and indoor air pollution. Awareness building can show how SLCP emissions reductions can contribute to the existing international commitments Liberia has already made.

Sectoral Recommendations for Consideration

Early and ambitious action to reduce short-lived climate pollutants (SLCPs) is cardinal to achieving the goals of the Paris Agreement and the Sustainable Development Goals. SLCPs include methane, hydrofluorocarbons (HFCs), black carbon, and tropospheric ozone. Actions to reduce these highly potent pollutants help avoid crossing important thresholds, such as a 1.5^{o} C temperature rise above pre-industrial levels, and potential climatic tipping points, which will affect poor and vulnerable communities first and worst. Reducing SLCPs also can deliver multiple benefits for development of the country and its inhabitants, supporting efforts to improve health, enhance food security, and alleviate poverty.

Despite the importance of reducing SLCPs, actions to mitigate these potent pollutants were underrepresented in the 2015 NDC. As Liberia looks toward to submitting its updated NDC by 2020 under the Paris Agreement's ambition process, the country now has an opportunity to take substantial steps to incorporate and strengthen actions to reduce SLCPs in its NDC.

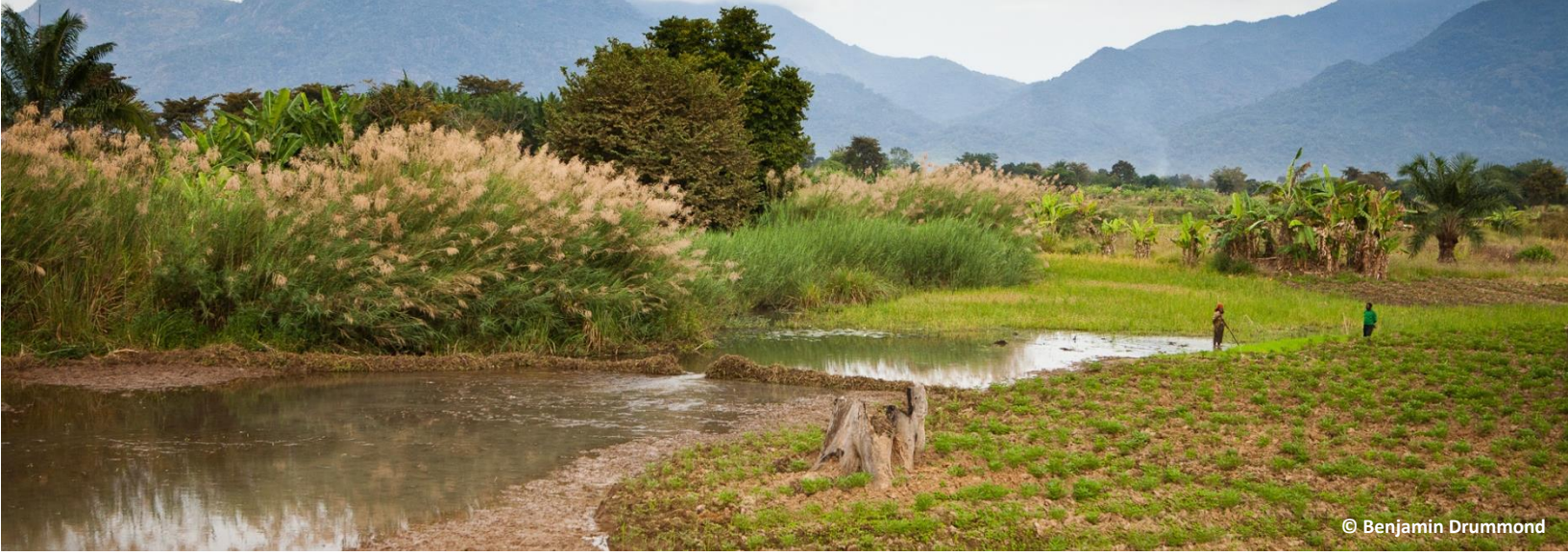
SLCPs have a powerful impact on global temperature and the climate system, particularly over short time horizons. For example, HFCs (which are emitted from refrigeration and air conditioning) have significantly higher global warming potentials (GWPs) than carbon dioxide, and black carbon can increase atmospheric warming and the melting rate when deposited on ice and snow. Moreover, the impact of these pollutants on global temperature rise can be mitigated in a comparatively short time span, since SLCPs exist for a relatively short period in the atmosphere (a few days to a decade or so). Therefore, removing SLCPs from the atmosphere has an almost immediate effect on limiting global temperature.

Considering the high global warming potential of HFCs and methane compared to other SLCPs, Liberia is considering including in its updated NDC, specific targets aimed at mitigation and adaptation to HFCs emission in the air conditioning and refrigeration, waste management and energy for cooking, health co-benefits and efforts in the forest sector. Below are potential policies and targets recommended for strengthening Liberia's updated NDC:

Table 4.3. Recommended policies and actions/mitigation measures for SLCPs.

Gas	Sector	Recommended Policies and Actions/Mitigation Measures
HFCs	Air Conditioning and Refrigeration	Increase the percentage of low-GWP alternatives in economy-wide uses of HFCs, consistent with the HFC phase-down level under the Kigali Amendment to the Montreal Protocol
		Commit to exceeding the country's current Kigali phase-down schedule
		Provide incentives for companies and consumers to replace high GWP HFC commercial equipment or appliances with low-GWP alternatives
		Replace high GWP HFCs with low-impact alternatives in specific classes of appliances and equipment, such as using R-290 instead of HFC-410a in room air conditioners
		Introduce a policy requiring all new high-efficiency cooling equipment to use either a low-GWP HFC or an HFC alternative
		Update public procurement processes to transition away from high GWP HFCs
Methane	Waste Management	Separation and treatment of biodegradable municipal waste through recycling, composting, and anaerobic digestion as well as landfill gas collection with combustion/utilization
		Ban open burning of municipal waste
Black Carbon	Household Energy	Replace traditional cooking to clean burning modern fuel cookstoves (i.e., LPG)
		Eliminate kerosene lamps

If fully implemented by 2030, these measures can bring multiple benefits to climate, health, food security, and ecosystems in ways that support achievement of SDGs.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Sector Highlight: Agriculture

National Sectoral Context

Agriculture is a key sector to the Liberian economy, as it employs more than 40% of the labor force and more than 70% of the rural population participate in agricultural activities. At the national level, the main priorities for agriculture are food security, sustainable agriculture, and resilience to climate change.[93]

Liberia's agriculture sector is highly integrated with forest ecosystems, occurring both alongside and overlapping with forested land, managed under traditional subsistence systems, occurring primarily in the uplands, and characterized by shifting cultivation, limited use of machinery and low production intensity. Most of Liberia's agricultural lands (87%) are dedicated to growing cassava, rice, and vegetables; however, production of staple goods remains lower than overall national demand[94] – approximately two-thirds of the food on the Liberian market is imported,[95] and in 2014, 49% of households reported suffering from food shortages in the past 12 months (up to 60% of households in rural areas).[96]

Tree crops (rubber, oil palm, cocoa, coffee, and coconut) have represented the highest income-generating sub-sector for agriculture, providing formal employment to the greatest number of workers in the sector and contributing significantly to the country's GDP.[97] The Liberia Agriculture Transformation Agenda (LATA) from 2016 promotes industrialization of the sector in order to access more investment finance, stable markets and better revenues for farmers.[98] The Pro-Poor Agenda for Prosperity and Development (2018) highlights the scaling up of agriculture and development of appropriate value chains as part of the

[93] Ministry of Agriculture. (2008) Food and Agriculture Policy and Strategy. http://www.moci.gov.lr/doc/Food%20and%20Agriculture%20Policy%20and%20Strategy.pdf.
[94] Ministry of Agriculture. (2015) Food and Agricultural Policy and Strategy, Monrovia.
[95] Liberia Ministry of Justice. (2012) 2012 National Sustainable Development Report. https://sustainabledevelopment.un.org/content/documents/598liberiantreport.pdf.
[96] Conservation International. 2017. Natural Capital Mapping and Accounting in Liberia: Understanding the contribution of biodiversity and ecosystem services to Liberia's sustainable development. Arlington, VA.
[97] Ministry of Agriculture. (2015) Food and Agricultural Policy and Strategy, Monrovia.
[98] Government of Liberia, Environmental Protection Agency. (2019) Forest Reference Level submission to UNFCCC. https://redd.unfccc.int/files/liberia_frel_submission_december_2019.pdf.

national development vision, along with giving priority to investments located in development corridors, and training agricultural specialists to "provide new skills, improve monitoring, and to collect and disseminate data at the district and clan level."

Major climate-related risks for agriculture are linked to changes in seasonal rainfall and increased rainfall events during the rainy season, resulting in decreased productivity as well as droughts that lower livestock productivity. These risks are compounded by insufficient weather and seasonal forecasts. Liberia's vision for agricultural policy focuses on adaptation, specifically seeking to:

> *…reduce the vulnerability of agricultural systems to risks related to climate change through direct and indirect support to farmers, including the* ***setting up of a robust monitoring system to detect early changes that will affect agriculture production*** *…. and moving towards a sustainable agriculture system by* ***encouraging lowland farming, investing in smallholder agriculture and allowing large-scale concessions on degraded land*** *to avoid and reduce national emissions levels.*[99]

Adaptation options identified for agriculture in national plans and strategies include improvements to on-farm practices, as well as institutional support from planning, budgeting, and public private partnerships.[100] Specific actions have been identified, such as the creation of an agricultural database-management system, the use of rice varieties that are resistant to climate impacts, replacement of inorganic fertilizers with soil-enriching (and carbon-absorbing) crop production inputs, processing of crops to minimize post-harvest losses, and decreasing animal stock.[101] The 2015 NDC provides sectoral baseline emissions for agriculture and identifies a list of adaptation actions for resilience and food security, in alignment with the information presented in the 2013 Initial National Communication (INC). Climate action in the agriculture sector will also contribute to the achievement of the Sustainable Development Goals (SDGs), especially, SDG 2 - Zero Hunger, SDG 12 - Sustainable Consumption & Production, SDG 13 - Climate Action, and SDG 15 - Life on Land.

The Ministry of Agriculture (MoA) holds the primary responsibility for advancing the development of agricultural production in Liberia, including leading the planning and budgeting processes for the sector, ensuring food security, and overseeing national research development. This includes tree crops like rubber, oil palm and cacao, and the permitting of agricultural concessions. MoA leads the Liberian Agricultural Sector Investment Plan II (LASIP II), which includes a set of activities around climate smart agriculture. The Ministry of Commerce and Industry plays an important role to create incentives and regulation of agricultural products, both for domestic consumption and for export.

[99] Liberia 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.

[100] Fortunate, M. (Forthcoming 2020). Draft Technical Report: Mainstreaming Climate Change Considerations into the Relevant Sector Specific Development Programs, Policies, Strategies and Management Plans in Liberia. United Nations Development Programme.

[101] Liberia Environmental Protection Agency. (2013) Initial National Communication. http://www.epa.gov.lr/sites/default/files/INITIAL%20NATIONAL%20COMMUNICATION%20LIBERIA.pdf.

Existing NDC Targets

Table 5.1. Existing Mitigation Targets and Activities in 2015 NDC – Agriculture.

Mitigation Targets and Activities in 2015 NDC – Agriculture Sector		
Sectoral Quantitative Target (if applicable)	**Sub-targets and activities identified**	**Baseline information used for 2015 NDC target[102]**
Not stated.	*Mitigation activities from the agricultural sector are not included in Liberia's 2015 NDC*	2,562 Gg

Source: Information from Liberia Initial Nationally Determined Contribution (2015).[103]

Table 5.2. Existing Adaptation Targets and Activities in 2015 NDC – Agriculture.

Adaptation Targets and Activities in 2015 NDC – Agriculture Sector		
Sectoral Quantitative Target (if applicable)	**Sub-targets and activities identified**	**Baseline information used for 2015 NDC target**
Not stated.	• Resilience through **diversification** of crop cultivation and small ruminants rearing • Creation of a national **hydro-meteorological monitoring** system. • Develop and promote drought-resistant, flood-tolerant and early maturing **crop species**. • **Intercropping, irrigation and the optimization of lowland/swamp farming**. • **Pest control** including fencing of farms against rodents, bird scarecrows, regular weeding, and the use of high echoing bells. • Develop **climate resilient crop/agroforestry diversification** and livestock production systems. • Create a **platform for knowledge and experience sharing** on best adaptation practices. • Develop and implement agriculture and hydrological technology **models and scenarios for planning**. • Establishment of a **gene bank of climate resilient varieties** of indigenous food crops.	*Not stated.*

Source: Information from Liberia Initial Nationally Determined Contribution (2015).[104] Emphasis added.

[102] Units in Gg can be converted to MT by dividing by 1,000. For example, 2,562 Gg = 2.562 MT.

[103] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC), emphasis added. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

[104] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC), emphasis added. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

Existing Relevant Policies, Strategies and Plans

Relevant climate change and sectoral policies were reviewed in order to examine their targets and strategies for the agriculture sector. The most relevant and updated strategies and plans for climate action in the sector were the focus of this review process:

- ✓ National Policy and Response Strategy on Climate Change (2018);
- ✓ Liberian Agricultural Sector Investment Plan – LASIP II (2018);
- ✓ Pro-Poor Agenda for Prosperity and Development (2018);
- ✓ Food and Agriculture Policy and Strategy (2008); and
- ✓ Initial National Communication (2013).

In 2008, the national government approved the Food and Agriculture Policy and Strategy (FAPS) which focused on increasing food production and improving food security. More recently, national development plans, such as the Pro-Poor Agenda for Prosperity and Development and the LASIP II combine both food security priorities with opportunities for economic development through increased commercial agriculture, modernization, and export commodities. While these development-focused plans recognize broad environmental considerations for the agricultural sector (such as resource use), they do not always integrate climate change, as climate mainstreaming has been evolving in recent years into an economy-wide consideration. Climate-specific strategies at the national level, however, do reference the agricultural sector, and provide extensive analysis of vulnerabilities and adaptation measures for the sector, as well as steps for mainstreaming adaptation in agricultural planning and budgets.[105,106] A detailed set of actions for addressing climate change in the agricultural sector come from the 2018 National Policy and Response Strategy on Climate Change, which lists opportunities to address mitigation of emissions from the sector and adaptation priorities, but does not provide quantitative goals for these actions.

Overall, alignment between the plans and strategies across the agricultural sector is low, and commodity-specific strategies (e.g. for palm oil development) have unclear linkages with sector-wide plans. Aligning existing adaptation priorities from other national strategies with LASIP II could be an important entry point for mainstreaming climate change considerations in Liberia's agricultural transformation. The actions and targets from these strategies and plans are detailed below, with emphasis added.

Agriculture Sector Strategies from the National Policy and Response Strategy on Climate Change (2018):

Mitigation Strategies:

- Support and encourage farmers towards lowland farming by providing tools, **training on soil management, integrated pest management and production of organic fertilizer, and seeds adapted for lowland farming** to farmers.

[105] See Initial National Communication (2013), National Adaptation Programme of Action (2008), Nationally Determined Contribution (2015), Climate Change Strategy (2018), Climate Change Gender Action Plan for the Government of Liberia (2012).

[106] Fortunate, M. (Forthcoming 2020). Draft Technical Report: Mainstreaming Climate Change Considerations into the Relevant Sector Specific Development Programs, Policies, Strategies and Management Plans in Liberia. United Nations Development Programme.

- Reduce the traditional approach of shifting cultivation or swidden agriculture by the introduction of diverse **Integrated Soil Fertility Management** (IFSM) practices, inclusive of **Conservation Agriculture, agroforestry, Integrated Pest Management (IPM), organic fertilizer** preparation that maximize returns on labor and/or inputs (e.g. fertilizers, seeds, pesticides).
- Provide support and enhance **farmer field school groups** to ensure adequate coordination and learning of sustainable agriculture which can later be used as a base to form cooperatives.
- Develop measures and **policies for use of degraded land** by agricultural concessionaires in order to reduce impacts and pressure on forest lands, which in turns will increase the country's carbon sink potential and reduce emission level.
- Enhance and properly coordinate the **management of agricultural wastes**.
- **Reduce the contribution of agriculture to GHG emission while improving its role as a carbon sink.**

Adaptation Strategies:

- Improve the effectiveness of pest, disease and weed management practices through the **wider use of integrated pest and pathogen management**, development, and use of varieties and species resistant to pests and diseases and improving quarantine capabilities and monitoring programs.
- **Assess crops vulnerability and suitability** (cropping pattern) for different Agro-ecological zones.
- Enhance **climate proof agro-infrastructural systems** (input, output, marketing, post- harvest technologies and infrastructure including storage) that strengthen the capacity of farmers to increase resilience and productivity.
- Build and strengthen the capacity of **extension officers** in new sustainable farming and livestock raising technologies, to enhance their support for farmers.
- Support communities in livestock and crop sectors through **inventory and dissemination of indigenous knowledge, establishing and/or strengthening insurance scheme, early warning and early action system, vaccination campaign, disease control,** etc., to cope with the stress based on climate variability. Set up **seed banks** to collect different varieties of crops in order to preserve local diversity and provide farmers with the opportunity of making informed choices based on suitability.
- Develop and introduce a diverse range of **integrated soil fertility management** (IFSM) techniques to farmers as a sustainable means of **improving soil fertility** and intensifying agricultural production.
- Promote wider use of appropriate technologies and **work with communities to harvest water** and **discourage the burning of organic residues on the soil surface**, in order to prevent soil erosion, water logging and nutrients leaching in increased rainfall scenarios; and to preserve soil moisture in drier rainfall scenarios.

- **Support farmers to diversify their income** through integrating farming activities with other income generation activities such as sustainable livestock raising, bee harvesting, rabbit, poultry, guinea fowl, etc.
- Encourage farmers to engage adaptation measures as well as coping strategies such as **intercropping**, **irrigation**, **aquaculture**, and the use of **climate resilient plant varieties** so as to create resilience to the shocks of climate change.
- Ensure technologies and methodologies promoted to farmers through agricultural programs are cognizant of different socio-economic levels (e.g., **pro-poor**) and are **gender sensitive**.

Source: National Policy and Response Strategy on Climate Change (2018). Emphasis added.

Selected targets from Pro-Poor Agenda for Prosperity and Development (2018):

By 2023:

- **Expansion of oil palm to 150,000 – 200,000 ha** from agricultural concessions in A Region.
- Development of **40,000 ha of oil palm concessions** in North Western Region.
- Reemphasizing the **scaling up of agriculture** and development of **appropriate value chains** and giving priority to those investments located in the development corridors.
- Training and **deployment of "agriculture specialists"** to the district and clan levels to introduce new technology, "provide new skills, improve monitoring, and to collect and disseminate data" relevant to the primary crops produced in the region.
- **Increased agricultural production and productivity and improved forest utilization** through competitive value chains and market linkages for food and income security, economic growth, and job creation.

Source: Pro-Poor Agenda for Prosperity and Development (2018). Emphasis added

Selected targets from Liberian Agricultural Sector Investment Plan – LASIP II (2018):

One of the five components of LASIP II focuses on natural resources and climate smart agriculture. Climate-related actions under this component include:

- Promote the dissemination of information on **climate smart technologies to small farmers**;
- Develop, train, and adapt productive enhancement technologies including propagation and **use of high-quality seeds and seedlings that are climate resistant**;
- Promote **agroforestry** and develop out-grower (smallholder) climate smart programs in cooperation with agricultural concessions and other partners;
- Support the diversification of climate smart **high value crops**;
- Promote **conservation agriculture** (agro-ecological farming);
- Support and promote actions for **establishment of forests** for protection of watersheds and wetlands;
- Advocate for and support the **combating of desertification** and **conservation of biological diversity** to contribute to the stabilization of global climate;
- Support climate change-related research, education and training for **women and youth**; and
- Promote proven best practices and measures that **support natural resource management**.

Source: Liberian Agricultural Sector Investment Plan – LASIP II (2018). Emphasis Added

Selected targets from Food and Agriculture Policy and Strategy (2008):

- Mechanisms in place with contributions from the agriculture sector, **monitoring climate change** situation in respect to Liberia**, ensuring agricultural activities in Liberia do not contribute to such changes**, and that such changes will not seriously undermine efforts directed at **poverty alleviation, food security, and environmental protection**.
- Providing information and advice through **statistical data and information**, and **mass media**, about **climate changes, causes and risks, and available adaptation strategies** especially in relation to the agriculture sector;
- Supporting and promoting sustainable agricultural production like **conservation agriculture**, and **rural development activities** which reduce vulnerability of cropping systems;
- Promoting proven **best practices, policies and measures** that encourage **forest protection, sustainable farming, and sustainable energy utilization**;
- Supporting the institutionalization of **adaptation capacities through partnerships** with NGOs, civil societies, private sector and concerned government organizations; and
- Supporting **climate change related research, education and training**.

Source: Food and Agriculture Policy and Strategy (2008). Emphasis added

Selected targets from the Initial National Communication (2013):

Sector	Adaptation Option and Mitigation Measure Identified
Agriculture	• Increase production through efficient irrigation; • Switch to resilient crop species (deep-rooted, drought tolerant, salt-tolerant); • Improve food security and self-sufficiency.

Source: Initial National Communication (2013).

Review of NDC Targets

Data. Significant data gaps exist for the sector, which stopped producing the agricultural census during the civil conflict. This means that national-level information is limited or incomplete regarding production extent, yield, and value of annual and perennial crops over time; land use change; livestock rearing; soil fertility and fertilizer use; cropping practices; meteorological data; and socioeconomic data on food production and consumption. The most recent source for GHG emissions in the agricultural sector is in the inventory included in the 2013 INC, which employed the Revised 1996 IPCC Guidelines and calculated emissions based on global statistics published by the UN Food and Agriculture Organization (FAO) for the year 2000. This lack of national data or country-specific emission factors in the 2013 INC suggests a high level of uncertainty regarding emissions for the sector. Emissions from agriculture in the 2015 INDC are based on the 2013 INC, improved information from the current GEF Capacity Building Initiative on Transparency (CBIT) project would allow for the use of the 2006 IPCC guidelines in Liberia's National Greenhouse Gas Inventory.

Data or evidence used to inform the adaptation activities listed for agriculture are not referenced in the 2015 NDC.

Sources of emissions. Emissions from agriculture in 2000 (2,562 Gg CO_2e)[107] accounted for approximately 31.9% of national emissions. These emissions primarily came from livestock (95%). See Table 5.3 below for a summary of the 2000 statistics of agricultural GHG emissions for Liberia. Several categories of emissions show missing or incomplete data.

Emissions estimates from the 2013 INC likely underrepresent emissions from the agriculture sector as a whole and overrepresent the emissions from livestock (enteric fermentation). This is due to limited or unavailable data from other agricultural emissions categories in the INC report, such as rice cultivation, burning, and land use change, as shown in Table 5.3, emissions from the agricultural sector do not include land use change from forests to crop land. However, improved accounting on GHG emissions from land use change will be very important to understanding the linkages and impacts between the agriculture, forests, and energy sectors over time.

Table 5.3. GHG emissions by category from the agricultural sector in 2000.[108]

Greenhouse Gas Source and Sink Categories	CO_2 (Gg) Removals	CH_4 (Gg)	N_2O (Gg)	2000 Gg CO_2 eq.	Contribution to national total (%)	Category contribution to sector (%)
Agriculture (Total)		**122**	**0**	**2,562**	**31.9%**	
A. Enteric fermentation		117		2,457	30.6%	95.9%
B. Manure management		4	0	84	1.0%	3.3%
C. Rice cultivation		0		NE	NE	0.0%
D. Agricultural soils			0	NO	NO	0.0%
E. Prescribed burning of savannahs		0	0	NE	NE	0.0%
F. Field burning of agricultural residues		1	0	21	0.3%	0.8%
G. Other (please specify)		0	0	0	0	0.0%

Source: Adapted from Liberia Initial National Communication (2013).[109] NO: Not occurring. NE: Not Estimated.

[107] Units in Gg can be converted to MT by dividing by 1,000. For example, 2,562 Gg CO_2e = 2.562 MT CO_2e.
[108] To convert values in Table 5.3 from Gigagrams (Gg) to Megatons (MT) divide each value by 1,000.
[109] Liberia Environmental Protection Agency. (2013) Initial National Communication. http://www.epa.gov.lr/sites/default/files/INITIAL%20NATIONAL%20COMMUNICATION%20LIBERIA.pdf.

Mitigation and Adaptation Opportunities for the Agricultural Sector

The following section summarizes existing government targets or science-based estimates of the scale of action to achieve adaptation and/or mitigation co-benefits in Liberia's agricultural sector. For example, in the case of adaptation actions, the number of expected beneficiaries, communities, or jurisdictions covered by an initiative can help to identify the scale of the intervention. Adaptation efforts or development plans may also result in decreased emissions or enhance sinks, by limiting agricultural expansion in forested areas, by redirecting expansion to degraded lands, or increasing the volume of trees in a standing forest, thus storing carbon in living ecosystems. For example, agroforestry (the addition of trees in agricultural lands) or avoided forest degradation through sustainable agricultural practices are sustainable development strategies for agriculture that can provide livelihood opportunities and include co-benefits of decreased carbon emissions or enhanced sinks. These mitigation co-benefits can be estimated by area of improved management or by volume of carbon to help identify the scale of the intervention. Developing estimates for the potential scale of adaptation actions or mitigation co-benefit from the agricultural sector can help to link activities, priorities, and budgets towards implementation.

Adaptation opportunities. The potential of the agricultural sector to adapt to the impacts of climate change depends on coordination, knowledge and technology, finance, and applied management practices. It also depends on the outcome of global mitigation efforts, making adaptation a necessary moving target. In Liberia, actions to support adaptation and support resilience in agriculture occur broadly through institutional coordination within the sector and across sectors, improved knowledge through research, climate-smart improvements to built- and green infrastructure, the application of adaptive management practices by small farmers and commercial concessions, and the access to the necessary financial support and appropriate technologies. This potential has been well-documented in the NAPA and LASIP-II and will be further detailed in the forthcoming National Adaptation Plan.

Global data and estimates for adaptation and mitigation opportunities. Global data sets and research can provide insights into the possible scale of action for adaptation and mitigation for the agricultural sector. Using global data sets with information on Liberia,[110] the mitigation potential for cost-effective abatement (less than $100 USD per MT CO_2e per year) from agriculture is estimated at 0.04 MT CO_2e (equivalent to 40 Gg CO_2e) per year from 2030-2050 from improved management of livestock grazing. Data from other possible pathways for reduced emissions from agriculture in Liberia, such as increasing trees on crop lands or nutrient management, were not available.

In Liberia, traditional subsistence farming and other agricultural activities occur mainly in the uplands, including shifting cultivation of cassava and vegetables, and harvesting of tree crops, such as rubber, oil palm, cacao, coffee, and coconut. Globally managed data from FAOSTAT provides estimates for

[110] Griscom BW et al. (2020) National mitigation potential from natural climate solutions in the tropics. Phil. Trans. R. Soc. B 375: 20190126. http://dx.doi.org/10.1098/rstb.2019.0126.

agricultural production in Liberia by crop over time. These figures combine both globally derived estimates as well as national government estimates to provide an approximate scale of land area under specific crops.

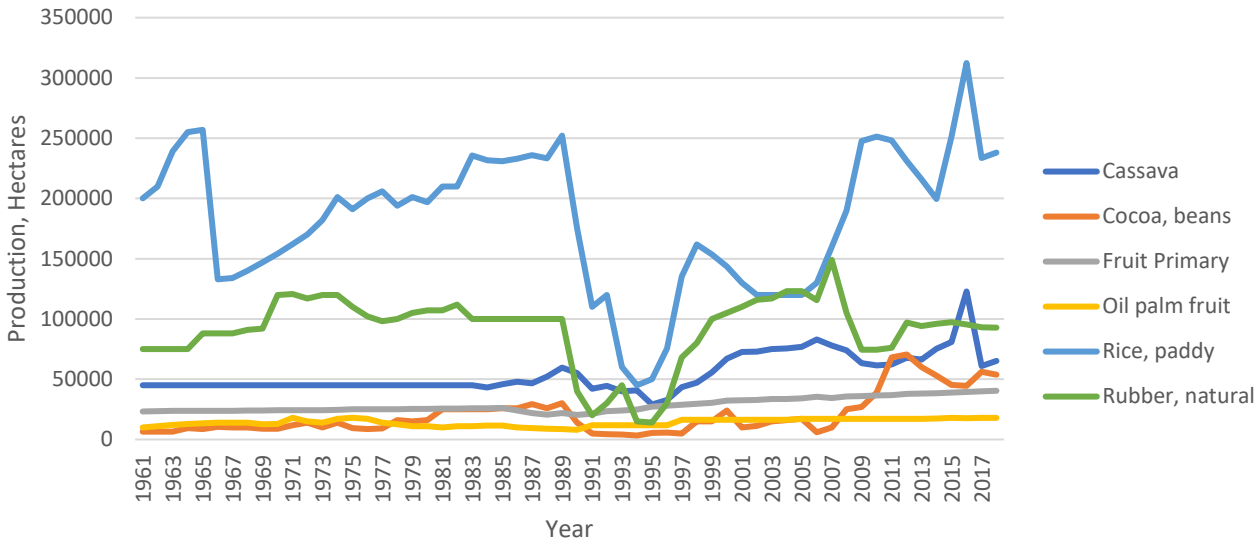


Figure 5.1. Production of selected agricultural crops in Liberia 1961-2018.
Source: Elaborated using FAOSTAT. (2020) http://www.fao.org/faostat/en.

Table 5.4. Production area (Ha) of selected agricultural crops in Liberia 2016-2018.

Crop	Estimated Production Area (Ha)			
	2016	2017	2018	Grand Total
Bananas	150465	152670	154877	458012
Cassava	820432	598960	644046	2063438
Cocoa, beans	51430	64802	61872	178104
Fruit Primary	246350	249452	252553	748355
Oil palm fruit	192777	192666	193955	579398
Rice, paddy	647494	481085	496085	1624664
Rubber, natural	169548	164672	163323	497543
Sugar cane	299293	300801	302307	902401
Grand Total	**2577789**	**2205108**	**2269018**	**7051915**

Source: Elaborated using FAOSTAT. (2020) http://www.fao.org/faostat/en.

National data opportunities for adaptation and mitigation in agriculture. National-level data are essential for developing reference points of land in agricultural activities, projections of sector growth, food security, country-specific agricultural practices, and patterns of land use based on national circumstances. At the national level, the potential for adaptation and mitigation actions in the agricultural sector has not been fully specified in government targets nor in country-specific datasets. Given the national priority of ensuring food security, further data on the opportunities for adaptation of the Liberian agricultural sector to climate impacts is essential, especially for smallholder farmers who are both

important for food production and highly vulnerable to climate impacts. The 2013 INC notes that its analysis on baseline GHG emissions was constrained by a "lack of reliable and updated information on activity, which made it difficult to conduct a quantitative assessment of mitigation options. The GHG inventory which was supposed to be the basis for the assessment … was incomplete, particularly for the forestry, agriculture, and waste sectors."[111] Additional national level data collection on agriculture and meteorological data could provide a more complete representation of the trends in land use, crop suitability in a changing climate, overlaps with other planned uses, and existing emissions. Such data would better inform the decision-making process for increasing resilience and improving the sustainable transformation of the agricultural sector.

Land cover analysis using satellites and spatially explicit data can provide information regarding land cover as a reference point to build better quantitative information on baselines and the scale of actions in the agricultural sector that may have impacts on forest cover or density. For reference, further data on land cover is available from the recent Conservation International and NASA report on natural capital accounting, which used land cover categories designed according to SEEA guidelines using the FAO's Land Cover Classification System (LCCS).[112] However, agricultural commodities are imperfectly captured within existing land cover maps because these maps do not reveal land use. For example, land cover categories described as "degraded forest" or "forest with low percentage of trees" are likely due to the use of traditional subsistence farming systems but could also represent natural or assisted forest regrowth. Similarly, land use activities such as rain-fed rice cultivation may appear under the "grassland" land cover category. These distinctions require information from *land use* data, which cannot be determined from the land cover information in satellite imagery alone, but requires country-specific data collection, processing, and reporting.

Spatial data showing the extent of tree crops is possible with additional information, such as concession boundaries. For example, the extent of woody crops in Figure 5.2 is based on the available boundaries of crop concessions.

