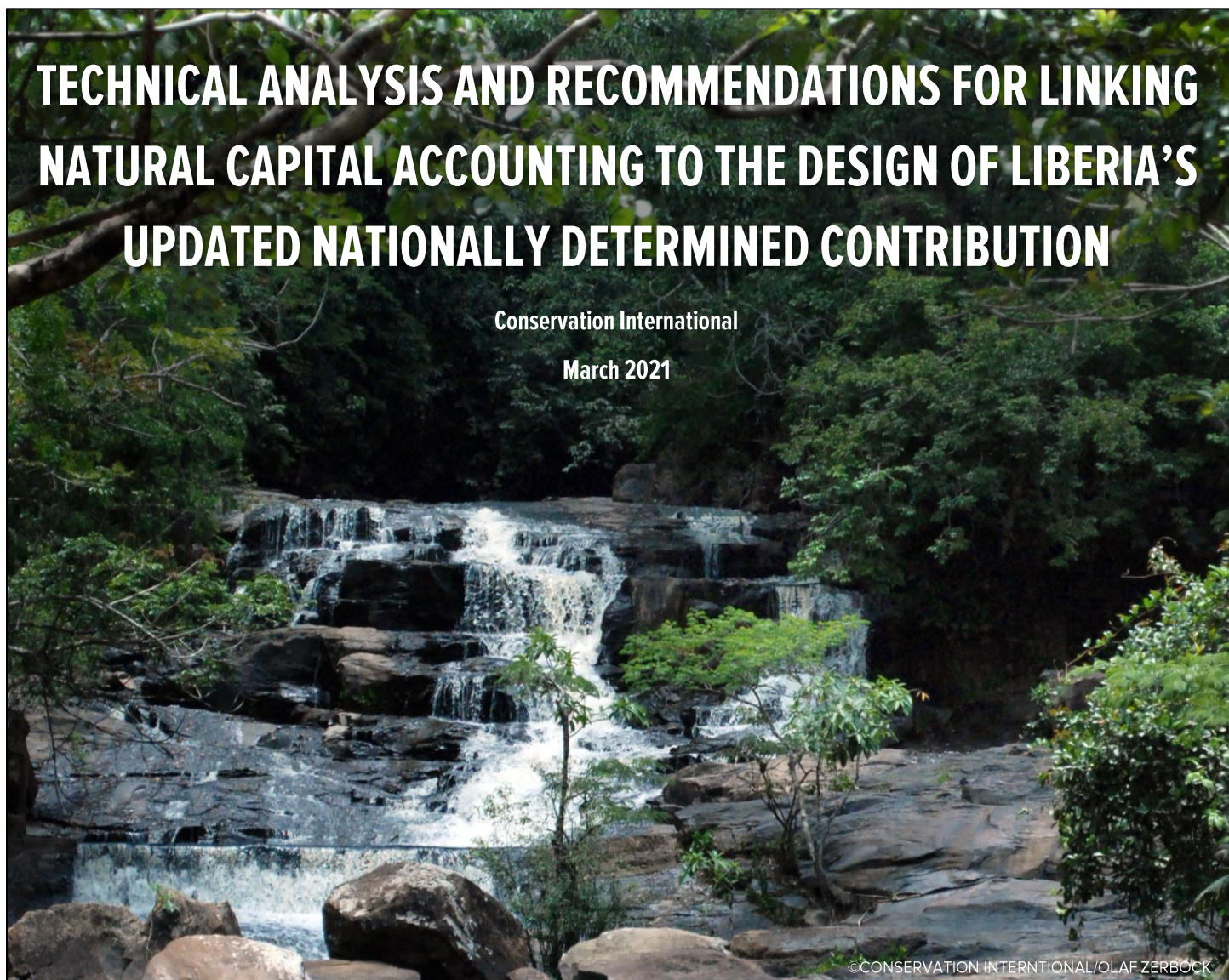




TECHNICAL ANALYSIS AND RECOMMENDATIONS FOR LINKING NATURAL CAPITAL ACCOUNTING TO THE DESIGN OF LIBERIA'S UPDATED NATIONALLY DETERMINED CONTRIBUTION

Conservation International

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Table of Contents:

Background	2
Crosswalk Analysis of Linkages between Liberia's NDC Sectors and NCA.....	4
Energy Sector	4
Transport & Infrastructure Sector	7
Agriculture Sector	7
Forests Sector	9
Coastal Zones Sector	11
Fisheries Sector	15
Health Sector	15
Key Synergies between NCA and the NDC	16
Recommendations	20
References	23
Annex: Enlarged Images from Figure 5	24

List of Figures & Tables:

Figure 1: Methodology used to produce the Ecosystem Extent Maps of Liberia	5
Figure 2: Examples of the Ecosystem Extent Maps of Liberia	6
Figure 3: Forest fragmentation analysis	8
Figure 4: Chimpanzee corridors connectivity analysis	10
Figure 5: Analysis of mangrove cover frequency.....	12
Figure 6: Estimates of CO ₂ emissions from conversion of mangroves.....	13
Figure 7: Analysis of coastal vulnerability and protection provided by mangroves	14
Table 1: Numerical emissions values for conversion and draining of mangroves	13
Table 2: Example NDC target options for mangroves and coastal systems, with related needs and benefits...	17

Background

As part of its commitments under the Paris Agreement, the Government of Liberia is undertaking a revision of its Nationally Determined Contribution (NDC) with the aim to enhance its climate action ambition in line with its national circumstances, which is a vital part of ensuring the success of the Agreement. The Government of Liberia has shown leadership in addressing climate change through an intended nationally determined contribution (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. Liberia's 2015 NDC also highlights the crucial role of adaptation for ensuring the resilience of the country's communities and natural systems.

As part of the efforts to update Liberia's NDC, Conservation International (CI) is supporting the Liberia Environmental Protection Agency (EPA) through a Climate Action Enhancement Package Project with the NDC Partnership. The present report was developed as a key support activity under this project to develop a technical analysis to link the design, planning and monitoring of NDC targets and activities to the statistical information generated by Natural Capital Accounting (NCA). The Government of Liberia requested this support, as it aspires to build a national NCA system and is interested in exploring avenues for how NCA can provide statistical information and relevant indicators for programming and tracking NDC progress.

Natural Capital Accounting (NCA) refers to the measurement of stocks of natural resources (both renewable and non-renewable) and the flows of benefits they provide. NCA efforts in the public sector are the domain of the United Nations' System of Environmental-Economic Accounts (SEEA), an internationally accepted framework for incorporating nature into national accounting systems. Released in March 2021, the SEEA Ecosystem Accounting (EA) framework is the international statistical standard to organize data about ecosystems and their assets, track changes in their condition, and measure their contribution to the economy in terms of the flow of ecosystem services to different beneficiaries. These are measured in both biophysical and monetary terms and in a spatially explicit manner. The information and statistics generated through NCA can support development planning, monitoring and reporting, ultimately leading to improved policy and decision-making for better natural resource management.

Conservation International is currently supporting the Government of Liberia to advance the implementation of NCA in country, including through a partnership with the US National Aeronautics and Space Administration (NASA) and the implementation of a Global Environment Facility (GEF) project on NCA in coastal areas. The NASA-CI and Government of Liberia partnerships focus on an innovative, low-cost, replicable approach for the identification and mapping of ecosystems, which maps ecosystem distribution and tracks changes over time in support of the SEEA EA extent accounts. The approach has been piloted in Liberia and resulted in the development of a timeseries of ecosystem extent maps ("Ecosystem Extent Maps of Liberia") that map the country's natural assets and how they have changed over time. The maps were fully endorsed by the Government of Liberia in 2020 as the country's official basis for ecosystem accounting. In addition, the Liberia EPA, in partnership with other governmental agencies, and support from Conservation International is currently implementing the GEF-funding project 'Conservation and sustainable use of Liberia's coastal natural capital' ("GEF NCA Liberia project"). Scheduled to take place over the next five years, this project seeks to improve conservation and sustainable use of Liberia's coastal natural capital by mainstreaming the value of nature into Liberia's development trajectory. One of the main goals of this project is to develop a complete set of ecosystem accounts to measure the value of benefits provided by mangroves, such as protection from storm surge, erosion prevention, regulation of coastal water quality, habitat provision for commercially important and endangered marine species, and food security for coastal communities. The Government of Liberia sees

these initiatives as an integral part of a national effort to develop Liberia's national ecosystem accounting that will inform planning and decision-making to ensure long-term sustainability for biodiversity and human well-being.

Within the Government of Liberia, several authorities are responsible for data collection and management relevant to developing climate action targets and NCA efforts in country. The Liberia Institute of Statistics and Geo-Informatics (LISGIS) is the premier government agency responsible for collecting, managing and disseminating data. It also sets the necessary quality standards for statistical and spatial data. Their [data repository](#) contains sectoral statistics and other information that are relevant for NDC target setting and reporting. The Forestry Development Authority (FDA) also collects and maintains sectoral data, especially forestry inventory datasets, which can be accessed for biophysical and socio-economic data/statistics for the NDC forest sector analysis. Other government agencies, including the EPA, Liberia Land Authority and Ministry of Finance and Development Planning maintain additional data repositories that are key for both NDC and NCA processes. Collaborative efforts between these authorities will be key to operationalize the recommendations in this report.

