RAPID MAPPING OF ECOSYSTEM SERVICES

CONSERVATION INTERNATIONAL'S APPROACH

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CONSERVATION INTERNATIONAL

BAILEY EVANS

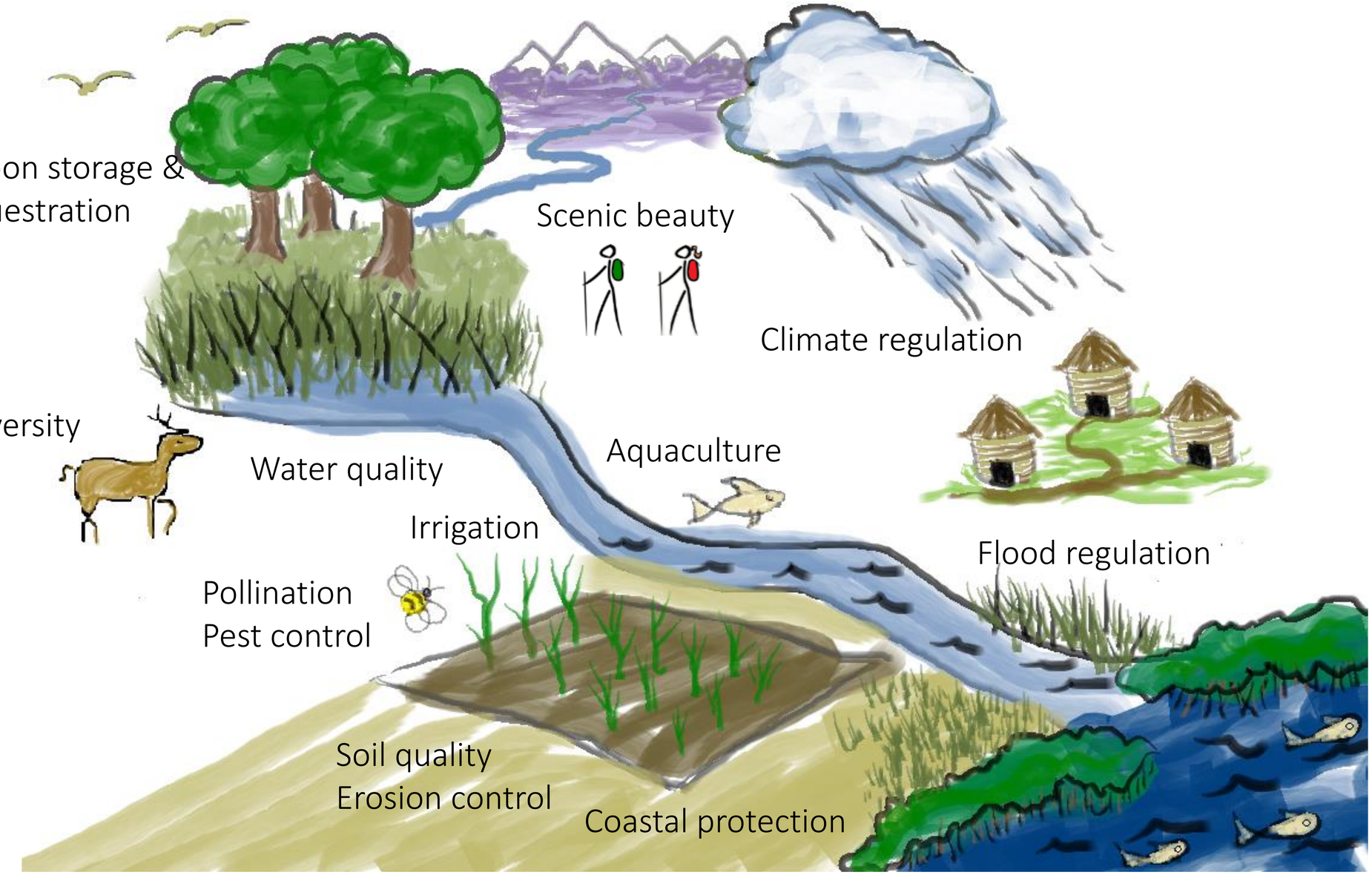
DEFINITIONS

Natural capital is the stock of biodiversity and ecosystems that provides a flow of benefits (***ecosystem services***) that support human well-being and economic activity.

***Essential* natural capital** is the sub-set of all natural capital that provides benefits that cannot be substituted or replaced, such as:

- Globally significant **biodiversity**
- Sources of **fresh water** that provide the sole supply for human population
- Wild sources of **food** that provide a safety net to people in times of crisis
- Natural places that are part of a **culture**'s identity

NATURAL CAPITAL PROVIDES ECOSYSTEM SERVICES



WHY MAP NATURAL CAPITAL?

Maps of **essential natural capital** are needed to:

- Guide scarce resources to the places where they can be most effective
- Support spatial planning
- Inform efforts to achieve conservation and sustainable development targets

A TYPICAL CHALLENGE
LIBERIA

- Maps of biodiversity & ES needed to inform conservation & development planning
- Provide a foundation for Natural Capital Accounting (NCA)
- No data on ecosystem services
- Limited time & budget (9 months, 200k)

METHODS

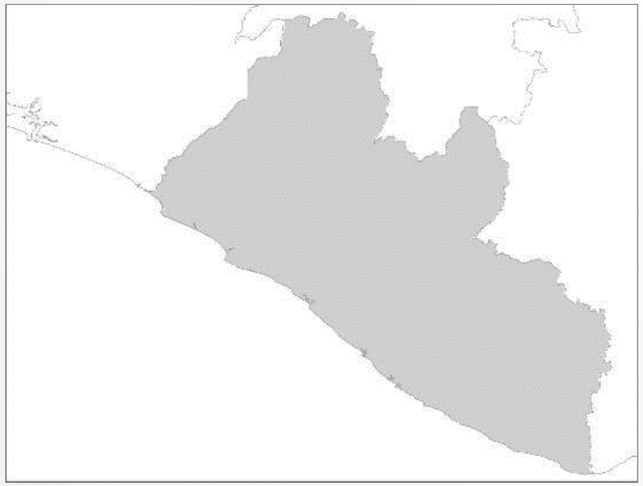
1. Define objectives
2. Identify important beneficiaries
3. Identify important biodiversity & ecosystem services
4. Collect relevant spatial data (& identify data gaps)
5. Identify criteria or thresholds for defining “essential natural capital”
6. Conduct GIS analyses & modeling
7. Review and refine preliminary results
8. Share results with stakeholders & decision makers