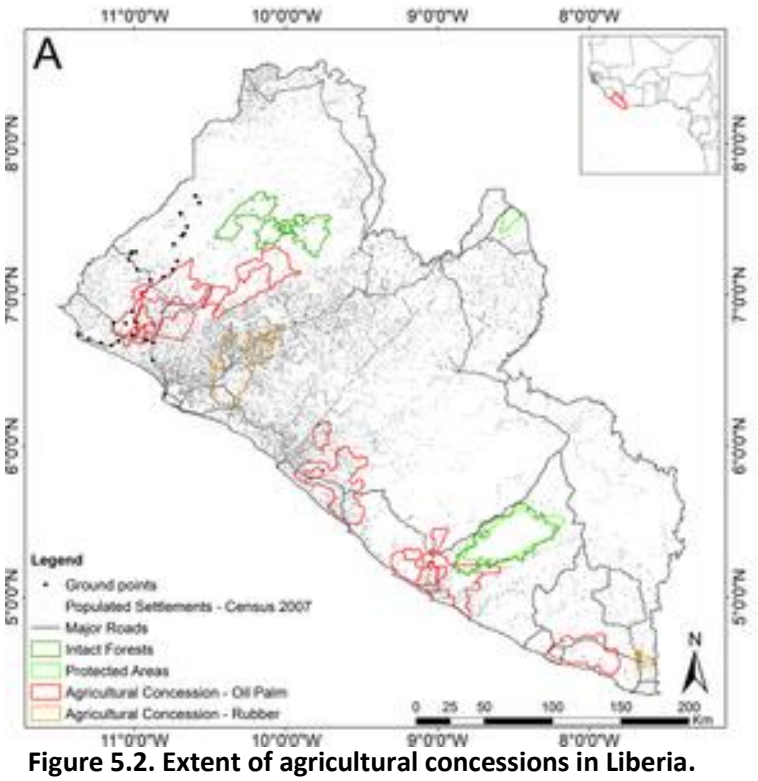


Figure 5.2. Extent of agricultural concessions in Liberia.
Source: de Sousa, C et al. (2020)

[111] Liberia Environmental Protection Agency. (2013) Initial National Communication. http://www.epa.gov.lr/sites/default/files/INITIAL%20NATIONAL%20COMMUNICATION%20LIBERIA.pdf.
[112] Food and Agriculture Organization. (2000) Land Cover Classification System (LCCS). http://www.fao.org/3/x0596e/x0596e00.htm.

Opportunities from Liberia-specific policy actions. As noted early in the sector analysis, agriculture and forest land use in Liberia are closely linked. This section considers a 2016 analysis of policy options for low-emissions development in Liberia, which has potential costs and benefits for both the agriculture and forest sector. At the national scale, efforts in the forest sector to improve protection, management, and restoration of forested land have important linkages with agricultural adaptation to climate impacts, as well as low-emissions development for Liberia. An analysis of these win-win outcomes for development and mitigation allows for a combined understanding of the effort, costs, and associated mitigation outcomes. For example, a national scenario of implementing conservation agriculture, lowland irrigated rice, and providing fertilizer subsidies could reduce pressure on forests by increasing productivity on existing agricultural lands. Increased agricultural productivity could allow both subsistence and commercial farmers in Liberia to meet domestic food security needs, while also designating large areas to regenerate natural forest cover. Such an approach would include costs, but could be profitable to farmers in the long term.[113] Challenges to realizing the potential of this approach include insecure land tenure, lack of access to capital, knowledge, or appropriate land, and strong existing preferences among farmers and public institutions. [114]

Another policy option for achieving agricultural development while reducing negative impacts on Liberia's existing forest resources could include limiting tree crop plantations to degraded land rather than forest areas.[115] This would require the regulation of foreign-invested plantations to ensure that they are only permitted to operate on degraded land rather than primary or secondary forests.[116] A summary of policy-specific actions and the carbon mitigation potential assessed in an independent analysis is provided in Table 5.5 below.

Table 5.5. Policy options for Low-Emissions Development in Liberia – Agriculture.[117]

Policy options for Low-Emissions Development in Liberia	Average CO_2 saved per year over 25 years (MT CO_2)
100,000 ha of plantations are located on degraded land rather than forest areas	2.1
Fertilizer subsidies to increase efficiency of shifting agriculture	1.8
Lowland rice promoted in place of shifting agriculture	1.6
Conservation agriculture promoted in place of shifting agriculture	1.7
Accelerated creation of Protected Area Network	0.21
Increased efficiency of charcoal production & use	1.1
No further TSCs	3.2

[113] Donovan et al. 2016. Assessing potential carbon revenues from reduced forest cover loss in Liberia. https://www.hbs.edu/faculty/Publication%20Files/Assessing%20Potential%20Carbon%20Revenues%20Liberia.pdf_8d8b931e-889d-4f87-ad6b-a23803f354c1.pdf.
[114] Donovan et al. 2016. Assessing potential carbon revenues from reduced forest cover loss in Liberia. https://www.hbs.edu/faculty/Publication%20Files/Assessing%20Potential%20Carbon%20Revenues%20Liberia.pdf_8d8b931e-889d-4f87-ad6b-a23803f354c1.pdf.
[115] Donovan et al. 2016. Assessing potential carbon revenues from reduced forest cover loss in Liberia. https://www.hbs.edu/faculty/Publication%20Files/Assessing%20Potential%20Carbon%20Revenues%20Liberia.pdf_8d8b931e-889d-4f87-ad6b-a23803f354c1.pdf.
[116] Donovan et al. 2016. Assessing potential carbon revenues from reduced forest cover loss in Liberia. https://www.hbs.edu/faculty/Publication%20Files/Assessing%20Potential%20Carbon%20Revenues%20Liberia.pdf_8d8b931e-889d-4f87-ad6b-a23803f354c1.pdf.
[117] To convert values in Table 5.5 from Megatons (MT) to Gigagrams (Gg), multiply each value by 1,000.

Sub-total for potential low-carbon development strategy	*11.7*
Restrict FMCs to 1.6 million ha	1.8

Source: Assessing potential carbon revenues from reduced forest cover loss in Liberia (2016).[118]

Institutional Framework

Through the Ministry of Agriculture, the highest decision-making body at the sectoral level is the Inter-ministerial Food Security and Nutrition Steering Committee (FSNSC), which is chaired by the MoA and includes representation from other sectors such as environment, health, and finance. The LASIP II and the Pro-Poor Agenda are the two most important strategies for achieving the development goals for food security, commercial and subsistence agriculture and natural resource use. The MoA also forms part of the National Steering Committee on Climate Change. The following table details the roles and responsibilities of public entities in the agricultural sector who have an interest in national climate planning.

Table 5.6. Institutions and agencies with mandates on agriculture in Liberia.

Institution	Mandate
Ministry of Agriculture (MoA)	• Oversees agronomy, animal husbandry and other agriculture industries, the economic organization of the agriculture and food industries, and national food security. The work of the Ministry is divided into sectors of Livestock Production, Agricultural Chemicals and Crop Production. • Ensures that agricultural challenges that impede production are investigated and lasting solutions found, and the farmers are provided with the supportive services and the enabling environment to produce.
Central Agricultural Research Institute (CARI)	• Public research institution under supervision of MoA with the mission of applied and adaptive research for enhanced productivity of food, feed, fiber, and other agricultural products in Liberia for the attainment of food security, poverty alleviation, income generation and job creation."
Environmental Protection Agency (EPA)	• Principal authority in Liberia for the management of the environment, mandated to coordinate, monitor, supervise, and consult with relevant stakeholders on all activities in the protection of the environment and sustainable use of natural resources. • Build the capacity of line Ministries, authorities and organizations through the exchange of data and information, and to render advice, technical support and training in environment and national resource management so as to enable them to carry out their responsibilities effectively; ensure the preservation and promotion of important historic, cultural and spiritual values of natural resources heritage and, in consultation with indigenous authority, enhance indigenous methods for effective natural resource management.

[118] Donovan et al. 2016. Assessing potential carbon revenues from reduced forest cover loss in Liberia. https://www.hbs.edu/faculty/Publication%20Files/Assessing%20Potential%20Carbon%20Revenues%20Liberia.pdf_8d8b931e-889d-4f87-ad6b-a23803f354c1.pdf.

Forestry Development Authority (FDA)	• Works to conserve and sustainably manage all forest resources to enable them to continue to provision of a complete range of goods and services for the benefit of all Liberians and also contribute to poverty reduction.
Ministry of Finance and Development Planning (MoFDP)	• Works to formulate, institutionalize and administer economic development, fiscal and tax policies for the promotion of sound and efficient management of financial resources of the government.
Ministry of Commerce & Industry	• Establish and regulate commodity and trade standards. • Collect, evaluate, and publish data pertaining to Commerce and Industry. • Establish and enforce standards for business practices. • Promote sound dev elopement of foreign and domestic trade. • Issue Import and Export Permits. • Control quality of goods and commodity imported into and exported from the Country. • Implement efficient and effective trade management system including pre-shipment Inspection of imports and exports. • Monitoring and regulating prices of essential goods.

Source: Elaborated from Ministry of Agriculture. (2020); Central Agricultural Research Institute. (2020); Liberia Environmental Protection Agency. (2020) Statutory Mandate; Forestry Development Authority. (2020); Ministry of Finance and Development Planning. (2020); Ministry of Commerce & Industry. (2020).

Costs and Investment Opportunities

The 2018 National Policy and Response Strategy on Climate Change included an "Action Plan and Resource Mobilization Plan," which outlines specific activities for undertaking climate action in each sector between 2017-2026. Table 5.7 below includes information regarding the activities, estimated costs and relevant government implementing agencies related to agriculture, as outlined in the 2018 Resource Mobilization Plan.[119]

Table 5.7. Action Plan for the Implementation of Strategic Interventions – Agriculture.

Sectoral and Cross-Sectoral Intervention Area: Agriculture					
Strategic Interventions	**Intervention Period** (Years 2017 to 2026)			**Estimated Cost** (Million USD)	**Implementing Agencies**
	(1-3) Short-term	(4-5) Mid-term	(6-10) Long-term		
Strengthen the capacity of the MOA including training of experts, logistics and use of technology for the management of the sector	X	X	X	2	MoA, CARI, EPA, MoFDP, Universities and Colleges
Improve the effectiveness of pest, disease, and weed management practices through the wider use of integrated pest and pathogen management; development and use of varieties and species resistant to pests and diseases and improving quarantine capabilities and monitoring programs.	X	X	X	1	MoA, CARI, EPA, MoFDP, Universities and Colleges

[119] Liberia 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.

Assess crops vulnerability and suitability (cropping pattern) for different Agro-ecological zones.		X	X	0.25	MoA, CARI, EPA, MoFDP, Universities and Colleges
Enhance climate proof agro-infrastructural systems (input, output, marketing, post-harvest technologies and infrastructure including storage), that strengthen the capacity of local farmers to increase productivity	X	X	X	5	MoA, CARI, EPA, MoFDP, Universities and Colleges
Build and strengthen the capacity of extension officers in new sustainable farming technologies in order to enhance their support for farmers	X	X	X	0.25	MoA, CARI, EPA, MoFDP, Universities and Colleges
Build and strengthen capacity of local farmers to increase agricultural productivity including post-harvest techniques/technologies to minimize losses resulting from poor harvest.	X	X	X	2	MoA, CARI, EPA, MoFDP, Universities and Colleges
Support communities in livestock and crop sectors through inventory and dissemination of indigenous knowledge, establishing and/or strengthening insurance scheme, early warning and early action system, vaccination campaign, disease control, etc., to cope up with the stress based on climate variability	X	X	X	2	MoA, CARI, EPA, MoFDP, Universities and Colleges
Develop and introduce a diverse range of integrated soil fertility management (IFSM), water harvesting and conservation techniques to farmers as a sustainable means of improving soil fertility and intensifying agricultural production as well as cope with extreme conditions (aridity, water-logging, flood, etc.)	X	X	X	5	MoA, CARI, EPA, MoFDP, Universities and Colleges
Strengthen the capacity of the Central Agricultural research Institute for research, development of climate smart agriculture initiates in Liberia including the setting up of seed banks, soil management, crop diversification, irrigation, improved livestock breeds, etc.	X	X	X	5	CARI, MoA, MME, EPA, MoFDP, Universities and Colleges
Develop and implement agriculture technologies and methodologies including hydrological technology models and scenarios for planning and ensure its promotion through agricultural programs by considering socio-economic and gender differences		X	X	0.5	CARI, MoA, EPA, MoFDP, Universities and Colleges
Develop and support coping strategies such as irrigation infrastructure, intercropping, aquaculture, climate resilient plant varieties to support farming systems and encourage farmers to engage in them.		X	X	2	CARI, MoA, EPA, MoFDP, Universities and Colleges
Promote the development of sustainable livestock programs for farmers including grazing management systems, Livelihood diversification (bee harvesting, rabbit, guinea fowl, indigenous poultry) and breeding animals to adapt to climate change.	X	X	X	5	MoA, CARI, EPA, MoFDP, Universities and Colleges
Develop a communication strategy to increase farmers' awareness of climate change and strengthen the coordination of existing structures and institutions that are available to help them adapt to its impact.	X	X		0.1	MICAT, MoA, EPA, MoFDP

Source: Adapted from National Policy and Response Strategy on Climate Change (2018).

Agency abbreviations: MoA = Ministry of Agriculture; CARI = Central Agricultural Research Institute; EPA = Environmental Protection Agency; MoFDP = Ministry of Finance and Development Planning; MICAT = Ministry of Information Culture Affairs & Tourism

Policy Gaps and Challenges

The following policy gaps and challenges are present for the agricultural sector in the context of climate change.

Challenge: Weak inter-ministerial coordination leading to overlapping use claims. The agricultural sector involves diverse stakeholders, including women, youth, smallholders, commercial plantations, and others, and has important linkages with other sectors, such as energy, environment, forests, and mining. Coordination between both the public and private sectors is important to understand how needs and opportunities may be differentiated between various stakeholder groups, and across various sub-sectors. This limited coordination between relevant ministries and private sector stakeholders has resulted in unclear and outdated national land use policies and regulations for agriculture that no longer reflect current practices. For example, this results in overlapping designations across sectors, such as protected areas and agricultural concessions, or subsistence agricultural activities and mining concessions.

Challenge: Infrequent coordination among farmer stakeholders. The agricultural sector provides direct livelihood benefits for most Liberians; however, there are limited organizations or associations established to represent farmers directly.

Challenge: The level of public and private investments in the agricultural sector is not clear. It is important to have clarity on the scale of public and private funding dedicated to agricultural production, especially if the goal is to identify further investment opportunities. Existing incentives/subsidies, as well as perverse incentives in the agriculture sector, should be more clearly identified, along with strengths and limitations of the financial sector for agricultural investments. Information on public investment should be transparent under the Comprehensive Africa Agriculture Development Programme to monitor progress towards the target of investing 10% of GDP in the agricultural sector under the Maputo Declaration and reaffirmed in Malabo in 2014.

Sectoral Recommendations for Consideration

Preparation of agricultural sector recommendations to be developed with inputs from a robust stakeholder input and consultation process. The below suggestions are proposed as a potential starting point for further examination.

Recommendation 1: Identify opportunities to mainstream climate goals in agricultural development plans and vice versa.

As part of the NDC review and consultation process, strategies for development of the agricultural sector should identify existing points of alignment with national climate goals. This could start with a mapping of the sector's development strategies and existing adaptation priorities, coordination with the LASIP II unit, MoA, FDA, and other relevant stakeholders. Opportunities for climate mainstreaming in agriculture could

mean linking with Reducing Emissions from Deforestation and Forest Degradation (REDD+) activities, as well as making climate considerations part of the training and deployment of the agricultural specialists prioritized in the Pro-Poor Agenda. For example, agroforestry schemes may add economic value for smallholder farmers by integrating forestry components into existing agricultural activities. Coordination between agriculture and the National REDD+ Strategy could allow for synergies between the two complimentary agendas. Trade-related policies for the sector are important to include in the NDC updating process, as well as policies related to market access and infrastructure development targeted to the agricultural sector.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation and validation of this recommendation.

Recommendation 2: Consider opportunities to add quantified and/or time bound goals and targets to the adaptation activities identified for the revised NDC.

The agriculture-related actions for adaptation in the 2015 NDC show an incomplete alignment with the national ambition of transforming the agricultural sector, as well as national targets for the SDGs. For consistency with previous UNFCCC communications, Liberia could build upon the 2013 INC, the 2015 NDC, and the 2018 Climate Strategy to update its planned adaptation actions and targets for agriculture, as well as develop more quantitative and time-bound goals. Alignment with the SDG targets would also be useful considering that they already include time-bound goals and quantifiable indicators. Socioeconomic activities listed in LASIP II (e.g. value chain development, access to markets etc.), as well as the actions listed in the climate-focused component of LASIP II, provide actions and targets with implications for adaptation and future emissions in the sector, and could be reflected in the revised NDC.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation and validation of this recommendation.

Recommendation 3: Underscore the co-benefits from adaptation actions in agriculture practices, including mitigation outcomes, as well as potential trade-offs.

Low-emission and climate-resilient agricultural practices and activities can enhance food security and livelihood security by maintaining and/or increasing yields, while reducing emissions and making the sector more resilient to the impacts of climate change, as identified in the 2015 NDC (e.g., increasing rainfall variability, flooding, high temperature). Incorporating the benefits that accompany adaptation actions into the NDC revision could further align it with the Ministry of Agriculture's focus on food security, sustainable agriculture, and climate change resilience, as expressed in the Food and Agriculture Policy and Strategy of 2008.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation and validation of this recommendation.

Recommendation 4: Improve data for specific GHG inventory categories and continue to increase technical and institutional capacities for MRV and GHG inventory development.

Existing categories in the National Greenhouse Gas Inventory could be used to guide national data collection on activities like rice cultivation, agricultural soils, and field burning of agricultural residues (shown in Table 5.3). These improved data points should be used in combination with stronger reporting on land use change, for example under commercial agriculture concessions and permitting. Immediate updating of the national GHG inventory is critical to this end, including by generating country-specific emission factors, and for the country to demonstrate robustness and accuracy for any potential participation in carbon markets and similar mechanisms, such as results-based payments. Specific technical and institutional capacities should also be created to manage the future elaboration of inventories, implement required MRV requirements, and move towards fulfilling the transparency framework under construction in the context of the Paris Agreement.

Improved information from the current GEF Capacity Building Initiative on Transparency (CBIT) project would allow for the use of the 2006 IPCC guidelines in Liberia's National Greenhouse Gas Inventory.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation and validation of this recommendation.

Recommendation 5: Address gender and youth considerations in training of institutional and local experts in agriculture sector planning, monitoring, and reporting.

As addressed above, there are several challenges impeding the full implementation of agricultural planning and development in Liberia, including: insufficient data; lack of trained individuals to measure, monitor and evaluate climate impacts on agriculture; and limited capacity at all levels of implementation. Women's groups and youth should be considered and prioritized for relevant trainings and jobs related to agricultural resilience.

The 2012 "Climate Change Gender Action Plan for the Government of Liberia" outlines as number of examples of action across the sector. For example, this would include training and empowering women extension officers and setting up weather monitoring approaches utilizing mobile phone technology. Women could also support agricultural development efforts by educating women about best agricultural practices, agroforestry, conservation agriculture and more.[120]

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation and validation of this recommendation.

[120] Aguilar, L., Rogers, F., and Bobtoya, S. (2012) Climate Change Gender Action Plan for the Government of Liberia (ccGAP:LIBERIA). International Union for Conservation of Nature. https://portals.iucn.org/union/sites/union/files/doc/liberia_0.pdf.

Recommendation 6: Consider strengthening of climate services and early warning systems for farmers to build and strengthen resilience of the agriculture sector.

There is a need strengthen the technical capacity of meteorological department to produce localized climate information products and services in agriculture. This can be a full range of advice regarding weather and climate, its impacts on agriculture, and management practices to be followed to manage climate risks. The information can be tailored to assist farmers in making decisions to reduce the risks and benefit from the opportunities presented by variable and changing climate.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation and validation of this recommendation.

Recommendation 7: Take stock of progress made in implementing existing agriculture sector policies and the NDC. ***[Linkages with other sectors]***

In the process of reviewing and updating the NDC, it is critical to take stock of progress made toward implementing existing sectoral and climate change targets and plans. The revised NDC should be informed by experiences, challenges, and lessons learned from implementing current targets and plans in the agriculture sector. The stakeholder consultation process should identify any changes in national circumstances, political priorities, development priorities, and efforts to achieve SDGs (including progress made toward relevant sectoral SDG targets), which can help identify new opportunities and synergies to pursue emissions reduction strategies within the context of national priorities. The work done by EPA under the ongoing Second National Communication can provide a useful input into this stocktaking process.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders could contribute to identify new opportunities for mitigation strategies.

Recommendation 8: Consider linkages with national COVID response and recovery priorities as part of the update of NDC targets for this sector. ***[Linkages with other sectors]***

The productivity and resilience of the agricultural sector will be a particular priority for COVID recovery because of the importance of food and nutrition for both health and economic recovery. This creates an important need to link the NDC revision to COVID recovery in the agricultural sector.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation and validation of this recommendation.

Sector Highlight: Forests

National Sectoral Context

Liberia's forest ecosystems and overall forest cover are exceptional within the West Africa region, representing the largest remaining tracts of Upper Guinean Forest.[121] These forested areas provide important timber resources, food, fuelwood, freshwater provisioning, biodiversity and climate regulation, along with additional economic and cultural benefits. In 2019, tropical forests[122] made up approximately 7.5 million hectares,[123] of which approximately 4.3 million hectares represents tropical forest with greater than 80% canopy cover, suggesting the importance of these forested areas in national planning and sustainable development.[124]

The forest sector in Liberia has several remarkable characteristics:[125]

- Forests contribute 10% to the national economy;
- Forest cover is the highest among West African countries;
- High biodiversity value; and
- High commercial value.

As population growth and economic development increase demand for land use, Liberia expects threats and pressures on forested land to also increase.[126] Liberia's national strategy for forest management and

[121] Government of Liberia, Environmental Protection Agency. (2019) Forest Reference Level submission to UNFCCC. https://redd.unfccc.int/files/liberia_frel_submission_december_2019.pdf.

[122] In 2018, Liberia has for the first time, established a definition of forest, which was developed and validated by the Forestry Development Authority. Forest is defined as an area of land that: Has a canopy cover of minimum 30%; Contains trees with a minimum of 5 m height or the capacity to reach it; Covers a minimum of 1 hectare of land. This includes shifting cultivation in its fallow phase (in so far as the threshold values are met) but does not include land with predominant agricultural use (oil palm, rubber). From EPA. (2019) Forest reference level. https://redd.unfccc.int/files/liberia_frel_submission_december_2019.pdf.

[123] Government of Liberia, Environmental Protection Agency. (2019) Forest Reference Level submission to UNFCCC. https://redd.unfccc.int/files/liberia_frel_submission_december_2019.pdf.

[124] Forestry Development Authority. (2015) Status report on Liberia's Land Cover and Forest Mapping – Oct 2015. Consultants: Joint Venture Metria AB and GeoVille GmbH. http://www.fda.gov.lr/status-report-on-liberias-land-cover-and-forest-mapping-oct-2015/.

[125] The World Bank. (2018) Liberia: Country Forest Note. http://documents1.worldbank.org/curated/en/233271527176589175/pdf/Liberia-Country-Forest-Note.pdf.

[126] Government of Liberia, Environmental Protection Agency. (2019) Forest Reference Level submission to UNFCCC. https://redd.unfccc.int/files/liberia_frel_submission_december_2019.pdf.

economic activities follows a "three C's approach," integrating community, conservation, and commercial objectives for national benefit. Approximately half of the land in Liberia has been allocated for concessions for logging, agriculture, mining and conservation. Most commercial concessions have not yet been developed, and protected areas are in the process of being proposed and established, so future deforestation and forest degradation depends heavily upon how these allocated areas are developed.[127] Major national programs and initiatives to support sustainable development of the forest sector have included the Liberia Forest Program with support from Norway, the Reducing Emissions from Deforestation and Forest Degradation (REDD+) program with support from the World Bank, the USAID Land Rights and Community Forestry Project, the U.S. Forest Service Liberia Forestry Support Program, and the protected areas projects "EXPAN" and "COPAN" supported by the Global Environment Fund, among others.

Evidence suggests that Liberia will experience negative impacts on forests and related ecosystem services as a result of climate change.[128] Climate impacts, such as unpredictable rainfall, expanded disease ranges, flooding, and unpredictable weather patterns affect agricultural productivity and can drive informal expansion of agricultural activities into forested land. It is important to highlight that forested land is an important source of food security, energy, clean water, medicinal products, and livelihoods for rural Liberians, with over one-third of Liberia's population (~1.5 million people) living in forested areas.[129] Adaptation strategies to climate impacts in the forest sector were identified in the 2015 NDC, as well as the 2018 National Policy and Response Strategy on Climate Change. These sector-specific activities include advancing efforts to avoid forest conversion (including the national REDD+ program), promoting restoration and cacao and coffee agroforestry systems, supporting alternative livelihood and conservation activities with forest-dependent communities, creating a protected area network, and increasing institutional capacity for forest governance, rights, data, and monitoring. Climate action for forests can also contribute to the achievement of the Sustainable Development Goals (SDGs), in particular, SDG 15 - Life on Land, as well as SDG 2 - Zero Hunger, SDG 12 - Sustainable Consumption & Production, and SDG 13 - Climate Action.

The Forest Development Authority (FDA) is the primary public institution for policy development and decision-making regarding Liberia's forests and forest resources. As part of the FDA, the REDD+ Implementation Unit provides key technical expertise to advance the National Strategy for REDD+. The FDA participates in collaboration with the Environmental Protection Agency in sectoral target setting for national action on climate change through the National Climate Change Steering Committee (NCCSC). Agricultural concessions for tree crops in forested areas, such as oil palm, cacao, and rubber, are managed under the Ministry of Agriculture, and more information can be found in the agriculture section of this document.

[127] The World Bank. (2018) Liberia: Country Forest Note. http://documents1.worldbank.org/curated/en/233271527176589175/pdf/Liberia-Country-Forest-Note.pdf.
[128] Fortunate, M. (Forthcoming 2020). Draft Technical Report: Mainstreaming Climate Change Considerations into the Relevant Sector Specific Development Programs, Policies, Strategies and Management Plans in Liberia. United Nations Development Programme.
[129] The World Bank. (2018) Liberia: Country Forest Note. http://documents1.worldbank.org/curated/en/233271527176589175/pdf/Liberia-Country-Forest-Note.pdf.

Existing NDC Targets

Table 6.1. Existing Mitigation Targets and Activities in 2015 NDC – Forests.

Mitigation Targets and Activities in 2015 NDC – Forest Sector		
Sectoral Quantitative Target (if applicable)	**Sub-targets and activities identified**	**Baseline information used for 2015 NDC target[130]**
Not stated.	*Mitigation activities from the forest sector are not included in Liberia's 2015 NDC.[131]*	-96,811 Gg for LULUCF

Source: Information from Liberia Initial Nationally Determined Contribution (2015).[132]

Table 6.2. Existing Adaptation Targets and Activities in 2015 NDC – Forests.

Adaptation Targets and Activities in 2015 NDC – Forest Sector		
Sectoral Quantitative Target (if applicable)	**Sub-targets and activities identified**	**Baseline information used for 2015 NDC target**
Not stated.	Liberia is currently implementing Reducing Emissions from Deforestation and Forest Degradation (REDD+) readiness activities.	*Not stated.*
	Increase awareness and strengthen participation of local dwellers in forest conservation.	
	Protection of forest and biodiversity rich forest zones.	
	Increase the amount of forested land through reforestation of degraded lands.	

Source: Information from Liberia Initial Nationally Determined Contribution (2015).[133]

Existing Relevant Policies, Strategies and Plans

Relevant climate change and sectoral policies were reviewed in order to examine their targets and strategies for the forest sector. The most relevant and updated strategies and plans for climate action in the sector were the focus of this review process:

- ✓ National Policy and Response Strategy on Climate Change (2018);
- ✓ Pro-Poor Agenda for Prosperity and Development (2018);
- ✓ National Strategy for REDD+ in Liberia (2016);
- ✓ National Forestry Policy and Implementation Strategy (2006);
- ✓ National Biodiversity Strategy and Action Plan - II (2018); and

[130] Units in Gg can be converted to MT by dividing by 1,000. For example, -96,811 Gg CO_2e = 96.811 MT CO_2e.

[131] While the forest sector was not fully included in the 2015 NDC, Liberia's 2015 NDC energy sector goal of improving energy efficiency by at least 20 percent by 2030 is strongly linked to outcomes in the forest sector.

[132] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC), emphasis added. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

[133] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC), emphasis added. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

- ✓ Initial National Communication (2013).

In 2006, Liberia issued its National Forestry Policy and Implementation Strategy, which outlined the main strategies for forest conservation and sustainable management and was further specified by the National Forest Management Strategy in 2007. A more recent key policy is the National Strategy for Reducing Emissions from Deforestation and Forest Degradation (REDD+) (2016), which sets strategic priorities relating to the reduction of forest loss, reducing the impact of commercial logging, declaring and managing protected areas, preventing the deforestation of areas of high conservation value, and working towards a sustainable and fair benefit sharing. Other relevant policies for the forestry sector include the National Biodiversity Strategy and Action Plan – II 2017-2025 (2018), and the Pro-Poor Agenda (2018), which include targets and strategies related to sustainable management of forests, the reduction of forest degradation and deforestation. The Climate Vulnerability and Risk Assessment for the Sectors of Agriculture, Fisheries and Forestry in Liberia (2019) includes references to forestry and provides an up-to-date analysis of vulnerabilities and adaptation measures for the sector.

The most detailed set of actions for addressing climate change in the forestry sector come from the 2018 National Policy and Response Strategy on Climate Change, which lists opportunities to address both adaptation and mitigation measures but does not set quantitative targets for these actions. This document identifies a climate change mitigation strategy for forests and wildlife that aims to "significantly enhance Liberia's potential for carbon sequestration by promoting conservation, sustainable forest management, community forestry and curbing key drivers of deforestation and forest degradation, which in turn will contribute to sustainable wildlife management." The actions and targets from these strategies and plans are detailed below, with emphasis added.

Forest sector strategies from the National Policy and Response Strategy on Climate Change (2018):

Mitigation Strategies:

- Promote the development of **REDD+ activities** across Liberian forest landscapes.
- Provide adequate and sustainable support for conservation and engage nationally for **increment in the number of areas set aside as protected areas** within forested landscape.
- Build a **national carbon registry** and **accounting system** as well as clarify the issues of **carbon rights, ownerships, and tenure.**
- Provide adequate regulation and enforcement of current and future **national forest management law and policies** which address drivers of deforestation and forest degradation as well as wildlife degradation.
- Adopt fiscal and regulatory measures to **reduce unsustainable wood utilization**, particularly in constructions and charcoal production.
- Promote activities which **enhance carbon density**, such as reforestation, afforestation and agroforestry initiatives across the country, which also brings benefits to reduce the stress and pressure on natural forests and ecosystems.

- Develop and facilitate the adequate **management of community forests** by strengthening forest governance and institutions, including wildlife, to ensure better stewardship.
- Increase **capacity building programs and monitoring capabilities** to minimize degradation or impacts to forest areas and wildlife by nearby communities and other external economic agents.
- Ensure the **sustainable use of forest and wildlife resources** to contribute to the livelihoods of the rural communities as they adapt to climate change, and to contribute also to mitigation.

Adaptation Strategies:

- Implement sustainable and, where applicable**, alternative livelihood initiatives for forest-dependent communities**, to enable them to become less reliant on forest resources or to be able to use them in a sustainable way.
- Promote **community forests activities beyond timber extraction** as a management tool for sustainable forest management, using indigenous species and knowledge.
- Establish a comprehensive **monitoring system for forest resources** by building on existing system (including non-timber forest products) to detect changes in the conditions of the ecosystem that might affect these resources and other ecosystem services provided by forests.
- Implement **reforestation and afforestation activities to increase vegetation cover**, to improve ecosystem services in degraded areas, to increase rural income, and to improve biodiversity richness including wild fauna.
- Enhance the management and conservation of forest biodiversity, focused on **preventing perturbations such as fire, invasive species, insects and diseases** through including the adoption of a strategic approach to communication that clearly outlines the cost and benefits of various actions affecting forests.
- Strengthen and/or **implement reforestation and afforestation activities** to increase vegetation cover, improve ecosystem services in degraded areas, increase rural income, and improve biodiversity richness, identify and map for proper management water catchment areas, valuable to communities, in the forests.
- Promote **consolidation of the protected area network** by considering landscape approach and ensuring that it consists of a large spectrum of forest types across various environmental gradients to enhance connectivity between habitats and support species migration.
- Establish and/or **strengthen coordination mechanisms** with other line ministries and agencies that might be implementing activities that affect forest and wildlife and to ensure that the principle of sustainable forest and wildlife management is mainstreamed in national and sectorial policies and programs.
- 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 take action to adapt to these changes.

Source: National Policy and Response Strategy on Climate Change (2018). Emphasis added.