Conservation International has developed this report to analyze, demonstrate examples, and provide recommendations for how the Government of Liberia can use NCA data to guide Liberia's NDC update, implementation plan, and progress-tracking systems. The report draws on existing and new NCA analysis, as described above, with a focus on the coastal zones sector and accompanying guidance that can be used to replicate and scale up this approach in other sectors. This report and all recommendations are intended as a starting point for technical expert input and consultation under the direction of the EPA, which will also be supported by participatory consultations as part of whole-of-government and whole-of-society approach to ensure that updates to the NDC fully reflect Liberia's national priorities, circumstances, and ambition.

Crosswalk Analysis of Linkages between Liberia's NDC Sectors and NCA

This section of the report identifies areas in relevant NDC sectors where NCA data and analysis could complement and enhance the formulation of NDC targets, planning, and implementation of related policies and measures. Some NDC sectors were not found to have linkages with NCA, and therefore are not included in the analysis. The crosswalk analysis was conducted using the *Joint Analysis of Existing and Proposed Sectors for Updating Liberia's NDC* as reference.

Energy Sector

According to the 2015 INDC, the energy sector is the primary source of greenhouse gas (GHG) emissions in Liberia. In 2000, it accounted for 67% of total GHG emissions and household energy use, dominated by burning biomass, i.e., firewood and charcoal, which accounted for more than 90% of the total. The existing energy sector mitigation target is to reduce emissions by 10% by 2030, and the 2015 INDC also included an adaptation target to conserve water catchments for hydropower production. However, there is no explicit link between energy sector actions and associated forest sector outcomes. Furthermore, information and/or criteria about which water catchments, and which areas within the catchments, were not specified. The 2015 INDC also lacks a monitoring and evaluation framework for these targets.

These gaps could be addressed in the NDC update by using products generated by current and future NCA work in Liberia, including:

- The Ecosystem Extent Maps of Liberia (see Figures 1 and 2), could be used to identify ecosystems currently threatened by firewood and charcoal production, which could be included in NDC targets for conservation and/or restoration measures.
- The Ecosystem Extent Maps of Liberia could be used to locate degraded areas suitable for energy plantations and/or other sustainable biomass production that would maximize biomass energy yield, while avoiding further forest loss and degradation (see Figures 2 and 3).
- The GEF NCA Liberia project can quantify the link between the household energy use and ecosystems in Liberia using surveys and models to monitor and evaluate biomass use and production.
- The degree of ecosystem loss and degradation driven by firewood and charcoal production can be monitored using the GEF NCA Liberia project indicators that describe ecosystem condition.
- The Ecosystem Extent Maps of Liberia and information derived from hydrological modeling of freshwater services, such as water flow and sediment regulation, could be used to target areas that should be conserved to achieve the greatest impact in reducing sedimentation and enhancing water yield, and hence maximizing hydropower electricity production.

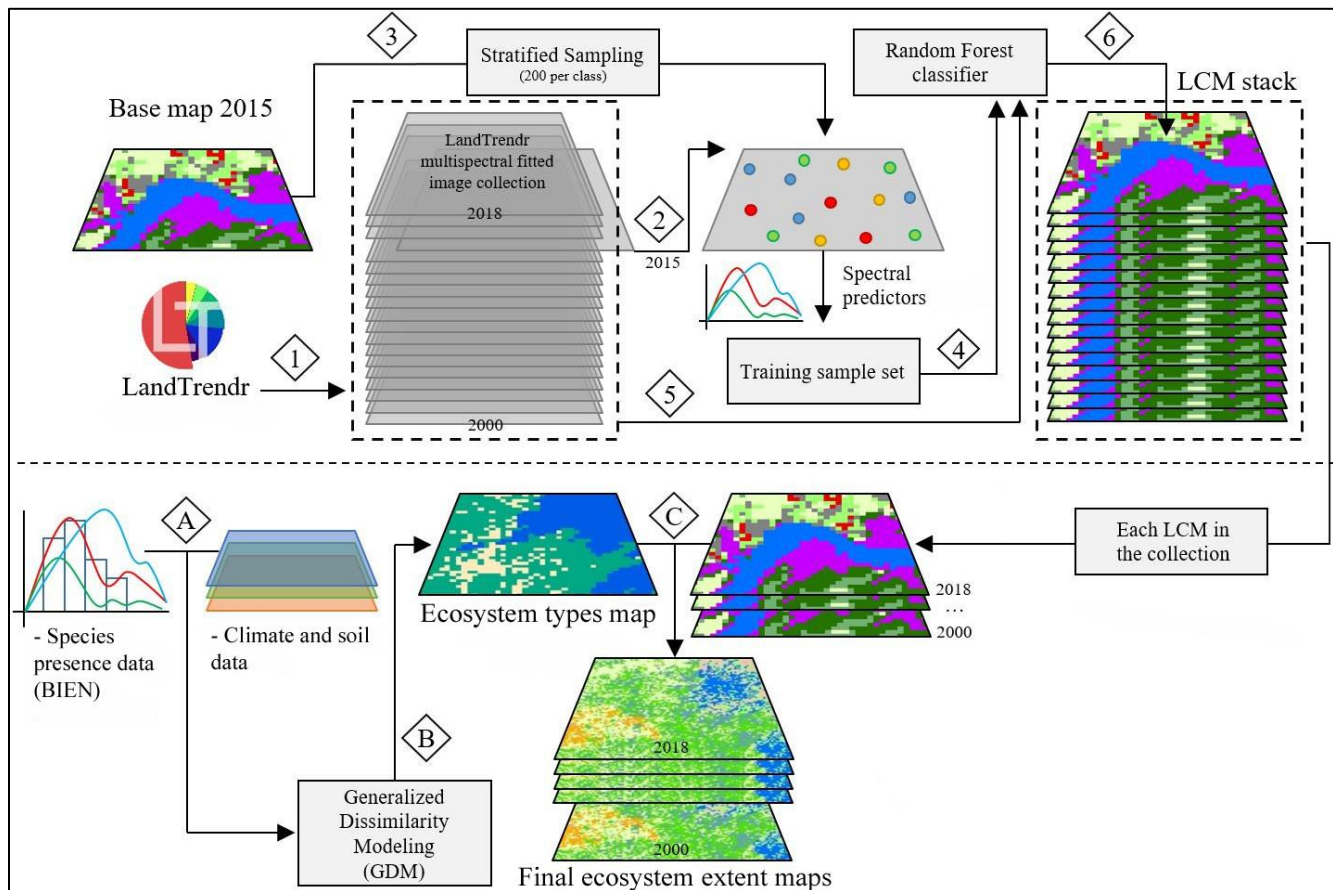


Figure 1: Methodology to produce the Ecosystem Extent Maps of Liberia

Figure 1 presents an overview of the methodology used to produce annual land cover and ecosystem extent maps from 2000-2018. Numbers and letters represent the order of each process: (1) Annual temporal composite images were produced using the LandTrendr methodology (Kennedy et al., 2018). (2) The LandTrendr 2015 image was matched to the 2015 base map of land cover types (de Sousa et al., 2020). (3) Stratified samples for 10 classes were selected from the 2015 base map. Spectral information was extracted from the 2015 LandTrendr composite images at the location of each sample. (4) The training sample set was used to train a random decision forest classifier. (5) The temporal composite images were classified using the trained random decision forest model. (6) Output timeseries of land cover maps (LCM stack). (A) Species presence were extracted from BIEN dataset (Enquist et al., 2016), bioclimatic and soil data were used in generalized dissimilarity modelling (GDM; Ferrier et al., 2007) (B), to produce a modelled ecosystem types map. (C) The modelled ecosystem types map and timeseries of land cover maps were merged to produce final ecosystem extent maps.

