

# EO 4 Ecosystem Accounting 2022



## Using Earth Observation-based Above Ground Biomass Estimates to Compile Condition and Carbon Accounts for Forest Ecosystems in Liberia

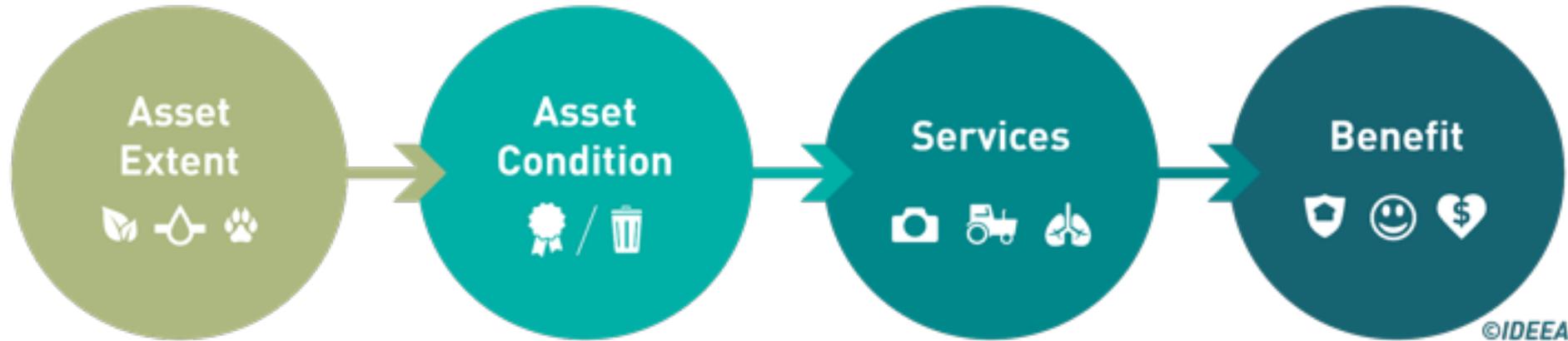
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et al.

November 30, 2022

CONSERVATION  
INTERNATIONAL



+ THE EUROPEAN SPACE AGENCY



Stocks

Flows

Area of ecosystem assets (ha)

Tree age/density  
Species diversity  
Pests/weeds  
Understory density  
**Above ground biomass density**  
Fragmentation  
Connectivity, etc.

Wood provisioning  
Non-wood forest products  
**Carbon sequestration and storage**  
Water regulation and purification  
Soil retention  
Air filtration  
Recreation

Ecosystem and species appreciation

# Liberia

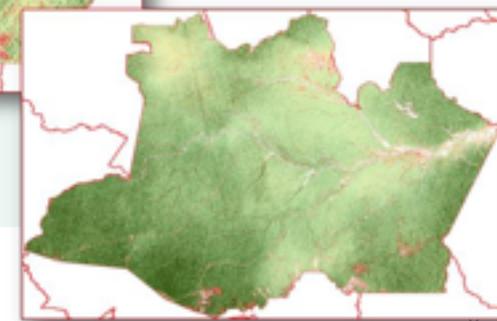
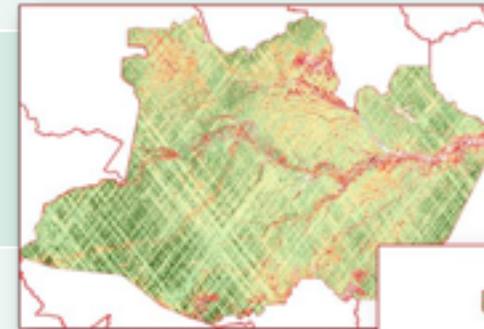


# Ecosystem Condition

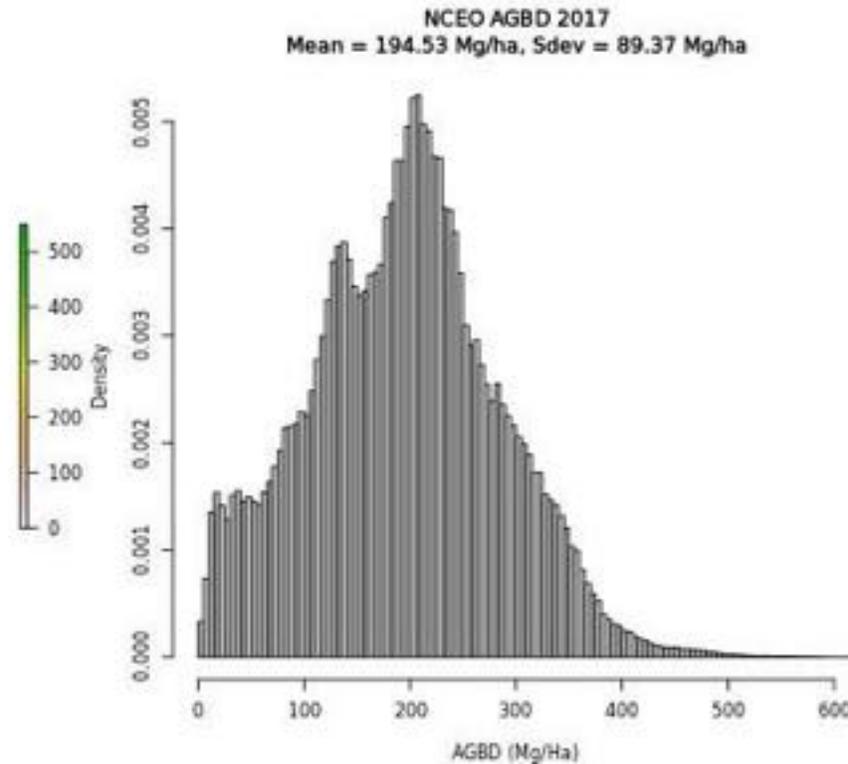
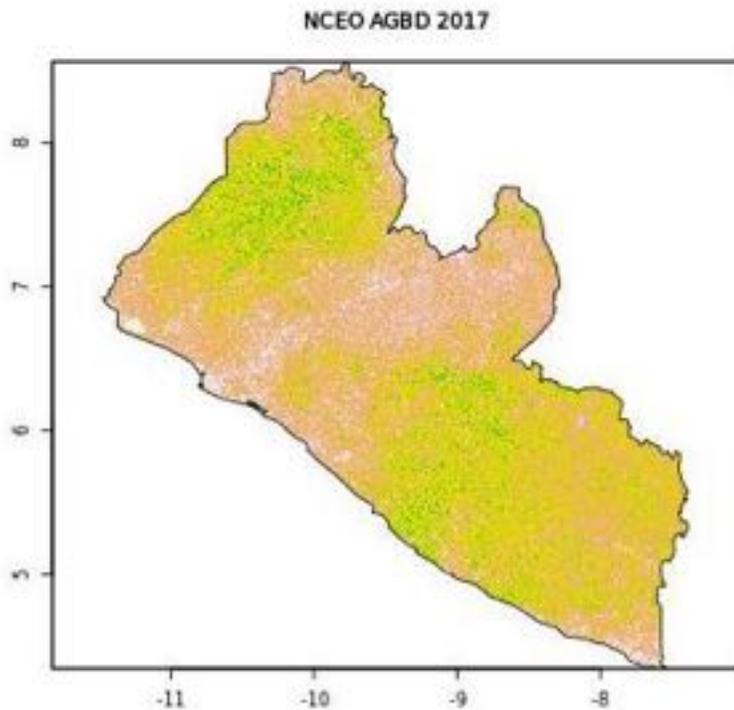