Selected targets from Pro-Poor Agenda for Prosperity and Development (2018):

By 2023:

- Emphasis will be placed on **forest contract and concessional enforcement** to promote effective distribution of benefits via Community Benefit-Sharing Mechanism (CBSM), spur sustainable economic development, and empower communities living and working in the forest.
- Government will improve the **policy, legal and institutional framework for forestry management**; strengthen its **monitoring** and law-enforcement capabilities, enhance **transparency** of its operations and bolster **accountability** in the overall governance of the forestry sector. Regulations on drivers of deforestation and environmental degradation will also be enforced.
- The government will support **sustainable fuel-wood and charcoal production** while creating **alternatives for domestic energy resources** and establish an information dissemination and data management repository system.
- To reduce deforestation and environmental degradation, **alternative livelihood for forest dependents and local communities** will be created in select areas.

Source: Pro-Poor Agenda for Prosperity and Development (2018). Emphasis added.

Selected targets from National Strategy for REDD+ in Liberia (2016):

Liberia's REDD+ program focuses on addressing the small-scale drivers of deforestation, while policy measures implemented at the national scale (Liberia Land Rights Act) focus on the larger scale drivers[134]. The goal of Liberia's REDD+ Strategy is to reduce emissions from deforestation and forest degradation and increase benefit sharing-related actions including:

Strategic Priority 1. Reduce forest loss from chainsaw logging, charcoal production and shifting agriculture

Strategy Options

1.1 Reduce impact of pit sawing (chainsaw logging) on forest through better regulation, improved efficiency and developing alternatives.

1.2 Reduce impact of charcoal industry on forest through better regulation, improved efficiency and the development of alternative energy sources.

1.3 Reduce expansion of shifting agriculture in forest areas by **promoting permanent food and cash crops in non-forest area**s and through **conservation agriculture**.

1.4 Locate services and new infrastructure development beyond a **3km buffer from areas of dense forest and Protected Areas** (including proposed PAs).

1.5 Integrate **hunting**, **artisanal mining** and **forest restoration** into community-led livelihood and sustainable forest management practices.

Strategic Priority 2: Reduce impact of commercial logging in all forestry concessions

[134] Government of Liberia, Environmental Protection Agency. (2019) Forest Reference Level submission to UNFCCC. https://redd.unfccc.int/files/liberia_frel_submission_december_2019.pdf.

Strategy Options

2.1 Ensure that all **commercial logging (FMC, CFMA, TSC) is practiced to high conservation standards** in keeping with national regulations and international standards.

2.2 Conserve and **maintain areas of highest conservation value** within commercial forestry concessions, such as important **wildlife corridors**.

2.3 Review **Timber Sales Contracts** to ensure compliance with forestry laws and EIA standards and establish a strong presumption against further TSC contracts on dense forest and critical habitats.

2.4 Prevent **unregulated pit sawing and charcoal production** within forestry concessions.

2.5 Manage **commercial forestry in community forests** to achieve **sustainable logging standards** as apply to FMCs.

Strategic Priority 3: Complete and manage a network of Protected Areas

Strategy Options

3.1 Complete the **Protected Areas Network** and strengthen management to prevent forest degradation.

3.2 Expand the Protected Areas Network to **conserve 30% of forest land**.

3.3 Reduce pressure on Protected Areas from surrounding communities (using priority 1 measures).

3.4 Develop and implement **land use plans at landscape scale**, to integrate production and conservation.

Strategic Priority 4: Prevent or offset clearance of high carbon stock and high conservation value forest in agricultural and mining concessions.

Strategy Options

4.1 Conserve HCV-HCS forest within agricultural concession areas, including developing and implementing a policy for the sustainable management of these conserved areas (using priority 1 measures).

4.2 Apply policy of conserving HCS-HCV forest to all agricultural concessions, including large private farms.

4.3 Ensure that **mining concessions result in zero-net deforestation**, through mechanisms such as biodiversity offsets.

4.4 Locate future large-scale **agriculture and mining concessions in less dense and non-forest areas**.

Strategic Priority 5: Fair and sustainable benefits from REDD+

Strategy Options

5.1 Define **carbon rights** and develop **policies and regulations** for upholding these.

5.2 Establish **benefit sharing mechanisms for REDD+**, in harmony with those operating in the forestry, mining, agriculture and other relevant sectors.

5.3 Operate a robust **monitoring, reporting and verification system** for demonstrating reductions in emissions achieved through REDD+ policies.

Source: National Strategy for REDD+ in Liberia (2016). Emphasis added.

Selected targets from National Forestry Policy and Implementation Strategy:

5.1.1. Develop and implement a set of rules and procedures for forest management in concessions, including a logging code and a new forest concession contract that sets out requirements for the following: forest management plans; environmental impact assessment; legal and financial qualifications; and local participation in the sector.

5.1.2. Demarcate forest concession boundaries and implement a transparent and competitive concession allocation system.

5.1.4. Develop and implement a mechanism to share the benefits from forest concession activities between the government, private sector and local communities.

5.2.1. Develop and implement a national reforestation program, based on sound scientific and technical principles (best practices) and including realistic annual targets for new planting, enrichment planting and agroforestry.

5.2.2. Develop appropriate mechanisms and incentives to encourage involvement of the private sector and local communities in reforestation.

5.2.3. Encourage tree planting for environmental improvement and income generation in green belts within and around urban area

7.1.4. Strengthen and improve alternative livelihood opportunities to reduce rural dependence on forests and wildlife (see also activity 6.2.2).

7.3.4. Integrate ecotourism and nature tourism into rural development and forest management plans

Source: National Forestry Policy and Implementation Strategy (2006).

Selected targets from National Biodiversity Strategy and Action Plan II 2017-2025 (2017):

Goal Two: Reduce the direct pressures on biodiversity and promote sustainable use.

Target 2.1: By 2024, the rate of loss and degradation of natural habitats outside protected areas serving ecological corridors or containing key biodiversity areas or providing important ecosystem services is minimized by 3% through integrated land use planning.

Actions:

2.1.1 Ensure establishment of **community forests** and provide **incentives to communities for ecosystem services**

2.1.2 Carry out **reforestation** and **afforestation** projects; establish **woodlots**

2.1.3 Ensure **SLM practices**

2.1.4 Invest in the establishment and management of hydro and biogas energy technologies to **reduce the over-dependence on fuelwood**

2.1.5 Promote use of **eco-stoves**

Target 2.6: By 2018, ecosystems most vulnerable to climate change and their anthropogenic pressures are identified and assessed, and by 2020 appropriate adaptation measures are developed and implemented in priority areas.

Actions:

2.6.1 Conduct **studies on prioritized ecosystems** vulnerable to climate and take appropriate to reduce/avoid/ threats.

2.6.2 Conduct **studies in agriculture, fisheries and forestry practices** on felt or potential negative impact on the natural environment

Goal Three: Improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity

Target 3.1: By 2020, at least 4% of existing terrestrial protected areas (national parks, nature reserves, conservation areas set aside in community forests, etc.) are conserved, effectively and equitably managed, within an ecologically representative and well-connected system, and by 2022, at least 5% of coastal and marine areas of particular importance to biodiversity and ecosystem services, are identified, assessed and measures taken for their protection.

Actions:

3.1.1 Conduct **baseline surveys of terrestrial and aquatic (freshwater, marine) protected ecosystems** to determine their current conservation status and threats they face

3.1.2 Establish additional **ecologically representative protected areas**

3.1.3 Update/develop **management plans** for the PAs

3.1.4 Conduct **economic valuation of the PAs**

3.1.5 Promote REDD+ program

Goal Four: Enhance the benefits to all from biodiversity and ecosystem services

Target 4.1: By 2022, ecosystems that provide essential services and contribute to health, livelihoods and well-being, are safeguarded, and **restoration programmes have been initiated for degraded ecosystems covering at least 15% of the priority areas**

Actions:

4.1.1 Develop and initiate implementation of measures to **restore and/or rehabilitate at least 2% of these ecosystems**

Target 4.2: By 2018, ecosystem resilience and the contribution of biodiversity to carbon stocks will be enhanced through the protection of additional forest ecosystems which Liberia's current **REDD+** project will create, in addition to the project's enhancement of the mitigation of climate change and **restoration of degraded grasslands through reforestation** by 2023.

Actions:

4.2.1 Promote and support **community-based forest management** programs

4.2.2 Support **reforestation** and **afforestation**

4.2.3 Establish **woodlots in degraded landscapes**

4.2.4 Put in place program to provide **incentives to forest dependent communities for ecosystem services** under the REDD+ Project

Source: National Biodiversity Strategy and Action Plan II (2017). Emphasis added.

Selected targets from the Initial National Communication (2013):

Sector	Adaptation Option and Mitigation Measure Identified
Forest protection	Measures which increase the opportunities for harvesting and marketing of non-timber forest products such as nuts, honey, and fiber can aid forest protection. Introducing small-scale rural industries such as carpentry, brickmaking, weaving, etc. may stem the rate of deforestation associated with subsistence farming.
Improvements in harvesting techniques, e.g., reduce logging impact	A good harvest selection system aims to keep all-aged stands through timber cuttings at shorter intervals and many light cuttings. Seedlings become established in small gaps. Under this system two or more intensive harvests are possible during one rotation. At periodic intervals exploitable trees are selectively felled over an area.
Improvements in product conversion and utilization efficiency	Anti-log forests attempt to reverse the loss of forest cover by planting trees and lesser plants on deforested lands, regenerating the structure and functions of original forests. This is also commonly known as enhance regeneration or enrichment planting.
Reforestation	Planting trees on degraded land in forest area.
Afforestation	Conversion of non-forest area into forest area by planting trees.
Timber plantation	Large-scale plantings on degraded land using short- rotation species, long rotation species, or exotic species with intensive management for wood production.
Agroforestry (social forestry	Improving carbon sequestration and storage in both soil and biomass through planting trees intercropped with annual crops for the purpose of producing both agricultural and forest products. Long rotation systems that use trees for windbreaks, border planting, and over-story shade can sequester carbon for many decades.
Urban forestation	Planting trees in parks and gardens, green belts, residential shade trees, and roadside and demarcation trees in the rural areas. Urban tree planting offers advantages of reducing GHG through reduction in energy consumption from air conditioning.
Stoves for cooking	Replacing cooking stoves with low thermal efficiency (5-10%) with the higher-efficiency (40%) stoves.
Biogas	Biogas is a combustible gas produced by anaerobic fermentation of cellulosic materials such as animal dung, plant leaves, and waste from food processing and households.

Source: Initial National Communication (2013).

Review of NDC Targets

Data in the NDC. The 2015 NDC reflects Land-use, Land-use Change, & Forestry (LULUCF) emissions from the 2013 INC, which used data from FAO for the 2000 GHG inventory, due to a lack of country-specific data. The 2013 INC used IPCC 1996 default emission factors to calculate an estimated sink of -96,811 Gg CO_2 (equivalent to -968.11 MT CO_2) for LULUCF with a deforestation rate of ~ 0.2%. As a result, the 2013 INC recognizes high uncertainty of the data used for LULUCF baseline emissions and reinforces a need to strengthen institutional and technical capacities to generate country-specific emission factors and improve the accuracy of the inventory. Data on the land area of forest/biomass stocks for 2000 were compiled from several sources including a 2004 World Bank report on the forest cover of Liberia, FDA annual reports, and the 1993 FAO report, Forest Resources Assessment for Tropical Countries. Default values of emission factors were used due to difficulties encountered in deriving national data. Improved information from the current GEF Capacity Building Initiative on Transparency would allow for the use of the 2006 IPCC guidelines in Liberia's National Greenhouse Gas Inventory.

Data used to inform adaptation activities in forestry are not referenced in the 2015 NDC.

Sources of emissions. Emissions and removals from the forest sector come from loss of forest cover (deforestation and land use change), increases in forest stocks, degradation of forests (including mangroves) and soils. There is limited data for national-level estimates of emissions from forest activities such as commercial logging, shifting agriculture, or charcoal production. Table 6.3 summarizes of the estimated LULUCF GHG emissions and removals for Liberia from the 2013 INC. Several categories of emissions show incomplete data.

The main direct drivers of deforestation and forest degradation in Liberia include:[135]

- Palm oil conversion;
- Timber sales contracts;
- Pit sawing and charcoal production;
- Shifting agriculture;
- Commercial logging; and
- Mining.

In 2001, total forest cover of Liberia was estimated at 4.52 million ha, with an annual deforestation rate of 0.2% or a cumulative 2.6% loss of forest since the 1980s.[136] Recent studies estimate the deforestation rate at 0.46% per year for 2005–2015, based on the available data.[137] A recent study by Winrock of the Reference Level for REDD+ in Liberia estimates that over 350,000 hectares have been deforested from

[135] Forestry Development Authority. (2016) National Strategy for Reducing Emissions from Deforestation and Forest Degradation (REDD+) in Liberia. https://www.ltsi.co.uk/wp-content/uploads/2015/01/Technical-Annex-A-REDD-Strategy-final.pdf.
[136] Environmental Protection Agency of Liberia (EPA). (2013) Initial National Communication. https://unfccc.int/sites/default/files/resource/lbrnc1.pdf.
[137] The World Bank. (2018) Liberia: Country Forest Note. http://documents1.worldbank.org/curated/en/233271527176589175/pdf/Liberia-Country-Forest-Note.pdf.

2000 to 2014, which is more than the total area of forest in Liberia's three established Protected Areas (approximately 263,000 ha).[138]

Loss of trees results from distinct activities that vary across sub-national regions. Most forest loss and associated emissions were focused in the Tropical Forest Zone to the east, where selective logging and smallholder agriculture has converted dense forest into degraded forest, thicket, or savanna or is being used for agriculture.[139] Coastal areas have experienced recent tree cover loss from oil palm cultivation, while tree cover loss in the center of the country has been driven by rubber plantations. Across Liberia's central corridor, scattered, small (<1 ha) patches of tree cover loss are likely from small-scale agriculture, charcoal production, and local timber harvesting.[140]

Table 6.3. GHG emissions by category from the forest sector in 2000.[141]

Greenhouse Gas Source and Sink Categories	CO_2 (Gg) Emissions	CO_2 (Gg) Removals	CH_4 (Gg)	N_2O (Gg)
Land Use Change and Forestry	**17,631**	**-114,442**	**NE**	**NE**
A. Changes in forest and other woody biomass stocks	17,631		NE	NE
B. Forest and grassland conversion	-114,442		NE	NE
C. Abandonment of managed lands	NE	NE	NE	NE
D. CO_2 emissions and removals from soil	NE	NE	NE	NE
E. Other (please specify)		0	0	0
Net Emissions		**-69,991**		

Source: Adapted from Liberia Initial National Communication (2013).[142]

Current and future emissions related to deforestation and forest degradation are linked to different land uses:

Subsistence land use. The most common use of forested land (outside of commercial and conservation designations) is small-scale and subsistence land use, which includes shifting agriculture, chainsaw milling, charcoal production, small-scale mining, firewood harvesting, and use of non-timber forest products. These activities are informal and have limited data regarding their scale and impact on forests.[143] Existing

[138] Forestry Development Authority REDD+ Implementation Unit. (2016) National Strategy for Reducing Emissions from Deforestation and Forest Degradation (Redd+) In Liberia, page 9-10. https://www.ltsi.co.uk/wp-content/uploads/2015/01/Technical-Annex-A-REDD-Strategy-final.pdf.

[139] The World Bank. (2018) Liberia: Country Forest Note. http://documents1.worldbank.org/curated/en/233271527176589175/pdf/Liberia-Country-Forest-Note.pdf.

[140] Conservation International. (2017) Natural Capital Mapping and Accounting in Liberia: Understanding the contribution of biodiversity and ecosystem services to Liberia's sustainable development. Arlington, VA.

[141] To convert the values in Table 6.3 from Gigagrams (Gg) to Megatons (MT), divide each value by 1,000.

[142] Environmental Protection Agency of Liberia (EPA). (2013) Initial National Communication. https://unfccc.int/sites/default/files/resource/lbrnc1.pdf.

[143] Forestry Development Authority REDD+ Implementation Unit. (2016) National Strategy for Reducing Emissions from Deforestation and Forest Degradation (Redd+) In Liberia, page 9-10. https://www.ltsi.co.uk/wp-content/uploads/2015/01/Technical-Annex-A-REDD-Strategy-final.pdf

national data indicates that these activities are the key drivers of deforestation and degradation across the largest areas of forest.[144]

Forestry concessions. Logging concessions represent the second-largest land use category in Liberia, with the potential to affect 24% of total forest area. According to the National Strategy for REDD+, "Forest management concessions (FMCs) contain a large proportion (29%) of the densest forest (>80% canopy cover). Furthermore, the scale and positioning of FMCs, often between Protected Areas or proposed Protected Areas and covering large blocks of dense forest, make them an important part of the REDD+ Strategy."[145]

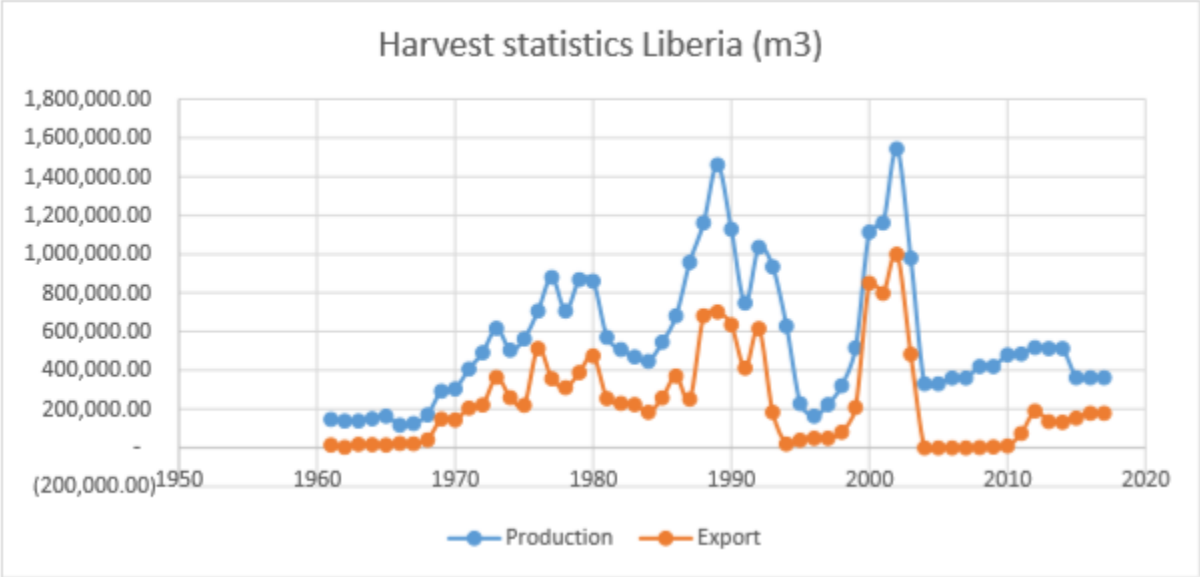


Figure 6.1. Industrial round wood harvest - production & export (FAOSTAT).

Source: Reproduced from Forest Reference Level submission to UNFCCC (2019).[146]

Palm oil concessions. Concession agreements for oil palm development represent the third-largest land use, covering 5% of total forest area. These concessions are considered and managed under the agricultural sector. The development of oil palm concessions is a primary driver of deforestation for Liberia, because the concessions are large and completely cleared before planting. Furthermore, Liberia has prioritized industrial oil palm production as a key industry for economic development and estimates that up to 530,000 ha of land, including forests, may be cleared for oil palm plantations in the next 10-15 years.[147] In line with global trends, many of the palm oil companies currently operating in Liberia have committed to avoiding loss of High Carbon Stock (HCS) forest and High Conservation Value (HCV) areas in

[144] Forestry Development Authority REDD+ Implementation Unit. (2016) National Strategy for Reducing Emissions from Deforestation and Forest Degradation (Redd+) In Liberia, page 9-10. https://www.ltsi.co.uk/wp-content/uploads/2015/01/Technical-Annex-A-REDD-Strategy-final.pdf

[145] Forestry Development Authority REDD+ Implementation Unit. (2016) National Strategy for Reducing Emissions from Deforestation and Forest Degradation (Redd+) In Liberia, page 10. https://www.ltsi.co.uk/wp-content/uploads/2015/01/Technical-Annex-A-REDD-Strategy-final.pdf

[146] Government of Liberia, Environmental Protection Agency. (2019) Forest Reference Level submission to UNFCCC. https://redd.unfccc.int/files/liberia_frel_submission_december_2019.pdf

[147] Government of Liberia, Environmental Protection Agency. (2019) Forest Reference Level submission to UNFCCC. https://redd.unfccc.int/files/liberia_frel_submission_december_2019.pdf.

favor of developing on previously cleared or degraded lands;[148] thus, if these approaches are implemented, the industry can limit its impact on forests and other natural ecosystems. Even after taking these commitments into account, the Liberia Forest Reference Level estimates that the palm oil industry is likely to have a negative impact on forest cover and is likely to drive national emissions.[149]

Fuelwood consumption. Most Liberian households rely on fuelwood as a primary energy source for cooking, heating and power production. Estimated fuelwood use shown in Figure 6.2. includes wood from the trunk, branches, and other parts of tress harvested for fuel, as well as wood used to produce charcoal.[150]

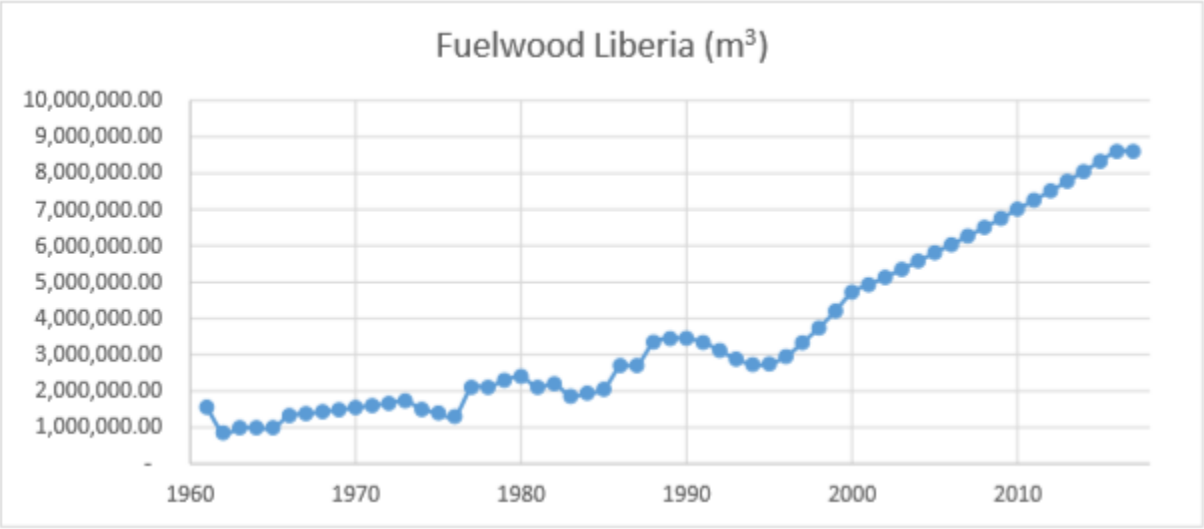


Figure 6.2. Fuelwood consumption - 1960 & 2010 (FAOSTAT).

Source: Forest Reference Level submission to UNFCCC (2019).[151]

Other land uses that would potentially affect forest area are timber sales contracts (3% of total forest), community forest agreements (2%), mining (2%), and rubber and other plantations (1%).[152]

[148] Forestry Development Authority REDD+ Implementation Unit. (2016) National Strategy for Reducing Emissions from Deforestation and Forest Degradation (Redd+) In Liberia, page 10. https://www.ltsi.co.uk/wp-content/uploads/2015/01/Technical-Annex-A-REDD-Strategy-final.pdf.

[149] Government of Liberia, Environmental Protection Agency. (2019) Forest Reference Level submission to UNFCCC. https://redd.unfccc.int/files/liberia_frel_submission_december_2019.pdf.

[150] Government of Liberia, Environmental Protection Agency. (2019) Forest Reference Level submission to UNFCCC. https://redd.unfccc.int/files/liberia_frel_submission_december_2019.pdf.

[151] Government of Liberia, Environmental Protection Agency. (2019) Forest Reference Level submission to UNFCCC. https://redd.unfccc.int/files/liberia_frel_submission_december_2019.pdf.

[152] Forestry Development Authority REDD+ Implementation Unit. (2016) National Strategy for Reducing Emissions from Deforestation and Forest Degradation (Redd+) In Liberia, page 10. https://www.ltsi.co.uk/wp-content/uploads/2015/01/Technical-Annex-A-REDD-Strategy-final.pdf.

Mitigation and Adaptation Opportunities for the Forest Sector

The following section summarizes existing government targets or science-based estimates of the scale of action to achieve adaptation and/or mitigation co-benefits in Liberia's forest sector. For example, in the case of adaptation actions, the number of expected beneficiaries, communities, or jurisdictions covered by an initiative can help to identify the scale of the intervention. Adaptation efforts or development plans may also result in decreased emissions or enhanced sinks, by decreasing deforestation or forest degradation, or increasing the volume of trees in a standing forest through improved management practices, thus storing carbon in living ecosystems. For example, community forest management and cocoa and coffee agroforestry systems are sustainable development strategies for forestry that can provide livelihood opportunities and include co-benefits of decreased carbon emissions or enhanced sinks. For example, community forest management and cacao and coffee agroforestry systems are sustainable development strategies for forestry that can provide livelihood opportunities and include co-benefits of decreased carbon emissions or enhanced sinks. These mitigation co-benefits can be estimated by area of improved management or by volume of carbon to help identify the scale of the intervention. Developing estimates for the potential scale of interventions in the forestry sector can help to link activities, priorities, and budgets towards implementation.

Adaptation opportunities. The potential of the forest sector to adapt to the impacts of climate change depends on coordination, knowledge and technology, finance, and applied management practices. It also depends on the outcome of global mitigation efforts, making adaptation a necessarily moving target. In Liberia, actions to support adaptation and support resilience in forestry occur broadly through institutional coordination within the sector and across sectors, improved knowledge through research, the application of adaptive forestry management practices and access to the necessary financial support and appropriate technologies. Adaptation actions in the forest sector have been well-documented in the 2018 National Climate Policy and Strategy, as well as the forthcoming National Adaptation Plan.

Global data and estimates for mitigation potential.[153] Global data sets and research can provide insights into the possible scale of action for adaptation and mitigation for the forest sector. Using global data sets with information on Liberia,[154] mitigation potential for cost-effective abatement (<$100 USD per MT CO_2e per year) from avoided forest conversion showed the largest mitigation potential, projected at a maximum of 16.4 MT CO_2e per year from 2030-2050, as detailed in Table 6.4. Other forest-related actions, such as improved natural forest management showed significant, but lower, overall potential (1.96 MT per year), followed by forest restoration (1.29 MT per year) and reduced woodfuel harvest (0.33 MT per year). Data on the scale of reductions from improved fire management of savannahs was not available.[155]

[153] To convert values in the "Global data and estimates for mitigation potential" section from Megatons (MT) to Gigagrams (Gg), multiply each value by 1,000.

[154] Griscom BW et al. (2020) National mitigation potential from natural climate solutions in the tropics. Phil. Trans. R. Soc. B 375: 20190126. http://dx.doi.org/10.1098/rstb.2019.0126.

[155] Griscom BW et al. (2020) National mitigation potential from natural climate solutions in the tropics. Phil. Trans. R. Soc. B 375: 20190126. http://dx.doi.org/10.1098/rstb.2019.0126.

In a separate study of 83 tropical timber-producing countries, potential mitigation from implementing Reduced Impact Logging (RIL) practices in Liberia was estimated at 1.41 MT CO_2 per year.[156]

Table 6.4. Potential mitigation from forest protection, management, and restoration in Liberia (in MT CO_2e per year 2030-2050).[157]

	Protect - Forest	Manage - Forest	Manage - Forest	Manage - Forest	Restore - Forest
Country	**Avoided Forest Conversion**	**Improved Natural Forest Management**	**Reduced Woodfuel Harvest**	**Improved Fire Management (Savannas)**	**Reforestation**
Cost effective mitigation potential for Liberia from natural climate solutions (MT CO_2e per year 2030-2050)	16.4	1.96	0.33	0	1.29

Source: National mitigation potential from natural climate solutions in the tropics (2020).[158]

National data and estimates on mitigation potential. National-level data are essential for developing reference points of forest cover, projections of forest loss, and patterns of forest management based on national circumstances. At the national level, the potential for adaptation and mitigation in the forest sector has not been fully specified in government targets nor in country-specific datasets. The 2013 INC notes that the lack of robust data on land use makes it difficult to quantify the potential scale of impact from climate actions in the forest sector. The data on the forest sector in the 2015 NDC comes from the 2013 INC, which is based on a combination of national and global information. This provides quantitative information on the area of unprotected forest (2.6 million ha) and protected or proposed protected areas (1.01 million ha). These designations could provide the basis for policy planning scenarios and associated impacts for forest cover, carbon, biodiversity, and other ecosystem services.

In 2019, Liberia submitted a forest definition and reference level,[159] which is a first step to establishing a reference point for the forest sector and estimating emissions reductions or removals that come from achieving specific goals. However, improved capacity in regular data collection and reporting of tree cover and land uses is still needed at the national level to better inform target setting and tracking of progress.

The National Forest Reference Emissions Level (FREL) for Liberia identifies drivers of deforestation and national REDD+ priority areas of action. Liberia's FREL is sub-national, covering two priority landscapes

[156] Ellis et al. (2019) Reduced-impact logging for climate change mitigation (RIL-C) can halve selective logging emissions from tropical forests. Forest Ecology and Management. 438: 255–266.
[157] To convert values in Table 6.4 from Megatons (MT) to Gigagrams (Gg), multiply each value by 1,000.
[158] Griscom BW et al. (2020) National mitigation potential from natural climate solutions in the tropics. Phil. Trans. R. Soc. B 375: 20190126. http://dx.doi.org/10.1098/rstb.2019.0126.
[159] Government of Liberia, Environmental Protection Agency. (2019) Forest Reference Level submission to UNFCCC. https://redd.unfccc.int/files/liberia_frel_submission_december_2019.pdf.

(North West and South East) focusing on regions with important small-scale drivers of deforestation and forest degradation, as shown in Figure 6.3. The reference period is 2009 – 2018 and follows the 2006 IPCC guidelines. Liberia reports the FREL separately between the two landscapes with be 31.25 MT CO_2e (equivalent to 31,250 Gg CO_2e) per year for the North West priority landscape and 10.71 MT CO_2e (equivalent to 10,710 Gg CO_2e) per year for the South East priority landscape.[160] Emission factors for each of the priority landscapes are provided in Table 6.5. It should be noted that this forest reference level does not include emissions related to tree crops such as rubber, oil palm, or cacao.[161]

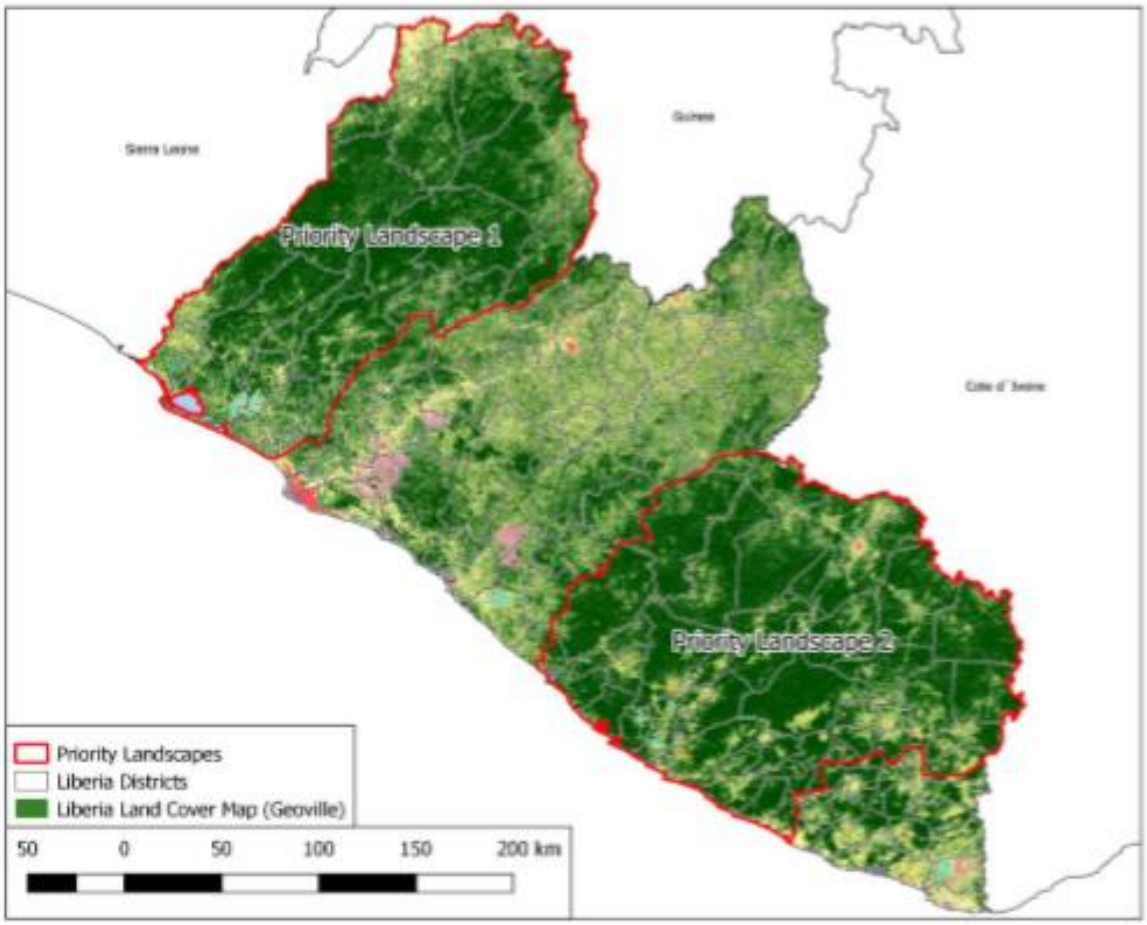


Figure 6.3. Land cover and REDD+ priority landscapes in Liberia.