STAKEHOLDER **ENGAGEMENT**

WHERE WE HAVE MAPPED

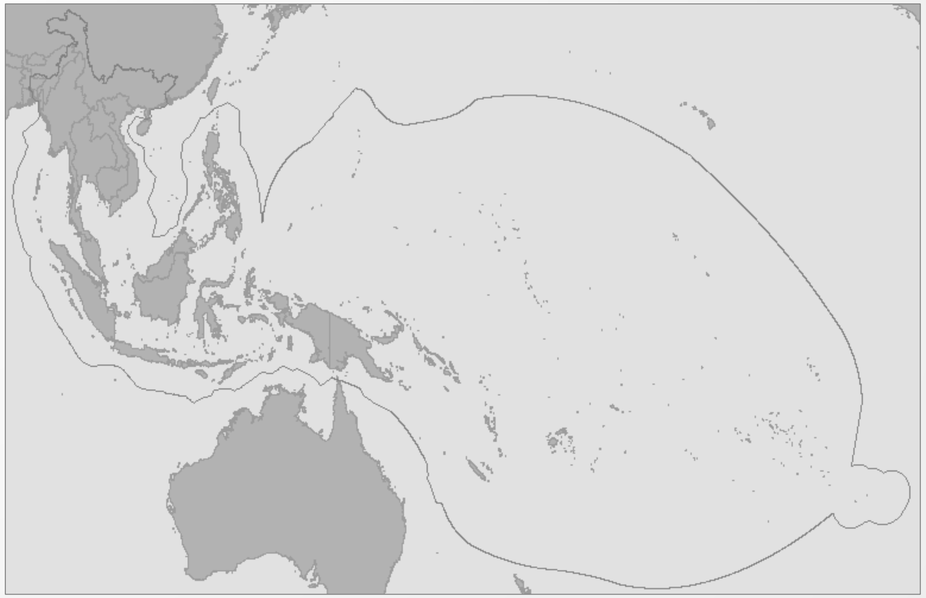
MADAGASCAR

CAMBODIA



LIBERIA

AMAZONIA



ASIA PACIFIC (ONGOING)

LIBERIA

- Guinean Forests of West Africa Biodiversity Hotspot
- Some of the largest remaining intact forests in western Africa
- Western chimpanzees, pygmy hippos, and elephants

www.globalforestwatch.org

RUSS MITTERMEIER

LIBERIA: BENEFICIARIES

- 4.5 million people, more than 16 major ethnic groups
- More than 70% of the population is rural and depends principally on natural resources for livelihoods
- Civil war & Ebola crisis have decimated the country's infrastructure, health care system, and education
- Poverty increases vulnerability to loss of natural capital (floods, food insecurity, loss of income, illness)

Bright EA, Coleman PR, Rose AN, Urban ML. 2012. LandScan 2011. Oak Ridge National Laboratory. Available from http://web.ornl.gov/sci/landscan/.
EPA (Environmental Protection Agency of Liberia). 2012. Liberia's national biodiversity strategy and action plan. Environmental Protection Agency of Liberia, Monrovia, Liberia.

LIBERIA: IMPORTANT ECOSYSTEM SERVICES

Provisioning

- Drinking water
- Bushmeat
- Forest products

Regulating

- Carbon storage
- Flood regulation
- Sediment regulation for hydropower
- Coastal protection

Cultural

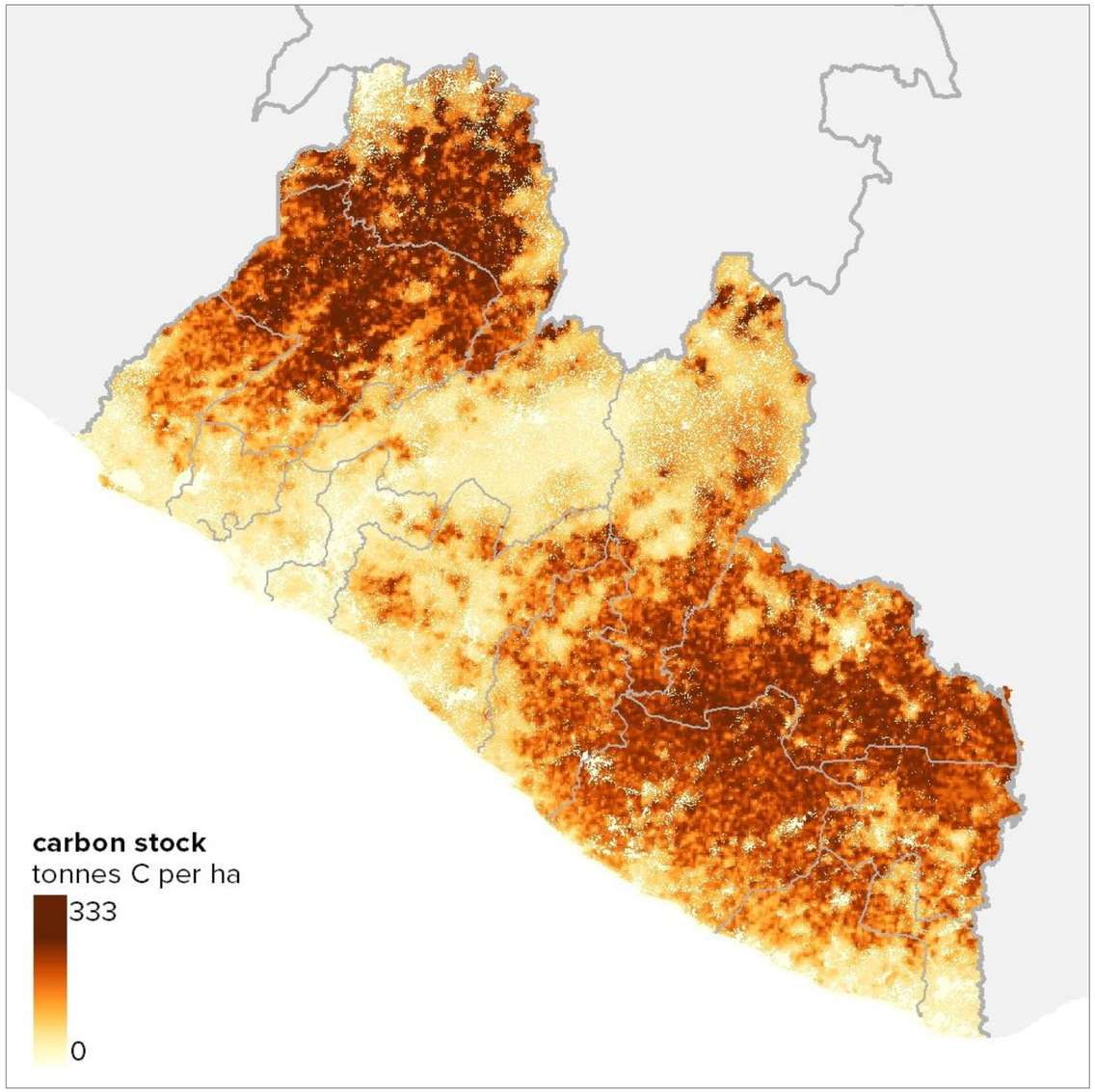
- Recreation

CLIMATE REGULATION: FOREST CARBON STOCK

BAILEY EVANS

FOREST CARBON STOCK

- Darker brown areas = more carbon
- Liberia's forests have globally high forest carbon stocks (per hectare)
- **High carbon stock areas could be targeted for long-term conservation of Liberia's forest carbon**