# Available Above Ground Biomass Products

Product (reference)	Input data, (Mission(s))	Years, Pixel-size, Domain	Challenges
<b>Global Ecosystem Dynamics Investigation (GEDI) L4B</b>	LiDAR, (GEDI)	2019 - 2021 L4B product at 1 km +/- ~51.6° lat	<ul style="list-style-type: none"> <li>• Large spatial data gaps and is provided at 1 km.</li> <li>• The data is relatively novel</li> <li>• Geolocation uncertainty of footprints</li> </ul>
<b>ESA's Climate Change Initiative (CCI) Biomass</b>	LiDAR, SAR, Optical (Envisat ASAR, ALOS, Sentinel-1/2, GEDI, ICESat-2)	<b>2010, 2017, 2018, 2020 (to be released)</b>  <b>~100 m at equator</b>  <b>Global</b>	<ul style="list-style-type: none"> <li>• The inherently used (non-)forest definition is unknown</li> <li>• Training sample variability is unaccounted for</li> <li>• Loss of model sensitivity at ~400 Mg ha<sup>-1</sup></li> </ul>
<b>NASA JPL Biomass Map 2020</b>	LiDAR, SAR, Optical (Landsat-8, ALOS, Sentinel-1, GEDI, ICESat-2)	2020 (to be released)  ~100 m at equator  Global	<ul style="list-style-type: none"> <li>• Same as all above</li> </ul>
<b>National Center for Earth Observation (NCEO) Africa</b>	LiDAR, SAR, Optical (GEDI, ALOS-2, Landsat)	2017  ~100 m at equator  Africa	<ul style="list-style-type: none"> <li>• Same as all above</li> <li>• Product covers only Africa</li> </ul>