Source: Forest Reference Level submission to UNFCCC (2019).[162]

[160] Government of Liberia, Environmental Protection Agency. (2019) Forest Reference Level submission to UNFCCC. https://redd.unfccc.int/files/liberia_frel_submission_december_2019.pdf.

[161] Government of Liberia, Environmental Protection Agency. (2019) Forest Reference Level submission to UNFCCC. https://redd.unfccc.int/files/liberia_frel_submission_december_2019.pdf.

[162] Government of Liberia, Environmental Protection Agency. (2019) Forest Reference Level submission to UNFCCC. https://redd.unfccc.int/files/liberia_frel_submission_december_2019.pdf.

Table 6.5. Emission Factors for REDD+ Priority Landscapes in Liberia.[163]

		Before (tCO/ha)	After (tCO/ha)	Difference (tCO/ha)	Emission Factor tCO_2e/ha	Uncertainty
Priority Landscape 1	Deforestation Intact Forest	300	57	243	890	23%
	Deforestation Secondary Forest	169	57	112	409	16%
	Degradation	300	169	131	480	18%
Priority Landscape 2	Deforestation Intact Forest	357	30	328	1201	24%
	Deforestation Secondary Forest	155	30	125	460	17%
	Degradation	357	155	202	741	19%

Source: Forest Reference Level submission to UNFCCC (2019).[164]

Land cover analysis using satellites and spatially explicit data can provide information regarding land cover as a reference point to build better quantitative information on baselines and the scale of actions in the agricultural sector that may have impacts on forest cover or density. For example, Table 6.6 shows several land use designations in Liberia and tree cover change from 2000 to 2014.[165]

Table 6.6. Land Use Designations and Tree Cover Change in Liberia.

	Tree cover 2000 (ha)	Proportion of tree cover 2000	Tree cover 2015 (ha)	Proportion of tree cover 2015	Tree cover loss 2000-2014	Proportion of loss 2000-2014	Tree cover loss rate % yr-1
Liberia total	**8,504,508.96**		**8,141,749.38**	**-**	**362,759.58**	**-**	**0.30%**
Proposed protected area	867,034.62	10.19%	861,213.06	10.58%	5,821.56	1.60%	0.05%
Designated protected area	325,240.11	3.82%	322,043.94	3.96%	3,196.17	0.88%	0.07%
Ratified timber concession	984,586.77	11.58%	978,402.24	12.02%	6,184.53	1.70%	0.04%
Proposed timber concession	1,227,087.81	14.43%	1,216,625.40	14.94%	10,462.41	2.88%	0.06%
Oil palm plantations	614.070.45	7.22%	560,822.13	6.89%	53,248.32	14.68%	0.62%
Rubber plantations	60,521.49	0.71%	40.352.31	0.50%	20,169.18	5.56%	2.38%

Source: Conservation International (2017).[166]

[163] To convert values in Table 6.5 from tons (T) to Gigagrams (Gg), divide each value by 1,102.

[164] Government of Liberia, Environmental Protection Agency. (2019) Forest Reference Level submission to UNFCCC. https://redd.unfccc.int/files/liberia_frel_submission_december_2019.pdf.

[165] Conservation International. 2017. Natural Capital Mapping and Accounting in Liberia: Understanding the contribution of biodiversity and ecosystem services to Liberia's sustainable development. Arlington, VA.

[166] Conservation International. 2017. Natural Capital Mapping and Accounting in Liberia: Understanding the contribution of biodiversity and ecosystem services to Liberia's sustainable development. Arlington, VA.

Table 6.7. Selected forest use categories in Liberia.

Land Use	Total Area in 2020 (Hectares)
Forest Management Contracts (FMC)	1,007,266
Community Forests (Active)	676,454
Protected Areas (Reserves + National Parks) (Proclaimed)	412,568
Protected Areas (Reserves+ National Parks) (Proposed)	660,757

Source: Liberia Forest Atlas (2020).[167]

Potential from policy-specific actions. At the national scale, efforts in the forest sector to improve protection, management and restoration of forested land have important linkages with low-emissions national development for Liberia. An analysis of these win-win outcomes for development and mitigation allows for a combined understanding of the effort, costs, and associated mitigation outcomes. For example, legislation could create 1.5 million hectares of protected areas. The Government of Liberia included this commitment in the redrafting of forestry laws, demonstrating its commitment to sound forest management practices under the 3C approach of harmonizing Commercial, Conservation and Community uses. Accelerating the establishment of these areas would further reduce carbon emissions, as well as protecting the cultural and natural assets they contain.[168]

Another policy option includes the possibility of reducing timber sales contracts (TSCs) and instead placing these areas into carbon concessions, would have significant mitigation outcomes. The agricultural land opened by clearing under TSCs would not be needed if approached in an integrated manner with agricultural policies. the above-mentioned agricultural policies are also implemented.[169] A summary of policy-specific actions and the carbon mitigation potential assessed in an independent analysis is provided in Table 6.8 below.

Table 6.8. Policy options for Low-Emissions Development in Liberia – Forests.[170]

Policy options for Low-Emissions Development in Liberia	Average CO_2 saved per yr over 25 yrs (MT CO_2)
100,000 ha of plantations are located on degraded land rather than forest areas	2.1
Fertilizer subsidies to increase efficiency of shifting agriculture	1.8
Lowland rice promoted in place of shifting agriculture	1.6
Conservation agriculture promoted in place of shifting agriculture	1.7
Accelerated creation of Protected Area Network	0.21
Increased efficiency of charcoal production & use	1.1

[167] Liberia Forestry Development Authority. (2020) Liberia Forest Atlas. https://lbr.forest-atlas.org/map.
[168] Donovan et al. (2016) Assessing potential carbon revenues from reduced forest cover loss in Liberia. https://www.hbs.edu/faculty/Publication%20Files/Assessing%20Potential%20Carbon%20Revenues%20Liberia.pdf_8d8b931e-889d-4f87-ad6b-a23803f354c1.pdf.
[169] Donovan et al. (2016) Assessing potential carbon revenues from reduced forest cover loss in Liberia. https://www.hbs.edu/faculty/Publication%20Files/Assessing%20Potential%20Carbon%20Revenues%20Liberia.pdf_8d8b931e-889d-4f87-ad6b-a23803f354c1.pdf.
[170] To convert values in Table 6.8 from Megatons (MT) to Gigagrams (Gg), multiply each value by 1,000.

No further TSCs	3.2
Sub-total for potential low-carbon development strategy	***11.7***
Restrict FMCs to 1.6 million ha	1.8

Source: Assessing potential carbon revenues from reduced forest cover loss in Liberia (2016).[171]

As part of the Forestry action plan, the Climate Vulnerability and Risk Assessment identified and costed a $150 million USD proposal for "Climate-resilient emissions reductions in the forest systems of Liberia."[172] The goal of the proposed action is to restore degraded and deforested lands and water catchments through afforestation and reforestation, resulting in increased carbon removals. Non-carbon benefits are to include livelihood improvement, economic opportunities, climate change adaptation, good forest governance, biodiversity conservation, improved water quality and quantity, and other ecosystem services.

Institutional Framework

The Forest Development Authority (FDA) is the primary public institution for policy development and decision-making regarding Liberia's forests and forest resources. FDA functions include the creation of forest policy, management of forest resources, control and management of forest concessions, collection of revenue from forest activities, research, and training.[173] The forest sector has a robust legal framework, which recognizes customary rights of local communities to access and manage forests for their benefit.[174]

Table 6.9. Institutions and agencies with mandates on forestry in Liberia.

Institution	Mandate
Forestry Development Authority (FDA)	• Management of the use of forest-related Government property, including the use of Forest Land and the harvest or other use of Forest Resources. • Management of all concessions including authorizations for Commercial Use of Forest Resources through Forest Management Contracts, Timber Sale Contracts, Forest Use Permits, or Private Use Permits. • Formulating forestry policy and guidelines. • Undertaking measures to institutionalize the participation of communities in forest management and agroforestry programs. • Validate the suitability of areas to be committed to proposed land uses. • Establish forestry fees. • Establish a Protected Forest Areas Network, issue management plans for the areas and conserve Forest Resources within this network. • Implement Liberia's REDD+ strategy.

[171] Donovan et al. (2016) Assessing potential carbon revenues from reduced forest cover loss in Liberia. https://www.hbs.edu/faculty/Publication%20Files/Assessing%20Potential%20Carbon%20Revenues%20Liberia.pdf_8d8b931e-889d-4f87-ad6b-a23803f354c1.pdf.
[172] Fobissie, Kalame et al. (2019) Climate Vulnerability and Risk Assessment for the Sectors of Agriculture, Fisheries and Forestry in Liberia.
[173] Government of Liberia. (2006) Act Adopting the National Forestry Reform Law of 2006. https://ekmsliberia.info/wp-content/uploads/2019/11/Liberia_forestry_reform_law.pdf.
[174] The World Bank. (2018) Liberia: Country Forest Note. http://documents1.worldbank.org/curated/en/233271527176589175/pdf/Liberia-Country-Forest-Note.pdf.

REDD+ Implementation Unit	• Operates under the supervision of the FDA to develop and advance Liberia's National REDD+ Strategy. • Coordinates with Ministries of Agriculture, Mines and Energy, the Environmental Protection Agency, Liberia Institute of Statistical and Geo-Information Services (LISGIS) and other sectors to address key drivers of deforestation and forest degradation which are linked to sectors related to land use change, agriculture, mining, and energy.
Forestry Management Advisory Committee (FMAC)	• Appointed by the FDA with the main mandate to advise the Forestry Development Authority on forestry policy.
Environmental Protection Agency (EPA)	• Review and approve environmental impact assessments of all forestry activities that may have significant impacts on the environment. • Work in formal cooperation with the FDA to validate proposed forest land uses and policies. • Ensure the preservation and promotion of natural resources heritage and, in consultation with indigenous authority, enhance indigenous methods for effective natural resource management. • Establish environmental criteria, guidelines, specifications and standards for production processes and the sustainable use of natural resources. • Oversees a Technical Committee on Forestry/Agriculture/Wildlife that provides advice on specific major issues.
Ministry of Mines & Energy	• Approves mining concessions on forest land. • Regulates artisanal mining.
Ministry of Finance & Development Planning (MoFDP)	• Provides revenue support to FDA. • Oversees land use planning, as well as rural and urban development.
Land Authority	• Resolves land ownership and rights issues. • Oversees land administration.
Liberia Institute of Statistics and Geoinformation Services (LISGIS)	• Data management and GIS for monitoring forest cover and land use change.
National Bureau of Concessions	• Monitors and oversees concession agreements.

Source: Adapted from Climate Vulnerability and Risk Assessment for the Sectors of Agriculture[175]; Fisheries and Forestry in Liberia (2019); Act Adopting the National Forestry Reform Law of 2006 (2006)[176]; Environmental Protection Agency (2020)[177,178]; Memorandum of Understanding between FDA and EPA (2007)[179]; Forest Reference Level submission (2019) [180].

Co-benefits

Forest-based mitigation and adaptation activities offer significant opportunities for environmental, social, and economic co-benefits. Developing a sustainable forest sector can help address rural poverty by allowing for the development of forest-based enterprises and non-timber forest products, leading to

[175] Fobissie, Kalame et al. (2019) Climate Vulnerability and Risk Assessment for the Sectors of Agriculture, Fisheries and Forestry in Liberia.
[176] Government of Liberia. (2006) Act Adopting the National Forestry Reform Law of 2006. https://ekmsliberia.info/wp-content/uploads/2019/11/Liberia_forestry_reform_law.pdf.
[177] Environmental Protection Agency. (2020) Statutory Mandate. http://www.epa.gov.lr/content/statutory-mendate.
[178] Environmental Protection Agency. (2020) Structure of the EPA. http://www.epa.gov.lr/content/structure-epa.
[179] Memorandum of Understanding between the Forestry Development Authority and the Environmental Protection Agency. (2007) http://extwprlegs1.fao.org/docs/pdf/lbr160039.pdf.
[180] Government of Liberia, Environmental Protection Agency. (2019) Forest Reference Level submission to UNFCCC. https://redd.unfccc.int/files/liberia_frel_submission_december_2019.pdf.

secure incomes and employment, as well as revenue for the government.[181] Forest-based employment opportunities include employment in nurseries where seedlings are to be raised, land preparation, planting of seedlings, thinning, maintenance and even harvest.[182] Increased income from additional or new employment opportunities is another co-benefit of forestry activities.[183] Further, integrated practices like agroforestry can increase profitability of staple food crops 15-20 times more than that achieved with traditional practices.[184]

Forest-based mitigation and adaptation activities can also promote biodiversity through reduced soil erosion and enhanced wildlife habitat, which can lead to increased ecosystem resilience to climate change. These activities can increase the provision of ecosystem services through improved air quality and water regulation, including the long-term efficiency of hydro-power facilities. Overall, investments in sustainable forestry and conservation have the wider benefit of ensuring continued benefits from forests for the country for future generations.[185]

Costs and Investment Opportunities

The 2018 National Policy and Response Strategy on Climate Change included an "Action Plan and Resource Mobilization Plan," which outlines specific activities for undertaking climate action in each sector between 2017-2026. Table 6.10 below includes information regarding the activities, estimated costs and relevant government implementing agencies related to forestry, as outlined in the 2018 Resource Mobilization Plan.[186]

Table 6.10. Action Plan for the Implementation of Strategic Interventions – Forests.

Sectoral and Cross-Sectoral Intervention Area: Forests and Wildlife					
Strategic Interventions	**Intervention Period** (Years 2017 to 2026)			**Estimated Cost** (Million USD)	**Implementing Agencies**
	(1-3) Short-term	(4-5) Mid-term	(6-10) Long-term		
Strengthen the capacity of the FDA including training of experts and logistics for forest management.	X	X	X	2	FDA. EPA, MoFDP, Universities and college

[181] The World Bank. (2018) Liberia: Country Forest Note. http://documents1.worldbank.org/curated/en/233271527176589175/pdf/Liberia-Country-Forest-Note.pdf.

[182] Natural Science, Murthy & Prasad. (2018) Co-Benefits and Risks of Implementation of Forestry Activities for Climate Change Mitigation in India. https://www.researchgate.net/publication/326652768_CoBenefits_and_Risks_of_Implementation_of_Forestry_Activities_for_Climate_Change_Mitigation_in_India.

[183] Natural Science, Murthy & Prasad. (2018) Co-Benefits and Risks of Implementation of Forestry Activities for Climate Change Mitigation in India. https://www.researchgate.net/publication/326652768_CoBenefits_and_Risks_of_Implementation_of_Forestry_Activities_for_Climate_Change_Mitigation_in_India.

[184] Forestry Development Authority REDD+ Implementation Unit. (2016) National Strategy for Reducing Emissions from Deforestation and Forest Degradation (Redd+) In Liberia, page 9-10. https://www.ltsi.co.uk/wp-content/uploads/2015/01/Technical-Annex-A-REDD-Strategy-final.pdf.

[185] Forestry Development Authority REDD+ Implementation Unit. (2016) National Strategy for Reducing Emissions from Deforestation and Forest Degradation (Redd+) In Liberia, page 9-10. https://www.ltsi.co.uk/wp-content/uploads/2015/01/Technical-Annex-A-REDD-Strategy-final.pdf.

[186] Liberia 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.

Implement sustainable and where applicable alternative livelihood initiatives for forest-dependent communities, to enable them to become less reliant on forest resources.	X	X	X	5	MoA, FDA, MoIA, NGOs, EPA, MoFDP
Promote community forests activities beyond timber extraction as a management tool for sustainable forest management, using indigenous species and knowledge.	X	X	X	1	FDA, EPA, MoFDP
Establish a comprehensive monitoring system for forest resources by building on existing system (including nontimber forest products) to detect changes in the conditions of the ecosystem that might affect these resources and other ecosystem services provided by forests.	X	X		0.25	FDA, MoA. EPA, MoFDP
Implement reforestation and afforestation activities to increase vegetation cover to improve ecosystem services in degraded areas, increase rural income, and improve biodiversity richness including wild fauna.	X	X	X	3	FDA, EPA, MoFDP
Identify and map, for proper management, water catchment areas in forests that are valuable to communities.		X	X	0.5	FDA, LWSC, LISGIS, MoIA, MoA, EPA, MoFDP
Promote the consolidation of the 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.	X	X	X	1	FDA, MoA, MoIA, EPA, MoFDP
Establish and/or strengthen coordination mechanisms with other line ministries and agencies that might be implementing activities that affects forest and wildlife and ensure that the principle of sustainable forest and wildlife management is mainstreamed in national and sectorial policies and program	X	X	X	0.1	FDA, MoIA, MoA, MoJ, MoFDP, EPA
Enforce regulations related to illicit hunting, eliminate poaching, develop and implement an environmental 'Code of Ethics' in the wildlife sector.	X	X	X	0.13	FDA, MoIA, MoFDP, EPA
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 take action to adapt to these changes	X			0.05	MICAT, EPA, MoFDP

Source: Adapted from National Policy and Response Strategy on Climate Change (2018).[187]

Agency abbreviations: FDA = Forestry Development Authority; EPA = Environmental Protection Agency; MoFDP = Ministry of Finance & Development Planning; MoA = Ministry of Agriculture; MoIA = Ministry of Internal Affairs; LWSC = Liberia Water & Sewer Corporation; MoJ = Ministry of Justice; LISGIS = Liberia Institute of Statistics and Geoinformation Services.

Policy Gaps and Challenges

The following policy gaps and challenges are present for the forest sector in the context of climate change.

Challenge: **Lack of activity-level data for national GHG inventory.** The 2013 INC notes that its analysis was constrained by a "lack of reliable and updated information on activity, which made it difficult to conduct a quantitative assessment of mitigation options. The GHG inventory which was supposed to be the basis for the assessment … was incomplete, particularly for the forestry, agriculture, and waste

[187] Liberia 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.

sectors."[188] Improved data collection at the national level could provide a more complete representation of existing emissions, and better inform the decision-making process for climate action in the forestry sector.

Challenge: Weak implementation of forest governance. Constrained institutional capacity in the FDA has affected implementation and coordination of the 3C's approach and resulted in limited oversight of forest management activities.[189]

Challenge: Regulations on land-based carbon. To prepare for results-based finance for low-carbon development pathways, Liberia will need to develop proper legal and policy frameworks to enable smooth functioning of such mechanisms, including regulations on definition of carbon rights, baselines, nesting, registry and MRV of emission reduction in accordance to existing international recommendations of transparency, no double-counting, and environmental integrity.

Challenge: Weak inter-ministerial coordination leads to overlapping claims. The forestry sector involves diverse stakeholders, including women, youth, smallholders, commercial plantations, and others, and has important linkages with other sectors, such as energy, environment, agriculture, and mining.

Gap: **Deforestation is not fully addressed in national forest policy.** The current forest policy does not fully explore the negative impacts of deforestation. For example, the policy should have elements that more robustly address erosion issues and how this affects water quality and agricultural production.[190]

Sectoral Recommendations for Consideration

Preparation of forest sector recommendations to be developed with inputs from a robust stakeholder input and consultation process. The below suggestions are proposed as a potential starting point for further examination.

Recommendation 1: Consider estimating mitigation benefits of existing policies and targets in the forest sector.

It is important to recognize that some of the proposed mitigation actions from other sectors -- in particular in the energy sector (use of charcoal, biofuels) -- could have important impacts in the forest subsector emissions. To address these linkages, a collaborative cross-sectoral policy framework should be developed, which will also need to integrate some of the proposed adaptation measures with significant mitigation co-benefits such as reforestation of degraded lands and conservation of coastal mangrove ecosystems.

[188] Environmental Protection Agency of Liberia (EPA). (2013) Initial National Communication. https://unfccc.int/sites/default/files/resource/lbrnc1.pdf.
[189] The World Bank. (2018) Liberia: Country Forest Note. http://documents1.worldbank.org/curated/en/233271527176589175/pdf/Liberia-Country-Forest-Note.pdf.
[190] Conservation International (2017) Nature and the Sustainable Development Goals: Priority Linkages Summary for Liberia. Arlington, VA.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation this recommendation.

Recommendation 2: Consider opportunities to add quantified and/or time bound goals and targets to the activities identified for the revised NDC.

For consistency with previous UNFCCC communications, these targets and goals could build from the 2013 INC forest sector "mitigation actions," the 2015 NDC, and the 2018 Climate Strategy to develop more quantitative and time-bound goals.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation this recommendation.

Recommendation 3: Integrate improvements in data availability and reporting from the forest sector into the revision and update of the Nationally Determined Contribution.

To strengthen the data on forests and land use change in the national greenhouse gas inventory, Liberia should prepare forest data as part of a transition to using the 2006 IPCC Guidelines, including the use of national data. Strengthening this forest and land use data will support better assessments of Liberia's opportunities for mitigation action in the forest sector.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation this recommendation.

Recommendation 4: Consider linkages with climate goals across sectors and promote mainstreaming of climate objectives.

Recognizing the synergies between climate actions in different sectors can increase multi-sector benefits of individual climate actions. For example, there are key linkages between the forestry, agriculture, coastal zones, and energy sections of Liberia's NDC as well as the 2018 National Policy and Response Strategy on Climate Change.

The forthcoming Technical Report on Mainstreaming Climate Change Considerations into the Relevant Sector Specific Development Programs, Policies, Strategies and Management Plans in Liberia, supported by United Nations Development Programme, provides proposed steps for mainstreaming climate actions in each step of the policy cycle—from policy formulation, review and planning to resource allocation, programming and implementation. This document will serve as an important resource for mainstreaming climate actions across all sectors, including forests.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation this recommendation.

Recommendation 5: Address gender considerations in training of institutional and local experts in forest sector planning, monitoring, and reporting.

As addressed above, there are several challenges impeding the full implementation of forest management, protection, and restoration in Liberia, including insufficient data; number of trained individuals to measure, monitor and forecast climate impacts; and capacity at all levels of implementation.

Women groups should be considered and prioritized for relevant trainings and jobs related to coastal resilience.

The 2012 "Climate Change Gender Action Plan for the Government of Liberia" outlines as number of examples of action across the sector. For example, the government could put in places a robust, gender-balanced monitoring system for the forest sector. This would include training and empowering women forest monitors and setting up forest monitoring approaches utilizing mobile phone technology. Women could also support forest regeneration efforts by educating women about alternative energy sources for food cooking, heat, and energy; and by introducing a women-led and managed forest regeneration program linked with the REDD+ strategy.[191]

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation this recommendation.

Recommendation 6: Take stock of progress made in implementing existing forest sector policies and the NDC. *[Linkages with other sectors]*

In the process of reviewing and updating the NDC, it is critical to take stock of progress made toward implementing existing sectoral and climate change targets and plans. The revised NDC should be informed by experiences, challenges, and lessons learned from implementing current targets and plans in the forest sector. The stakeholder consultation process should identify any changes in national circumstances, political priorities, development priorities, and efforts to achieve SDGs (including progress made toward relevant sectoral SDG targets), which can help identify new opportunities and synergies to pursue emissions reduction strategies within the context of national priorities. The work done by EPA under the ongoing Second National Communication can provide a useful input into this stocktaking process.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders could contribute to identify new opportunities for mitigation strategies.

Recommendation 7: Consider linkages with national COVID response and recovery priorities as part of the NDC update for this sector. *[Linkages with other sectors]*

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of this recommendation.

[191] Aguilar, L., Rogers, F., and Bobtoya, S. (2012) Climate Change Gender Action Plan for the Government of Liberia (ccGAP:LIBERIA). International Union for Conservation of Nature. https://portals.iucn.org/union/sites/union/files/doc/liberia_0.pdf.

Sector Highlight: Green Corridors

National Sectoral Context

Liberia reported 1.89 MT CO_2e (equivalent to 1,890 Gg CO_2e) greenhouse gas (GHG) emissions in its 2015 NDC. Notwithstanding, the country is home to approximately 4.3 million ha of lowland tropical forest, which comprises 43% of the remaining Upper Guinea forests of West Africa. In 2015, forests covered around 68% of the country's land surface. The NDC recognizes the importance of the sector as a net carbon sink, and the Government of Liberia envisages adding a mitigation commitment for the Land-use, Land-use Change, and Forestry (LULUCF) sector, as increasing reforestation and afforestation activities presents high potential for future carbon sequestration.

Forests continue to provide a rich assortment of products and services that offer exceptional values in health, economic, cultural, social, spiritual and local knowledge systems.[192] The Liberian forest, particularly mangroves and tropical lowland rainforests, provides multi-dimensional roles in changing the biological, chemical and physical state of the natural environment.[193] However, the country's forests are threatened by logging, uncontrolled hunting and mining, the expansion of settlements, including roads, unregulated and unsustainable farming, and agro-industrial crop plantations; the annual deforestation (tree cover loss) rate is approximately 0.31%. Wetlands in urban areas were significantly impacted by the civil war, which ended in 2003, due to the large influx of people from the rural areas to the cities.

As populations in Monrovia and other urban cities continue to grow rapidly over the past decades, the Government of Liberia (GoL) through the Environmental Protection Agency (EPA) has started to focus on

[192] Toledo et al. (2003) The Multiple Use of Tropical Forests by Indigenous Peoples in Mexico: A Case of Adaptive Management. https://www.researchgate.net/publication/42763416_The_Multiple_Use_of_Tropical_Forests_by_Indigenous_Peoples_in_Mexico_A_Case_of_Adaptive_Management.; Amo-Rodriguez et al. (2010) Community Landscape Planning for Rural Areas: A Model for Biocultural Resource Management. https://www.tandfonline.com/doi/abs/10.1080/08941920802537781.

[193] GEF. (2007) Consolidation of Liberia Protected Area Network (Copan): Request for CEO Endorsement/Approval; Odum. (1989) Ecology and our endangered life-support systems. https://www.cambridge.org/core/journals/journal-of-tropical-ecology/article/eugene-p-odum-1989-ecology-and-our-endangered-lifesupport-systems-sinauer-associates-incmass-283-pages-isbn-0878936351-price-1095-paperback/1D80FEAD4322DD153E64A0B15462F411.

strategies to curb urbanization challenges and climate change impacts. The GoL considers creating green corridors in major cities a way to enhance climate mitigation and adaptation. A key strategy is to conserve trees in cities and further reduce the rate at which urban areas risks losing trees. Fundamental to this strategy is understanding the morphology of urban areas in relation to land cover, as this sets the basis for planning towards green and sustainable urban settlements. In 2019, the EPA with support from United Nations Development Programme (UNDP) commissioned a study on tree canopy in Monrovia. The study aimed to assess opportunities to integrate green landscapes into city planning, specifically to a) provide baseline data cataloguing/sampling tree populations within Monrovia and its immediate environs; b) establish rates of increase/decrease in tree populations and associated social-economic impacts; and c) show the parts of Monrovia shaded by trees.

The EPA and UNDP study highlights the importance of boosting green urban areas and connecting fragments of green space with ecological corridors to improve biodiversity and dispersal of animal species within urban areas. The study demonstrates that if green corridors are adequately designed, they can have a positive impact on urban ventilation, allowing for cooler air from outside to penetrate more densely built areas, and reduce warming. The greening of urban corridors areas can also have positive effects on the health of the human population as well as adaptation to climate change. Additionally, the capacity of green corridors to retain water is an important flood prevention feature that can reduce peak discharges and improve stormwater management. Establishing green corridors can also contribute to the achievement of the Sustainable Development Goals (SDGs), especially SDG 6 - Clean Water & Sanitation, SDG 11 - Sustainable Cities & Communities, SDG 13 - Climate Action, and SDG 15 - Life on Land.

In Monrovia, Buchanan, Greenville, and many urban cities, green areas, such as mangrove wetlands, are often threatened by expanding settlements. This has resulted in fragmented ecosystems, with small patches of green spaces in amongst buildings and roads. The EPA recognizes that the establishment of green corridors in urban settlements through the revised NDC can limit the negative effects of fragmentation, while enhancing climate change adaptation and mitigation. The focus of this intervention is to work with local authorities, heads of city corporations, and city planners to promote the planting of trees and mangrove revegetation in urban settlements in a way that supports healthy wildlife and habitat connectivity.

Existing NDC Targets

Table 7.1. Existing Mitigation Targets and Activities in 2015 NDC – Green Corridors.

Mitigation Targets and Activities in 2015 NDC – Green Corridors		
Sectoral Quantitative Target (if applicable)	**Sub-targets and activities identified**	**Baseline information used for 2015 NDC target**
Not stated.	*Mitigation activities from green corridors are not included in Liberia's 2015 NDC.*	*Not stated.*

Source: Information from Liberia Intended Nationally Determined Contribution (2015).

Table 7.2. Existing Adaptation Targets and Activities in 2015 NDC – Green Corridors.

Adaptation Targets and Activities in 2015 NDC – Green Corridors		
Sectoral Quantitative Target (if applicable)	**Sub-targets and activities identified**	**Baseline information used for 2015 NDC target**
Not stated.	Increase the amount of forested land through reforestation of degraded lands	*Not stated.*

Source: Information from Liberia Intended Nationally Determined Contribution (2015).[194]

Existing Relevant Policies, Strategies and Plans

Relevant climate change and sectoral policies were reviewed in order to examine their targets and strategies for the green corridors sector. The most relevant and updated strategies and plans for climate action in the sector were the focus of this review process:

- ✓ National Policy and Response Strategy on Climate Change (2018);
- ✓ National Biodiversity Strategy and Action Plan-II 2017-2025 (2017);
- ✓ Environmental Protection & Management Law (2002)
- ✓ Forestry Reform Law (2006)
- ✓ Zoning Law (1958)

The National Biodiversity Strategy & Action Plan II: 2017-2025 (NBSAP) outlines Liberia's strategic goals and objectives for the sustainable management and utilization of the country's treasured and threatened biological resources in line with its development plans and international commitments. This is in recognition of the threats posed by the loss of biodiversity and climate change to the country's natural resources, and the urgent need to take concrete actions to mitigate them.

The proposed NDC actions on green corridors are linked to all five goals of the NBSAP and specifically supports Goal II: Reduce the direct pressures on biodiversity and promote sustainable use, as well as Target 2.: "By 2020, the rate of loss and degradation of natural habitats outside protected areas serving ecological corridors or containing key biodiversity areas or providing important ecosystem services is minimized by 3% through integrated land use planning". The interventions can also support the NBSAP Communication Strategy and Action Plan: "Providing information on activities such as human settlements and population pressures, shifting cultivation, beach erosion, poaching and hunting, etc. that threaten biodiversity".

The National Policy and Response Strategy on Climate Change (August 2018) recognized urbanization and settlement as one of the critical sectors for adaptation to climate change. Additionally, the Environment Protection and Management Law of 2002, Forestry Reform Law of 2006, and Zoning Law of 1958 support land cover in urban settlements in Liberia. These frameworks are generally skewed toward general use

[194] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC), emphasis added. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

management, with little emphasis on managing use within the urban context to derive environmental benefits. Notwithstanding, it is generally anticipated that urban structural arrangements will provide some level of framework to guide the form and pattern, as well as growth of urban centers for the purpose of ensuring functional efficiency and environmental sustainability.

Many of the cities in Liberia lacks zoning ordinances. Monrovia, the capital and most populated city, has a zoning ordinance from 1958, but the focus of the zoning act and ordinance is on the control and regulation of physical infrastructure rather than the natural environment or preservation of vegetation. The Monrovia City Corporation and other cities have recognized the importance of green corridors and have started to implement early actions.[195]

The Environmental Protection & Management Law (EPML), however, provides some form of guarantee for conserving urban forestry. Amongst its many intents, this instrument aspires to ensure sustainable use of natural resources, conservation of the environment, and the restoration, protection and conservation of biodiversity, including measures to plant trees and other vegetation in urban areas. These broad objectives present opportunities to nest green corridors within urban settlements. On the other hand, implementation and coordination arrangements conflict with the law's intent due to the actual administration of urban land. Urban land use planning and zoning activities are highly fragmented, implemented haphazardly, and do not balance the built and natural environment. Hence, conservation of urban tree cover is not usually considered. This necessitates the need for coordination between the authorities for land planning and environmental management.