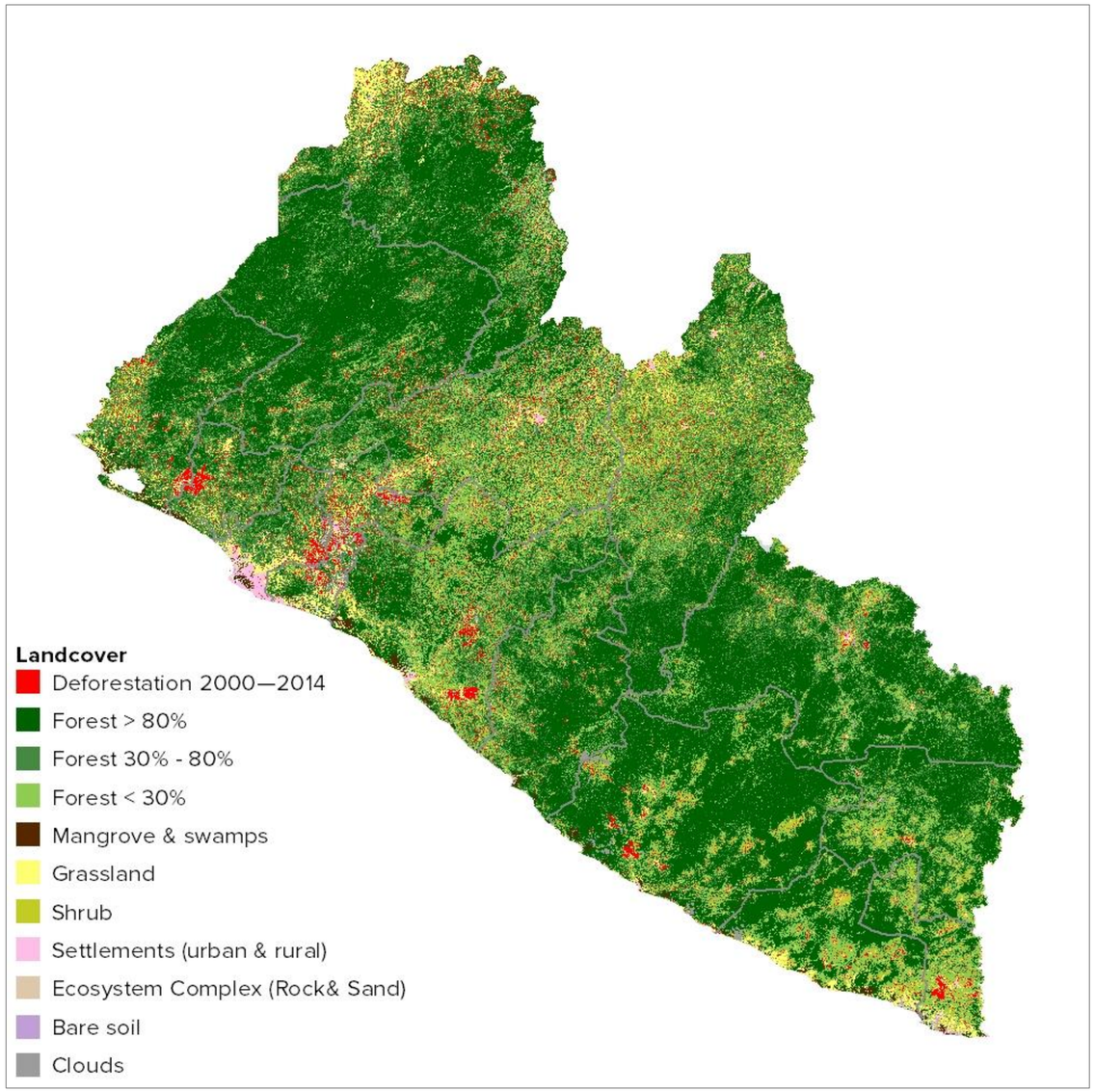


Avitabile V et al. 2016. An integrated pan-tropical biomass map using multiple reference datasets. Global Change Biology 22:1406–1420.

*NOT SUITABLE FOR REDD+ FEASIBILITY

TREE COVER* LOSS

- Land cover 2015
- Tree cover loss from 2000-2014 (red)
- Loss rate 25,996 ha/yr
- **Primarily driven by clearing for oil palm, rubber, and small-scale agriculture**