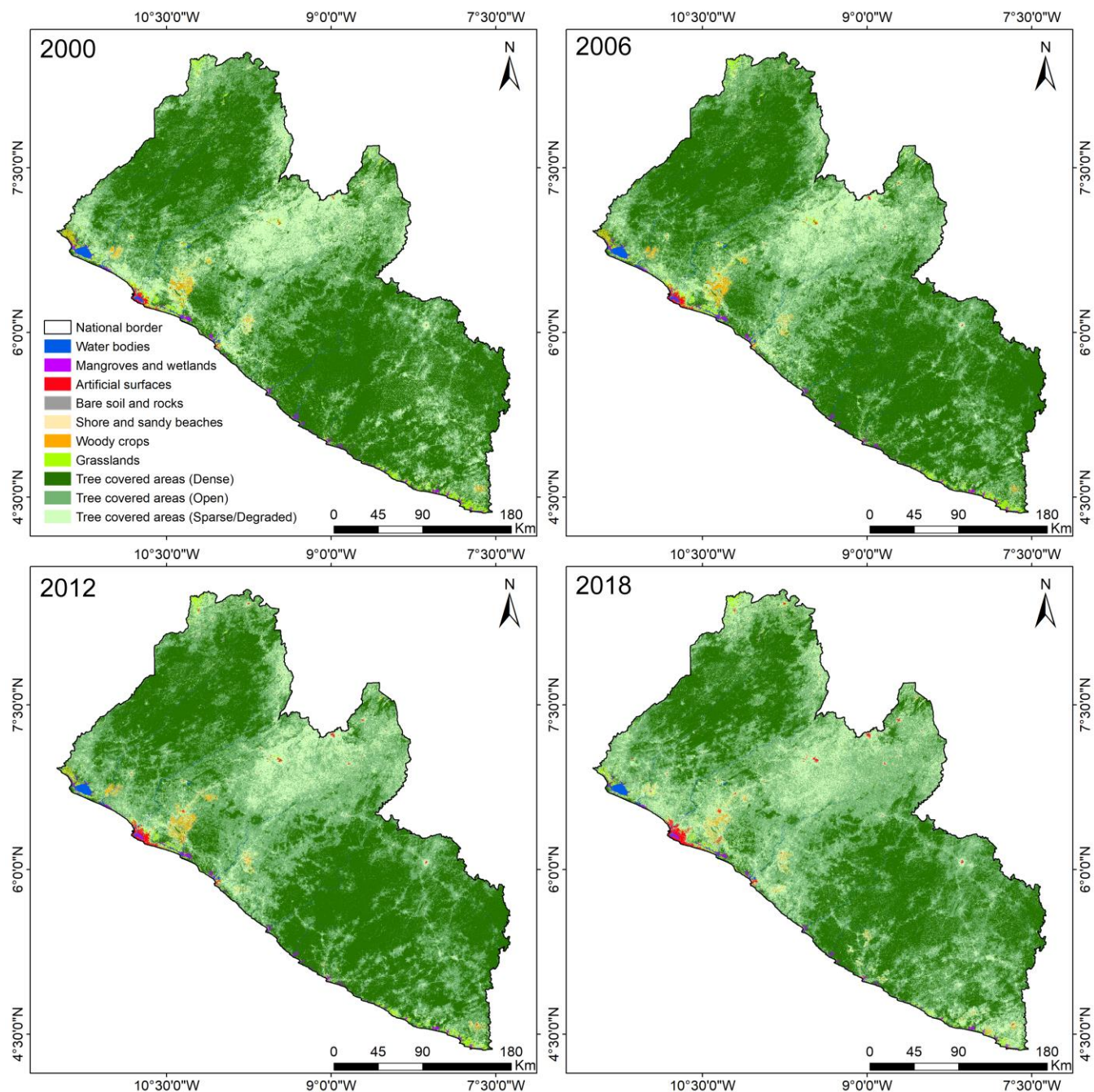


Figure 2: Examples of the Ecosystem Extent Maps of Liberia

Land cover type		Area (km ²)			
		2000	2005	2010	2018
	A	2,882.1	2,915.3	2,877.4	2,843.3
	B	584.7	594.9	524.7	408.2
	C	275.3	281.2	320.7	519.8
	D	263.3	247.1	340.1	476.7
	E	1,274.3	1,305.9	1,560.3	1,184.0
	F	1,276.8	1,238.6	1,357.1	1,041.4
	G	51,383.4	52,341.8	48,548.4	37,294.3
	H	28,335.7	30,889.5	35,573.2	42,926.7
	I	18,030.0	14,490.7	13,202.9	17,610.7

Figure 2 presents examples of land cover/use maps for four selected years (Step 6 in Figure 1). Preliminary area estimates, as shown in the accompanying table (see *left*), were conducted for the following nine classes: (A) water bodies, (B) mangroves and wetlands, (C) artificial surfaces and human settlements, (D) bare soil, (E) woody crops, (F) grasslands, (G) tree covered areas (dense), (H) tree covered areas (sparse) and (I) tree covered areas (mixed/degraded). These initial estimates will be revised as part of the ongoing NCA work in Liberia.

Transport and Infrastructure Sector

According to the 2015 INDC, the transportation sector is responsible for over 27% of the national GHG emissions (contributing CO₂ and CH₄ emissions). A 40% emissions reductions target was proposed, which would be achieved by substituting 5% of fossil fuels with palm-oil-derived biodiesel. However, the linkages between this target and emissions in the agriculture and forestry sectors was not explored, as the increased demand for biofuels could produce offsetting emissions from land-use change and agricultural activities (e.g., heavy machinery, fertilizers) on oil palm plantations. The 2015 INDC also established a target to design climate-resilient roads and other related infrastructure to withstand expected impacts of climate change, e.g., flooding, wind, and storm surges.

Achievement of these goals can be assisted by the following information:

- To assist Liberia in achieving an overall reduction in GHG emissions through increased use of biofuels, the Ecosystem Extent Maps of Liberia could be utilized to locate degraded areas suitable for oil palm plantations (and other biomass-based energy plantations) that would maximize yields while avoiding emissions from the conversion and degradation of natural ecosystems (see Figure 2).
- The GEF NCA Liberia project's assessment of coastal protection ecosystem services could be used to identify existing green infrastructure, e.g., mangroves, that provide protection from storm surges and wind, as well as identify vulnerable areas suitable for either green or green-grey infrastructure development to increase their resilience (see Figure 7).

Agriculture Sector

Liberia's subsistence-based upland agriculture is highly integrated with forest ecosystems characterized by shifting agriculture, minimal mechanization, and low production intensity. This is in contrast with large plantations of tree crops, such as rubber, oil palm, coffee, cocoa, and others that are grown on agriculture concessions, many of them through foreign direct investments schemes. One of the goals of the Pro-Poor Agenda for Prosperity and Development of 2018 is to encourage intercropping, irrigation and optimization of lowland/swamp farming and developing large-scale concessions primarily on degraded land. Furthermore, the 2015 INDC includes several adaptation actions for the sector.

Several aspects of NCA work can assist with Liberia's goals, as well as help develop mitigation actions within the agriculture sector, as appropriate. These include:

- Collection of hydrological data and modeling of freshwater flows could facilitate the design of climate resilient irrigation.
- Outputs derived from ecosystem accounting data can inform the development of scenarios and restoration activities to increase climate resilience of agriculture in Liberia.
- The Ecosystem Extent Maps of Liberia can be used to prioritize establishment and improvement of agricultural sites and minimize trade-offs between land uses. The maps can provide information on forest fragmentation, such as the size of forest patches with high carbon density, which can optimize establishment of agricultural concessions on degraded land (see Figure 3).