Green Corridor related Strategies from the National Policy and Response Strategy on Climate Change (2018):

- Develop a comprehensive **land-use plan** to achieve **sustainability in urbanization and settlement developments** in order to adapt to climate change
- Develop and implement proper "**spatial Land Use Planning**" which considers existing and predictions of climate change, and which encourages vertical instead of horizontal expansion of urban housing projects.
- Improve the **management of coastal zones** including the **rehabilitation and conservation of vital coastal ecosystems such as wetlands and the mangroves** they support through the development of an Integrated Coastal Zone Management Plan, a National Disaster Risk Management Response Plan and implement the National Environment Action Plan.

Source: Adapted from National Policy and Response Strategy on Climate Change (2018). Emphasis added.

[195] Wanjiku, J. (2019) Massive Tree Planting in Monrovia, Liberia. https://africaotr.com/massive-tree-planting-in-monrovia-liberia/.

Mitigation and Adaptation Opportunities for Green Corridors

To be further elaborated following the conduct of analysis of quantitative data available on adaptation and mitigation potential of adding the creation of green corridors in urban areas, which takes into consideration overlap with forests, coastal areas and other sectors.

Institutional Framework

Several agencies have mandates related to green corridors in Liberia, which is outlined in Table 7.3 below. The Environmental Protection Agency, mainly through the Environmental Impact Assessment and Licensing processes has a working relationship with all these relevant agencies, development partners, investors, concessions and other stakeholders to, including consultations, developing environmental plans and issuance of license for land use activities. Such a multisectoral coordination and engagement will be useful for planning, issuing guidelines and developing green corridors in municipalities across the country.

Table 7.3. Institutions and agencies with mandates on green corridors in Liberia.

Institution	Main Mandate
Forestry Development Authority (FDA)	• Ensure the sustainable management and conservation of Liberia's forest and related natural resources, including wildlife, for the benefit of current and future generations • Carry out programs for the wise use and perpetuation of the forest, recreational, and wildlife resources of the country
Liberia Land Authority	• Formulate and implement laws, policies, regulations, and programs to support land governance, including land administration and management • Promotion and support of the development of land use plans • Allocate land for conservation in parks or reserves • Propose any needed adjustments in existing land commitments
Ministry of Finance and Development Planning (MFDP)	• Formulate, institutionalize and administer economic development, fiscal and tax policies for the promotion of sound and efficient management of financial resources of the government
Ministry of Public Works (MPW)	• Through the Department of Zoning, MPW is the government authority in charge of zoning, a process in which certain land uses are permitted or prohibited. • Regulates the construction of roads, building and other public and private infrastructure • Administers urban planning and zoning, including issuing guidelines for controlling urban growth and development.
Liberia Institute for Statistics and Geo-Information Services (LISGIS)	• LISGIS is the prime, authoritative agency responsible for collecting, managing, coordinating, supervising, evaluating, analyzing, disseminating and setting quality standards for statistical and associated geo-information for overall planning. • Provides support in generating maps and socio-economic data.

Environmental Protection Agency (EPA)	• Sets guidelines and standards for the management of the environment and natural resources, including the protection of landscapes from environmental degradation, regulation of human settlements, afforestation and reforestation, and developing guidelines for setting aside a percentage of forest land to conserve biological diversity • Carries out Environmental Impact Assessment and Licensing processes • Develop environmental plans • Issuance of licenses for land use activities

Costs and Investment Opportunities

The development cost for establishing green corridors in targeted cities will be estimated following the feasibility studies. However, it is important to note that Liberia is on the verge of developing its tourism sector, which holds a lot of potential and investment opportunities both for the private and public sectors. The country is endowed with rich natural resources that provide a potential tourism and hospitality market, including forests, rivers, seas, waterfalls, hills, mountains, lagoons, lakes, wetlands, and river deltas. The development of green corridors, including development of recreational parks in urban settlements across the country and supporting connected habitats for thriving wildlife populations will further increase this potential, while achieving multiple environmental and health benefits for the country.

Monrovia's first post-war park, Chevron Monrovia Central Park, was developed in 2014 and funded by Chevron-Liberia, as the key sponsor, along with the National Oil Company of Liberia (NOCAL) and several business partners. Since then, the Monrovia City Corporation and Paynesville Corporation has made some limited strides in developing park facilities to support public recreation, improving scenic attraction and greening of the city.

The following table details the short- medium- and long-term interventions to address climate change through the development of green corridors from the EMPL 2002, Poverty Reduction Strategy 2008, 2018 National Policy and Response Strategy on Climate Change and the Master Plan Study on Urban Facilities Restoration and Improvement in Monrovia.

Table 7.4. Action Plan for the Implementation of Strategic Interventions – Green Corridors.

Sectoral and Cross-Sectoral Intervention Area: Green Corridor					
Strategic Interventions	**Intervention Period** (Years 2020 to 2030)			**Estimated Cost** (Million USD)	**Implementing Agencies**
	(1-3) Short-term	(4-5) Mid-term	(6-10) Long-term		
Conduct feasibility study to determine baseline and targets for adaptation/mitigation potential of setting up green corridors in 5 municipalities as well as habitat connectivity to support wildlife migration	X				EPA, Local City Corporation, LISGIS
Develop guidelines for green corridors	X				EPA, FDA, MPW, MFDP, Local City Corporations, LLA

Establish Local Environmental Committees and Develop Local Environmental Action Plans	X				EPA, MIA, MFDP, Local City Corporations
Pilot the creation of green corridors in five municipalities i) the City of Monrovia, ii) The City of Buchanan, iii) the City of Gbarnga, iv) the City of Ganta, and v) the City of Paynesville.	X	X			EPA, MoFDP, FDA MPW, local City Corporations, LLA
Update/develop zoning ordinances for the 5 target cities, including to incorporate the development and maintenance of green corridors	X	X			MPW, EPA, MoFDP, local City Corporations, LLA
Develop a National Zoning Act	X	X			MoFDP, EPA, MPW, FDA, MOA, LLA
Develop city master plan, County Environmental Action Plan	X	X			MoFDP, EPA, MPW, FDA, MOA, LLA
Develop Long-term Urban Development Policy and Urban Master Plan	X	X	X		MoFDP, EPA, MPW, FDA, MOA, LLA

Policy Gaps and Challenges

Challenge: The rapid urbanization of cities exerts a lot of pressure on the management of the country's forest landscape. Most often, these rapidly sprawling communities are not planned, and as such, the infrastructure and resources needed to support these communities are often not available. Human encroachment and urban expansion into aquatic ecosystems and water resources, such as mangroves, river deltas, estuaries, and coastal lagoons also adds significant stress on these water resources. The pollution of water resources is also directly attributed to human action through farming, alluvial mining, etc.

Challenge: Most of the municipalities that manage urban cities are underfunded.

Challenge: The Zoning Act for City of Monrovia was established in 1958, but it has not been executed in two decades because the Regulation Plan (Zoning Plan) had been lost and a new plan is not yet prepared. Many of the other urban cities also do not have a Regulation Plan.

Challenge: Weak institutional capacity of planning sector in MFDP, MPW and city corporations due to the long absence of planning execution.

Sectoral Recommendations for Consideration

Preparation of green corridor recommendations is to be influenced by a detailed stakeholder consultation, including with the Forestry Development Authority, Department of Zoning- Ministry of Public Works, Liberia Land Authority, and City Mayors-Ministry of Internal Affairs, led by the Environmental Protection Agency with inputs from a consultant. The below suggestions are proposed as a potential starting point for further discussions.

Recommendation 1: Establishment of a Local Environment Committee to identify areas at risk for environmental degradation and appropriate for establishing green corridors.

The EPML of 2002 requires the EPA to set environmental committees at the district and county levels. These committees have a crucial role in supporting the EPA functions for environmental planning and management, but they are yet to be established across the country. Once established, a Local Environment Committee shall ensure that any issues guidelines issued and measures for setting up green corridors are implemented, especially through voluntary self-help activities of local communities, the private sector, and resources of the city corporations.

Recommendation 2: The EPA, in consultation with the relevant line Ministries, provides guidelines and measures necessary for establishing green corridors in urban areas.

While cities and the Ministry of Public Works have made efforts to set up green corridors along roads and city landscapes, there are currently no country specific guidelines for developing green corridors. This is a mandate given to the EPA in consultation with other relevant agencies. The development of such guidelines is important for ensuring that such initiative is done systematically and sustainably, in lieu of other development priorities and constraints. This will also support replication in urban areas across the country.

Recommendation 3: Preparation of County Environmental Action Plans to identify areas targeted for afforestation or reforestation.

The EPML of 2002 provides that every County Environment Committee shall prepare a County Environment Action Plan, which shall specify the areas identified in accordance with the EPML, including targets for afforestation or reforestation. Though the committees are yet to be set up and environmental action plans do not yet exist at the county level, the EPA will complete the National Environmental Action Plan (NEAP) in 2020, which should inspire the development of the county environmental action plans. Such plans will identify priorities in each locality and planning areas for improving environmental and economic activities, which will be locally derived and owned.

Recommendation 4: Capacity-building for the Ministry of Public Works, LISGIS, and Municipal Authorities.

These entities will need technical support and a comprehensive capacity development program for city/regional plans, institutional systems, and urban development and management. This should include urban monitoring and database development, urban planning survey and GIS data development, zoning, preparation of draft laws for city planning, land adjustment, urban renewal, and urban development, housing complexes and industrial parks, etc. Additionally, the capacity building plans should include staff to plan trainings and ongoing, on-the-job training for urban master planning, zonal planning, and local action planning.

Recommendation 5: Draft a National Zoning Act and produce a zoning map of 5 municipalities.

The development of zoning acts and maps is essential to address the current land use and urban sprawl of many urban cities. This will help to:

- Identify the areas most likely to urbanize over the next ten years;
- Identify the types of urbanization expected over the next ten years to create the appropriate zoning policies and measures to ensure strategic urban development, including through well-managed settlement improvement areas; and
- Prepare specific regulations to control or promote sustainable building/land development actions.

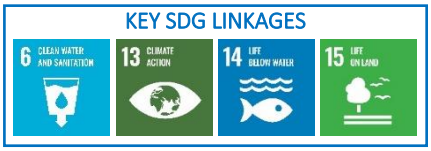
Recommendation 6: Promote green corridor connectivity with a focus on supporting healthy wildlife populations.

Wildlife species are becoming increasingly isolated in habitat patches surrounded by human-dominated landscapes, especially in urban areas. Green corridor connectivity is important for maintaining biodiversity through the conservation of potentially at-risk local populations in the wild and has proven to greatly improve species richness. This action directly supports Goal 2 of the NBSAP.

Recommendation 7: Consider linkages with national COVID response and recovery priorities as part of the update of NDC targets for this sector. *[Linkages with other sectors]*

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of this recommendation.

Sector Highlight: Coastal Zones



National Sectoral Context

Liberia's coastline spans approximately 560 km (350 miles) and is largely built from sand with some exposed rock outcrops.[196] Approximately 58% of the country's population lives along the coast, including dense population centers in the Monrovia Metropolitan Area and other coastal cities.[197] About 17% of the coast is developed or under plantation or agricultural use. Additionally, 62% of the coast houses economically or biologically valuable forest or mangrove ecosystems.[198] The coastline also features mangroves, savannah woodlands and other swamp vegetation, which, in some areas, extend up to 25 km inland.[199]

The increasing frequency and intensity of climate events threatens the Liberian coastline with sea level rise and coastal erosion as two of the greatest climate-related challenges. It is projected that about 95 km^2 of the land in the coastal zone will be fully inundated with one meter of sea level rise. This sea level rise could threaten Liberia's freshwater supply through saltwater intrusion. Further, the associated flooding directly impacts coastal infrastructure, services to coastal communities, health, sanitation, agricultural production and economic growth.[200]

The potential sea level rise will further exacerbate coastal erosion in the country, which has already become a significant problem by displacing populations and degrading infrastructure.[201,202] Coastal

[196] Kalinski, V. (2019) Climate Hazard, Vulnerability and Risk Assessment for the Coastal Zone of Liberia. Liberia Environmental Protection Agency, United Nations Development Programme, Green Climate Fund.
[197] Republic of Liberia. (2017) National Biodiversity Strategy and Action Plan-II 2017-2025. https://www.cbd.int/doc/world/lr/lr-nbsap-v2-en.pdf.
[198] Kalinski, V. (2019) Climate Hazard, Vulnerability and Risk Assessment for the Coastal Zone of Liberia. Liberia Environmental Protection Agency, United Nations Development Programme, Green Climate Fund.
[199] Republic of Liberia. (2017) National Biodiversity Strategy and Action Plan-II 2017-2025. https://www.cbd.int/doc/world/lr/lr-nbsap-v2-en.pdf.
[200] Liberia 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.
[201] Republic of Liberia National Disaster Management Agency. (2016) National Action Plan for Disaster Risk Reduction – Liberia 2016-2021. https://ndmaliberia.org/wp-content/uploads/2018/06/Liberia-National-Draft-Action-Plan-2016-Updated-version-2-2.pdf.
[202] Republic of Liberia National Disaster Management Agency. (2012) National Disaster Management Policy. http://www.mia.gov.lr/doc/Web%201%20National%20Disaster%20Risk%20Management%20Policy-clean-12102012.pdf.

erosion is affecting approximately 72% of the coastline, sometimes up to several meters per year; though, some areas (about 28%) are experiencing a gradual increase in accumulated sand, it is only at a rate of less than one meter per year.[203] In areas like Monrovia and Buchanan, sea level rise and associated coastal erosion could lead to more than $250 million in infrastructure damage with additional impacts on communities themselves.

While coastal zones are highly sensitive to the impacts of climate change, there are many climate adaptation, resilience, and mitigation opportunities for this sector. These actions will also contribute to the achievement of the Sustainable Development Goals (SDGs), especially SDG 6 - Clean Water & Sanitation, SDG 13 - Climate Action, SDG 14 - Life Below Water, and SDG 15 - Life on Land.

Liberia's Initial National Communication (INC) highlights several "coastal protection technologies" to reduce the coastline's vulnerability to climate impacts. All the technologies proposed—groynes, sea walls, revetments, offshore breakwaters, and beach nourishment or replenishment—are considered traditional, "grey infrastructure" approaches. "Grey infrastructure refers to traditional built structures that provide a high level of protection but often require maintenance and cannot adapt to a changing climate."[204] "Green" coastal resilience approaches focus on protecting, conserving and restoring coastal ecosystems, such as mangrove forests, to serve as storm barriers, protection against coastal erosion.[205] Green, grey and combined (known as green-grey) infrastructure approaches should be pursued to maximize coastal protection and benefits to coastal communities.

In addition to protecting coastlines and stabilizing sediment, mangroves also support food production and other valuable ecosystem services. In a study of mangroves in Lake Piso, Bomboja, Monrovia, Marshall, and Buchanan, Liberia's mangroves maintain healthy and productive fishing sites, provide fuelwood and other wood products, as well as several non-wood products, such as thatch, sugar, medicine and honey.[206] However, these mangrove ecosystems are threatened by coastal development, agricultural expansion, transportation infrastructure, mining and oil exploration, and pollution.[207] "[I]n some cases mangrove degradation and mangrove forest loss is higher than in Liberia's terrestrial forests (Clark and Thompson 2015)."[208]

The Liberia Environmental Protection Agency (EPA) is responsible for environmental issues related to coastal resilience, though this work is implemented in close partnership with the Liberia Maritime Authority, Ministry of Mines and Energy (MME), and other entities. Coastal management strategies have

[203] Kalinski, V. (2019) Climate Hazard, Vulnerability and Risk Assessment for the Coastal Zone of Liberia. Liberia Environmental Protection Agency, United Nations Development Programme, Green Climate Fund.
[204] Global Mangrove Alliance. Green-Grey Infrastructure in the Philippines. www.mangrovealliance.org/Philippines.
[205] Conservation International. 2017. Natural Capital Mapping and Accounting in Liberia: Understanding the contribution of biodiversity and ecosystem services to Liberia's sustainable development. Arlington, VA.
[206] Conservation International. 2017. Natural Capital Mapping and Accounting in Liberia: Understanding the contribution of biodiversity and ecosystem services to Liberia's sustainable development. Arlington, VA.
[207] Conservation International and Global Environment Facility. (2015) "Review of the status, distribution and importance of mangrove habitats in Liberia."
[208] Conservation International. 2017. Natural Capital Mapping and Accounting in Liberia: Understanding the contribution of biodiversity and ecosystem services to Liberia's sustainable development. Arlington, VA.

significant linkages and overlaps with adaptation efforts in the forest and fisheries sectors. Continued and enhanced coordination among these agencies is important to align resources with impactful action.

Existing NDC Targets

Liberia's NDC targets for Coastal Zones builds on the priorities identified under its 2008 National Adaptation Programme of Action (NAPA), which includes a goal on "building of coastal defense walls to reduce the vulnerability of urban coastal areas."[209]

Table 8.1. Existing Mitigation Targets and Activities in 2015 NDC – Coastal Zone.

Mitigation Targets and Activities in 2015 NDC – Coastal Zone		
Sectoral Quantitative Target (if applicable)	**Sub-targets and activities identified**	**Baseline information used for 2015 NDC target**
Not stated.	*Mitigation activities from the coastal zones are not included in Liberia's 2015 NDC.*	*Not stated.*

Source: Information from Liberia Initial Nationally Determined Contribution (2015).[210]

Table 8.2. Existing Adaptation Targets and Activities in 2015 NDC – Coastal Zone.

Adaptation Targets and Activities in 2015 NDC – Coastal Zone		
Sectoral Quantitative Target (if applicable)	**Sub-targets and activities identified**	**Baseline information used for 2015 NDC target**
Not stated.	Develop and implement Coastal Zone policy, strategy and management plan.	*Not stated.*
	Construct hard structures such as sea walls or revetment.	
	Manage and conserve coastal mangrove ecosystem.	
	Facilitate technology transfer and training of institutional and local experts in coastal zone management and monitoring.	

Source: Information from Liberia Initial Nationally Determined Contribution (2015).[211]

[209] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC), emphasis added. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

[210] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC), emphasis added. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

[211] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC), emphasis added. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

Existing Relevant Policies, Strategies and Plans

Relevant climate change and sectoral policies were reviewed in order to examine their targets and strategies for the coastal zone. The most relevant and updated policies for climate action were part of this review process:

- ✓ National Policy and Response Strategy on Climate Change (2018);
- ✓ National Biodiversity Strategy and Action Plan-II 2017-2025 (2017);
- ✓ Liberia Initial National Communication (2013);
- ✓ Climate Change Gender Action Plan (2012); and
- ✓ National Adaptation Programme of Action (2008).

In 2018, the National Policy and Response Strategy on Climate Change presented nine targets related to climate adaptation for coastal areas. These proposed activities built on the sectoral goals outlined in the NDC from 2015 with the ultimate objective of "Ensur[ing] the protection of Liberia's 350 miles coastline."[212]

Coastal Area Strategies from the National Policy and Response Strategy on Climate Change (2018):

Adaptation Strategies:

- Develop **management plan for coastal areas** to ensure their continuous functioning and availability.
- Set up **early warning systems and educational program**, especially for people living along the coast.
- Promote **disaster risk management** in general (especially disaster preparedness) and **protective infrastructure** (e.g. seawalls and flood reservoirs) to protect against rising sea level.
- Support the **rehabilitation and protection of wetlands and mangroves** or manage retreat where it occurs for the primary purpose of **buffering coastal communities from storm surge and coastal erosion.**
- Establish mechanisms for **coastal erosion control** and promoting alternative sources and technologies to **enhance water availability.**
- **Climate proofing and enhancing of infrastructures (roads, sewers, water supplies and other infrastructure) in coastal settlements** (particularly from Robertsport to Harper) and rural areas to protect continuous access to livelihoods, health care and education.
- **Engage with communities along the coast** to participate in actions aimed at protecting the coast and ensuring its continuous viability.
- Investigate the suitability and, where possible, implement the **living shorelines approach (LSA),** which uses natural vegetation, sand and some rocks to protect shorelines and habitat.

[212] Liberia 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.

- 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.

Source: National Policy and Response Strategy on Climate Change (2018). Emphasis added.

Selected Targets from Liberia's NBSAP II Goals (2017):

- **Target 1.2:** By 2020, biodiversity values and prioritized ecosystem services are quantified, monitored and mainstreamed to support national and sectoral policy-making, planning, budgeting and decision-making frameworks. Actions:
  - Measure and map out representative samples of prioritized ecosystems.
  - Identify and estimate various goods and services ecosystem provides.
  - Identify and assess the forest, agricultural and biodiversity and quantitative values in monetary terms.
  - Develop a **sectoral policymaking, planning, budgeting and decision-making frameworks on biodiversity values**.
- **Target 2.2:** By 2023, at least 20-25% of living marine and aquatic resources are managed sustainably and guided by the ecosystem approach. Actions:
  - Establish at least **2 marine protected areas.**
  - Enforce fishery **regulations on illegal fishing practices**.
  - Ensure **restoration** of at least **30 % of degraded wetlands**.
  - Ensure **protection of mangrove forests** of global importance through community participation.
  - Finalize **National Wetlands Policy**.
- **Target 3.1:** By 2020, at least 4% of existing terrestrial protected areas (national parks, nature reserves, conservation areas set aside in community forests, etc.) are conserved, effectively and equitably managed, within an ecologically representative and well-connected system, and by 2022, at least 5% of coastal and marine areas of particular importance to biodiversity and ecosystem services, are identified, assessed and measures. Actions:
  - Conduct **baseline surveys of terrestrial and aquatic** (freshwater, marine) **protected ecosystems** to determine their current conservation status and threats they face.
  - Establish **additional ecologically representative protected areas**.
  - Update/develop **management plans for the PAs**.
  - Conduct **economic valuation of the PAs**.
  - **Promote REDD+ program**.
- **Target 4.1:** By 2022, ecosystems that provide essential services and contribute to health, livelihoods and well-being, are safeguarded, and restoration programmes have been initiated for degraded ecosystems covering at least 15 per cent of the priority areas. Actions:

- Identify and map out the country's terrestrial and aquatic 68 ecosystems, **document the essential services they provide**.
- Determine threatened ecosystems and the extent of such threats.
- Develop and initiate **implementation of measures to restore and/or rehabilitate at least 2% of these ecosystems**.
- Identify and monitor threats to all ecosystems

Source: National Biodiversity Strategy and Action Plan-II 2017-2025 (2017). Emphasis added.

Review of NDC Targets

Data. Emissions attributed to coastal ecosystems were not specifically addressed in the Initial National Communication or the country's greenhouse gas inventory, so there are no official, national figures on coastal zone emissions used by the government.

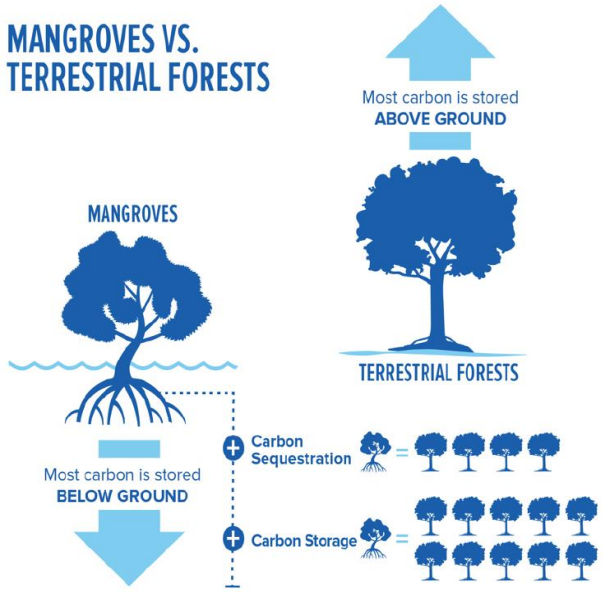


Figure 8.1: Comparison of carbon sequestration and storage potential of mangrove vs. terrestrial forests.

Source: Conservation International.

Sources of emissions. Globally, mangroves only comprise 2% of the world's tropical forests; however, their destruction and degradation accounts for 20% of global emissions from tropical deforestation.[213,214] It is estimated that "[b]etween 1980 and 2005, 19% of the world's mangroves were lost, resulting in increasing exposure to coastal hazards due to development and increasing vulnerability due to a loss of coastal protection."[215]

In addition to their adaptation benefits, mangrove ecosystems sequester up to four times more carbon and store up to 10 times more carbon, per unit area, than terrestrial forests.[216,217,218] In turn, when mangroves are degraded or destroyed, their carbon stock that took millennia to accumulate are released in a matter of years, turning a carbon sink into a significant carbon source.

[213] Pendleton, Linwood, et al. "Estimating global "blue carbon" emissions from conversion and degradation of vegetated coastal ecosystems." PloS one 7.9 (2012): e43542.
[214] Van der Werf, G. R., et al. "CO2 emissions from forest loss. Nature Geoscience, 2, 737–738." Supporting Information Additional Supporting Information may be found in the online version of this article: Appendix S 1 (2009).
[215] Beck. M. et al. (2018) The miracle of mangroves for coastal protection in numbers. World Bank Blog. Published 31 May 2018. https://blogs.worldbank.org/voices/miracle-mangroves-coastal-protection-numbers.
[216] Pan, Yude, et al. "A large and persistent carbon sink in the world's forests." Science 333.6045 (2011): 988-993.
[217] Mcleod, Elizabeth, et al. "A blueprint for blue carbon: toward an improved understanding of the role of vegetated coastal habitats in sequestering CO2." Frontiers in Ecology and the Environment9.10 (2011): 552-560.
[218] Pendleton, Linwood, et al. "Estimating global "blue carbon" emissions from conversion and degradation of vegetated coastal ecosystems." PloS one 7.9 (2012): e43542.

In Liberia, approximately 45-65% of mangrove forests have been lost since 1980.[219] With the exception of a few pockets of primary mangroves in the center of the country, much of the primary mangrove forest has been replaced by secondary ones.[220,221] According to the Food and Agriculture Organization, Liberia and Côte D'Ivoire are the two countries in Africa with the highest loss rate of mangrove area.[222]

The primary drivers of mangrove loss in Liberia are urban development, agricultural expansion, transportation infrastructure, mining and oil exploration, pollution and municipal waste discharge.[223] One key challenge for protecting mangrove forests from conversion in Liberia is the lack of recognition of the long-term value of intact and functioning mangrove ecosystems in comparison to short-term gains (e.g., fuelwood and charcoal) resulting from their destruction or degradation.[224]

Mitigation and Adaptation Opportunities for Coastal Zones

According to the Forestry Development Authority, only about 0.4% of Liberia's landcover is described as mangrove ecosystems.[225] Using global data sets, the mitigation potential for cost-effective abatement (less than $100 USD per MT CO_2e per year) from coastal ecosystems is estimated at 0.16 MT CO_2e (equivalent to 160 Gg CO_2e) per year from 2030-2050 from avoided mangrove loss, peat restoration, and avoided peat impacts.[226] See Figure 8.2 below.

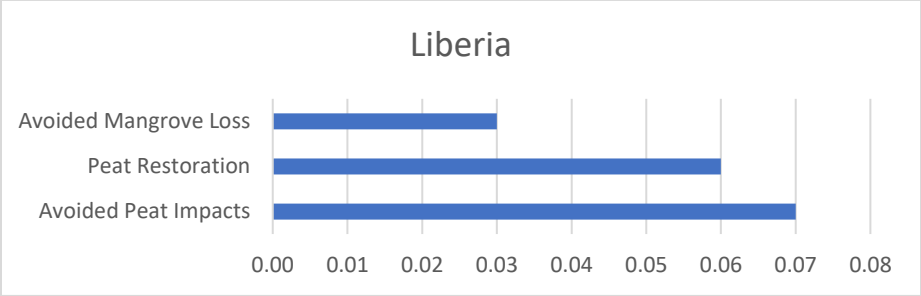


Figure 8.2. Mitigation potential of natural climate solutions pathways at "cost-effective" levels for coastal ecosystems in Liberia. (X-axis units are MT CO_2e per year 2030-2050)

Source: Griscom BW et al. (2020)[227] Based on global data sets.

[219] Corcoran, Emily, Corinna Ravilious, and Mike Skuja. Mangroves of western and central Africa. No. 26. UNEP/Earthprint, 2007.
[220] Corcoran, Emily, Corinna Ravilious, and Mike Skuja. Mangroves of western and central Africa. No. 26. UNEP/Earthprint, 2007.
[221] Republic of Liberia. (2017) National Biodiversity Strategy and Action Plan-II 2017-2025. https://www.cbd.int/doc/world/lr/lr-nbsap-v2-en.pdf.
[222] FAO 2007. The World's Mangroves 1980-2005. FAO Forestry Paper 153 http://www.fao.org/3/a1427e/a1427e05.pdf.
[223] Conservation International and Global Environment Facility. (2015) "Review of the status, distribution and importance of mangrove habitats in Liberia."
[224] Republic of Liberia. (2017) National Biodiversity Strategy and Action Plan-II 2017-2025. https://www.cbd.int/doc/world/lr/lr-nbsap-v2-en.pdf.
[225] Forestry Development Authority. (2015) Status report on Liberia's Land Cover and Forest Mapping – Oct 2015. Consultants: Joint Venture Metria AB and GeoVille GmbH. http://www.fda.gov.lr/status-report-on-liberias-land-cover-and-forest-mapping-oct-2015/.
[226] Griscom BW et al. (2020) National mitigation potential from natural climate solutions in the tropics. Phil. Trans. R. Soc. B 375: 20190126. http://dx.doi.org/10.1098/rstb.2019.0126.
[227] Griscom BW et al. (2020) National mitigation potential from natural climate solutions in the tropics. Phil. Trans. R. Soc. B 375: 20190126. http://dx.doi.org/10.1098/rstb.2019.0126.

Figure 8.3 below shows the geographical distribution of mangrove and wetland ecosystems in Liberia. The inset maps A-D show the specified regional land cover classes in finer detail.

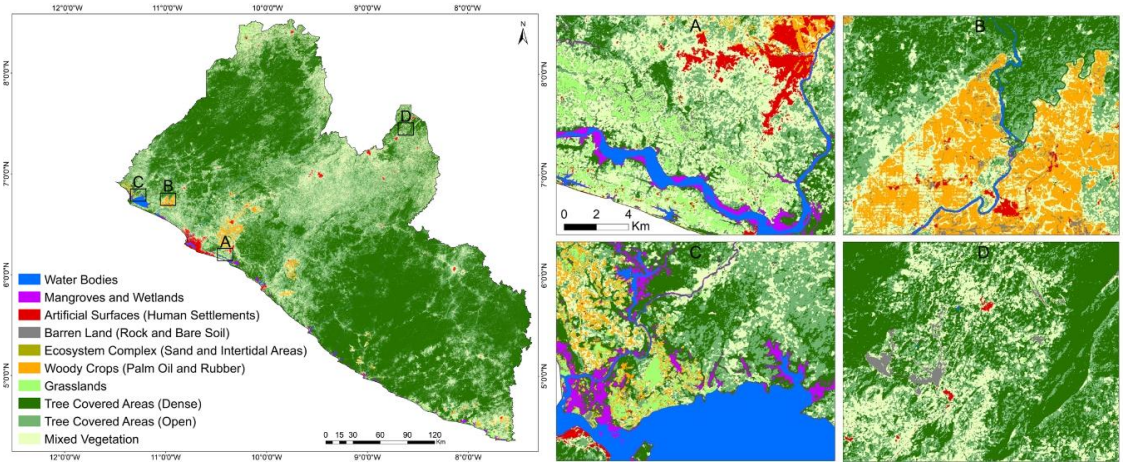


Figure 8.3. Forest model predicted land cover map for Liberia 2015.

Source: de Sousa, C et al. (2020)[228]

Coastal resilience efforts can come in the form of "green" (ecosystem-based adaptation),[229] "grey" (engineered solutions), "green-grey" (combined ecosystem and engineered actions) and "soft" (policy, legal) approaches. Each approach can contribute to Liberia's adaptation response in different ways. The 2019 Climate Hazard, Vulnerability and Risk Assessment for the Coastal Zone of Liberia includes a thorough overview of the benefits and challenges of each type of coastal adaptation solution.[230] See Annex I.