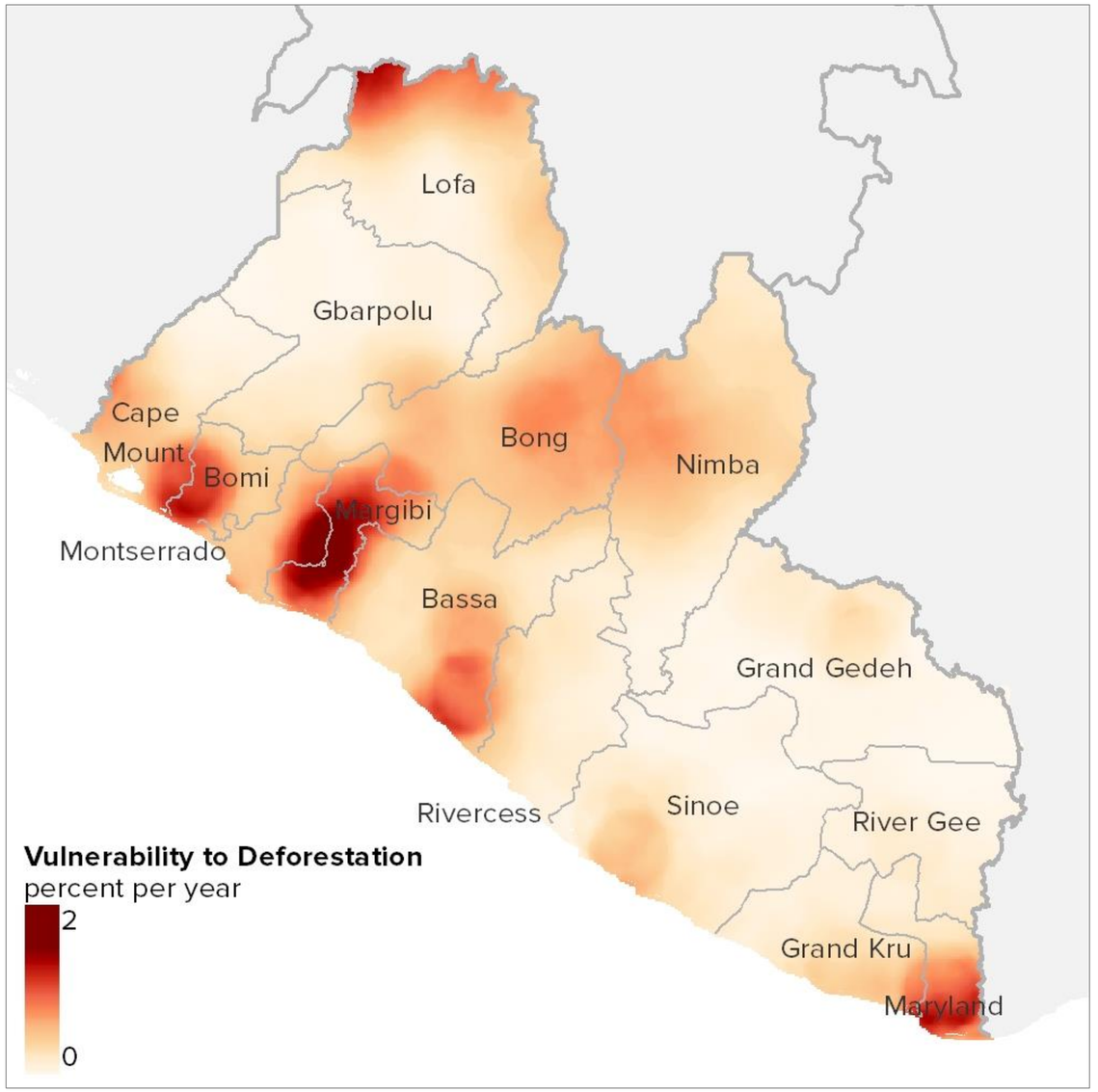


JV Metria/Geoville. 2015. Liberia Land Cover and Forest Mapping 2015. JV Metria/Geoville and Forestry Development Authority, Monrovia, Liberia.
Hansen MC et al. 2013. High-Resolution Global Maps of 21st-Century Forest Cover Change. Science 342:850–853.

*INCLUDES PLANTATIONS

VULNERABILITY TO TREE COVER LOSS*

Areas vulnerable to future tree cover loss (including plantations), based on trends 2000-2014

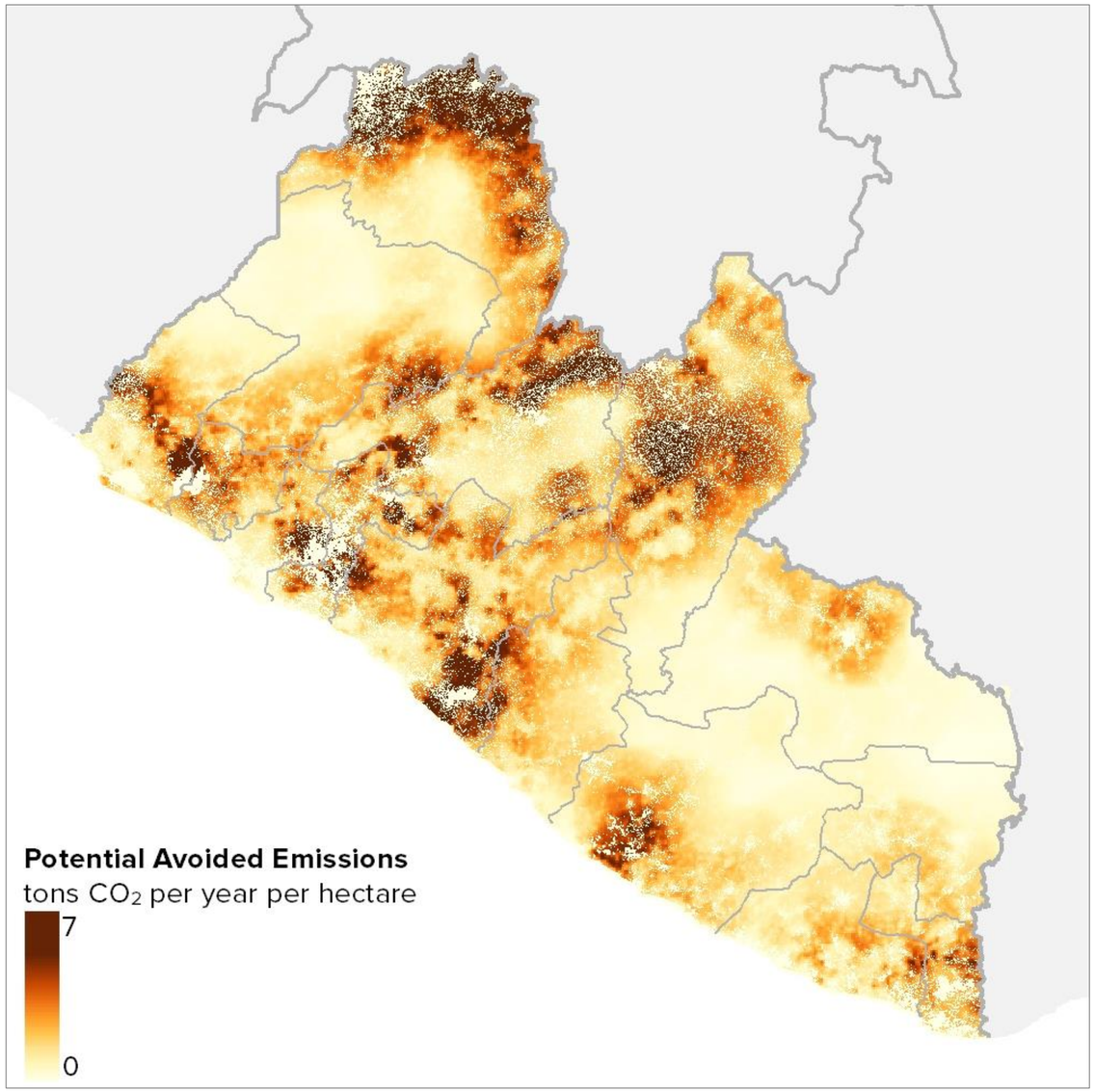


Hansen MC et al. 2013. High-Resolution Global Maps of 21st-Century Forest Cover Change. Science 342:850–853.