# Variability of Above Ground Biomass Products



No product is currently produced as a **consistent time-series**

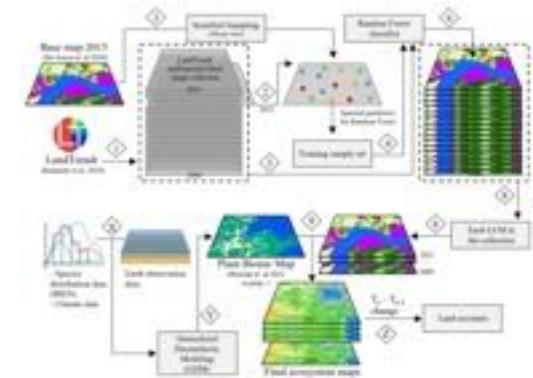
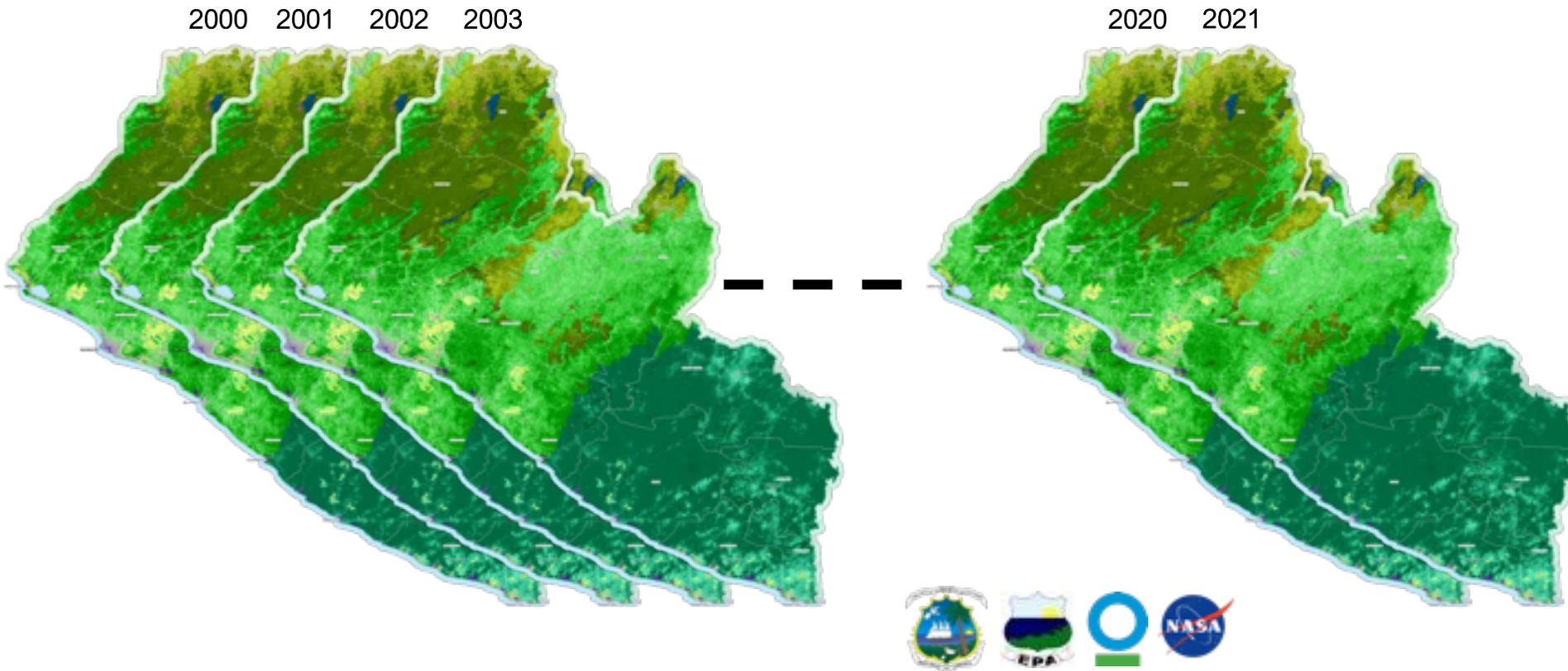
It is not known how products **perform comparatively**

It is not known how the **products' uncertainties scale**

It is not known how to **calibrate or correct systematic errors**

# Annual Time Series of Ecosystem Maps

Data: Landsat 5, 7, 8  
Epoch: 2000 – 2021  
Spatial resolution: 30 m  
Method: LandTrender  
Number of classes: 22



## Forest frequency

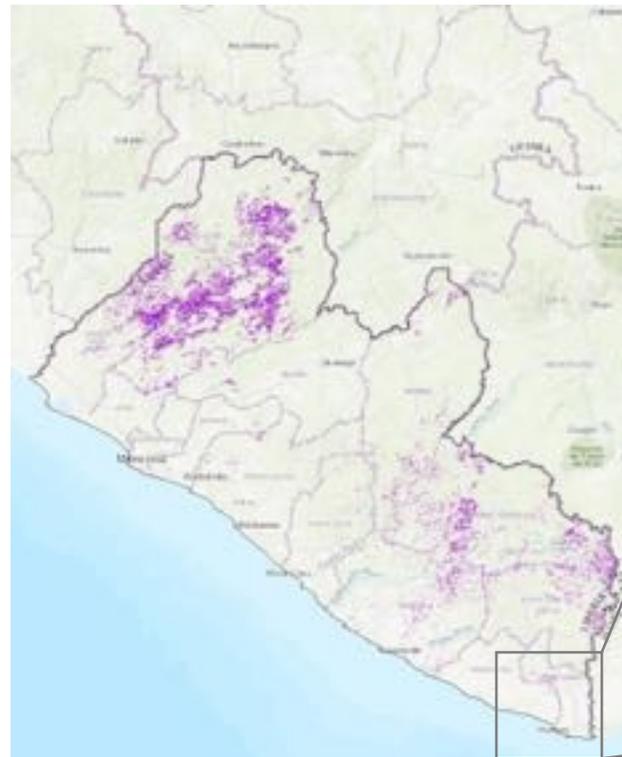
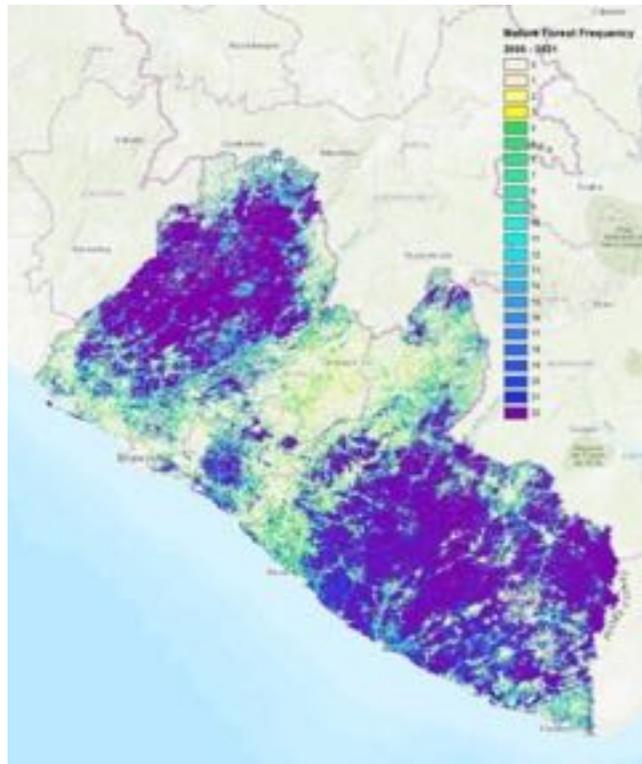
2000 – 2021; max. = 22 (purple)