Green-grey infrastructure combines the conservation and/or restoration of ecosystems with the selective use of conventional engineering approaches to provide people with solutions that deliver climate change resilience and adaptation benefits. By blending "green" conservation with "grey" engineering techniques, communities can incorporate the benefits of both solutions while minimizing the limitations of using either green or grey infrastructure individually. For example, a combination of wetland restoration with limited geoengineering approaches, such as breakwaters, combines the wave attenuation and flood control value of wetlands—in addition to the fisheries, biodiversity, water quality and numerous other benefits of this ecosystem—with the benefits of engineered structures to stabilize the coastal zone and attenuate waves through beach accretion. The combined solution can be more comprehensive, robust and cost-effective than either solution alone. Successful use of green-grey technology requires a sophisticated understanding of coastal ecosystem function and restoration techniques, relative risk from sea level rise and extreme weather events, and infrastructure engineering. The goal is to make targeted, efficient investments that provide protection for coastal communities at the greatest risk.

[228] de Sousa C, Fatoyinbo L, Neigh C, Boucka F, Angoue V, Larsen T. (2020) Cloud-computing and machine learning in support of country-level land cover and ecosystem extent mapping in Liberia and Gabon. PLoS ONE 15(1): e0227438. https://doi.org/10.1371/journal.pone.0227438.

[229] The International Union for Conservation of Nature (IUCN) defines ecosystem-based adaptation as a nature-based solution that harnesses biodiversity and ecosystem services to reduce vulnerability and build resilience to climate change.

[230] Kalinski, V. (2019) Climate Hazard, Vulnerability and Risk Assessment for the Coastal Zone of Liberia. Liberia Environmental Protection Agency, United Nations Development Programme, Green Climate Fund.

To aid consideration of how and where to prioritize green approaches, Figure 8.4 below depicts the climate risks along Liberia's coastline and Figure 8.5 depicts the location of mangrove ecosystems along the coastline and their ability to protect the coast from climate impacts. Both maps were modeled using the InVEST model (Tallis and Polasky 2009). "The model is based on a combination of global data on human population, wind, and wave energy as well as data specific to Liberia on coastal geomorphology, mangrove habitat, and other variables."[231] Based on this modeling in 2017, Bassa, Rivercess, Sinoe, and Grand Kru counties are most vulnerable to coastal erosion. Mangroves provide the greatest coastal protection in Bassa and Rivercess counties, and to a lesser extent in Sinoe county. "Currently the only protected area that includes mangrove areas is located near Lake Piso. Therefore, most mangroves in Liberia are currently unprotected and may be threatened with loss or conversion in the future. Specifically, the mangroves that may be providing the most benefits in terms of coastal protection, according to [this] model, are currently unprotected."[232]

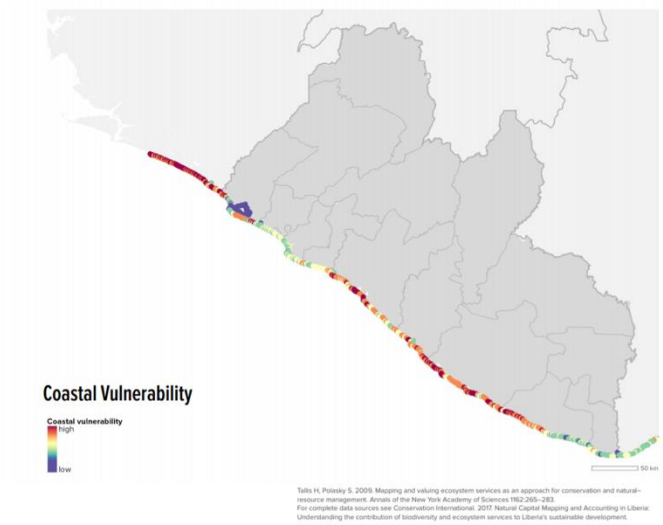


Figure 8.4: Coastal Vulnerability in Liberia.
Source: Neugarten, R. et al. (2017)

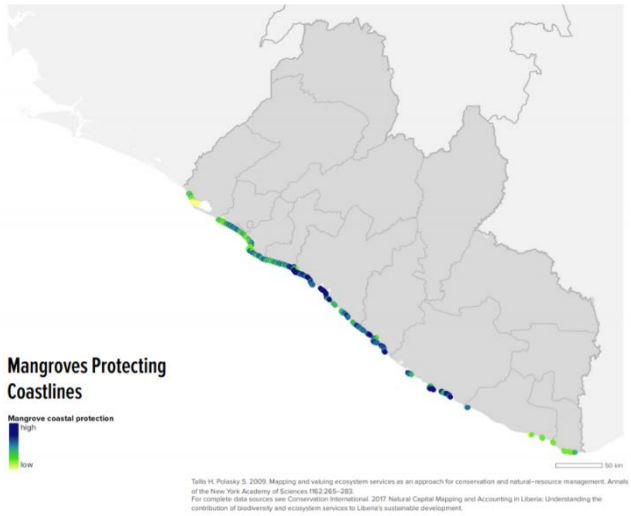


Figure 8.5 Mangroves Protecting Coastlines in Liberia.
Source: Neugarten, R. et al. (2017)

Co-Benefits

Coastal ecosystems, including mangroves, provide critical natural infrastructure protecting coasts globally. Over 200 million people worldwide live within 10 kilometers of mangrove forests and depend on mangroves to protect their communities from the impacts of climate change, including storm surges, flooding, and erosion.[233] At the global scale, "if today's mangroves were lost, 18 million more people

[231] Neugarten, R. et al. (2017) Liberia: Mapping Natural Capital. https://www.conservation.org/docs/default-source/publication-pdfs/liberia_mapping_natural_capital_highres.pdf?sfvrsn=c7325ede_2.
[232] Neugarten, R. et al. (2017) Liberia: Mapping Natural Capital. https://www.conservation.org/docs/default-source/publication-pdfs/liberia_mapping_natural_capital_highres.pdf?sfvrsn=c7325ede_2.
[233] Hutchison, J. et al. (2014) The Role of Mangroves in Fisheries Enhancement. https://www.wetlands.org/publications/the-role-of-mangroves-in-fisheries-enhancement/.

would be flooded every year, an increase of more than 39%. The annual damages to property would increase by 16% and US $82 billion."[234] Loss and degradation of coastal ecosystems has resulted in increased exposure of coastal populations to climate hazards, coastal flooding and erosion, loss of biodiversity and livelihoods, along with numerous other impacts.

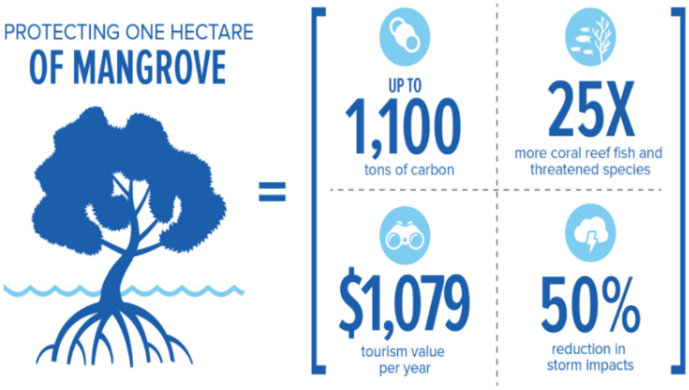


Figure 8.6: Benefits of mangrove protection.
Source: Conservation International.

Mangrove ecosystems do so much more than store carbon. Mangroves provide habitat to a wealth of coastal and marine biodiversity, offer nearby communities a stable supply of food and jobs, and play an important role in cultural practices and identity. Mangroves play an important role in serving as fish nurseries. Fish is the primary source of protein for many Liberians and the fisheries sector contributes about 10% to the gross domestic product (GDP).[235]

Although they often receive little attention, seagrasses are one of the most productive ecosystems in the world. Seagrasses provide shelter and food to an incredibly diverse community of animals, from invertebrates to large fish, crabs, turtles, marine mammals, and birds. Seagrasses support commercial fisheries and biodiversity, clean the surrounding water, and help take carbon dioxide out of the atmosphere and water column – resulting in climate mitigation benefits as well as some localized benefit related to ocean acidification. Because of these benefits, seagrasses are believed to be the third most valuable ecosystem in the world (preceded only by estuaries and wetlands), with one hectare of seagrass estimated to be worth over $19,000 USD per year.[236]

Institutional Framework

The Liberia Environmental Protection Agency is responsible for environmental issues related to coastal resilience, though this work is implemented in close partnership with the Liberia Maritime Authority, Ministry of Mines and Energy, and other entities, which is outlined in Table 8.3 below. It is important to note the linkages and overlap between addressing the climate impacts on coastal zones and the forest and fisheries sectors.

[234] Beck. M. et al. (2018) The miracle of mangroves for coastal protection in numbers. World Bank Blog. Published 31 May 2018. https://blogs.worldbank.org/voices/miracle-mangroves-coastal-protection-numbers.
[235] Republic of Liberia. (2019) Sixth National Report of Liberia to the Convention on Biological Diversity. https://www.cbd.int/doc/nr/nr-06/lr-nr-06-en.pdf.
[236] Smithsonian. (2020) Seagrass and Seagrass Beds. https://ocean.si.edu/ocean-life/plants-algae/seagrass-and-seagrass-beds.

Table 8.3. Institutions and agencies with mandates on coastal zones in Liberia.

Institution	Mandate
Environmental Protection Agency (EPA)	• Co-ordinate, integrate, harmonize and monitor the implementation of environmental policy and ensure the integration of environmental concerns in overall national planning. • Collect, analyze and prepare basic scientific data and other information pertaining to pollution, degradation and on environmental quality, resource use and other environmental protection and conservation matters. • Build the capacity of line Ministries, authorities and organizations through the exchange of data and information, and to render advice, technical support and training in environment and national resource management. • Promote public awareness through public participation in decision making and formal and non-formal education about the protection and sustainable management of the environment. • Identify projects, activities, policies, and programs for which environmental impact assessment must be conducted under this Act. • Initiate and co-ordinate actions required in a state of environmental emergency or any other situation which may pose serious threat to the environment and public health.
Forestry Development Authority (FDA)	• Ensure the sustainable management and conservation of Liberia's forest and related natural resources for the benefit of current and future generations. • Conserve Liberia's forest biodiversity and ecological services through the regulation of wildlife consumption and the creation and management of Liberia's National Protected Areas Network. • Assist communities in realizing the benefits of forest resources and managing forest resources in a sustainable manner.
Liberia Maritime Authority	• Promote Integrated Coastal Management Program, Liberia Coastal Zone, and programs that safeguard Liberia's marine and waterways from invasive species. • Develop and implement an integrated system and public policies for the protection of the marine environment, including policies governing the protection from pollution that could cause environmental damage to the marine environment. • Coordinate with other relevant government agencies for the establishment of a national system for immediate response to marine pollution incidents, reducing the risks and threats posed for such incidents. • Contribute to capacity building of personnel of all stakeholders in marine emergency response, damage assessment and identify measures needed to address them.
Ministry of Mines and Energy (MME)	• Administer the "Enhancing Resilience of Vulnerable Coastal Areas to Climate Change Risks in Liberia" project, which help coastal communities in three counties (Grand Cape Mount, Montserrado and Grand Bassa) to develop defensive mechanisms against the effects of climate change, in partnership with UNDP. • House an Integrated Coastal Zone Management Unit. • Regulate beach sand mining.
Ministry of Public Works	• Responsible for the construction, maintenance and rehabilitation of coastal infrastructure, including roads, bridges, retaining walls, harbors, etc.

	• Improvement of service delivery to ensure quality of life in rural areas (which may include coastal areas).
National Disaster Management Agency	• Responsible for implementing the National Disaster Management Policy, coordinating the national disaster management system. And incorporating state and nonstate actors at national, county, district and chiefdom levels • Handle disaster-related issues to ensure reduced vulnerabilities to natural and human induced hazards.
National Biodiversity Secretariat	• Implement and monitor national biodiversity programs, including the implementation of the National Biodiversity Strategy and Action Plan.

Sources: Environmental Protection Agency[237], Forestry Development Authority[238], National Forest Management Strategy[239], Liberia Maritime Authority[240], Ministry of Mines and Energy[241], NAP National Capacity Assessment[242], Ministry of Public Works[243], NBSAP II[244]

Cost and Investment Opportunities

The 2018 National Policy and Response Strategy on Climate Change included an "Action Plan and Resource Mobilization Plan," which outlines specific activities for undertaking climate action in each sector between 2017-2026. Table 8.4 below includes information regarding the activities, estimated costs and relevant government implementing agencies, as outlined in the 2018 Resource Mobilization Plan.[245]

Table 8.4. Action Plan for the Implementation of Strategic Interventions – Coastal Zone.

Sectoral and Cross-Sectoral Intervention Area: Coastal Areas					
Strategic Interventions	**Intervention Period** (Years 2017 to 2026)			**Estimated Cost** (Million USD)	**Implementing Agencies**
	(1-3) Short-term	(4-5) Mid-term	(6-10) Long-term		
Assess and build the capacity of agencies and managers responsible for the management of coastal adaptive capacity in the sector	X	X	X	2	LWSC, MME, MoA, MoIA, EPA, MoFDP, Universities and Colleges
Develop an integrated management plan for coastal zone management as well as early warning system that includes training and capacity development for coastal management and monitoring		X		5	MME, MOD, Maritime, EPA, MoFDP, Universities and

[237] Liberia Environmental Protection Agency. (2020) Statutory Mandate. http://www.epa.gov.lr/content/statutory-mendate. Accessed: 2 June 2020.
[238] Liberia Forestry Development Authority. (2020) About Us: History. http://www.fda.gov.lr/about/history/. Accessed: 2 June 2020.
[239] Liberia Forestry Development Authority. (2007) National Forest Management Strategy. http://wri- sites.s3.amazonaws.com/forest-atlas.org/lbr.forest-atlas.org/resources/Documents/National%20Forest%20Management%20Strategy.pdf.
[240] Liberia Maritime Authority. (2020) Department of Marine Environmental Protection. http://www.lima.gov.lr/index.php/services/technical-services/marine-environmental-protection.html. Accessed 2 June 2020.
[241] Republic of Liberia Ministry of Mines and Energy. (2020) Coastal Defense Project. https://mme.gov.lr/coastal-defense-project/. Accessed: 2 June 2020.
[242] Liberia Environmental Protection Agency (2019) NAP National Capacity Assessment for Managing Climate Change Impact in Liberia. United Nations Development Programme and Green Climate Fund.
[243] Republic of Liberia Ministry of Public Works. (2020) Department or Rural Development. http://www.mpw.gov.lr/2content.php?sub=205&related=24&third=205&pg=sp&pt=Rural%20Development. Accessed: 2 June 2020.
[244] Republic of Liberia. (2017) National Biodiversity Strategy and Action Plan-II 2017-2025. https://www.cbd.int/doc/world/lr/lr-nbsap-v2-en.pdf.
[245] Liberia 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.

					Colleges
Promote and implement disaster risk management in general (especially disaster preparedness)	X	X	X	100	DMA, MoPW, MME, LISGIS, MoIA, EPA, MoFDP
Support the rehabilitation and protection of wetlands and mangroves, including awareness and education of their host communities	X	X	X	3	MoA, MoPW EPA, MICAT, MoFDP
Develop and implement a program to climate proofing and enhancing infrastructures (roads, sewers, water supplies and other infrastructure) in coastal settlements and rural areas to protect continuous access to livelihoods, health care and education.		X	X	50	MoPW, MOA, LWSC, MOH, EPA, MoFDP
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.	X	X		2	MICAT, MoIA, MME, EPA, MoFDP

Source: Adapted from National Policy and Response Strategy on Climate Change (2018).[246]
Agency abbreviations: DMA = Disaster Management Agency; EPA = Environmental Protection Agency; LWSC = Liberia Water & Sewer Corporation; Maritime = Liberia Maritime Authority; MICAT = Ministry of Information Culture Affairs & Tourism; MoA = Ministry of Agriculture; MOD = Ministry of Defense; MoFDP = Ministry of Finance & Development Planning; MoIA = Ministry of Internal Affairs; MME = Ministry of Mines and Energy; MoPW = Ministry of Public Works; NIC = National Investment Commission

Policy Gaps and Challenges

Challenge: Limited data availability. Emissions attributed to coastal ecosystems were not specifically addressed in the Initial National Communication or the country's greenhouse gas inventory. As of 2020, mangroves and coastal ecosystems are not separated in the national greenhouse gas inventory, making it difficult to understand the contribution of mangrove loss and degradation to the country's emissions.

To illustrate the challenge, Figure 8.7 (right) compares the land area classified as mangroves by different mapping efforts. The purple area, representing areas of mangroves and wetlands derived from remote sensing imagery by CI and NASA,[247] shows good agreement with global estimation of mangrove and wetland ecosystems;[248]

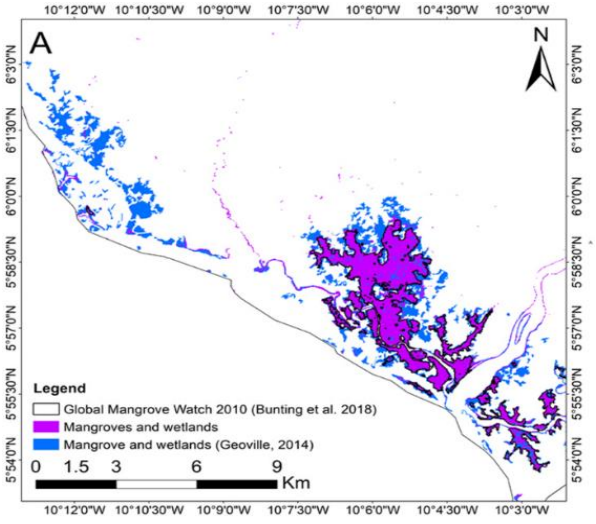


Figure 8.7: Comparison between de Sousa, C et al. predicted land cover maps, the latest land cover land use product available for Liberia for 2014 and the global mangrove extent product for 2010.
Source: de Sousa, C et al. (2020)

[246] Liberia 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.
[247] de Sousa C, Fatoyinbo L, Neigh C, Boucka F, Angoue V, Larsen T (2020) Cloud-computing and machine learning in support of country-level land cover and ecosystem extent mapping in Liberia and Gabon. PLoS ONE 15(1): e0227438. https://doi.org/10.1371/journal.pone.0227438
[248] Bunting, P. et al. (2018) The Global Mangrove Watch—A New 2010 Global Baseline of Mangrove Extent. *Remote Sens*. 2018, *10*, 1669. https://www.mdpi.com/2072-4292/10/10/1669.

however, the blue areas, classified as mangroves and wetlands in the map produced by GeoVille,[249] may include other types of costal vegetation. Limitations in remote sensing and variations in data interpretation make it difficult to correctly identify areas of loss and degradation over time; however, this challenge is not unique to Liberia or to coastal ecosystems.

The lack of access to or the resources to hire trained personnel to measure, monitor and forecast coastal impacts is a challenge. Improved data collection, storage, analysis processes, and dissemination are needed to support national coastal adaptation efforts.[250,251] This is already identified as a target under the NDC and should be prioritized for implementation, noting that data collection and tracking must be done routinely.

Challenge: Capacity of coastal, local governments to implement coastal resilience strategies. Subnational and local governments lack the resources to hire staff with the necessary knowledge and personnel to support coastal resilience planning and implementation efforts.[252] Recent coastal adaptation projects, such as the 2018 Green Climate Fund proposal supported by the United Nations Development Programme, can play a significant role in building regional and local capacity. The 2012 "Climate Change Gender Action Plan for the Government of Liberia" also proposes the creation of university programs for coastal zone management, with scholarships that could prioritize the training of women within this field.[253]

A major policy gap for regulating coastal activities is the lack of policies that define setback areas, or defined distances away from the shoreline where areas for human settlements and activities should be located according to the risk of sea level rise.

Sectoral Recommendations for Consideration

The targets for the coastal zone as outlined in the NDC cover the most pressing needs to support Liberia's climate and sustainable development goals. The recommendations below are focused on refining and elaborating these goals to make them more specific and tangible. These refined targets may belong as part of the revised NDC or in a detailed implementation plan.

[249] Forestry Development Authority. (2015) Status report on Liberia's Land Cover and Forest Mapping – Oct 2015. Consultants: Joint Venture Metria AB and GeoVille GmbH. http://www.fda.gov.lr/status-report-on-liberias-land-cover-and-forest-mapping-oct-2015/.

[250] Aguilar, L., Rogers, F., and Bobtoya, S. (2012) Climate Change Gender Action Plan for the Government of Liberia (ccGAP:LIBERIA). International Union for Conservation of Nature. https://portals.iucn.org/union/sites/union/files/doc/liberia_0.pdf.

[251] For resources on data collection methods, see the Blue Carbon Manual (https://www.thebluecarboninitiative.org/manual) and the IPCC wetlands Supplement Chapter 4 (https://www.ipcc.ch/publication/2013-supplement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories-wetlands/).

[252] Aguilar, L., Rogers, F., and Bobtoya, S. (2012) Climate Change Gender Action Plan for the Government of Liberia (ccGAP:LIBERIA). International Union for Conservation of Nature. https://portals.iucn.org/union/sites/union/files/doc/liberia_0.pdf.

[253] Aguilar, L., Rogers, F., and Bobtoya, S. (2012) Climate Change Gender Action Plan for the Government of Liberia (ccGAP:LIBERIA). International Union for Conservation of Nature. https://portals.iucn.org/union/sites/union/files/doc/liberia_0.pdf.

Recommendation 1: Increase the specificity of coastal adaptation actions.

As part of a revised NDC, a more-detailed implementation plan is required to increase the specificity on quantity and location of intended coastal adaptation efforts. The increased specificity will help operationalize the NDC, as well as in reporting on progress and NDC achievement. This could be achieved via a mandated convening of relevant coastal municipalities and their stakeholders—with technical support as needed from universities, local agencies, and international partners—to assess and develop an action plan based on recommendations that will be developed based on sea-level rise predictions, salt water infiltration, and coastal flooding.

As an adaptation measure, predictive scenarios modeling the risk of coastal flooding and sea level rise, including risk maps, will be crucial for urban planning and settlements. There is also the need for legislative instruments and legal framework for regulation and enforcement of code of public practices in coastal areas.

For example, the revised NDC targets could build on the 2019 "Blue Ocean Conference Call to Action" in which participants "commit[ed] to no net loss of Liberia's mangroves post-2020 by developing a robust set of projects and programs to conserve and restore Liberia's mangrove ecosystems."[254]

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of this recommendation.

Recommendation 2: Prioritize green-grey infrastructure approaches to coastal resilience.

Liberia's Initial National Communication highlights several "coastal protection technologies" to reduce the coastline's vulnerability to climate impacts. All the technologies proposed—groynes, sea walls, revetments, offshore breakwaters, and beach nourishment or replenishment—are considered traditional, "grey infrastructure" approaches. Liberia's coastal zone NDC targets include both hard infrastructure solutions and ecosystem-based approaches. However, the 2015 NDC does not acknowledge how the combination of the two, known as green-grey adaptation approaches, can support coastal resilience by utilizing both natural defenses (e.g., mangroves) and human-made structures (e.g., levees) to achieve greater resilience at lower cost. National planned actions may also need to consider the option of relocating current homes and necessary infrastructure (e.g., waste management) that are located in the zone of predicted saltwater inundation in the next 10 to 30 years. As such upgrades and relocations are considered, it would be beneficial to increase sewage plant systems to a tertiary level which can also include green-grey design. This will further aid in the reduction of pollutant threats to coastal ecosystems.

[254] Blue Ocean Conference. (2019) Call to Action Participant Commitments. https://blueoceansconferenceliberia.com/wp-content/uploads'/2019/05/Commitment_Liberia_BOC-Final-3-17.pdf.

Example of a Green-Grey Adaptation Approach

For example, mangroves planted in front of a dike or sea wall can lessen erosion of the dike and reduce maintenance costs. But, if mangroves regenerate well, the dike is often not necessary. In addition, dikes are fixed and inflexible and cannot keep pace with sea level rise where mangroves accrete soil and raise the local elevation to keep pace with sea level rise. However, hydrological connectivity needs to be considered and not impeded by the dike, as this can facilitate better inland flooding and stormwater management by allowing drainage and water passageways to the ocean.

Potential policy strategies for supporting green-grey approaches:

- Requiring infrastructure projects receiving federal funding to dedicate a portion of those investments to hybrid solutions;
- Providing incentives to businesses funding and/or applying green-grey solutions to reduce climate vulnerabilities- for example, by conserving and/or restoring marsh ecosystems in combination with reinforcing sea walls, with the purpose of protecting vulnerable coastal infrastructure; and
- Encourage insurance products to value the risk reduction benefits provided by freshwater and coastal ecosystems and combined green-grey approaches.

Of note, the "Climate Hazard, Vulnerability and Risk Assessment for the Coastal Zone of Liberia" proposes planting fruit trees as a "green" coastal adaptation approach. While fruit trees would certainly have some coastal resilience benefits and provide an economic commodity, they may not be as readily suited to withstand future climate impacts on Liberia's coastline as mangrove species. Mangroves are favorable over other vegetation because of their carbon storage and soil retention benefits. Native mangrove species accumulate over time keeping pace with sea level rise. They are a habitat for fisheries, which benefit not just those working in the mangroves, but the entire community, as fish is the primary source of protein for many Liberians. They offer coastal protection from wave energy and wind and their complex root structure make them especially resistant compared to other tree species. The carbon mitigation value of mangroves is also much higher than other tree species and people can still sustainably harvest mangroves for wood if needed as well as other mangrove products that can provide livelihoods, such as mud crab, honey, sugar, and ecotourism. Non-native species of any flora or fauna can overtake endemic species; therefore, we strongly recommend that native mangrove species are prioritized for both "green" and "green-grey" coastal adaptation approaches.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of this recommendation.

Recommendation 3: Connect the coastal zone adaptation actions to their mitigation co-benefits.

Liberia's NDC includes proposed action to "Manage and conserve coastal mangrove ecosystems;" however, linking blue carbon actions with their mitigation benefits can allow for a more complete

representation of the Liberia's mitigation contributions to be recognized in the UNFCCC global stocktake process that will take place in 2023.

If the mitigation co-benefits of these actions were also recognized, the true ambition of Liberia's NDC would be more accurately reflected and would allow for Liberia's full contribution to be counted toward global goals.[255] Doing so can also facilitate access to increased funding to achieve adaptation and mitigation objectives via REDD+ and blue carbon.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of this recommendation.

Recommendation 4: Consider linkages with climate goals across sectors and promote mainstreaming of climate objectives. ***[Linkages with other sectors]***

Recognizing the synergies between climate actions in different sectors can increase multi-sector benefits of individual climate actions. For example, there are key linkages between the coastal zone, infrastructure, forests, and fisheries sections of Liberia's NDC, as well as the 2018 National Policy and Response Strategy on Climate Change. Achieving this will also contribute to Liberia fulfilling its commitment to the RAMSAR Convention, several sustainable development goals, and the Convention on Biological Diversity (CBD), including Liberia's strategy for achieving the still to-be-agreed CBD "Apex Goals."

The forthcoming Technical Report on Mainstreaming Climate Change Considerations into the Relevant Sector Specific Development Programs, Policies, Strategies and Management Plans in Liberia, supported by United Nations Development Programme, provides proposed steps for mainstreaming climate actions in each step of the policy cycle—from policy formulation, review and planning to resource allocation, programming and implementation. This document will serve as an important resource for mainstreaming climate actions across all sectors, including coastal zones.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of this recommendation.

Recommendation 5: Address gender considerations in training of institutional and local experts in coastal zone management and monitoring.

As addressed above, there are several challenges impeding the full implementation of coastal resilience efforts in Liberia, including insufficient data, a lack of trained individuals to measure, monitor and forecast climate impacts, and limited capacity at all levels of implementation. Women groups should be considered and prioritized for relevant trainings and jobs related to coastal resilience. This will also contribute to the SDG 5 on Gender Equality.

[255] See recently published resource for incorporating blue carbon in NDCs: https://www.thebluecarboninitiative.org/policy-guidance.

The 2012 "Climate Change Gender Action Plan for the Government of Liberia" outlines as number of examples of action across the sector. For example, the government could put in places a robust, gender-balanced monitoring system in coastal zones. This would include training and empowering women coastal monitors and setting up coastal zone monitoring approaches utilizing mobile phone technology. Women could also support coastal forest regeneration efforts by educating women about alternative energy sources for food cooking, heat and energy, as well as by introducing a women-led and managed forest regeneration program linked with the REDD+ strategy.[256]

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation this recommendation.

Recommendation 6: Take stock of progress made in implementing existing coastal sector policies and the NDC. ***[Linkages with other sectors]***

In the process of reviewing and updating the NDC, it is critical to take stock of progress made toward implementing existing sectoral and climate change targets and plans. The revised NDC should be informed by experiences, challenges, and lessons learned from implementing current targets and plans in the coastal sector. The stakeholder consultation process should identify any changes in national circumstances, political priorities, development priorities, and efforts to achieve Sustainable Development Goals (SDGs) (including progress made toward relevant sectoral SDG targets), which can help identify new opportunities and synergies to pursue emissions reduction strategies within the context of national priorities. The work done by EPA under the ongoing second national communication can provide a useful input into this stocktaking process.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders could contribute to identify new opportunities for mitigation strategies.

Recommendation 7: Consider linkages with national COVID response and recovery priorities as part of the update of NDC targets for this sector. ***[Linkages with other sectors]***

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of this recommendation.

[256] Aguilar, L., Rogers, F., and Bobtoya, S. (2012) Climate Change Gender Action Plan for the Government of Liberia (ccGAP:LIBERIA). International Union for Conservation of Nature. https://portals.iucn.org/union/sites/union/files/doc/liberia_0.pdf.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Sector Highlight: Fisheries

National Sectoral Context

Liberia's Fisheries sub-sector (component of the Agriculture Sector) contributes to 65% of local animal protein needs with 7,616 metric tons of fish and 126 of mollusks and crustaceans produced annually and it represents 3.2% of the country's gross domestic product.[257] This sub-sector has not reached its full potential, as a similar amount of fish is imported annually to meet the population's nutritional needs.[258]

The fisheries can be classified into: a) marine small-scale fisheries: mostly artisanal, semi-industrial and subsistence fisheries; b) marine industrial scale fisheries: trawl fishery and demersal finfish; c) inland fisheries: based on rivers, lakes and wetlands; and d) recreational fisheries.[259] The last acoustic survey conducted in 1984 showed a total biomass of 800,000 metric tons of pelagic and demersal species in Liberia; although this is the latest available information, Liberian authorities consider that overexploitation of commercial and artisanal fisheries can specially have a negative impact in the amount of demersal species.[260] The destruction of mangroves also contributes to the reduction of available fish "with losses to coastal fisheries amounting to as much as 480 kg of fish per year for every hectare of forest that is lost (MacKinnon & MacKinnon 1986)."[261] At the same time, mangroves are cut down and used to help preserve fish through a smoking process that enables the product to be stored long term, since electricity for refrigeration is scarce.[262]

[257] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf Pg. 14, 46.
[258] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf Pg. 46.
[259] Republic of Liberia. (2014) Fisheries and Aquaculture Policy and Strategy. https://www.moa.gov.lr/doc/fisheries_policy_doc.pdf .Pg.7
[260] Liberia 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. Pg. 14-15.
[261] Conservation International and Global Environment Facility. (2015) "Review of the status, distribution and importance of mangrove habitats in Liberia."
[262] The Global Gender Office, International Union for Conservation of Nature - IUCN (2012) Climate Change Gender Action Plan for the Government of Liberia. https://www.climatelinks.org/resources/liberia-climate-change-gender-action-plan-ccgap-report.

Extreme events and climate change are expected to further negatively impact ecosystems that support fisheries, resulting in reduced availability of this resource and, consequently, decreasing the amount of fish that is available for local consumption and for production. This could result in impacts on food security, reduced income from the fisheries sub-sector, as well as effects on the communities and people that depend on this resource.[263] It is estimated that around half of the coastal population (including women and local communities) depend to some extent on fisheries, and about 11,250 people are employed by this sub-sector.[264,265]

These climate impacts make the fisheries sector highly sensitive to climate change, and Liberia's 2015 NDC identifies several adaptation options to address them. These actions will also contribute to the achievement of the Sustainable Development Goals (SDGs), in particular, SDG 14 - Life Below Water, as well as SDG 2 - Zero Hunger, SDG 12 - Sustainable Consumption & Production, and SDG 13 - Climate Action.

The National Fisheries & Aquaculture Authority (NaFAA) is the main agency responsible for the management of all fishery resources in Liberia.[266] The Environmental Protection Agency (EPA) is responsible for environmental monitoring and management, as well as the supervision of the Environmental Impact Assessments and permits for fisheries infrastructure.[267] The NaFAA also coordinates with other entities including the National Port Authority and the Liberia Maritime Authority, among others.[268]

Existing NDC Targets

Table 9.1. Existing Mitigation Targets and Activities in 2015 NDC – Fisheries.