*INCLUDES PLANTATIONS. NOT SUITABLE FOR REDD+ FEASIBILITY

POTENTIAL EMISSIONS FROM TREE COVER LOSS*

- Areas with high forest carbon stocks that are also vulnerable to tree cover loss
- Darker brown areas = higher potential emissions if trees are lost
- **If conserved, these areas could reduce emissions from tree cover loss**



*INCLUDES PLANTATIONS. NOT SUITABLE FOR REDD+ FEASIBILITY

FLOOD REGULATION

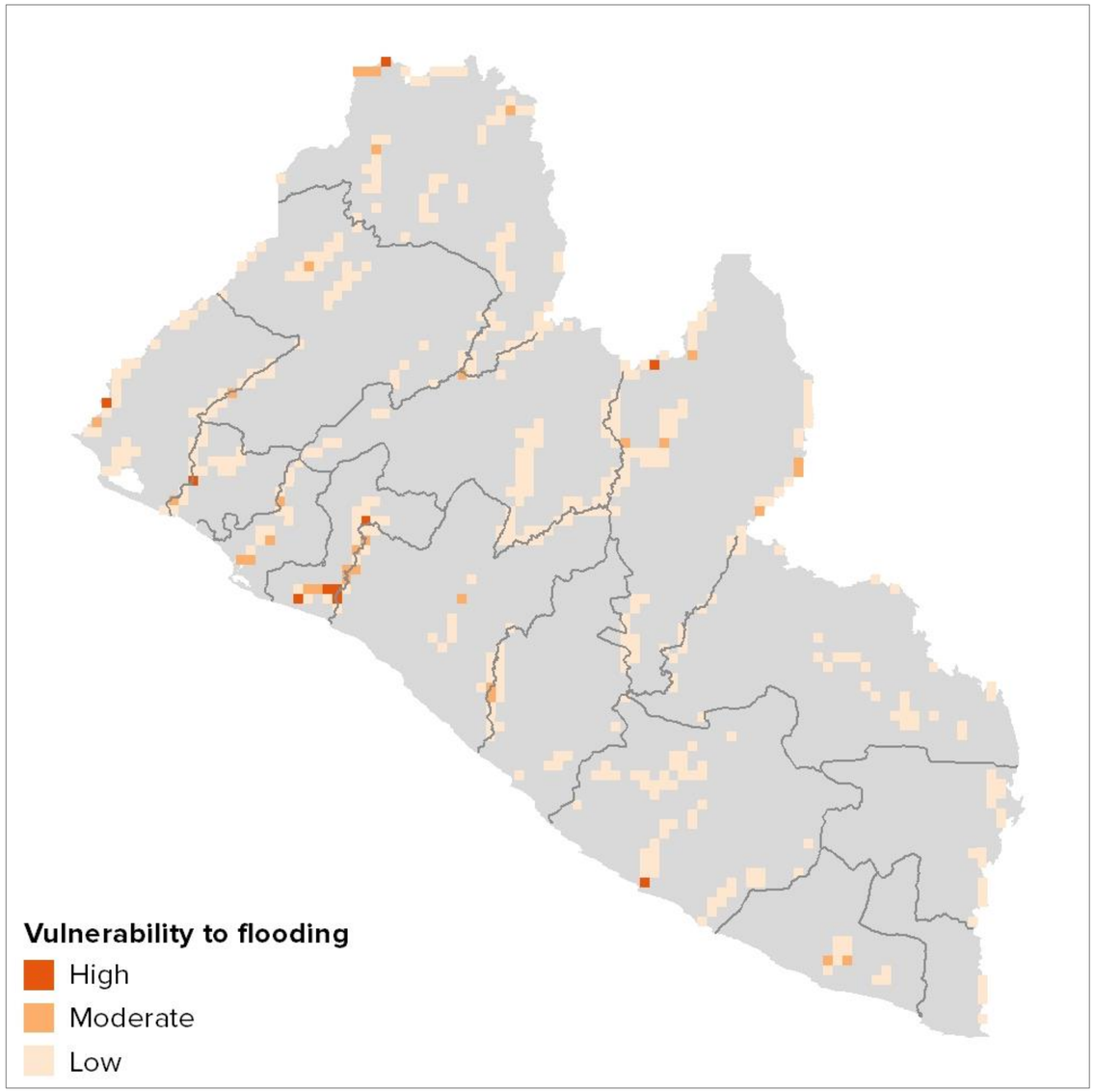
RUSSELL MITTERMEIER

NEWS / AFRICA

Sierra Leone mudslides 'kill more than 1,000'