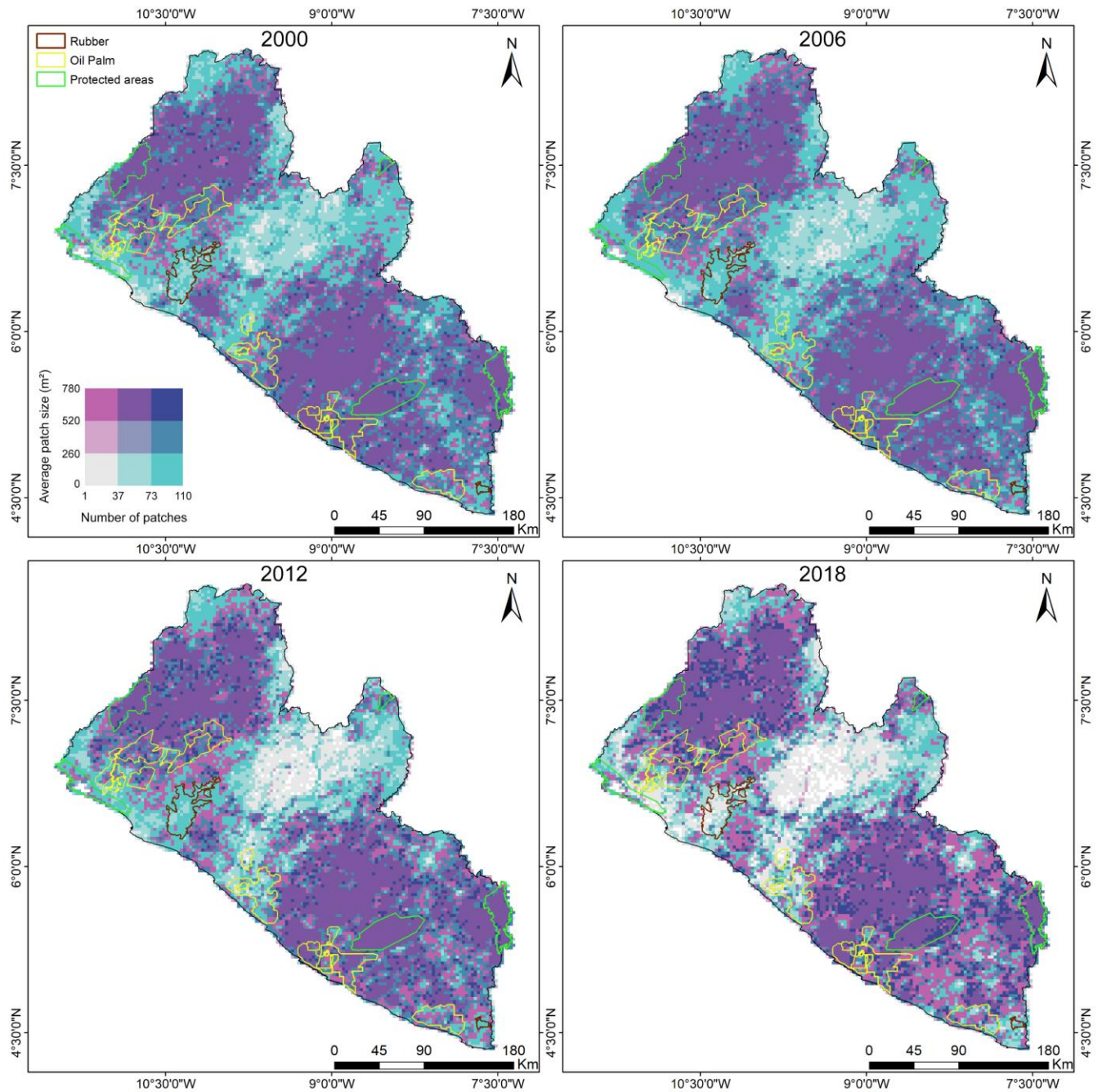


Figure 3: Forest fragmentation analysis

Figure 3 presents four bivariate maps depicting forest fragmentation in Liberia, which were derived from the 2000-2018 annual land cover/use maps (Step 6 of Figure 1). Two metrics were combined to create these maps: (1) number of forest fragments, and (2) size of forest fragments. The results for the four selected years depicted in the figure reveal that the decreasing number of forest fragments is driven by conversion of existing forest fragments to other land cover/use and not by the fragments growing/merging into larger ones. This trend is particularly evident in the central part of Liberia where lighter colors indicate a trend toward both fewer and smaller forest fragments. Conversely, the darker-colored landscape units within protected areas reflect the relatively larger and more numerous forest fragments compared to their surroundings. This analysis can be used to identify and optimize and prioritize areas for protection, restoration, and agriculture to reduce forest fragmentation. (Source: de Sousa et al., 2021)

Forests Sector

Liberia's forest ecosystems encompass the largest remaining tracts of Upper Guinean Forests, which provide important ecosystem services for local and national level economies. They also contain unique biodiversity and provide habitat for iconic species, such as the western chimpanzee, forest elephant and pigmy hippopotamus. In the National Forestry Reform of 2006, the Government of Liberia committed to set aside 1.5 million hectares (i.e., 30% of the country's forest area) for protection. The latest efforts to implement the law include a successful and smooth gazettelement of Grebo-Krahn National Park (NP) in 2017, demarcation of the expanded boundary of Sapo NP in January 2020 and a conference with stakeholders to discuss Krahn-Bassa NP in December 2020. The Krahn-Bassa Protected Area will become the 6th in the series of protected areas and the 4th national park in Liberia when established.

Liberia will need to protect additional forest areas to reach their 30% target. Furthermore, the 2015 INDC includes several adaptation actions for the forests sector. Actions in the forest sector can also complement planned actions for urban Green Corridors, which were identified in the 2019 Tree Canopy study led by the EPA with support of the UNDP in Monrovia that highlighted the importance of wildlife corridors for biodiversity and local communities in urban areas. Establishing forest and wildlife corridors that connect both urban and rural areas can limit negative effects of forest fragmentation, while enhancing climate change adaptation and mitigation.

Several aspects of NCA work can assist with Liberia's goals, as well as help develop mitigation actions within the forest sector, as appropriate. These include:

- Information derived from the Ecosystem Extent Maps of Liberia and the GEF NCA Liberia project's biodiversity and ecosystem services surveys can provide the necessary information for optimizing the location of forest areas important for both biodiversity and provision of ecosystem services. These areas can be prioritized for protection to meet the 30% target.
- Information derived from these maps and surveys on biodiversity and ecosystem services can provide the necessary information to optimize the design of urban green corridors, as well as facilitate ecosystem and habitat connectivity across the larger landscape (see Figure 4).
- The Ecosystem Extent Maps of Liberia can facilitate efforts to assess and design mitigation actions in the forest sector, as well as strengthen the data on land cover/use change in the national GHG inventory. For example, the maps can be used to locate areas most suitable for activities to support Liberia's Reducing Emissions from Deforestation and Forest Degradation (REDD+) strategy.
- The information collected about ecosystem condition by the GEF NCA Liberia project can be used to assess forest degradation and guide restoration efforts to help meet Liberia's goals to increase the amount of forested land through reforestation of degraded lands.
- To strengthen the participation of local communities in forest conservation and target awareness-building efforts, the GEF NCA Liberia project-derived data can provide data on ecosystem services and benefits important to these communities, such as non-timber forest products. This information can help build an understanding of the value of these ecosystem services and benefits, as well as monitor their use, which is important for managing them sustainably.

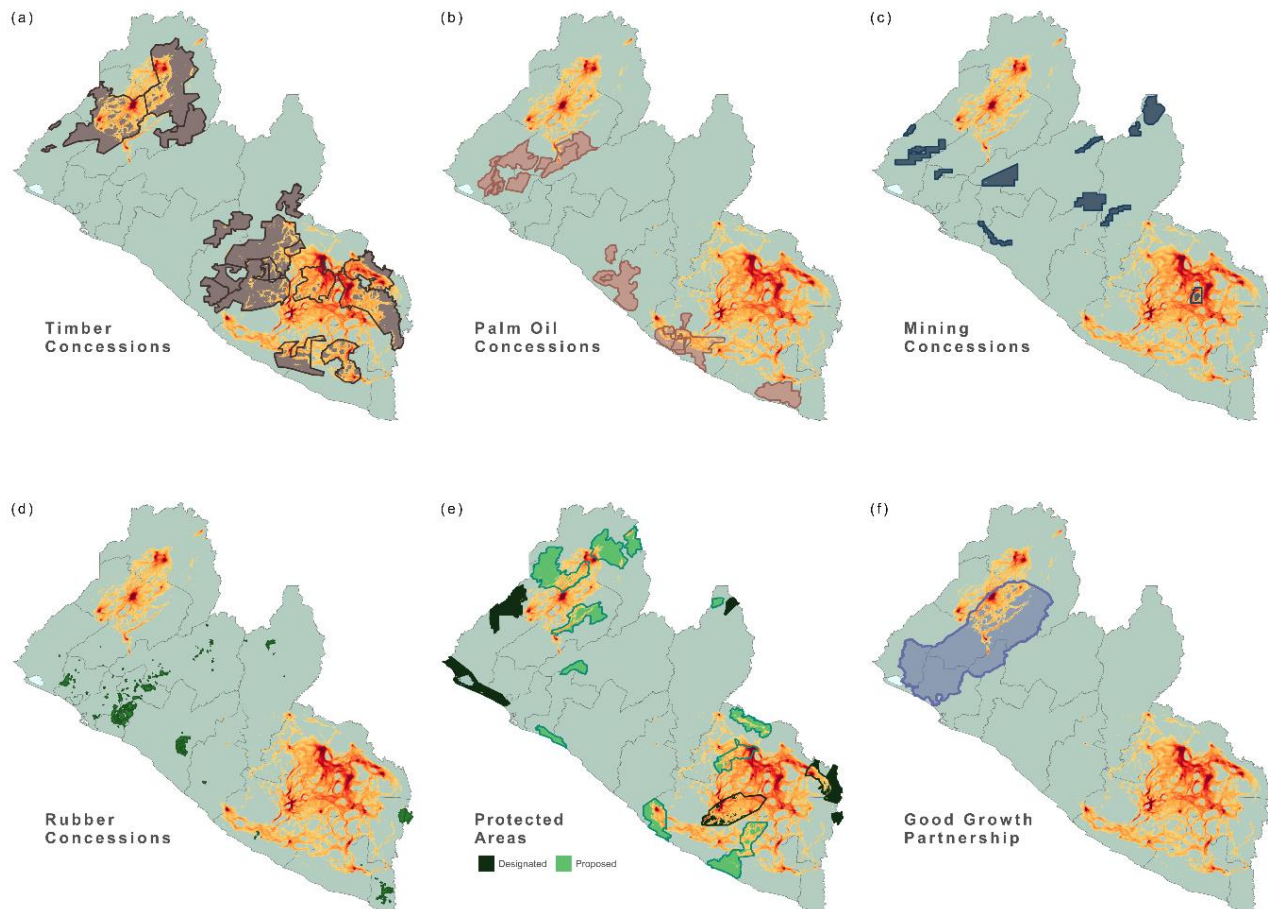


Figure 4: Chimpanzee connectivity corridors analysis

Figure 4 shows an analysis of chimpanzee connectivity corridors, which is derived from the 2015 base land cover/use map (de Sousa et al. 2020), among other sources. These figures depict chimpanzee connectivity corridors in hues of yellow and red overlaid with other land uses. Connectivity maps like these can guide planning for production areas (e.g., oil palm and rubber), to ensure that intervention designs contribute toward prosperity of both humans and chimpanzees, particularly as they concern existing and future mining and logging concessions. In Figure 4(a), existing timber concessions currently overlap considerably with the important connectivity identified corridors for chimpanzee movement in both the southern and northern areas. In Figure 4(b), oil palm concessions interfere to a lesser degree, but are present along the southern coast. In Figure 4(c), mining concessions, which have resulted in widespread tropical deforestation in Liberia in the past, largely avoid the areas of high connectivity importance (darker red paths) in the northern and southern networks and can continue to be sited outside of these important areas. Figure 4(d) shows that rubber concessions have little to no overlap with chimpanzee corridors currently, but siting of future concessions in southeastern Liberia may pose a risk. In Figure 4(e), protected areas have some overlap with chimpanzee corridors, but can be expanded or connected to ensure greater coverage in areas of high importance. Note that protected areas that are partially or fully obscured by the connectivity map have a layered outline to facilitate visualization. Figure 4(f) depicts an overlay with the Good Growth Partnership landscape in which the Government of Liberia aims to support sustainable production of palm oil while conserving biodiversity and safeguarding the rights of forest-dependent communities. (Source: Frazier et al., 2021)

Coastal Zones Sector

A large portion of Liberia's population lives in coastal areas, and they depend a great deal on mangrove resources for their cash income and subsistence livelihoods. Liberia's 2015 INDC includes several actions for coastal adaption and resilience, in addition to other related national policies. Since the GEF NCA Liberia project focuses on coastal ecosystems, there is ample opportunity for the NDC to draw upon the project's data, information, field work and policy analysis to formulate updated adaptation targets and new mitigation targets for the coastal zones sector, as appropriate.