Mitigation Targets and Activities in 2015 NDC – Fisheries Sector		
Sectoral Quantitative Target (if applicable)	**Sub-targets and activities identified**	**Baseline information used for current NDC target**
Not stated.	*Mitigation activities from the fisheries sector are not included in Liberia's 2015 NDC.*	*Not stated.*

Source: Information from Liberia Initial Nationally Determined Contribution (2015).[269]

[263] Liberia 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. Pg. 15.

[264] Fobissie, Kalame et al. (2019) Climate Vulnerability and Risk Assessment for the Sectors of Agriculture, Fisheries and Forestry in Liberia.

[265] The Global Gender Office, International Union for Conservation of Nature - IUCN (2012) Climate Change Gender Action Plan for the Government of Liberia. https://www.climatelinks.org/resources/liberia-climate-change-gender-action-plan-ccgap-report.

[266] Fobissie, Kalame et al. (2019) Climate Vulnerability and Risk Assessment for the Sectors of Agriculture, Fisheries and Forestry in Liberia.

[267] Sherif, Sheck Abdul (2014) "The development of fisheries management in Liberia: vessel monitoring system (vms) as enforcement and surveillance tools: national and regional perspectives". World Maritime University Dissertations. http://commons.wmu.se/all_dissertations/462.

[268] National Port Authority of Liberia. (2018) Overview of the authority. http://www.npaliberia.com/corporate/overview/.

[269] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC), emphasis added. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

Table 9.2. Existing Adaptation Targets and Activities in 2015 NDC – Fisheries.

Adaptation Targets and Activities in 2015 NDC – Fisheries Sector		
Sectoral Quantitative Target (if applicable)	**Sub-targets and activities identified**	**Baseline information used for current NDC target**
Not stated.	Strengthen institutional and local capacity and monitoring systems for fishery management.	*Not stated.*
	Develop and implement climate smart fishery systems to enhance the adaptive capacity and resilience of fisher communities.	
	Identification and conservation of endangered fish species.	

Source: Information from Liberia Initial Nationally Determined Contribution (2015).[270]

Existing Relevant Policies, Strategies and Plans

The climate change related policies that include references to the fisheries sector were reviewed in order to examine their targets and strategies for this specific sector. The most relevant and updated policies were part of this review process:

- ✓ National Policy and Response Strategy on Climate Change (August 2018);
- ✓ Liberia National Adaptation Programme of Action (NAPA) (2008);
- ✓ Pro-Poor Agenda for Prosperity and Development (PAPD) (2018);
- ✓ Liberia National Communication (2013); and
- ✓ Climate Change Gender Action Plan for the Government of Liberia (2012).

The most relevant sector specific policies were also identified and reviewed:

- ✓ Liberia Blue Oceans Conference Report (2019);
- ✓ Food and Agriculture Policy and Strategy (2008);
- ✓ Fisheries and Aquaculture Policy & Strategy (2014) (*overarching vision by 2030)*;
- ✓ National Biodiversity Strategy and Action Plan – II 2017-2025 (2017);
- ✓ Climate Vulnerability and Risk Assessment for the Sectors of Agriculture, Fisheries and Forestry in Liberia (2019); and
- ✓ Act to Amend the National Fisheries and Aquaculture Authority Law by Adding thereto the Fisheries and Aquaculture Management and Development (2019).

In 2018, the National Policy and Response Strategy on Climate Change (NPRS) presented eleven targets related to climate adaptation in the fisheries sector. These proposed activities built on the goals outlined in the NDC from 2015 with the ultimate objective of "Recognizing the importance of fisheries as major contributor to food supply, food security and livelihoods, adopt policies and programmes that maintain and protect the integrity of Liberia's fishery sector."[271]

[270] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC), emphasis added. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

[271] Liberia 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.

Fisheries Sector Strategies from the National Policy and Response Strategy on Climate Change (2018):

Adaptation Strategies:

- Investment and support for **artisanal fishery communities**, including training, fishing gears and alternative livelihood.
- Set up a robust **monitoring, reporting and verification system** that captures and reports in a timely and accurate manner changes in the stock, productivity, and pressure on fisheries.
- Use the **precautionary principle** as a cue, use information from monitoring to **implement adaptive management practices** that set catch limits based on changes in recruitment, growth, survival and reproductive success.
- Conduct research to fully **understand fishing pressures and adjust quotas to sustainable levels**, as well as into predicting where fish populations will move; finding species resistance to salinity and temperature fluctuations for aquaculture and, where necessary, support selective breeding for increased resilience in aquaculture.
- Support the **protection and restoration of mangroves**, recognizing their role as an important habitat for aquatic species, which contributes to biodiversity and increased food product availability for household consumption and resources for local markets, as well as providing water filtration services.
- Identify 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** and encouraging **native aquaculture species** to reduce impacts.
- Put in place or strengthen a system to reduce external stressors on fisheries by instituting **changes in vessel or gear types in order to reduce pressure on fishery** and to contribute to their sustainable harvesting, as well as 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).
- **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.
- Support the **diversification of the livelihood portfolio** of communities that are fishery dependent.
- Establish **improved information and communication networks for decision making and planning**, as well as between fishing communities, to support information sharing about potential shocks in the system.

Source: National Policy and Response Strategy on Climate Change (2018). Emphasis added.

Fisheries Sector Adaptation Strategies from Liberia National Adaptation Programme of Action (NAPA) (2008):

- Reducing the **number of fishing licenses issued to foreign vessels**;
- Raising the **licensing fee for demersal trawlers**;
- Regulating fishing practices to **prevent overexploitation** and fishing in restricted areas;
- Instituting **appropriate surveillance** of Liberian fishing waters;
- Funding research aimed at **fishery-related database development**; and

- Formulating a **national fishing policy**.

Source: Liberia National Adaptation Programme of Action (2008). Emphasis added.

Selected climate-related strategies from the Fisheries and Aquaculture Policy & Strategy (2014):

- Restoring **fish biomass capacities** to produce at **maximum sustainable yield levels**;
- **Conserving of aquatic ecosystems** associated with fish production;
- Encouraging **community and stakeholder participation** in fisheries management;
- Implementing effective **Monitoring, Control and Surveillance (MCS)** mechanisms; and
- Developing and promoting **conflict management mechanisms** and structures for sustainable management of the fisheries resources.

Source: Liberia Fisheries and Aquaculture Policy & Strategy (2014). Emphasis added.

Review of NDC Targets

GHG Emissions Data. Emissions attributed to fisheries were not specifically addressed in the Initial National Communication (whereby fisheries are considered a component from the agriculture sector), or the country's greenhouse gas inventory, so there are no official figures on emissions from the fisheries sector used by the government.

Sources of emissions. The fisheries sector is responsible for GHG emissions worldwide, with estimates showing "(…) that the world's fishing fleets in 2011 burned 40 billion litres of fuel and emitted 179 MT CO_2e GHGs to the atmosphere, or 2.2 kg CO_2e per kg of landed fish and invertebrates."[272] Nevertheless, no information on sources of greenhouse gas emissions from the fisheries sub-sector is available in Liberia's Initial National Communication or in other national policies. Although there is no official information, we note that considering the value chain of fisheries in the country, cooking practices fall into sources of GHG emissions, and we should therefore consider how these fit into household emissions.

Mitigation and Adaptation Opportunities for Fisheries

In terms of data regarding the availability of fish stock resources, the latest study was undertaken in 1984 and showed an estimated availability of 800,000 metric tons of fish in Liberia. No further assessments have been performed in more than 25 years, which means that no updated information regarding marine biomass is available.[273] In order to properly assess the needs for adaptation, pressures and possible impact of climate change in the availability of these resources and impact in food security, it would be advisable to update this data.

[272] Parker et al. (2018) Fuel use and greenhouse gas emissions of world fisheries. https://doi.org/10.1038/s41558-018-0117-x.
[273] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf.

Scientific-led research from the year 2013 produced an analysis with estimated catches until the year 2010, which is helpful to understand the dynamics and impacts of the different types of fishing.[274] According to this study, between 1950 and 2010, about 4 million tons of fish were caught in Liberia (although this value differs to the one reported to the Food and Agriculture Organization (FAO)). Illegal and unreported fishing in the country has led to the loss of up to $75 million USD per year for the Liberian economy.[275] An adequate monitoring and control system would enable these financial resources to be formally captured in the economy, while still contributing to food availability in the country. Aquaculture is one of the most promising areas for growth in the fisheries sub-sector, since it could potentially lead to the production of 15,000 tons by the year 2030.[276] "Aquaculture thus has the potential to enhance food security under a changing climate scenario in Liberia. Species raised by fish farms include salmon, tilapia, and catfish."[277] It should be noted that aquaculture that occurs on land or on the coast (e.g. fish and shrimp ponds), which may reduce the effectiveness of adaptation measures and/or increase GHG emissions, such as through deforestation or nutrient pollution.

Some adaptation activities for the fisheries sub-sector may include: identifying and protecting valuable ecosystems, capacity building, monitoring, fishing processing (e.g. smoked fish production using alternative energy sources), mainstreaming fisheries and aquaculture into climate change and food security policies, reducing external stressors, diversifying across species and livelihoods, among others.[278] Measures in this sector can contribute to SDG 14 - Life Below Water, which aims to conserve and sustainably use the oceans, seas and marine resources for sustainable development, and SDG 2 - Zero Hunger, which aims to achieve food security and improved nutrition and promote sustainable agriculture.[279]

It is also worth noting that Liberia is one of the countries participating in the Programme for Improved Regional Fisheries Governance in Western Africa (PESCAO), funded by the European Union and implemented in the Economic Community of West African States (ECOWAS) Commission to enhance cooperation between countries in the region and the sub-regional fisheries organizations. This program specifically aims to: a) Address regional fisheries policy; b) Build capacity for national and regional monitoring, control and surveillance to address illegal, unreported and unregulated fishing (IUU); and c) Demonstrate the importance of regional and coordinated approaches for shared fisheries management.[280] Regional collaboration can further contribute to closing some of the existing gaps, as well as addressing climate change impacts for the fisheries sector in Liberia.

[274] Belhabib et al. (2013) When 'reality leaves a lot to the imagination': Liberian fisheries from 1950 to 2010. http://www.seaaroundus.org/doc/publications/wp/2013/Belhabib-et-al-2013-Liberia.pdf.
[275] Belhabib et al. (2013) When 'reality leaves a lot to the imagination': Liberian fisheries from 1950 to 2010. http://www.seaaroundus.org/doc/publications/wp/2013/Belhabib-et-al-2013-Liberia.pdf.
[276] Republic of Liberia. (2014) Fisheries and Aquaculture Policy and Strategy. https://www.moa.gov.lr/doc/fisheries_policy_doc.pdf .Pg.7.
[277] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf Pg. 111.
[278] Shelton, Claire. (2015) FAO Fisheries and Aquaculture Circular No. 1088: CLIMATE CHANGE ADAPTATION IN FISHERIES AND AQUACULTURE Compilation of initial examples. http://www.fao.org/3/a-i3569e.pdf Pg. 3.
[279] United Nations. Sustainable Development Goals Knowledge Platform. https://sustainabledevelopment.un.org/.
[280] Fisheries Committee for the West Central Gulf of Guinea. 2020. PESCAO. https://fcwc-fish.org/projects/pescao.

Institutional Framework

Several agencies have mandates related to the fisheries sector in Liberia, which is outlined in Table 9.3 below. The Ministry of Agriculture had a Bureau of National Fisheries (BNF) in place until the year 2017; this was the main agency in charge of fishery in the country. Since the BNF ceased to exist, the National Fisheries & Aquaculture Authority (NaFAA) was created for the management of all fishery resources in the country, with the core responsibilities in this area. It coordinates with other authorities including the National Port Authority, Liberia Maritime Authority, and the EPA.

Table 9.3. Institutions and agencies with mandates on fisheries in Liberia.

Institution	Main Mandate
National Fisheries & Aquaculture Authority (NaFAA)	• The NaFAA is an autonomous body with a mandate based on the former Bureau of National Fisheries, which functioned as one of the units within the Ministry of Agriculture until 2017. • Its main mandate is to manage, conserve, and develop all fisheries resources which are the natural habitat and natural assets, heritage, and sovereign rights of the Liberian people. • Ensuring that fisheries and aquaculture resources are used sustainably to achieve socio-economic benefits.
National Port Authority (NPA)	• Manages, plans, and builds all public ports in Liberia.
Liberia Maritime Authority	• Manages commercial activities within the maritime domain of Liberia.
Environmental Protection Agency (EPA)	• Environmental monitoring and management: ○ Limiting of excessive exploitation and pollution of the fisheries waters. ○ Supervision of Environmental Impact Assessment processes in the establishment of fisheries infrastructure.

Source: Adapted from Climate Vulnerability and Risk Assessment for the Sectors of Agriculture[281]; Fisheries and Forestry in Liberia (2019); National Fisheries & Aquaculture Authority (2020)[282]; National Port Authority of Liberia (2018) [283]; Sherif, Sheck Abdul (2014)[284]; Fisheries and Aquaculture Policy and Strategy (2014) [285]; Liberia Maritime Authority (2019)[286].

Cost and Investment Opportunities

The 2018 National Policy and Response Strategy on Climate Change included an "Action Plan and Resource Mobilization Plan," which outlines specific activities for undertaking climate action in each sector between 2017-2026. Table 9.4 below includes information regarding the activities, estimated costs and relevant government implementing agencies, as outlined in the 2018 Resource Mobilization Plan.[287]

[281] Fobissie, Kalame et al. (2019) Climate Vulnerability and Risk Assessment for the Sectors of Agriculture, Fisheries and Forestry in Liberia.

[282] National Fisheries & Aquaculture Authority. (2020) Who we are. https://www.nafaa.gov.lr/index.php/about-nafaa/about-nafaa/who-we-are.

[283] National Port Authority of Liberia. (2018) Overview of the authority. http://www.npaliberia.com/corporate/overview/.

[284] Sherif, Sheck Abdul (2014) "The development of fisheries management in Liberia: vessel monitoring system (vms) as enforcement and surveillance tools: national and regional perspectives". World Maritime University Dissertations. http://commons.wmu.se/all_dissertations/462.

[285] Government of Liberia. (2019) Act to Amend the National Fisheries and Aquaculture Authority Law by Adding Thereto the Fisheries and Aquaculture Management and Development. http://extwprlegs1.fao.org/docs/pdf/lbr192628.pdf.

[286] Liberia Maritime Authority. (2019) Brief History http://www.lima.gov.lr/index.php/lima/history.html.

[287]Liberia 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.

Table 9.4. Action Plan for the Implementation of Strategic Interventions – Fisheries.

Sectoral and Cross-Sectoral Intervention for Adaptation: Fisheries					
Strategic Interventions	**Intervention Period** (Years 2017 to 2026)			**Estimated Cost** (Million USD)	**Implementing Agencies**
	(1-3) Short-term	(4-5) Mid-term	(6-10) Long-term		
Strengthen the capacity of the Bureau of National Fisheries including manpower and logistic for research, monitoring and enforcement	X	X	X	1	BNF, National Coast Guard, EPA, MoFDP, Universities and Colleges
Invest in and support artisanal fisher communities, including the provision of training, fishing gears and alternative livelihood.	X	X	X	3	EPA, MICAT, BNF, MoGCSP, MoFDP
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; and implement adaptive management practices for managing the sector.	X	X	X	0.5	BNF, EPA, MoFDP
Support research to fully understand pressures on fishery related to climate change impacts and identify appropriate measures including diversification of livelihood portfolio of fishery dependent communities.	X			0.1	EPA, MICAT, BNF, MoGCSP, MoFDP, Universities and Colleges
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.	X	X	X	0.5	BNF, LISGIS, LHS, FDA, EPA, MoFDP
Support the establishment of a system to reduce external stressors on fisheries by instituting changes in vessel or gear types as well as 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).	X	X		0.20	LISGIS, BNF, MoA, MoC, LHS, EPA, MoFDP
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.	X	X		0.25	BNF, MoA, EPA, MoFDP
Support the diversification of the livelihood portfolio of communities that are fishery dependent	X	X	X	2	MoA, BNF, EPA, MoFDP
Support the establishment of early warning systems to identify probable threats and risks related to fisheries.	X	X		1	BNF, MoT, EPA, MoFDP
Support the establishment of improved information and communication networks for decision making and planning as well as between fishing communities to support information sharing about potential shocks in the system.	X	X	X	0.30	MoA, BNF, MICAT, EPA, MoFDP

Source: Adapted from National Policy and Response Strategy on Climate Change (2018).[288]

Agency abbreviations: BNF= Bureau of National Fisheries *(BNF ceased to exist in 2017, the current equivalent would be the National Fisheries & Aquaculture Authority – an autonomous body*) ; EPA= Environmental Protection Agency; LISGIS= Liberia Institute of Statistics and Geoinformation

[288] Liberia 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.

Services; LHS= Liberian Hydrological Services; MICAT= Ministry of Information, Cultural Affairs & Tourism; MoA= Ministry of Agriculture; MoFDP= Ministry of Finance & Development Planning; MoGCSP= Ministry of Gender, Children & Social Protection; MoT= Ministry of Transport.

Policy Gaps and Challenges

Challenge: Management and access to fishery resources under a changing climate. One of the main challenges is the inexistence of an appropriate system to manage and allocate the responsible use of fish resources, including under a changing climate.[289] Fish stocks must be managed in a way that can ensure that they will not be depleted rapidly: "Decisions about who can and who cannot fish are fundamental to managing the sub-sector and will impact the type of management system and measures applied."[290] The recently approved, Act To Amend The National Fisheries And Aquaculture Authority Law By Adding Thereto The Fisheries And Aquaculture Management And Development (2019), aims to tackle that challenge by including a chapter concerning the conservation, management and sustainable use of fisheries, whereby the NaFAA is enabled to establish fishing rights, fisheries management plans and other measures.[291] However, since this law was approved in November 2019, as of the date of this report, there is no available information regarding its implementation. An integrated and climate-adaptive approach to management of the rights to fish is urgent to ensure its availability for future generations.

Challenge: Weak institutional capacities for monitoring and control. Another major challenge identified in Liberian policies is the "Weak institutional capacities for planning, advice, regulation and monitoring (…)."[292] This is especially relevant to ensure that regulations are followed with relation to the use of gear, reporting information about the number of catches, as well as any illegal activity that can be detrimental to the fish stock and its management.[293] Collaborative approaches like the PESCAO Programme from ECOWAS are intended to strengthen these capacities at both national and regional level, especially to tackle IUU fishing.

Challenge: Lack of reliable data, underreporting and limited understanding of climate change impacts on fisheries. Better information is required to understand the main geographic areas under pressure, which specific resources need more attention, how those pressures will change over time with climate change, and what is the best way to manage fisheries in Liberia. There is not enough information and data on fish stocks, and illegal fishing is not addressed.[294] A 2013 study suggests that the data reported by the government of Liberia to FAO regarding the total amount of catches of fish between 1950-2010 only

[289] Ministry of Agriculture of the Republic of Liberia. (2008) Food and Agriculture Policy and Strategy. http://www.moci.gov.lr/doc/Food%20and%20Agriculture%20Policy%20and%20Strategy.pdf.
[290] Republic of Liberia. (2014) Fisheries and Aquaculture Policy and Strategy. https://www.moa.gov.lr/doc/fisheries_policy_doc.pdf.
[291] Government of Liberia. (2019) Act to Amend the National Fisheries and Aquaculture Authority Law by Adding Thereto the Fisheries and Aquaculture Management and Development. http://extwprlegs1.fao.org/docs/pdf/lbr192628.pdf.
[292] Ministry of Agriculture of the Republic of Liberia. (2008) Food and Agriculture Policy and Strategy. http://www.moci.gov.lr/doc/Food%20and%20Agriculture%20Policy%20and%20Strategy.pdf. Pg 37.
[293] Republic of Liberia. (2014) Fisheries and Aquaculture Policy and Strategy. https://www.moa.gov.lr/doc/fisheries_policy_doc.pdf.
[294] Ministry of Agriculture of the Republic of Liberia. (2008) Food and Agriculture Policy and Strategy. http://www.moci.gov.lr/doc/Food%20and%20Agriculture%20Policy%20and%20Strategy.pdf. Pg 37.

represents a fifth of the actual catch estimates.[295] An adequate reporting system is needed, and more research will be required to produce some of this data.

Gap: Inexistent information on GHG emissions from the fisheries sub-sector. As noted above, there is no information in the Initial National Communication regarding the GHG emissions from the fisheries sub-sector. Some of the sources of greenhouse gas emissions in fisheries can come from energy used in the form of gas or diesel oil and the residual fuel oil (distillation residue) from this sub-sector.[296] Furthermore, according to Shelton, Claire (2015): "Fisheries and aquaculture contribute global greenhouse gas emissions (GHGs) during fish capture or growth, processing, transportation and storage. However, there are many different kinds of fisheries with many different fuel requirements. These range from small low-power single engines to larger vessels to fish factory ships."[297] Understanding GHG emissions during the post-harvest phase of the sector in Liberia is critically important, especially given the reliance on smoking fish products for preservation (using mangrove wood). Information on GHG emissions from this sector would help determine or establish mitigation alternatives to reduce such emissions.

Sectoral Recommendations for Consideration

The targets for the fisheries sub-sector as outlined in the NDC cover the most pressing needs to support Liberia's climate and sustainable development goals. The recommendations below are focused on refining and elaborating these goals to make them more specific and tangible. These refined targets may belong as part of the revised NDC or in a detailed implementation plan.

Recommendation 1: Set timelines and further specify existing targets.

The NDC has laid out adaptation targets for the fisheries sub-sector. However, neither one of the targets has a timeline for implementation; therefore, we recommend the inclusion of a timeline to ensure that these measures and targets are enforceable, and implementors are held accountable. Additionally, the implementation activities and their scope should be further specified for these targets.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the further specification and timelines for improved targets from the fisheries sector.

Recommendation 2: Enhance the target to broaden scope of research.

Undertaking research and obtaining data to evaluate the impacts of climate change in the fisheries sub-sector, as well as data regarding the status of stocks and fisheries, has been a recurring strategy among

[295] Belhabib et al. (2013) When 'reality leaves a lot to the imagination': Liberian fisheries from 1950 to 2010. http://www.seaaroundus.org/doc/publications/wp/2013/Belhabib-et-al-2013-Liberia.
[296] Food and Agriculture Organization of the United Nations. (2015) Estimating Greenhouse Gas Emissions in Agriculture A Manual to Address Data Requirements for Developing Countries. http://www.fao.org/3/a-i4260e.pdf.
[297] Shelton, Claire. (2015) FAO Fisheries and Aquaculture Circular No. 1088: CLIMATE CHANGE ADAPTATION IN FISHERIES AND AQUACULTURE Compilation of initial examples. http://www.fao.org/3/a-i3569e.pdf Pg. 3.

some of the reviewed Liberian policies reviewed for this section.[298,299] The NPRS has included the following strategy to address the need for data: "Support research to fully understand pressures on fishery related to climate change impacts and identify appropriate measures including diversification of livelihood portfolio of fishery dependent communities."[300] Critical to this research is understanding how fishing communities are currently responding to environmental change by surveying existing coping and adaptation mechanisms and the enabling conditions that can facilitate action. We recommend the existing adaptation target of "identification and conservation of endangered fish species" be enhanced by broadening the scope of research and data to include impacts of climate change, as well as an assessment of the country's marine biomass.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the enhancement of the target to broaden the scope of research to include the impacts of climate change and the status of the fisheries stocks.

Recommendation 3: Define rules around allocation and fishing rights.

The existing NDC target regarding "climate smart fishery systems to enhance the adaptive capacity and resilience of fisher communities" could be enhanced to include a specific sub-target related to the definition and allocation of clear fishing rights. "For capture fisheries, adaptation involves adjusting fishing pressure to sustainable levels. Setting catch limits based on changes in recruitment, growth, survival and reproductive success can be done via adaptive management, monitoring and precautionary principles."[301] The Fisheries and Aquaculture Policy and Strategy (2014) has already included the establishment of a collaborative management approach for allocating and managing fishing rights.[302] Although the Act to Amend the National Fisheries and Aquaculture Authority Law by Adding thereto the Fisheries and Aquaculture Management and Development (2019) enables the NaFAA to establish fishing rights, fisheries management plans, and other measures, questions about how that will be operatized still remain.[303] This is especially relevant given that there are concerns about protecting artisanal and small scale fisheries that can often compete for resources with industrial fisheries and that an integral approach to management of the rights to fish is urgent to ensure the availability of this resource for future generations.[304]

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of an improved target that includes fishing rights and management plans. Noting the significant issues around Illegal, Unregulated, and Unreported (IUU) fishing in Liberia,

[298] Republic of Liberia. (2014) Fisheries and Aquaculture Policy and Strategy. https://www.moa.gov.lr/doc/fisheries_policy_doc.pdf.
[299] Liberia 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.
[300] Liberia 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.
[301] Shelton, Claire. (2015) FAO Fisheries and Aquaculture Circular No. 1088: CLIMATE CHANGE ADAPTATION IN FISHERIES AND AQUACULTURE Compilation of initial examples. http://www.fao.org/3/a-i3569e.pdf Pg. 3.
[302] Republic of Liberia. (2014) Fisheries and Aquaculture Policy and Strategy. https://www.moa.gov.lr/doc/fisheries_policy_doc.pdf.
[303] Government of Liberia. (2019) Act to Amend the National Fisheries and Aquaculture Authority Law by Adding Thereto the Fisheries and Aquaculture Management and Development. http://extwprlegs1.fao.org/docs/pdf/lbr192628.pdf.
[304] Republic of Liberia. (2014) Fisheries and Aquaculture Policy and Strategy. https://www.moa.gov.lr/doc/fisheries_policy_doc.pdf.

particular attention should be focused on tangible targets and next steps to achieve a "robust monitoring, reporting, and verification system", as described in the 'Fisheries Sector Adaptation Strategies from the National Policy and Response Strategy on Climate Change (2018)'.

Recommendation 4: Support artisanal fisher communities.

Building on the NPRS adaptation strategy to "Invest in and support artisanal fisher communities, including the provision of training, fishing gears and alternative livelihood,"[305] we would recommend the inclusion of an adaptation target in the NDC that ensures that these needs are met to enable artisanal fisher communities to adapt to climate change. However, this target must be formulated in a way that can ensure that women and men from fisher communities have equitable access to these resources and training since, traditionally, "The technological bias that favors men, particularly in fisheries projects, also contributes to the inferior position and suppressed rights and privileges of women in the fishing sector. Women involvement in processing and marketing, though recognized, needs to be considered to a larger extent in the planning of fisheries development projects."[306]

<u>Recommendation to be refined:</u> As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of a target that includes support and provides training to artisanal fisher communities, particularly those that are most likely to be affected by climate change (please refer to recommendation 2), including reef-associated fishes.[307]

Recommendation 5: Inclusion of a new target related to conservation of mangroves.

The NPRS has included the following strategy: "Support the protection and restoration of mangroves, recognizing their role as an important habitat for aquatic species, which contributes to biodiversity and increased food product availability for household consumption and resources for local markets, as well as providing water filtration services."[308] Moreover, as a result of the Blue Oceans Conference Report from Liberia in 2019, the government already made a voluntary commitment to a no net loss of mangroves post 2020 through conservation and restoration programs and projects.[309] Building on these strategies and commitments, the conservation and restoration of mangroves should be included as a new adaptation target for the fisheries sub-sector within the NDC, due to the fundamental role it plays in providing a habitat for fisheries, food security, and the positive impact it has in the livelihoods of the communities that depend on this sub-sector.[310] This target should be formulated in conjunction with the revision of Coastal Zones section of the NDC.

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[305] Liberia 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.

[306] The Global Gender Office, International Union for Conservation of Nature - IUCN (2012) Climate Change Gender Action Plan for the Government of Liberia. https://www.climatelinks.org/resources/liberia-climate-change-gender-action-plan-ccgap-report. Pg 50.

[307] Information on reef associated fish in Liberia: https://www.fishbase.de/Country/CountryChecklist.php?c_code=430&vhabitat=reef.

[308] Liberia 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.

[309] Blue Oceans Conference. (2019) Liberia Blue Oceans Conference Report.

[310] Shelton, Claire. (2015) FAO Fisheries and Aquaculture Circular No. 1088: CLIMATE CHANGE ADAPTATION IN FISHERIES AND AQUACULTURE Compilation of initial examples. http://www.fao.org/3/a-i3569e.pdf Pg. 5.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of a target that includes the conservation and restoration of mangroves to contribute to the adaptation from the fisheries sub-sector, which should be aligned with the Blue Oceans Conference commitments from the EPA and the Government of Liberia.

Recommendation 6: Enhance the target to include sub-targets for aquaculture fisheries.

Aquaculture can play a significant part in adaptation within the fisheries sector since it has a huge potential to grow and contribute to food security amidst the unforeseen impacts of climate change. The Fisheries and Aquaculture Policy Strategy already includes specific interventions regarding this sub-sector, including "*identification of areas of high potential aquaculture zones where land-based aquaculture can be permitted land use and ecologically sustainable*" and research and identification of suitable species for aquaculture.[311] The Initial National Communication has also addressed aquaculture as one of the most promising fisheries for Liberia.[312] The NDC could enhance its adaptation target related to the implementation and development of smart fishery systems, to include specific targets for aquaculture fisheries given their importance. Any development of aquaculture production systems should be based on the best global practices and carefully consider impacts on mangroves and other coastal habitat destruction.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the enhancement of the existing target to include an aquaculture specific sub-target paying specific attention to avoid potential negative impacts of growing that sector on coastal and near shore systems.

Recommendation 7: Improve regional cooperation.

Building on the voluntary commitments set out in the Blue Oceans Conference to: *"Ratify and implement the Port State Measures Agreement as a mechanism for tackling illegal, unreported and unregulated (IUU) fishing*,"[313] and similar strategies stablished in the Fisheries and Aquaculture Policy & Strategy,[314] we recommend the inclusion of an additional target related to the need to improve cooperation with other countries from the region, especially in West Africa, to address climate-change impacts on trans-boundary fisheries (i.e., additional shifts in species distributed across multiple national jurisdictions). Liberia has since ratified the Port State Measures Agreement, but further work and resources are needed to support full implementation. Liberia could look to countries that have already ratified and are implementing the Port State Measures Agreement for lessons and best practices in their own application, while also leaning

[311] Republic of Liberia. (2014) Fisheries and Aquaculture Policy and Strategy. https://www.moa.gov.lr/doc/fisheries_policy_doc.pdf.
[312] Liberia Environmental Protection Agency. (2013) Liberia Initial National Communication. https://unfccc.int/resource/docs/natc/lbrnc1.pdf. Pg. 111.
[313] Blue Oceans Conference. (2019) Liberia Blue Oceans Conference Report.
[314] Republic of Liberia. (2014) Fisheries and Aquaculture Policy and Strategy. https://www.moa.gov.lr/doc/fisheries_policy_doc.pdf.

on ECOWAS for a common regional approach to fisheries management and a joint monitoring and control mechanisms to address IUU fishing across the region.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the inclusion of a new target to improve regional cooperation for this sector.

Recommendation 8: Take stock of progress made in implementing existing fisheries sector policies and the NDC. ***[Linkages with other sectors]***

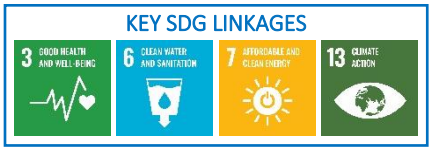
In the process of reviewing and updating the NDC, it is critical to take stock of progress made toward implementing existing sectoral and climate change targets and plans. The revised NDC should be informed by experiences, challenges, and lessons learned from implementing current targets and plans in the fisheries sector. The stakeholder consultation process should identify any changes in national circumstances, political priorities, development priorities, and efforts to achieve SDGs (including progress made toward relevant sectoral SDG targets), which can help identify new opportunities and synergies to pursue emissions reduction strategies within the context of national priorities. The work done by EPA under the ongoing Second National Communication can provide a useful input into this stocktaking process.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders could contribute to identify new opportunities for mitigation strategies.

Recommendation 9: Consider linkages with national COVID response and recovery priorities as part of the update of NDC targets for this sector. ***[Linkages with other sectors]***

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of this recommendation.

Sector Highlight: Health



National Sectoral Context

Liberia has set a target of becoming a middle-income country by 2030,[315] and the health and social welfare of the population is critically important in achieving that goal.[316] Since 2006, the Government of Liberia has invested heavily in health care and infrastructure development, specifically in the improvement of the road network in order to improve rural access to healthcare facilities.[317] Nonetheless, access to health services particularly for rural populations, built infrastructure for primary, secondary and tertiary facilities, availability of medical supplies, and clinical care development remain significant limitations at the national and county levels.