## Mature rainforest

300 x 300 m; n = 48,400 (4,356 km<sup>2</sup>)

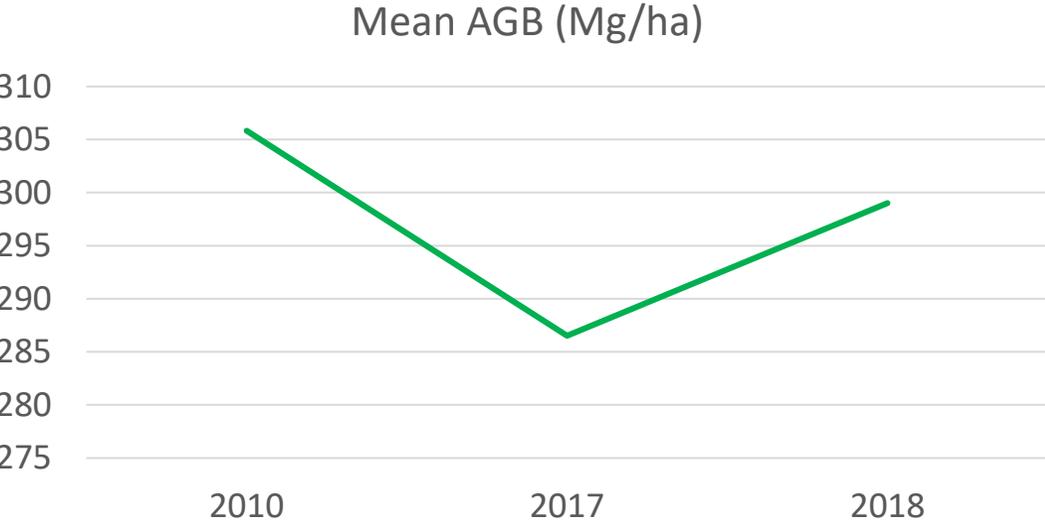
## Mangroves

300 x 300 m; n = 139 (12.5 km<sup>2</sup>)



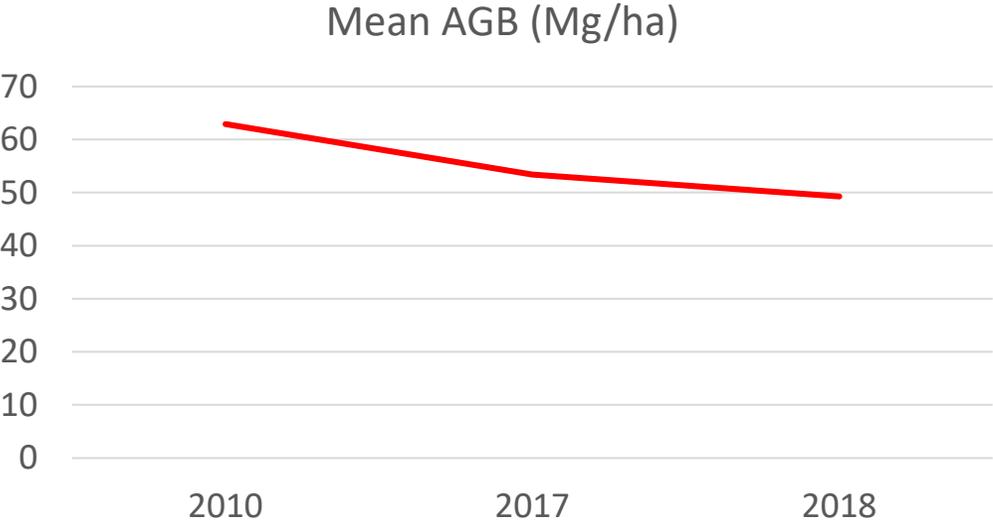
## Mature rainforest

Mean AGB of reference areas (Mg/ha)



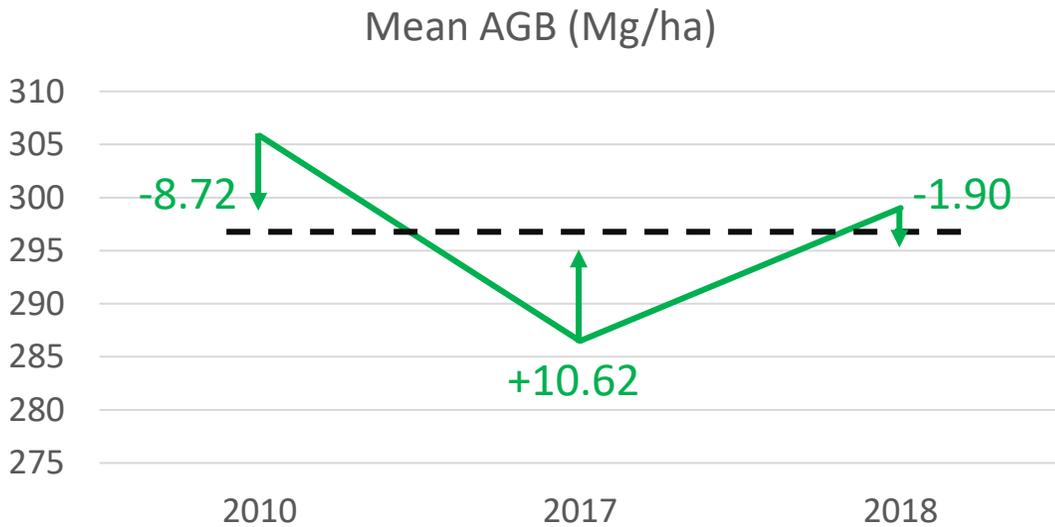
## Mangroves

Mean AGB of reference areas (Mg/ha)