During the initial assessment of the GEF NCA Liberia project, a key driver of the loss and degradation of coastal ecosystems has been identified as land conversion to obtain short-term financial gain. Yet, the estimates needed to economically value the adaptation benefits keeping mangrove ecosystems intact in the long-term (such as coastal protection) are not immediately available for policy makers.

The current and future NCA work in the coastal zones sector can assist in several ways, including:

- While Liberia's last comprehensive emission estimates are for the year 2000, the Ecosystem Extent Maps of Liberia covering coastal ecosystems can be used to retrospectively generate figures on emissions related to land cover/use change between 2000 and 2018 (see Figures 5-6 and Table 1). This data can support the development of specific and/or quantitative GHG mitigation targets for the NDC.
- Data collected by the GEF NCA Liberia project can be used to estimate the value of protecting mangrove ecosystems (see Figure 7), which can support the formulation of specific climate adaptation targets.
- Ecosystem accounting information will quantify and value the importance of mangrove ecosystems in the provisioning of long-term storm protection and erosion control.
- The stakeholder consultation process of the GEF NCA Liberia project can be used as a vehicle for awareness raising among the public and decision-makers alike.
- The GEF NCA Liberia project can provide the necessary data and information through field and biodiversity surveys that can provide inputs to policy analysis to help improve both human and ecosystem wellbeing in the coastal areas.

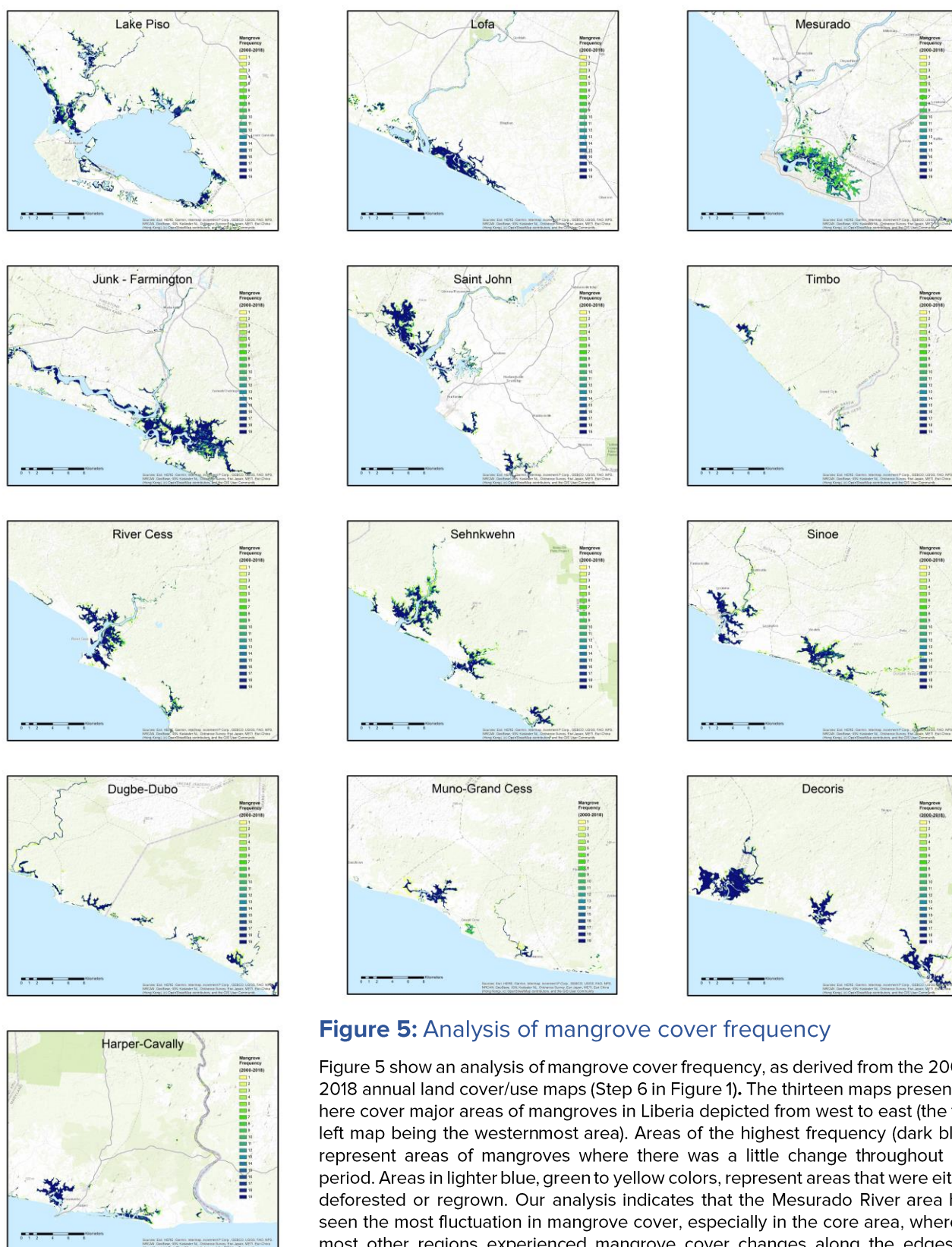


Figure 5: Analysis of mangrove cover frequency

Figure 5 show an analysis of mangrove cover frequency, as derived from the 2000-2018 annual land cover/use maps (Step 6 in Figure 1). The thirteen maps presented here cover major areas of mangroves in Liberia depicted from west to east (the top left map being the westernmost area). Areas of the highest frequency (dark blue) represent areas of mangroves where there was a little change throughout the period. Areas in lighter blue, green to yellow colors, represent areas that were either deforested or regrown. Our analysis indicates that the Mesurado River area has seen the most fluctuation in mangrove cover, especially in the core area, whereas most other regions experienced mangrove cover changes along the edges of mangrove areas. These maps can be used to target restoration and/or conservation actions.

Note that these are high resolution images that can be viewed in detail by zooming in when on an electronic device. Larger images are also available in the Annex.

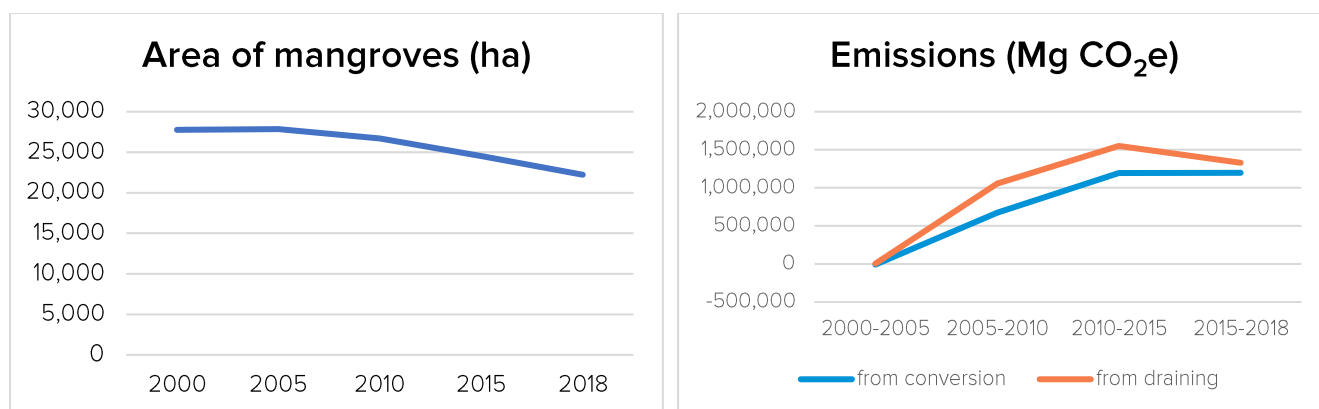


Figure 6: Estimates of CO₂ emissions from conversion of mangroves

Figure 6 shows the estimates of CO₂ emissions from conversion of mangroves to other land cover/use between 2000-2018. The area covered by mangroves was derived from the 2000-2018 annual land cover/use maps (Step 6 in Figure 1). The graph on the left shows 20% decline in mangrove area between 2000 and 2018. From these numbers, we calculated CO₂ emission using the IPCC Tier 1 approach separately for two possible cases of land cover change: (1) conversion of mangroves to degraded land (e.g., deforestation) and (2) draining of mangrove areas (e.g., conversion to agriculture). The EX-ACT_V9.0 tool developed by FAO was applied in 5-years increments with the exception for the period of 2015-2018 where the interval was just 3 years. Results displayed in the graph on the right show overall increase of the emissions between 2000-2018 for both cases.