Health impacts of a changing climate include: increased spread or range of diseases, physical risks from flood, heat stress, or other extreme climate events, nutritional and developmental impacts from food insecurity, air pollution (particularly indoor pollution), and physical damage to built infrastructure disrupting delivery or quality of health services. This includes increases in the spread of disease from food- and waterborne pathogens (such as cholera, typhoid and diarrhea) as well as those caused by vector-borne diseases (such as malaria, dengue fever, yellow fever, onchocerciasis and schistosomiasis).[318] In addition, vector-borne diseases which have aquatic phases and changes in the pattern of rainfall – and subsequent habitat change – will therefore also affect their epidemiology. Other climate-sensitive diseases of concern to the country include respiratory disease (such as tuberculosis) and disease

[315] Ministry of Health and Social Welfare. (2011) National Health and Social Welfare Policy and Plan. https://extranet.who.int/countryplanningcycles/sites/default/files/country_docs/Liberia/ndp_liberia.pdf.
[316] Ministry of Health and Social Welfare. (2007). National Health Policy. https://www.who.int/hac/techguidance/training/analysing_health_systems/Liberia_national_health_policy_2007.pdf.
[317] Liberia Ministry of Justice. (2012) 2012 National Sustainable Development Report. https://sustainabledevelopment.un.org/content/documents/598liberiantreport.pdf.
[318] Liberia Environmental Protection Agency. (2013) Initial National Communication. http://www.epa.gov.lr/sites/default/files/INITIAL%20NATIONAL%20COMMUNICATION%20LIBERIA.pdf.

associated with, or exacerbated by, malnutrition (such as HIV/AIDS).[319] Increased flood and drought also impact food security, worsening malnutrition and under nutrition, especially among vulnerable populations.[320]

The climate impacts and trends mentioned above make the health sector highly sensitive to climate change, placing additional disease burden and disease outbreaks on an already limited health infrastructure. Adaptation options identified for the health sector include improvements and investments in emergency preparedness for disease outbreaks, gender-differentiated responses for addressing existing health priorities, and scenario development for health planning and responsiveness.[321] The primary focus of the health sector in national climate planning focuses on adaptation to climate impacts and increased capacity to provide health services in the context of a changing climate. 2015 NDC identifies a list of adaptation actions for the health sector, in alignment with the information presented in the 2013 Initial National Communication (INC). Liberia's National Health and Social Welfare Policy and Plan (2011-2021) does not specify climate impacts, but covers emergency preparedness planning, coordination and increased capacity to respond to population displacement and disease outbreaks with epidemic potential.[322] Together with the water, sanitation, and hygiene (WASH) interventions that focus on environmental and community health, programs and strategies for enhancing WASH activities in communities is an entry point for adaptation efforts in the health sector.[323] These adaptation options also contribute to the achievement of the Sustainable Development Goals (SDGs), in particular, SDG 3 - Good Health & Well-being, as well as SDG 6 - Clean Water & Sanitation, SDG 7 - Affordable & Clean Energy, and SDG 13 - Climate Action.

The Ministry of Health and Social Welfare (MHSW) is the authority mandated to reform and manage the health sector to deliver comprehensive health and social welfare services that are "equitable, accessible and sustainable for all people in Liberia.[324] Importantly, the structure of public health services is decentralized, with services and policy oversight administered at the county level, and policy development, standards, and resource mobilization and allocation administered at the national level. MHSW participates at the national level in Liberia's National Climate Change Steering Committee to provide inputs into national climate planning.

[319] Liberia Environmental Protection Agency. (2013) Initial National Communication. http://www.epa.gov.lr/sites/default/files/INITIAL%20NATIONAL%20COMMUNICATION%20LIBERIA.pdf.
[320] Fortunate, M. (Forthcoming 2020). Draft Technical Report: Mainstreaming Climate Change Considerations into the Relevant Sector Specific Development Programs, Policies, Strategies and Management Plans in Liberia. United Nations Development Programme.
[321] Fortunate, M. (Forthcoming 2020). Draft Technical Report: Mainstreaming Climate Change Considerations into the Relevant Sector Specific Development Programs, Policies, Strategies and Management Plans in Liberia. United Nations Development Programme.
[322] Fortunate, M. (Forthcoming 2020). Draft Technical Report: Mainstreaming Climate Change Considerations into the Relevant Sector Specific Development Programs, Policies, Strategies and Management Plans in Liberia. United Nations Development Programme.
[323] Fortunate, M. (Forthcoming 2020). Draft Technical Report: Mainstreaming Climate Change Considerations into the Relevant Sector Specific Development Programs, Policies, Strategies and Management Plans in Liberia. United Nations Development Programme.
[324] Ministry of Health and Social Welfare. (2011) National Health and Social Welfare Policy and Plan. https://extranet.who.int/countryplanningcycles/sites/default/files/country_docs/Liberia/ndp_liberia.pdf.

Existing NDC Targets

Table 10.1. Existing Mitigation Targets and Activities in 2015 NDC – Health.

Mitigation Targets and Activities in 2015 NDC – Health Sector		
Sectoral Quantitative Target (if applicable)	**Sub-targets and activities identified**	**Baseline information used for 2015 NDC target**
Not stated.	*Mitigation activities from the health sector are not included in Liberia's 2015 NDC*	*Not stated.*

Source: Information from Liberia Initial Nationally Determined Contribution (2015).[325]

Table 10.2 Existing Adaptation Targets and Activities in 2015 NDC – Health.

Adaptation Targets and Activities in 2015 NDC – Health Sector		
Sectoral Quantitative Target (if applicable)	**Sub-targets and activities identified**	**Baseline information used for 2015 NDC target**
Not stated.	• Strengthen **integrated disease surveillance response systems** and **emergency preparedness** to prevent, mitigate, and respond to epidemics. • Strengthen preventive measures to **restrict preventable disease transmission**. • Develop **early warning systems** for climate-driven infectious diseases. • Integrate **climate change considerations into existing health policies and strategies**, taking into account **gender-differentiated impacts** and **responses**. • Conduct **research on health vulnerability and impact**, and **develop scenarios** to facilitate adequate planning.	*Not stated.*

Source: Information from Liberia Initial Nationally Determined Contribution (2015).[326] Emphasis added.

Existing Relevant Policies, Strategies and Plans

Relevant climate change and sectoral policies were reviewed in order to examine their targets and strategies for the health sector. The most relevant and updated strategies and plans were the focus of this review process:

[325] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC), emphasis added. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

[326] Republic of Liberia. (2015) Intended Nationally Determined Contributions (INDC), emphasis added. https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Liberia%20First/INDC%20Final%20Submission%20Sept%2030%202015%20Liberia.pdf.

- ✓ National Policy and Response Strategy on Climate Change (2018);
- ✓ Pro-Poor Agenda for Prosperity and Development (2018);
- ✓ Joint National Action Plan for Health Security (2018-2022);
- ✓ Water Supply and Sanitation Policy (2008);
- ✓ National Health and Social Welfare Policy (2011); and
- ✓ Initial National Communication (2013).

In 2011, Liberia's National Health and Social Welfare Policy established a vision for an expanded health care system with a continued process of decentralization to the county level, increased access to health services, health infrastructure, and information, as well as integrated social welfare services. The policy statement for the health sector in the 2018 National Policy and Response Strategy on Climate Change is to "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 SDG 3 - Good Health & Well-being in the face of climate change and its risks." This list of actions builds on national policies which are specific to the development of the health sector, but do not specifically consider climate change risks and impacts. There is limited integration across many of these strategies and plans, which focus primarily on health services delivery and infrastructure rather than integrating health issues related to a changing climate. While health sector information is included in national climate planning documents and disaster risk management, health sector strategies and policies often do not address climate-specific considerations.

Overall, alignment between the plans and strategies of the health sector and other climate-relevant sectors is low.

Health Sector Strategies from the National Policy and Response Strategy on Climate Change (2018):

Adaptation Strategies:

- Strengthen the **integrated disease surveillance response systems** and the **emergency preparedness** to prevent, mitigate, and respond to climate induced epidemics.
- Strengthen preventive measures to **restrict preventable disease transmission**.
- Develop **early warning systems** for climate-driven infectious diseases.
- **Improved community-level health care** and the **dissemination of information** on changing health risks to enhance the response to climate-related diseases.
- Increased **access to safe water** in order to improve disease vector control.
- Conduct **research on health vulnerability and impact** and **develop scenarios** to facilitate adequate planning.
- 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.
- Conduct periodic **health Impact assessments on proposed mitigation and adaptation strategies** to determine impacts on vulnerable populations and cumulative health impacts.

Source: National Policy and Response Strategy on Climate Change (2018). Emphasis added.

Selected targets from Pro-Poor Agenda for Prosperity and Development (2018):

By 2023, the population will experience increased access and **improved system delivery of quality healthcare and reduced overall morbidity and mortality** with special focus on malaria, major RMNCAH outcomes, **disease surveillance**, and more **effective health financing**; **improved access to safe drinking water and toilet/latrine facility**.

- Maternal mortality ratio: 497 per 100,000 live births by 2023.
- Under 5 Mortality ratio: 57 per 1,000 live births by 2023.
- Under 5 Malnutrition: Reduce stunting to 22 % by 2023.
- Malaria prevalence reduced to 20% by 2023.
- Rural population living beyond 5KM of health service delivery points with health services: 75%.
- 100% of outbreaks responded to within WHO recommended response time (24 to 48 hours) after notification.
- 90 percent of public facilities reporting no stock out of essential medicines by 2023.
- Out of pocket payment for health care: 35% by 2023.

Source: Pro-Poor Agenda for Prosperity and Development (2018). Emphasis added.

Selected interventions from the Joint National Action Plan for Health Security (2018-2022):

- Strengthen capacity for multi-disciplinary RRTs at national & sub-national levels.
- Strengthened institutional and legal system for **disaster risk reduction** in Liberia.
- Conduct all **hazards risk mapping** across the Country.
- Strengthen **regional storage facilities** and preposition MH response supplies including logistics.

Source: Joint National Action Plan for Health Security (2018-2022). Emphasis added.

Selected strategies from the Water Supply and Sanitation Policy (2008):

- Wherever possible community mobilization, development of water supply facilities, hygiene promotion, and the development of sanitation facilities will be facilitated/promoted as part of a **water and sanitation basic services package**.
- **Low cost and affordable technology** will be promoted for water supply systems.
- Proven, locally appropriate, community maintainable technologies, that provide safe drinking water on a continuous basis and that are best suited for local conditions will be promoted. These include dug wells and bore wells with hand pumps, protected springs, gravity pipe schemes, rainwater harvesting, and household water treatment technologies such as chlorination, bio-sand filters, and solar disinfection (SODIS).
- Service providers will deliver **25 liters per person per day of safe water** of WHO Guidelines for Drinking-water Quality or Liberian drinking water quality standards as and when they are framed.
- The **quality of water** supplied from all water supply systems in Liberia shall be **monitored** on a regular basis in accordance with the procedures established by a regulatory board.

- The **sewerage systems** in urban centers will be **restored** as quickly as possible and thereafter expanded gradually.

Source: Water Supply and Sanitation Policy (2008). Emphasis added.

Selected targets from Health and Social Welfare Policy (2011):

The health and social welfare sector can and must become more effective by:

- Improving the timely access to high-impact, **evidence-based interventions** and strengthening referral between all levels of the system;
- Increasing the utilization of services by improving the population's **care-seeking behavior**, the quality of care and the availability of essential drugs and equipment; and
- Improving the coherence between **strengthening the existing workforce, producing additional workers with the right skills mix, deploying according to service delivery needs and retaining skilled providers** where they are most needed.

At the same time, the health and social welfare sector must become more efficient by:

- **Allocating resources** among counties according to equitable criteria and optimally **distributing resources to health facilities according to population size, utilization and workload**;
- Improving the coordination of all efforts to support health and social welfare services, **eliminating duplication and minimizing gaps**; and
- Creating a culture at all levels of the system that values and strives to do more for the population within existing levels of resources.

Source: Liberian Agricultural Sector Investment Plan – LASIP II (2018). Emphasis Added

Selected targets from the Initial National Communication (2013):

Sector	Adaptation Option and Mitigation Measure Identified
Health	Development of a health database management system; Development and implementation of policy and strategic initiatives; and Strengthening of effective capacity.

Source: Initial National Communication (2013).

Review of NDC Targets

Data. Data or evidence used to inform the adaptation activities in health are not referenced in the 2015 NDC.

Mitigation and Adaptation Opportunities for the Health Sector

To be further elaborated in technical consultations with health sector stakeholders as part of the NDC revision process.

UNDP's Report "Mainstreaming climate change considerations into the relevant sector specific development programs, policies, strategies and management plans in Liberia" provides a list of adaptation options in the health sector.

Table 10.3. Adaptation options for the health sector in Liberia.

Action	Strengthen the integration of climate change adaptation into the health sector and the capacity to deal with climate change related disasters and diseases (e.g. early response strategies to deal with disease epidemics).
Sectoral Focus	WASH, public health, communicable – vector transmit diseases
Short-term actions	• Improve public outreach on environmental health issues. • Review and update existing Environmental Impacts Assessment (ESIA) into Environmental Social Health Impacts Assessment (ESHIA) regulations with climate change adaptation considerations. • Undertake a climate vulnerability and risk assessment of the impacts of climate change and variability on human health. • Increase public awareness and social mobilization on climate change and impacts on health. • Strengthen integrated disease surveillance response systems and emergency preparedness to prevent, mitigate, and respond to epidemics. • Strengthen preventive measures to restrict preventable disease transmission. • Develop early warning systems for climate-driven infectious diseases. • Increase public health awareness – disease hazard awareness education. • Disease/vector surveillance and forecast system • Design appropriate climate change related interventions for the health sector. • Establish more effective surveillance and emergency response systems, and sustainable prevention and control programs. • Design appropriate measures for surveillance and monitoring of climate

Source: Report for mainstreaming of climate change considerations into sector specific development programs policies, strategies (2020).[327]

[327] Fortunate, M. (Forthcoming 2020). Draft Technical Report: Mainstreaming Climate Change Considerations into the Relevant Sector Specific Development Programs, Policies, Strategies and Management Plans in Liberia. United Nations Development Programme.

Institutional Framework

The Ministry of Health and Social Welfare (MHSW) is the authority mandated to reform and manage the health sector to deliver comprehensive health and social welfare services that are "equitable, accessible and sustainable for all people in Liberia.[328] Importantly, the structure of public health services is decentralized, with services and policy oversight administered at the county level, and policy development, standards, and resource mobilization and allocation administered at the national level.

Table 10.4. Institutions and agencies with mandates on health in Liberia.

Institution	Mandate
Ministry of Health and Social Welfare (MHSW)	• Reform and manage the health sector to effectively and efficiently deliver comprehensive, quality health and social welfare services that are equitable, accessible and sustainable for all people in Liberia. • Implement projects to reduce vulnerability in areas which are susceptible to climate-sensitive diseases and epidemics. • Mainstream climate change issues in the health sector.

Source: National Health and Social Welfare Policy and Plan (2012).[329]

Costs and Investment Opportunities

The 2018 National Policy and Response Strategy on Climate Change included an "Action Plan and Resource Mobilization Plan," which outlines specific activities for undertaking climate action in each sector between 2017-2026. Table 10.5 below includes information regarding the activities, estimated costs and relevant government implementing agencies related to health, as outlined in the 2018 Resource Mobilization Plan.[330]

Table 10.5. Action Plan for the Implementation of Strategic Interventions – Health.

Sectoral and Cross-Sectoral Intervention Area: Health					
Strategic Interventions	**Intervention Period** (Years 2017 to 2026)			**Estimated Cost** (Million USD)	**Implementing Agencies**
	(1-3) Short-term	(4-5) Mid-term	(6-10) Long-term		
Integrate climate change considerations into existing health policies and strategies, taking into account gender-differentiated impacts and responses	X	X		0.5	MoH, MoGSP, EPA, MoFDP
Strengthen integrated disease surveillance response systems and emergency preparedness to prevent, mitigate, and respond to climate-induced epidemics	X	X		5	MoH, NPHIL, NDMA/MoIA, EPA, MoFDP
Strengthen preventive measures to restrict preventable disease transmission	X	X		3	MoH, NDMA/MoIA MoFDP, EPA

[328] Ministry of Health and Social Welfare. (2011) National Health and Social Welfare Policy and Plan. https://extranet.who.int/countryplanningcycles/sites/default/files/country_docs/Liberia/ndp_liberia.pdf.

[329] Ministry of Health and Social Welfare. (2011) National Health and Social Welfare Policy and Plan. https://extranet.who.int/countryplanningcycles/sites/default/files/country_docs/Liberia/ndp_liberia.pdf.

[330] Liberia 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.

Improved community-level health care and disseminate information on changing health risks to enhance the response to climate-related diseases	X	X	X	5	MoH, MICAT, MoIA, MoFDP, EPA
Promote the use of household level water purification technologies such as water filters that provide access to clean water while reducing demand for firewood used to boil water and, therefore, slowing deforestation.	X	X		2	MoH, FDA, EPA, MoFDP, WASH Commission
Support research on health vulnerability and impact, and develop scenarios to facilitate adequate planning.	X			1	MoH, EPA, MoFDP
Conduct periodic health Impact assessments on proposed mitigation and adaptation strategies to determine impacts on vulnerable populations and cumulative health impacts	X	X	X	5	MoH, NDMA/MoIA, EPA, MoFDP

Source: Adapted from National Policy and Response Strategy on Climate Change (2018).[331]

Agency Abbreviations: MoH = Ministry of Health; MoGSP = Ministry of Gender, Children and Social Protection ; EPA = Environmental Protection Agency; MoFDP = Ministry of Finance & Development Planning; NPHIL = National Public Health Institute of Liberia; NDMA = National Disaster Management Agency of Liberia ; MoIA = Ministry of Internal Affairs ; MICAT = Ministry of Information, Cultural Affairs, and Tourism; FDA = Forestry Development Authority

Policy Gaps and Challenges

The following policy gaps and challenges are present for the health sector in the context of climate change.

Challenge: Health service access in most rural households is limited. Rural households face a compounded effect of climate impacts from decreased productivity of livelihood activities resulting from a changing climate, widespread food insecurity, and a lack of access to affordable basic health care. Additionally, climate impacts on road infrastructure from changing rain patterns or flooding can further limit access to healthcare facilities. Based on the recommendations of the National Health and Welfare Policy, this requires a controlled redistribution of the health network.

Challenge: Health services or skills do not match community health needs.[332] Long waiting times, quality of patient care and a lack of medical supplies result in low use of health services. The provision of priority services at the community level is not organized according to an appropriate mix of clinical skills. There is a need to reassign the priority services provided at the community level.

Gap: The COVID-19 pandemic has revealed limitations to Liberia's intersectoral approach to provision of health services. This can lead to disparities in health outcomes, and varying levels of care across the population.

Gap: Increased flooding and other climate impacts cause contamination of freshwater sources and supplies, including from drinking water suppliers. Drinking water supply and access is essential for human health and hygiene, and reduced supply and access from flooding not only increases the spread of water-

[331] Liberia 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.

[332] Ministry of Health and Social Welfare. (2011) National Health and Social Welfare Policy and Plan. https://extranet.who.int/countryplanningcycles/sites/default/files/country_docs/Liberia/ndp_liberia.pdf.

borne diseases, but also can create water shortages during emergencies. A recent investigation done by EPA identified that many of the sachet water supplies were found to contain high concentration of coliform bacteria and other impurities which can threaten human wealth. This could worsen in consideration of fluctuation and scarcity in quality supply due to climate change and increased urbanization.

Sectoral Recommendations for Consideration

Preparation of health sector recommendations to be developed with inputs from a robust stakeholder input and consultation process. The below suggestions are proposed as a potential starting point for further examination.

Recommendation 1: Identify interlinkages between climate change and health, and opportunities to mainstream climate goals in health sector development plans.

As part of the NDC review and consultation process, strategies for development of the health sector should identify sources of climate-induced impacts on health and characterize the existing points of alignment with national goals for adapting to climate impacts. This could start with a list of multi-sector adaptation priorities and identifying linkages with the health sector to address or incorporate those adaptation options in future health sector planning at the national or county levels.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation this recommendation.

Recommendation 2: Consider opportunities to add quantified and/or time bound goals and targets to the activities identified for the revised NDC.

As part of the NDC review and consultation process, climate change adaptation strategies for the health sector should build towards more expanded or specific actions based on options included in existing national climate plans and strategies, and new actions considered relevant in enhancing climate response in the health sector.

As part of the NDC review, the ambition of the revised NDC can be enhanced by developing health-inclusive and health-promoting climate targets and policies through the consideration of the social co-benefits of climate action, the creation of climate-resilient health systems or through prioritized adaptation actions.[333] WHO recommends that co-benefits should be (1) identified, (2) measured, (3) monitored over time, and (4) included in cost-benefit analyses and policy-making processes for all mitigation and adaptation actions included in the NDC.[334]

[333] World Health Organization. (2019) Health in National Determined Contributions (NDCs): a WHO review, License: CC BY-NC-SA 3.0 IGO. https://www.who.int/publications/i/item/who-review-health-in-the-ndcs.

[334] World Health Organization. (2019) Health in National Determined Contributions (NDCs): a WHO review, License: CC BY-NC-SA 3.0 IGO. https://www.who.int/publications/i/item/who-review-health-in-the-ndcs.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation this recommendation.

Recommendation 3: Identify linkages between delivery of both health and rural development programs to increase the effectiveness and efficiency across sectors.

For example, the national goals for implementation of improved cookstoves in rural areas has complementary outcomes for the health sector (via reduced indoor and outdoor air pollution) and linkages to both the rural energy authority, transport sector, and sustainable forest management. As part of the NDC review and consultation process, these synergies can be discussed across sectors and specific actions identified that benefit the development goals across multiple sectors.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation this recommendation.

Recommendation 4: Specify the health co-benefits of reducing emissions from black carbon as part of national climate action.

Adding black carbon to Liberia's National Greenhouse Gas Inventory and setting targets for reductions will have important health implications, particularly for women and youth. These reductions are also relevant to outcomes of the energy sector NDC targets but are not specified in the 2015 NDC. An updated NDC should highlight the multiple health, development, environmental, and mitigation benefits of reduced emissions from black carbon.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation this recommendation.

Recommendation 5: Take stock of progress made in implementing existing health sector policies and the NDC. *[Linkages with other sectors]*

In the process of reviewing and updating the NDC, it is critical to take stock of progress made toward implementing existing sectoral and climate change targets and plans. The revised NDC should be informed by experiences, challenges, and lessons learned from implementing current targets and plans in the health sector. The stakeholder consultation process should identify any changes in national circumstances, political priorities, development priorities, and efforts to achieve SDGs (including progress made toward relevant sectoral SDG targets), which can help identify new opportunities and synergies to pursue emissions reduction strategies within the context of national priorities. The work done by EPA under the ongoing second national communication can provide a useful input into this stocktaking process.

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders could contribute to identify new opportunities for mitigation strategies.

Recommendation 6: Consider linkages with national COVID response and recovery priorities as part of the update of NDC targets for this sector. *[Linkages with other sectors]*

Recommendation to be refined: As part of the NDC review and consultation process, relevant stakeholders should contribute to the formulation of this recommendation.

Annex I: Types of Adaptation Options and Approximation of Costs

Source: Kalinski, V. (2019) Climate Hazard, Vulnerability and Risk Assessment for the Coastal Zone of Liberia. Liberia Environmental Protection Agency, United Nations Development Programme, Green Climate Fund.

1) **GREEN: Tree planting.** Tree planting adaptation measure strength and weaknesses. Figure left: coconut seedlings; right: coconut tree planted beach in the Philippines

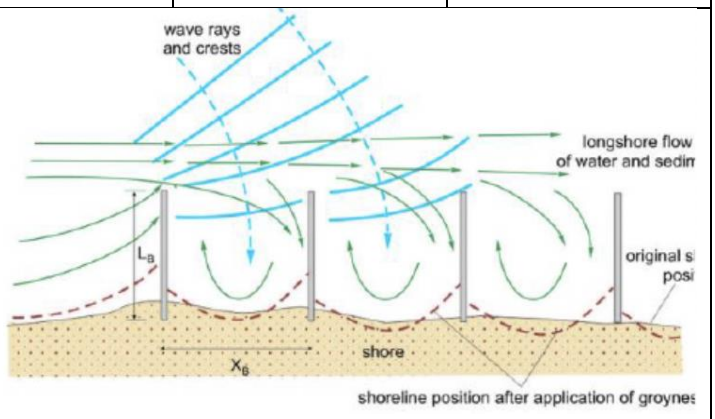
Technique	Description	Strengths (Advantages)	Weaknesses (Disadvantages)	Approximate Cost
Tree planting	Tree planting is an ecosystem-based adaptation (EbA) green option most recommended for low to medium energy coastal environments or in combination with hard solutions in high energy environments	- Low-cost no-regret measure that helps preserving a beach on natural way; - Long term solution; - Besides resilience function they may also have economical function as fruit trees (coconuts, mangoes, almonds)	- Not suitable for high energy coastal environment; - Requires several years for trees to mature and to be able to fully perform its function.	Greatly depends upon many factors (availability of seedlings, environmental conditions, maintenance costs, etc.) and can vary from USD 20 to USD 60/m^2 and more


2) **GREY: Beach Nourishment.** Beach nourishment adaptation measure: strength and weaknesses. Figure left: beach nourishment dredging from the sea; right: beach nourishment from the shore

Technique	Description	Strengths (Advantages)	Weaknesses (disadvantages)	Approximate Cost
Beach nourishment	Beaches are made higher and wider by importing sand and shingle to an area affected by longshore drift.	Acceptable costs, retains the natural appearance of the beach and preserves the natural appearance of the beach.	Off-shore dredging of sand and shingle increases erosion in other areas and effects the ecosystem. Large storms will require beach replenishment, increasing costs.	USD 30/m^3 and above

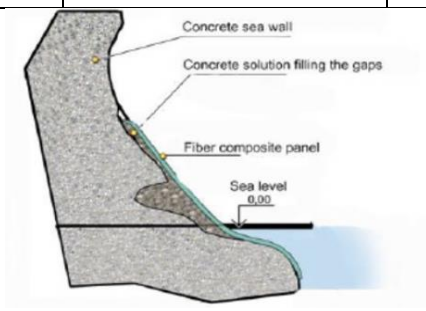

3) **GREY: Groynes**. Groynes adaptation measure: strength and weaknesses.
Figure left: groynes on sandy England shores; right: groynes schematic

Technique	Description	Strengths (Advantages)	Weaknesses (Disadvantages)	Approximate cost
Groynes	Groynes are rock barriers constructed at right angles to the beach to retain material. Material is trapped between these groynes and cannot be transported away by longshore drift. Groynes encourage a wide beach which helps absorb energy from waves, reducing the rate of coast erosion.	Relatively cheap, retain wide sandy beaches and do not affect access to the beach. Beach ecosystem is largely not affected.	Beaches down-stream of the defense system are starved of beach material due to their effect on longshore drift. Some consider it visually unattractive.	USD 200-3.500/m and above (depends upon length, height and environmental conditions)



4) **GREY: Armoured concrete sea wall.** Armoured concrete sea wall adaptation measure.
Figure left: cross-section of concrete armoured sea wall; right: example of sea wall application in South

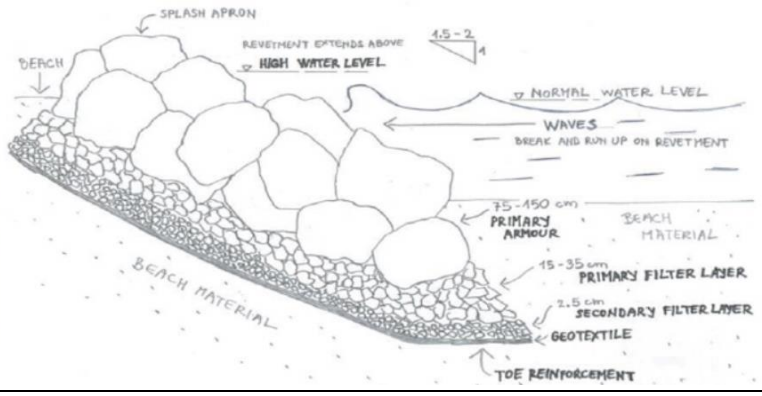
Technique	Description	Strengths (Advantages)	Weaknesses (Disadvantages)	Approximate cost
Armoured concrete sea walls	Sea walls are usually built along the front of cliffs, often to protect settlements. They are often recurved which means waves are reflected back on themselves. This can cause the erosion of material at the base of the sea wall.	Provided excellent defence where wave energy is high, reassures the public and have long life span. Sea walls often have a promenade on top of them which are popular with tourists	Usually expensive, can affect beach access, recurved sea walls an increase the erosion of beach material. Beach natural ecosystem is destroyed.	USD 2,000-8,000/m or above (vary greatly depending on site conditions, available raw materials, contractors, etc.)



5) GREY: Rock armour onshore revetment.

Figure left: rock armour application in Buchanan; right: cross-section of proper rock armour revetment design

Technique	Description	Strengths (Advantages)	Weaknesses (Disadvantages)	Approximate cost
Rock armour on-shore revetments	These are often large boulders placed along the base of a cliff to absorb energy from waves. Energy from waves is dissapated by them breaking against the revetments. In recent times concrete revetments such as accropodes have been used. This method is the most common found in Liberia.	Cheap and efficient. If properly applied (bellow sketch) it is efficient method against beach erosion. Usually it is cheaper than an armoured conrete sea wall.	Unattractive, visual eyesore, it provides dangerous access to beach, beach use is not possible. Beach ecosystem is destroyed.	USD 2-4000/m and above. Costs increase when rock is long transported or imported.



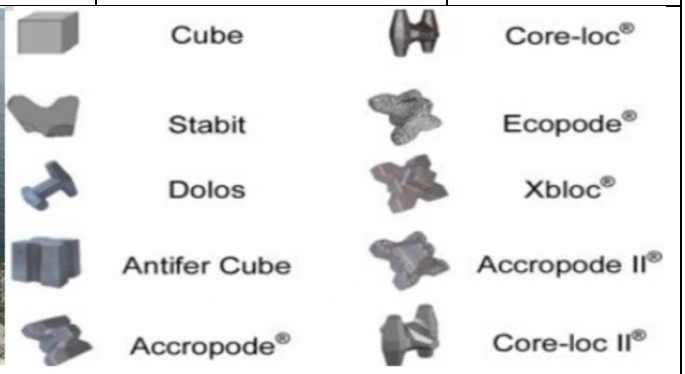
6) **GREY: Gabions.** Gabions adaptation measure.

Picture left: implementation of gabions in Buchanan area; left: gabion application on the beach

Technique	Description	Strengths (Advantages)	Weaknesses (Disadvantages)	Approximate cost
Gabions	Rocks and smaller boulders are encased in wired mesh. They absorb the energy from waves.	Good cost vs. effectiveness ratio	Shorter lifespan than other grey adaptation methods. Cases are subject to corosion and disintegration. Visually unattractive and dangerous access to beach – beach use is not possible. Beach ecosystem in most cases is destroyed.	USD 200/m and above (vary greatly depending on site conditions, available raw materials, etc.)

7) **GREY: Breakwaters.** Off-shore breakwaters/ revetment adaptation measure. Figure left: offshore breakwaters implementation; right: some types of prefabricated concrete armoured units

Technique	Description	Strengths (Advantages)	Weaknesses (Disadvantages)	Approximate Cost
Breakwaters	These are made of rock boulder, prefabricated concrete armoured units or concrete blocks located off shoreline to absorb the power and change the direction of waves, reduce longshore drift and ultimately decrease coastal erosion.	Beaches retain natural appearance and it can be still economically used (i.e. for tourism). When properly designed they provide superior coastal protection. Beach ecosystem is preserved and they can even imitate natural reefs and provide development of additional reef ecosystem.	They require proper design and on-spot installation. If not properly designed and installed they may be difficult to maintain. Depending on type and design they may be unattracted. If not installed properly they will not stop beach material from being eroded or erosion may occur down-drift. They demand more complicated construction logistics than other options.	USD 5000/m and above. Price vary greatly upon type of breakwater used, design used, depth of water where constructed, etc.



8) **SOFT: Managed retreat. Managed retreat adaptation option.**

Technique	Description	Strengths (Advantages)	Weaknesses (Disadvantages)	Approximate Cost
Managed Retreat	Accepting the impacts and bearing the losses that result from risks by doing planned managed rereat away from shoreline.	Managed retreat retains the natural balance of the coastal system. Eroded material encourages the development of beaches and salt marshes.	People may lose their assets and possibly livelihood. These people will need to be compensated and helped.	Depends on the amount of compensation (cost of estates) that need to be compensated to people affected by erosion.

9) **Other SOFT adaptation options may include:**

- Environmental and climate policy changes and implementation;
- Early warning systems (e.g. flood);
- Master plan of Development and implementation
- ICZMP development and implementation
- Livelihood change and improvement programmes;
- Specialised educational programmes;
- Insurance schemes (i.e. crop insurances);
- Innovative financial schemes (green credits, green entrepreneurship, and other).