VULNERABILITY TO FLOODING

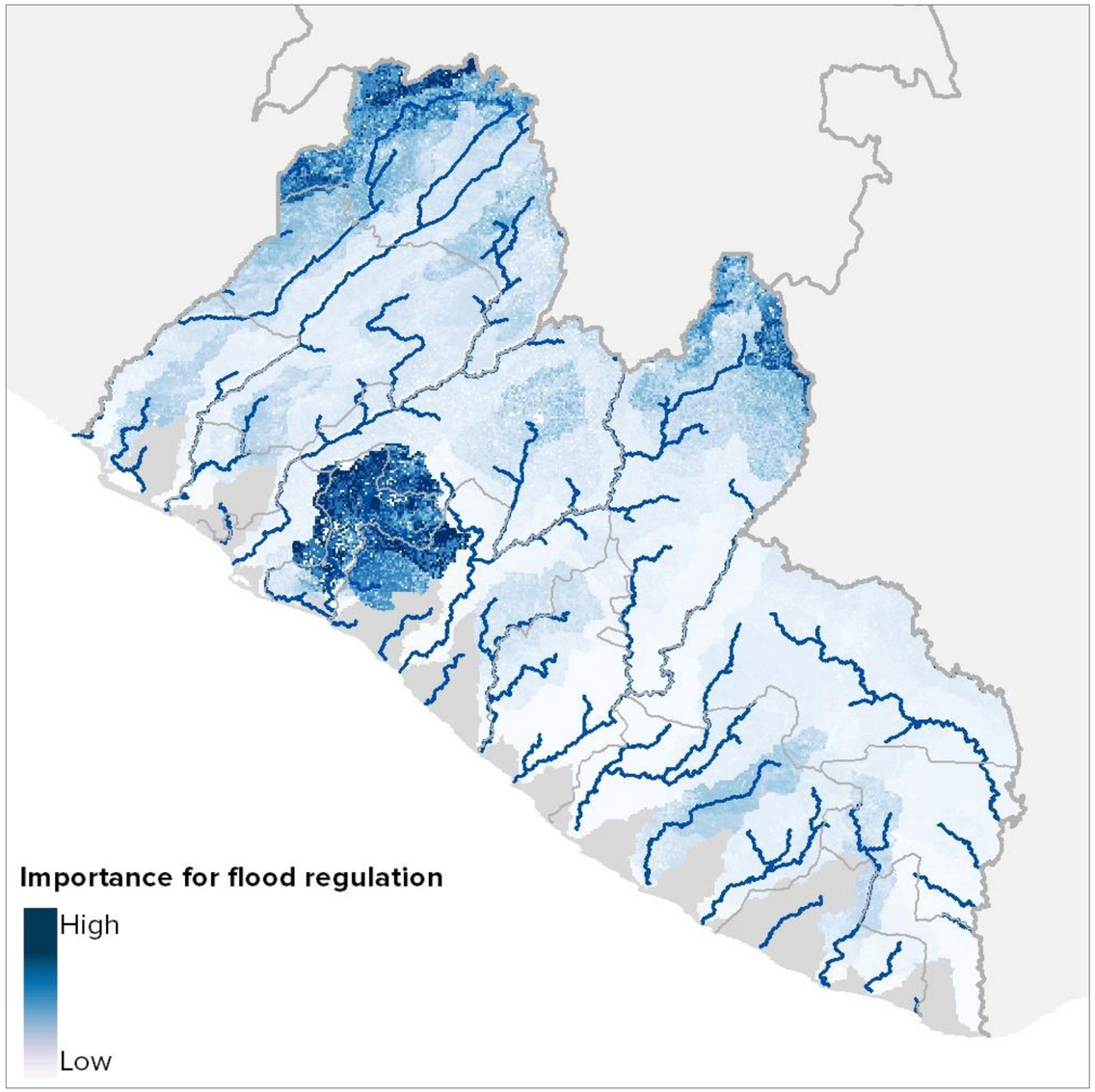
- People vulnerable to flooding
- Global dataset based on hydrological modeling, observed floods 1999-2007, and human population 2010



UNEP (2009) 2009 Global Assessment Report on Disaster Risk Reduction: Risk and poverty in a changing climate. Available at: http://www.preventionweb.net/gar09 (accessed on November 21, 2016).

FLOOD REGULATION FROM NATURAL VEGETATION

- Darker blue areas = vegetation provides flood regulation services for a larger number of people
- **These areas could be targeted for conservation or restoration investments to reduce flood risk in flood prone areas**

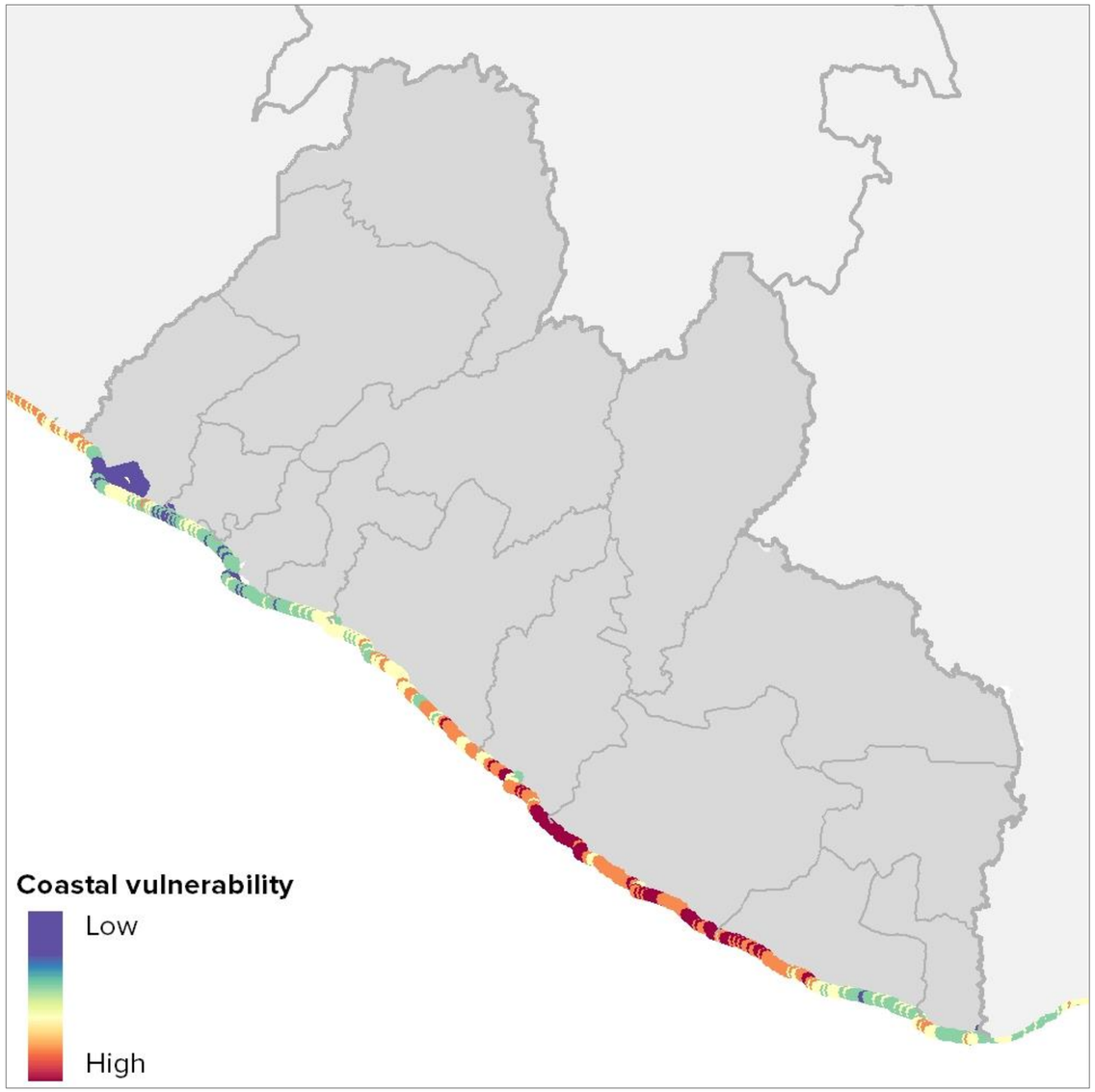


GeoVille (2015) Land cover Map of Liberia.
Lehner, B., Verdin, K., Jarvis, A. (2008) New global hydrography derived from spaceborne elevation data. Eos, Transactions, AGU, 89(10): 93-94.
UNEP (2009) 2009 Global Assessment Report on Disaster Risk Reduction: Risk and poverty in a changing climate. Available at: http://www.preventionweb.net/gar09 (accessed on November 21, 2016).