Table 1: Numerical emissions values for conversion and draining of mangroves

Emissions (Mg CO ₂ e)	2000-2005	2005-2010	2010-2015	2015-2018	Total
from conversion to degraded land or when reforested to tropical shrublands	-8,685	674,817	1,194,615	1,197,696	3,058,443
from draining or when rewetted after previously being drained	3,844	1,056,788	1,550,597	1,328,229	3,939,459

Table 1 shows that the total emissions from 2000-2018 were estimated to range between 3 million to 4 million Mg CO₂e depending on the type of conversion. Note that from 2000-2005, there was a slight increase in the area of mangroves. When we assumed that the area was converted from degraded land to tropical shrublands, results show net CO₂ sequestration (the negative value); however, when the same area was assumed to be rewetted (after previously being drained) results show net emissions (the positive value). These initial estimates will be revised as part of the GEF NCA Liberia Project.

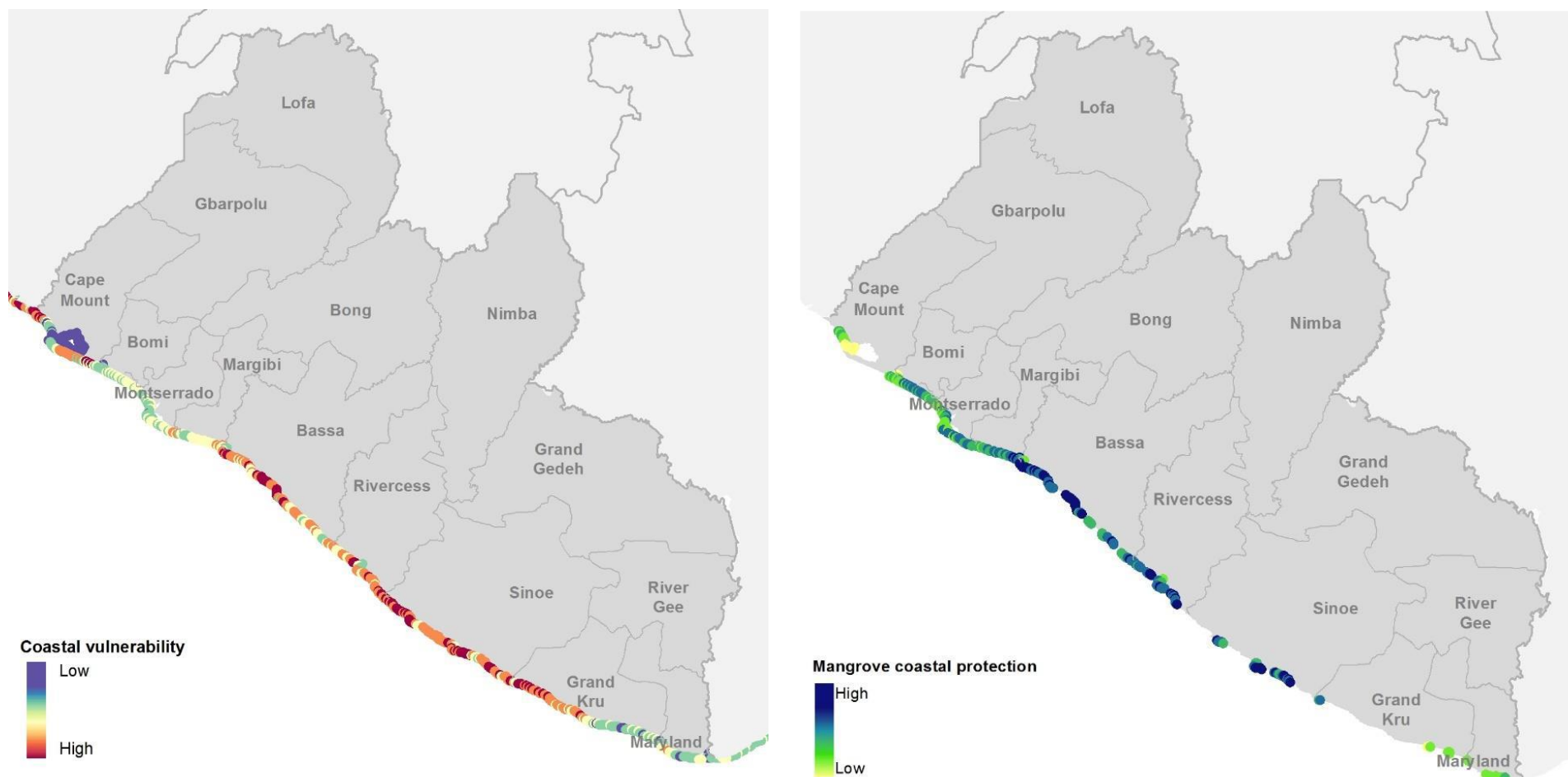


Figure 7: Analysis of coastal vulnerability and protection provided by mangroves

Figure 7 shows an analysis of coastal vulnerability and protection provided by mangroves. The left map shows **coastal vulnerability** (“exposure index”) calculated using the InVEST model. Red areas are more vulnerable, blue areas are less vulnerable. Values were calculated using geophysical and natural habitat characteristics of coastal landscapes to compare their exposure to erosion and flooding in severe weather. When overlaid with data on coastal population density, the model’s outputs can be used to identify where humans face higher risks of damage from storm waves and surge. The right map shows **coastal protection provided by mangroves** (“habitat role”) provided by InVEST model. Darker blue areas indicate where mangroves provide more protection. The role of mangroves in coastal risk reduction is well documented. Wind and swell waves are rapidly reduced as they pass through mangroves, lessening wave damage during storms. The dense roots of mangroves help to bind and build soils. The above-ground roots slow down water flows, encourage deposition of sediments and reduce erosion. By combining the results of these two maps, we see that mangroves are providing vital coastal protection along much of the highly vulnerable coastline areas, such as central Bassa county. These mangroves should be prioritized for conservation efforts due to this valuable ecosystem service, as the coastal vulnerability would be higher if mangroves were removed in those locations. Vulnerable areas without mangrove protection, such as along northern Sinoe county, can be targeted for development of green-gray infrastructure projects to increase coastal protection and resilience against erosion and severe weather. (Source: CI, 2017)

Fisheries Sector

Coastal fisheries play a huge role in the provisioning of food and livelihoods in Liberia. Mangroves, which cover much of the coast, are not only essential areas where fish are harvested, but also provide nurseries that support fisheries elsewhere. Much of the fish consumed in Liberia is smoked, usually using wood from mangroves in the process, contributing not only to loss of mangrove ecosystems, which further disrupts fisheries, but also GHG emissions. Liberia's 2015 INDC includes several actions for climate adaption and resilience in the fisheries sector, in addition to other related national policies.

As part of earlier CI projects, preliminary data on small-scale fisheries (e.g., catch amounts) and use of mangroves as firewood and for smoking fish have been collected in some areas. The GEF NCA Liberia project can provide additional information to assist with updating the NDC targets, including:

- Using household surveys, NCA can quantify patterns of mangrove harvesting for smoking fish and related fisheries data, which can help set specific NDC targets for increasing the resilience of the sector, while reducing GHG emissions from mangrove loss (link to the coastal zones sector).

Health Sector

Access to health services remains a significant limitation for many people in Liberia, especially in rural areas. Liberia's 2015 INDC includes several actions for climate adaption and resilience in the health sector, in addition to other related national policies. While there are several known health impacts of a changing climate, few data exist in Liberia to quantify the primary drivers of poor health. Similarly, there is a lack of health indicators at the national scale.

The GEF NCA Liberia project can provide additional information to assist with updating the NDC targets, including:

- Household surveys can provide data to describe indicators and drivers of poor health, and tie these to both climate and ecosystem loss and degradation. This data can help set specific NDC targets for increasing the resilience of the health sector, while reducing GHG emissions from ecosystem loss (tied to other sectors).

Key Synergies between NCA and the NDC

The results of the NDC-NCA crosswalk demonstrate that integrating natural capital accounting into the NDC processes can enhance both target setting and implementation planning. This section reviews several key synergies.