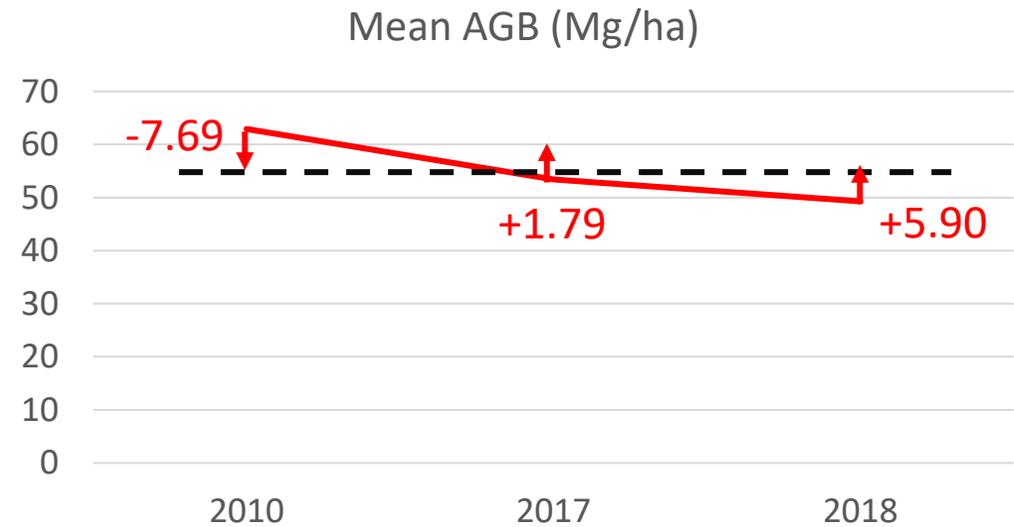
## Mature rainforest

Three epochs mean = 297 Mg/ha (black dashed line)



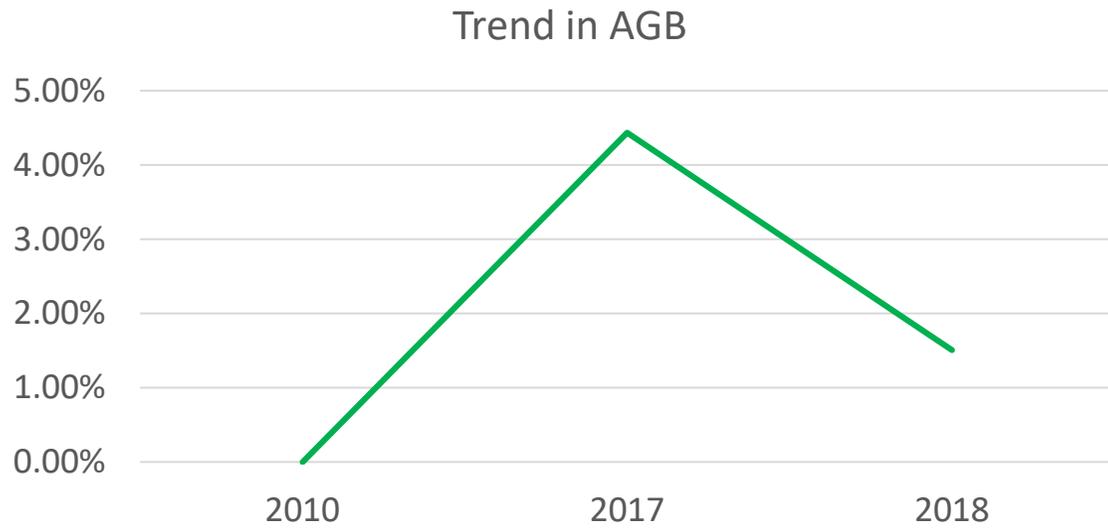
## Mangroves

Three epochs mean = 55 Mg/ha (black dashed line)