COASTAL PROTECTION

COASTAL VULNERABILITY

- This map shows vulnerability of people along Liberia's coast
- Red areas on the map are where there are people with higher vulnerability

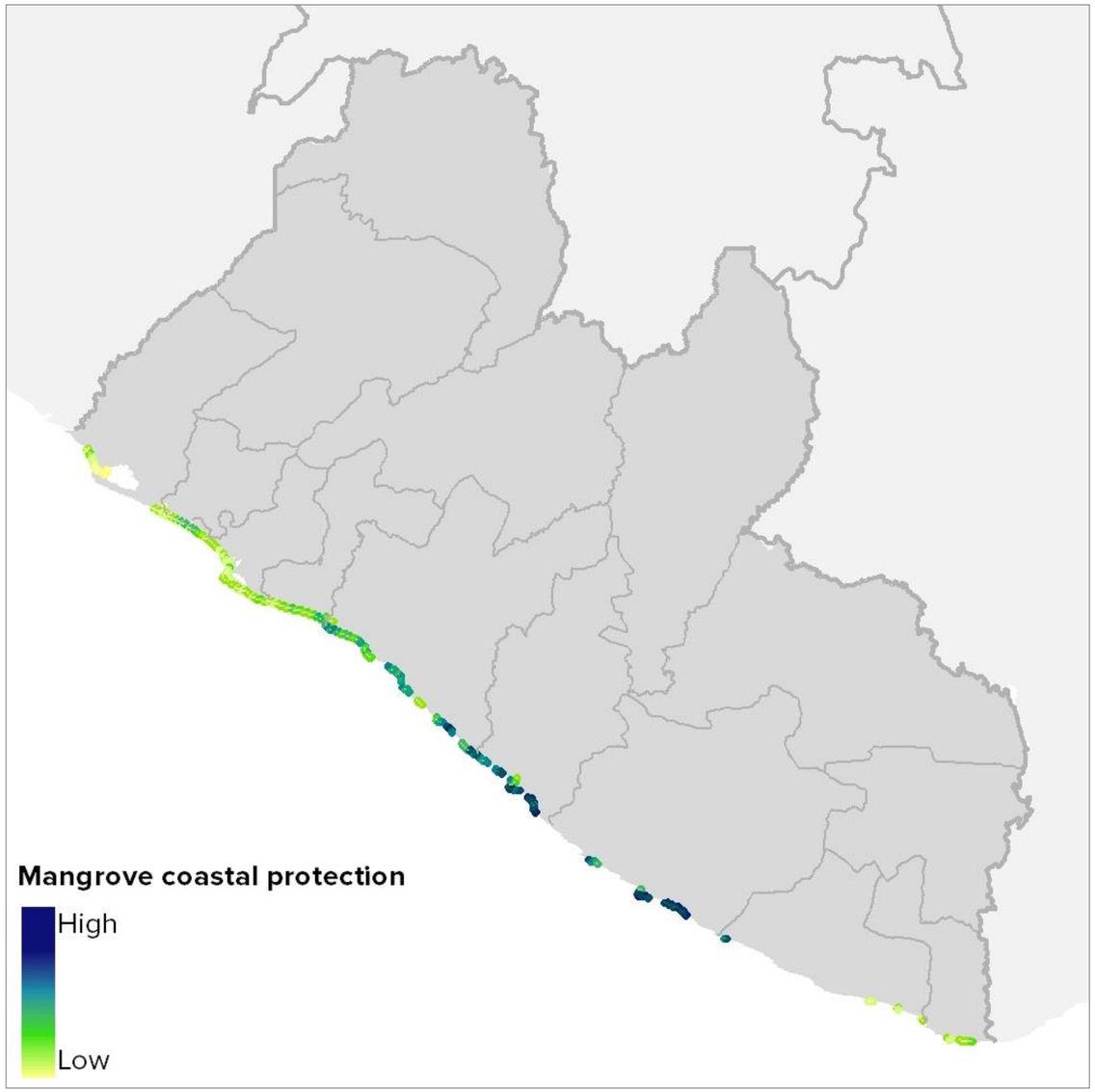


Tallis H, Polasky S. 2009. Mapping and valuing ecosystem services as an approach for conservation and natural-resource management. Annals of the New York Academy of Sciences 1162:265–283.