Integration of NCA into NDC processes can help address the information gaps to assess the possible GHG emissions reduction contributions of different sectors more accurately with spatially explicit information. NCA can provide valuable data and baselines for target setting and monitoring, especially around NDC ambition – in other words, what is possible to achieve and where. NCA can also quantify the associated co-benefits of emissions reduction and climate adaptation activities, especially as related to livelihood improvement and the provision of a range of ecosystem services through conservation activities. If data is disaggregated by population characteristics, such as gender and age, these NCA outputs can further contribute to understanding the relationship of vulnerable groups to key ecosystem services and co-benefits, and then enabling the NDC to include related efforts to strengthen the resilience of these groups to expected climate impacts. For example, the GEF NCA Liberia project that is currently being implemented in coastal areas will quantify those co-benefits through its Ecosystem Services Accounts. There are three specific areas where these synergies are strongest:

- In biophysical quantification of co-benefits of different coastal adaptation and mitigation options, which will identify priority locations where those benefits are greatest and thus where actions can have the greatest return on investment;
- In assessing the economic value of co-benefits generated by climate action activities and possibly assessing the cost-effectiveness of alternative options, which will help in identifying trade-offs related to different strategies; and
- In the generation of spatially explicit information and maps on coastal vulnerability and adaptation, which will assist the determination of priority geographies where mangrove conservation and restoration can provide the most benefits to vulnerable communities.

An additional key synergy is the consistent methodology offered by NCA for the NDC. The implementation of NCA takes place using a standard set of tools, techniques and methodologies. The overall methodological framework in the UN System of Environmental Economic Accounting – Ecosystem Accounting (SEEA EA) was developed through years of consultation with scientific communities and government partners. Governments in more than 100 countries expressed interest in using this standardized methodology to set up their natural capital accounts. Therefore, using those standardized methods for NDC reporting and target setting purposes, where applicable, would not only ensure consistency in data collection, analysis and reporting, but also provide the government with scientific data to determine what is possible and thus how much ambition is achievable (see Table 2). Such trustworthy and standardized methods are especially useful if the analysis and reporting needs to be repeated on a regular time interval, as is the NDC. Utilization of NCA methodologies for the NDC can also help fulfill the Paris Agreement's Katowice Guidance on NDCs, which calls for "consistency in scope and coverage, definitions, data sources, metrics, assumptions and methodological approaches."

Recognizing the growing demand for public policies related to climate adaptation and mitigation, SEEA EA is developing methodological guidance for its climate change thematic account, in addition to the carbon thematic account that already exists. Given that these methods are in early stages of implementation, NDC processes could offer good test cases to find and strengthen the synergies, and Liberia could be good case study since NCA is already being implemented.

Table 2. Example NDC target options for mangroves and coastal systems, with related needs and benefits

Note that CI has developed the framework for Table 2 to support governments examining the various considerations for setting NDC targets, which can be adapted to add or remove columns according to government priorities. Additional, more extensive versions of the framework are available for reference upon request.

Ambition Level	Proposed NDC Target Language <i>* denotes target can be considered under mitigation and/or adaptation</i>	Information Supplied to the UNFCCC	Data Requirements (red text = NCA can support)	Co-Benefits
Mitigation Targets				
Basic: Qualitative targets indicating an increase in ambition	<p>Enact detailed new policies and/or improve existing policies and measures to reduce GHG emissions related to conversion of mangroves and other blue carbon ecosystems, with time-bound milestones, including:</p> <ul style="list-style-type: none"> • Survey coastal zone ecosystems to identify threats* • Enhance national plans to increase mangrove and coastal conservation and restoration* • Develop mechanisms for sustainable community management of mangrove areas key for local livelihoods and sustenance, including alternatives to smoking fish* • Integrate local and indigenous knowledge, cultural systems, and gender and youth considerations into climate action plans* • Expand marine and coastal Protected Areas, and update/develop PA management plans* • Establish a coastal MRV system, including community-based monitoring systems* • Establish a Natural Capital Accounting system for coastal zones* • Develop an integrated spatial data management system for sustainable land use management* • Establish inter-ministerial regulatory task force on integrated land-use planning* • Improve capacity building and training for authorities and communities to implement mitigation actions • Promote mangroves within the national REDD+ strategy • Finalize National Wetlands Policy* • Explore innovative carbon financing models, such as payments for ecosystem services • Increase funding for coastal and blue carbon climate research* 	General statement with qualitative information related to activities or targets	<p>An overview of current and/or planned policies and implementation frameworks, with additional data needs depending on target language, which may include:</p> <ul style="list-style-type: none"> • Existing and/or improved coastal data, mangrove stocks and loss rates • Existing and improved data on training/ capacity-building programs • Community, household, and market surveys • High-resolution land-use cover data • Data on research and funding levels 	<p>Sets an operative target to build upon; Highlights work the country is already doing or plans to undertake; Strengthens the country's international commitments to relevant UN conventions and other Multilateral Agreements (e.g. Bonn Challenge, 20x20); Conservation, protection and or restoration of blue carbon ecosystems will yield adaptation co-benefits, that will increase in quantity and quality as more measures are implemented. These benefits include increased resilience of coastlines against storms and seas level rise, securing fisheries breeding grounds and supporting food security; Improved outcomes for ecosystem services, biodiversity, public health, green growth, and a just transition; Leadership on technical and MRV systems, including natural capital accounting; Flexible implementation; Mainstreaming of climate action into whole-of-government, society, and land-use planning; Builds in country capacity and innovation</p>

Ambition Level	Proposed NDC Target Language <i>* denotes target can be considered under mitigation and/or adaptation</i>	Information Supplied to the UNFCCC	Data Requirements (red text = NCA can support)	Co-Benefits
Higher: Quantitative target in non-GHG metrics (e.g., Ha)	<p>Selected above targets + quantitative targets with time-bound milestones, such as:</p> <ul style="list-style-type: none"> Improved protection and/or conservation of at least [X%] of mangroves by 2025, with an additional [X%] by 2030, and ensure these areas are effectively managed and monitored* Restore at least [X%] of degraded coastal wetlands by 2025, with an additional [X%] by 2030*, and ensure sites are effectively managed and monitored. To be effectively managed by integrating with existing management plans by [X date]. By doing this we will halt or reverse net coastal wetlands habitat loss by 2030. Establish [#X] Marine Protected Areas and/or coastal Protected Areas* 	Commitment text; implementation plan (optional); update in the Biennial Transparency Report	<p>Selected above needs +</p> <ul style="list-style-type: none"> Improved data collection on quantitative indicators Enhanced monitoring and evaluation frameworks Historic mangrove loss Identify priority sites for restoration Monitoring of biological and ecological indicators of mangrove stability and health Strong monitoring process and restoration success indicators integrated into MRV systems (e.g., REDD+) Adjustment of REDD+ FREL/FRL to differentiate mangroves (optional) 	<p>Selected above benefits +</p> <p>Enhanced mitigation action and emissions reduction potential; Increased climate action leadership; Quantifiable impacts and co-benefits; Additional opportunities for local ownership; Improved consistency and transparency; More clarity to attract international finance</p>
Highest: Quantitative GHG target + MRV	<p>Selected above targets + quantitative GHG targets with plans for monitoring, reporting, and verification as relevant, such as:</p> <ul style="list-style-type: none"> By [X date], reduce [X GgCO₂e (or X%)] of emissions from mangrove conversion and draining through improved protection, conservation and restoration. Progressive development into full accounting of blue carbon GHG fluxes (emissions and removals) integrated into the national GHG inventory and harmonized with other MRV systems 	Commitment text; implementation plan (optional); update in the Biennial Transparency Report	<p>Selected above needs +</p> <ul style="list-style-type: none"> LULUCF activity data GHG emissions estimates Enhanced GHG monitoring and evaluation frameworks 	<p>Selected above benefits +</p> <p>Significant regional leadership and enhanced mitigation action; Builds upon progress via CBIT program to improve GHG data collection and reporting; Improved to meet targets; Additional consistency, transparency, quantifiable impacts and co-benefits; Enhanced capacity to quantify emissions reduction targets and re-focus or strengthen interventions using data-driven methods; Improves international reporting of GHG emissions to the UNFCCC allowing for a more accurate Global Stocktake</p>