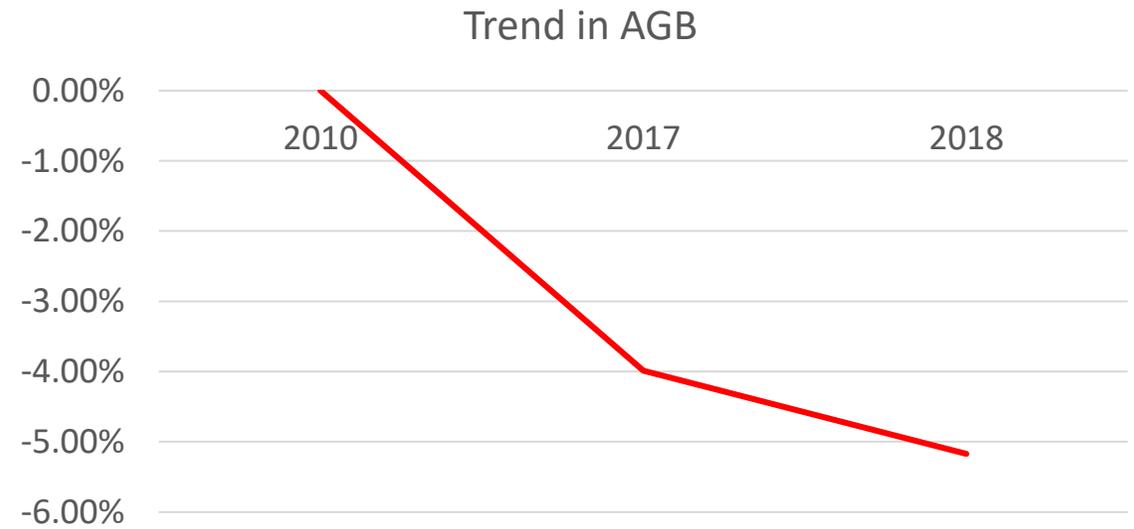
## Mature rainforest

Reference condition = forest extent in 2010



## Mangroves

Reference condition = mangrove extent in 2010



# Fragmentation of Mature Tropical Rainforest

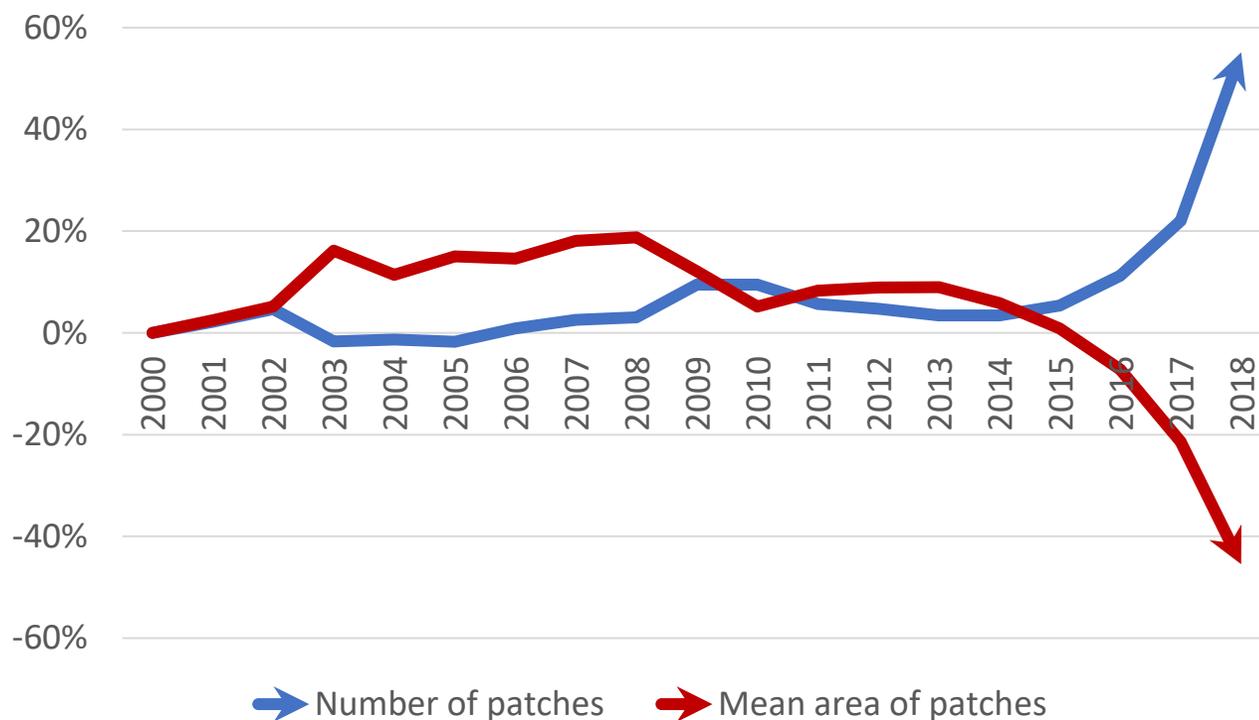
**93,000**

forest fragments  
in 2000

**220**

HECTARES  
mean size of  
forest fragments  
in 2000

Percent Change Since 2000



**55**

PERCENT  
increase in the  
number of forest  
fragments in 2018

**45**

PERCENT  
decrease in the  
mean size of forest  
fragments in 2018

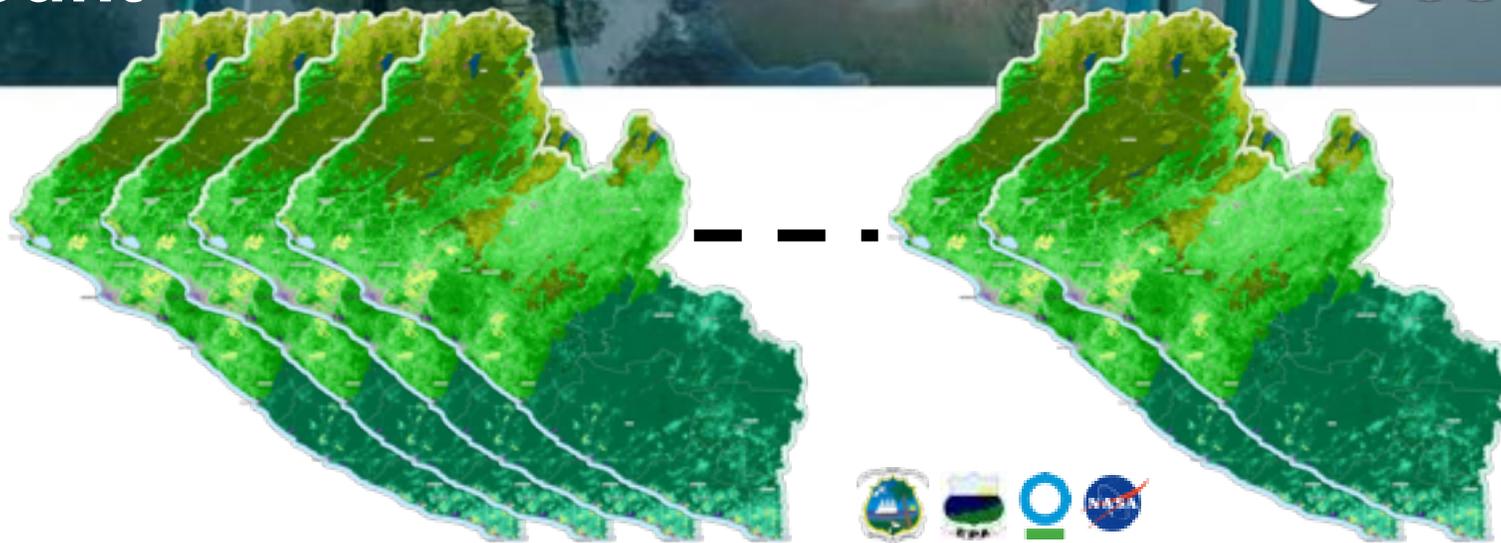
# Carbon Storage



# Ecosystem Extent Account

2000 2001 2002 2003