Ambition Level	Proposed NDC Target Language <i>* denotes target can be considered under mitigation and/or adaptation</i>	Information Supplied to the UNFCCC	Data Requirements (red text = NCA can support)	Co-Benefits
Adaptation Targets				
Basic Qualitative target	<p>Enact detailed new policies and/or improve existing policies and measures to increase coastal ecosystem and community adaptive capacity, with time-bound milestones, including:</p> <ul style="list-style-type: none"> • Develop national plan for ecosystem-based adaption • Implement green-gray infrastructure approaches along highly vulnerable coastline • Revise national policies to address interlinkages between mangrove forests/ coastal ecosystems, water quality, and fisheries/agricultural production • Relocate current homes and infrastructure in coastal flood zones • Establish an early warning system and predictive scenario modeling for climate disasters and coastal flooding • Develop a strategic communications plan to educate and disseminate adaptation actions • Improve capacity building and training for coastal authorities and communities to implement adaptation actions • Establish cross-ministerial coordination mechanisms to mainstream adaptive coastal management • Explore innovative financing models for ecosystem-based adaptation • Increase funding for research on adaptive coastal management solutions 	General statement with qualitative information related to activities or targets	<p>An overview of current and/or planned policies and implementation frameworks, with additional data needs depending on target language, which may include:</p> <ul style="list-style-type: none"> • Existing and/or improved downscaled data on climate-related risks to forests and communities • Existing and improved data on training/ capacity-building programs • Community, household, and market surveys • Land-use cover and baseline data to identify vulnerable areas • Existing and improved coastal data and NTFP extraction practices • Data on research and funding levels 	Mitigation co-benefits; Targets to build upon; Highlights ongoing and planned work; Strengthens the country's international commitments to relevant UN conventions and other Multilateral Agreements (e.g. Bonn Challenge, 20x20); Enhanced livelihood security; Flexible implementation; Gender equity and youth empowerment; Builds in country capacity and innovation; Increase the resiliency of coastlines and coastal communities against impacts of climate change including storms and sea level rise, among others, as well as securing fisheries breeding grounds and supporting food security.
Higher Quantitative target	<p>Selected above targets + quantitative targets, such as:</p> <ul style="list-style-type: none"> • By [X date], implement green-gray infrastructure approaches along [X%] of highly vulnerable coastline; • Conduct [#X] trainings with coastal communities on climate-related risks and adaptation actions; • Reach [X%] of coastal communities with strategic messaging about incentives and opportunities to enhance their resiliency to climate change at the household and community level 	Commitment text; implementation plan (optional);	<p>Selected above needs +</p> <ul style="list-style-type: none"> • Improved data collection on quantitative indicators • Enhanced monitoring and evaluation frameworks • Identify priority sites for green-gray infrastructure • Monitoring of biological and ecological indicators of mangrove stability and health 	Selected above benefits + The adaptation benefits of this option will be more measurable; More clarity to attract international finance; More quantifiable mitigation co-benefits; Additional opportunities for local ownership

Recommendations

Based on the key synergies identified in the NCA-NDC crosswalk analysis, this section outlines our recommendations for how Liberia can harness opportunities to link NCA statistical information in its current NDC update process and implementation planning, as well as considerations to strengthen these opportunities for future NDC updates.

Recommendation 1: Utilize NCA to opt for the most ambitious opportunities in the updated NDC.

Enhanced ambition from countries is urgently needed to achieve the goals of the Paris Agreement, as well as the ultimate goal of the UNFCCC. Climate action from nature has the potential to provide over one third of the global reductions of GHG emissions, ensure the integrity of ecosystems and ecosystem services, and contribute to key adaptation benefits. To harness this potential and enhance ambition, Liberia should fully integrate NCA and natural climate solutions into its NDCs so that these important nature-based climate actions may be prioritized for implementation and support. By using the suggestions framework in Table 2 to guide an understanding of where NCA can support climate ambition and the various considerations and benefits of increasing ambition in each sector, Liberia can opt for the highest ambition level possible in accordance with its national circumstances.

Recommendation 2: Integrate existing NCA information into technical target-setting exercises for the NDC update.

Although much of the NCA work in Liberia is ongoing, there are already useful outputs of the CI-NASA Partnership work and the GEF NCA Liberia project that can inform the updated targets for the NDC. Where available, NCA data and statistics derived from the Ecosystem Extent Maps of Liberia, GHG emissions estimates, NCA indicators on ecosystem condition, household surveys on the use and benefits of ecosystem services, and modeling of ecosystem services can all be combined with complementary data and other national considerations during the NDC revision.

For example, the information generated about GHG emissions from mangrove loss (see Figures 5 and 6) can help set quantitative targets and/or policies and measures targets for the coastal zones sector. Formulation of new policies and climate actions impacting coastal livelihoods should be quantified and monitored with science-based information where possible. By expanding this initial GHG emissions analysis to other ecosystems that were mapped in Liberia, NCA can lead to a comprehensive assessment of emissions in Liberia that occurred in the past two decades. The resultant set of tables and maps will identify ecosystems and areas that are the most significant sources/sinks of GHG. The data about trends will allow informed target-setting for each ecosystem separately. This trend data, while helpful for planning related to mitigation, is also valuable for understanding where adaptation co-benefits will occur, such as via reduced wave attenuation, as well as additional synergistic adaption targets that can be made, such as the inclusion of green-gray infrastructure where suitable.

In addition to supporting the formulation of GHG emissions reduction targets for coastal ecosystems, forests, agriculture, energy, transport & infrastructure, NCA data and statistics can be used to formulate both quantitative and detailed qualitative climate mitigation and adaption targets related to:

- Conservation and restoration of forests, including reduction of forest fragmentation
- Conservation and restoration of mangroves and coastal ecosystems
- Optimization of agriculture and biomass-derived energy production (firewood, charcoal, oil palm) in degraded areas
- Water catchment conservation and restoration, including links to maximizing hydropower electricity production

- Climate resilient agriculture, irrigation, and fisheries
- Climate resilient coastal planning for storm protection and erosion control, including deployment of green or green-grey infrastructure
- Climate resilient public health

Conservation International can work closely with sectoral experts within the Government of Liberia during forthcoming technical workshops on the NDC update to ensure that available NCA data and statistics are integrated into target-setting discussions where appropriate.

Recommendation 3: Consider NCA synergies and opportunities in NDC implementation planning and monitoring processes.

Many of the synergies between NCA and the NDC can enhance the development of specific actions in sectoral, regional, and local implementation plans to meet broader NDC targets, as well as inform NDC monitoring frameworks. The NCA statistical information derived from the ecosystem extent maps, indicators on ecosystem condition, and surveys on ecosystem services can provide policy-relevant and spatially explicit tools to enhance both human and ecosystem well-being during the NDC implementation, such as by:

- Guiding integrated land-use planning to balance competing land needs, minimize GHG emissions, and maximize the benefits of ecosystem conservation and restoration
- Strengthening the climate resilience and health of local communities, as well as their buy-in for taking climate action, by considering local benefits derived from natural capital and enhancing relevant ecosystem-services for health and livelihood improvements in local NDC implementation plans
- Identifying where opportunities to protect ecosystem services, enhance climate resilience, and reduce GHG emissions should be considered during development of energy resources (e.g., biomass, hydroelectricity), water systems, transport systems and other infrastructure
- Designing monitoring protocols for natural capital resource use, such as non-timber forest products or biomass use and production, including monitoring ecosystem loss and degradation driven by natural resource extraction
- Developing detailed plans to meet Liberia's 30% forest protection target and additional activities under the REDD+ strategy by locating key forest areas important for both biodiversity and provision of ecosystem services
- Optimizing the design of urban green corridors and facilitating ecosystem and habitat connectivity across the larger landscape
- Strengthening the national GHG inventory with additional data on land cover/use change
- Providing data on the economic value of co-benefits generated by climate action activities as inputs to cost-benefit and cost-effectiveness analyses of NDC implementation options

In areas where NCA would provide useful context, but data gaps exist, the NDC implementation plan can include specific actions to collect NCA-relevant data as the first step to enable further action plan development.

Recommendation 4: Integrate NCA considerations into processes for NDC data collection and management.

While NCA data and statistics can support NDC planning, implementation and monitoring, additional steps will need to be taken to create a national NCA system that can be used for high-quality information for future NDC updates and national GHG inventories. The Government of Liberia can establish a complementary primary data collection program to meet specific NCA data needs, as government

databases currently lack some necessary information used for ecosystem accounting. Where possible, data collection should aim to capture disaggregated information on key ecosystem indicators and population characteristics.

The gaps identified in the crosswalk primarily highlighted the need for additional data and analysis in most sectors. To fill those gaps a data management strategy needs to be developed primarily focusing on:

- identifying and cataloging existing NCA datasets for NDC and/or national GHG inventory purposes for ease of reference and access
- creating a catalogue of additional NCA data needs for the NDC and/or national GHG inventory based on the identified data gaps
- designing and developing NCA survey instruments in collaboration with LISGIS according to their standards

For example, one relatively inexpensive option would be to conduct rapid household surveys on a repeated basis. The GEF NCA Liberia project is currently designing comprehensive field surveys along the coastal areas that can provide some of the missing information in the NDC. In addition to field surveys, complementary market surveys will provide information to economic value of products exchanged in the market (e.g., firewood, fish, bushmeat). The protocols and survey instruments that will be developed for these surveys may be used for future surveys.

To enable the complementary data collection needed for a national NCA system, the Government of Liberia should identify any additional capacity-building needs for key agency staff, as well as any needs for enhanced interagency coordination, such as among the EPA, LISGIS, FDA, the Liberia Land Authority, the Ministry of Finance and Development Planning, and others as relevant. Many similar needs are already being explored and enhanced via the Capacity Building Initiative for Transparency (CBIT) project, which is a key opportunity to explore further synergies with NCA development.

Recommendation 5: Synchronize NDC activities with NCA for future target updates.

NDCs, like NCA, are repeated and updated on a regular time interval. Key to this repeatability is adopting and following a consistent methodology. Some of these analytical methods are already standardized in the SEEA Ecosystem Accounting guidelines, which can be readily available to use in quantifying carbon storage and sequestration, measuring emissions and quantifying/valuing ecosystem services co-benefits identified in the NDC. Specific recommendations to help achieve consistency are to:

- Standardize NDC analytical methods used for measuring and reporting key indicators and statistics by customizing existing standards, such as SEEA EA.
- Coordinate NDC planning with NCA for joint field work, data collection and data management

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Annex: Enlarged Images from Figure 5