2020 2021

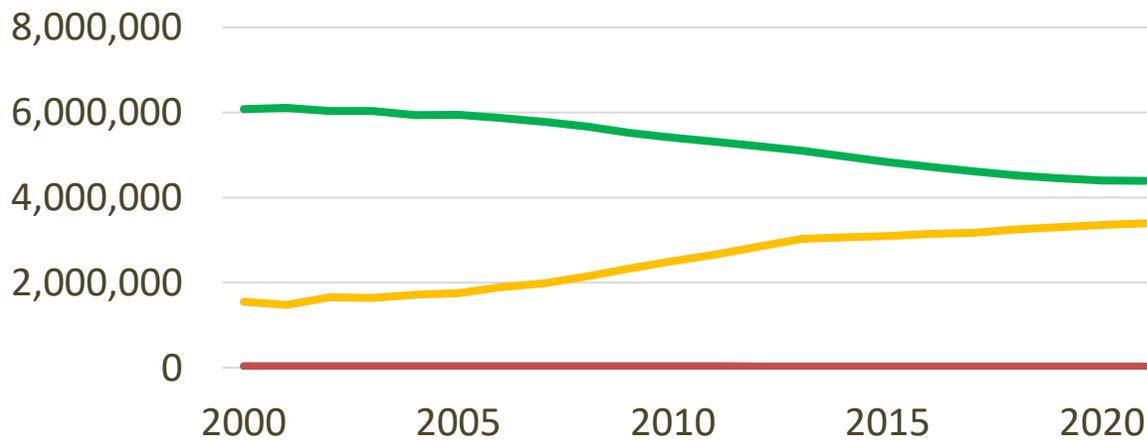


Forest Area (ha)

**4.4**

**MILLION**

hectares of **mature tropical rainforest** in Liberia in 2021



**28**

**PERCENT**

of mature tropical rainforest **degraded and converted** between 2000-2021

— Mature Tropical Rainforest — Degraded Tropical Rainforest — Mangrove and Swamps



Source: [Carbon Streaming Corporation](#)

## Forest & other land cover

### DATA USED:

- AGB: 2017 NCEO AGB for Africa (100 m)
- BGBC: 2010 Global Harmonized Carbon Map (300 m)
- SOC: 2020 SoilGrids 0-30 cm (250 m)

## Mangroves

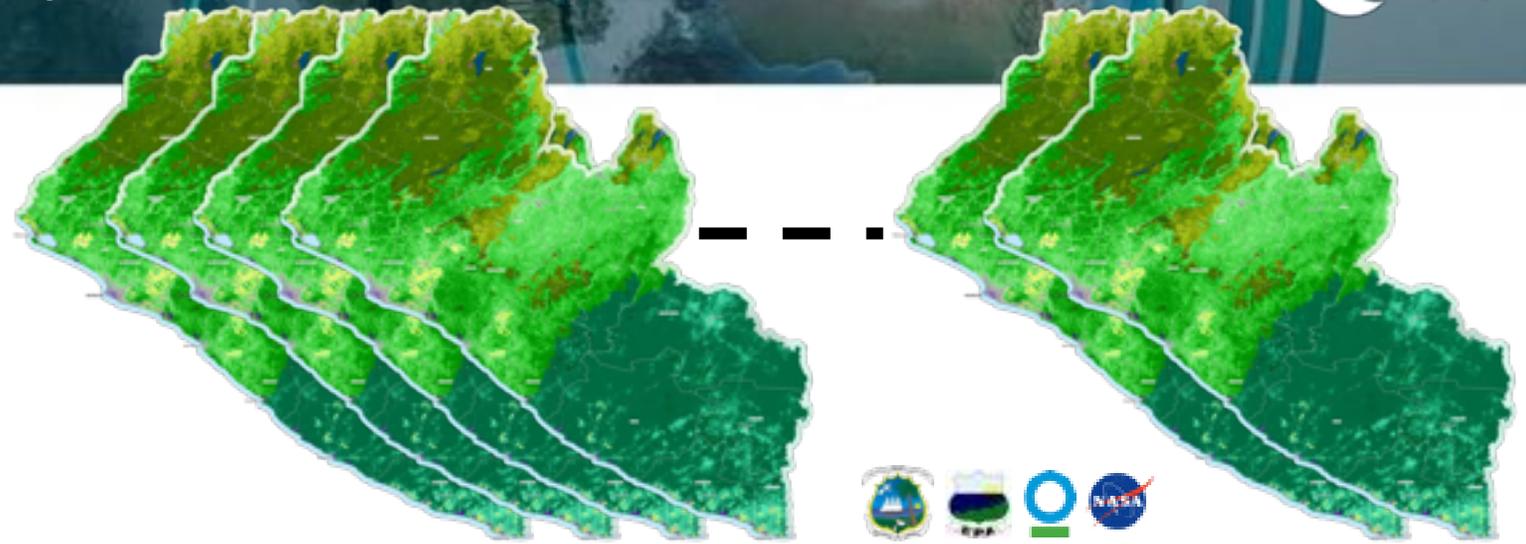
### DATA USED:

- AGB: 2000 NASA global mangrove biomass (30 m)
- BGBC: 2010 Global Harmonized Carbon Map (300 m)
- SOC: 2000 WHRC mangrove data (30 m)

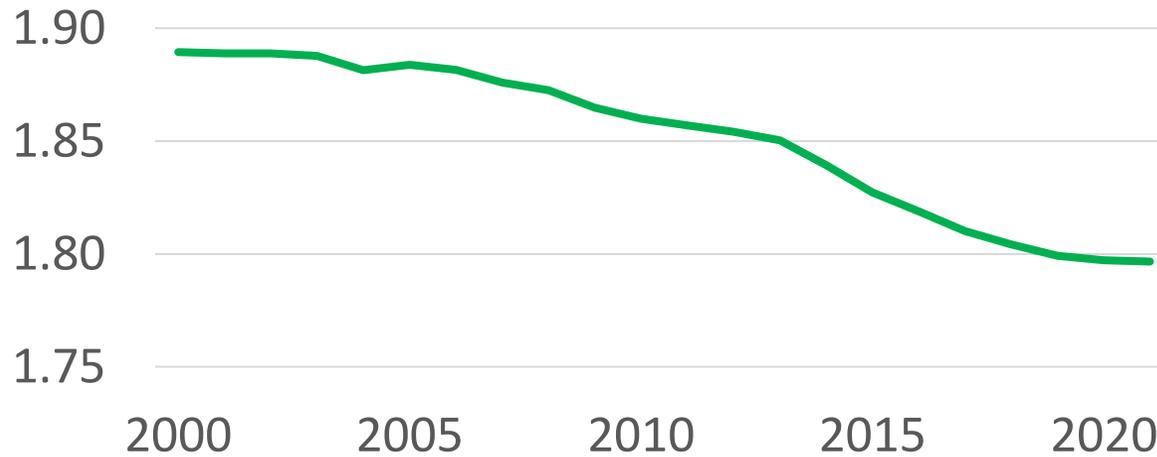
# Carbon Storage Account

2000 2001 2002 2003

2020 2021



Total Carbon Gt



**1,797**

**MILLION**

metric tons  
of **carbon** located  
in Liberia in 2021

**5**

**PERCENT**

of **carbon lost**  
between 2000-2021



## Challenges

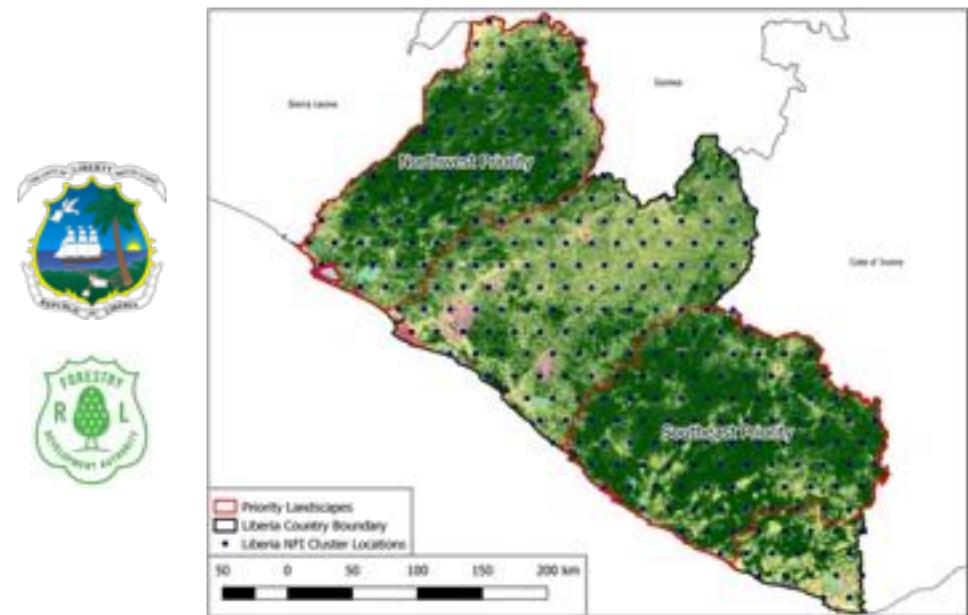
- CCI products may be suitable for monitoring condition at the national scale, however, additional intertemporal or spatial calibration may be needed
- Finer spatial resolution of calibrated AGB products may be needed to monitor ecosystem condition of highly spatially variable ecosystems such as mangroves

## Recommendations

- Spatial calibration using e.g., national forest inventory data may be the best option
- We plan to revise our analysis using finer thematic resolution of ecosystem classes

## Opportunities

- Conduct spatial calibration and verify the results using the Liberian National Forest Inventory data conducted during 2018 and 2019



# Acknowledgements



This presentation features products that were developed as part of partnerships between Conservation International and the U.S. National Aeronautics and Space Administration (NASA). The NASA – Conservation International Space Act Agreement seeks to share technical expertise and data for designing and informing the framework for natural capital and ecosystem accounting.

The information shared here is the result of the implementation of the System of Environmental-Economic Accounting Ecosystem Accounting in Liberia. Conservation International and its partners have made every effort to ensure the accuracy and reliability of the information provided in this presentation. Please note that these findings are preliminary results intended purely for discussion. Results may contain inconsistencies due to the input data that were sources from different sources. Do not cite or circulate the contents of this document without obtaining a permission from Conservation International.

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## Thank You!

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