COASTAL PROTECTION FROM MANGROVES

InVEST
integrated valuation of ecosystem services and tradeoffs

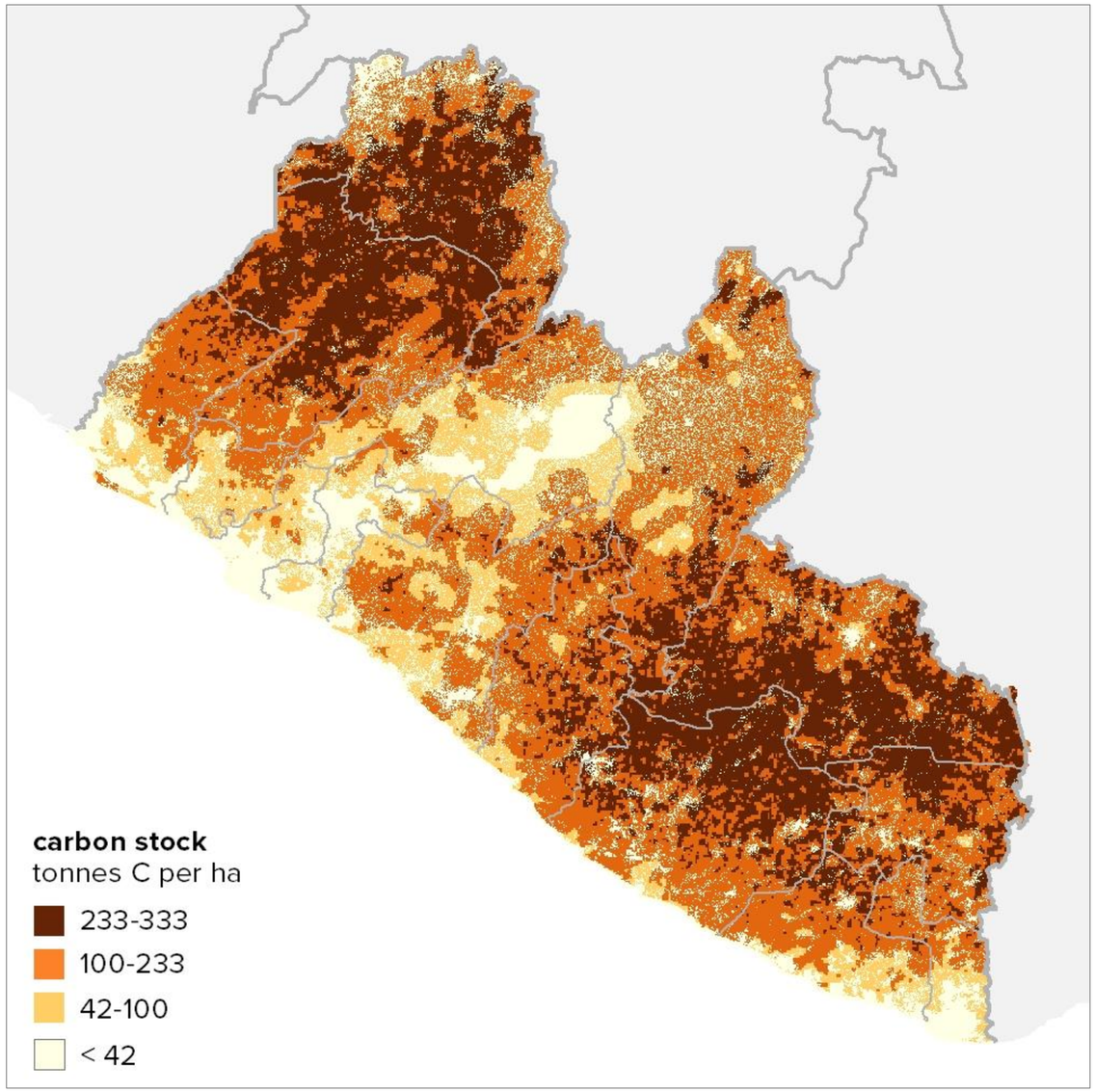
- This map shows mangroves that are providing protective benefits to vulnerable people
- Darker blue = more protection
- **These areas might be targeted for conservation or restoration to ensure ongoing coastal protection**

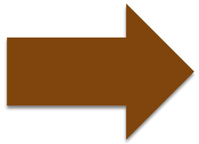


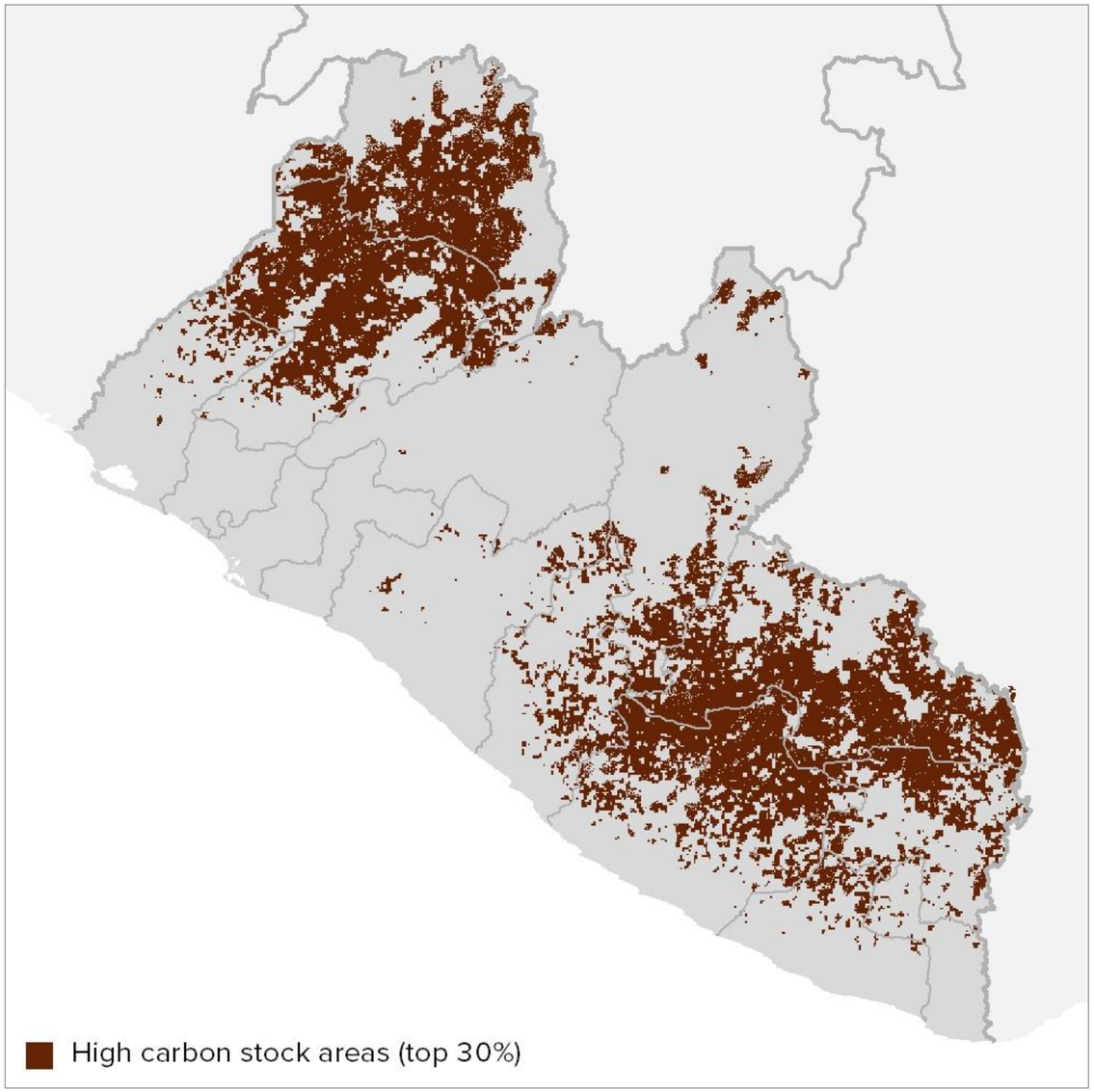
Tallis H, Polasky S. 2009. Mapping and valuing ecosystem services as an approach for conservation and natural-resource management. Annals of the New York Academy of Sciences 1162:265–283.


PUTTING IT ALL TOGETHER
ROB MCNEIL

“ESSENTIAL” NATURAL CAPITAL



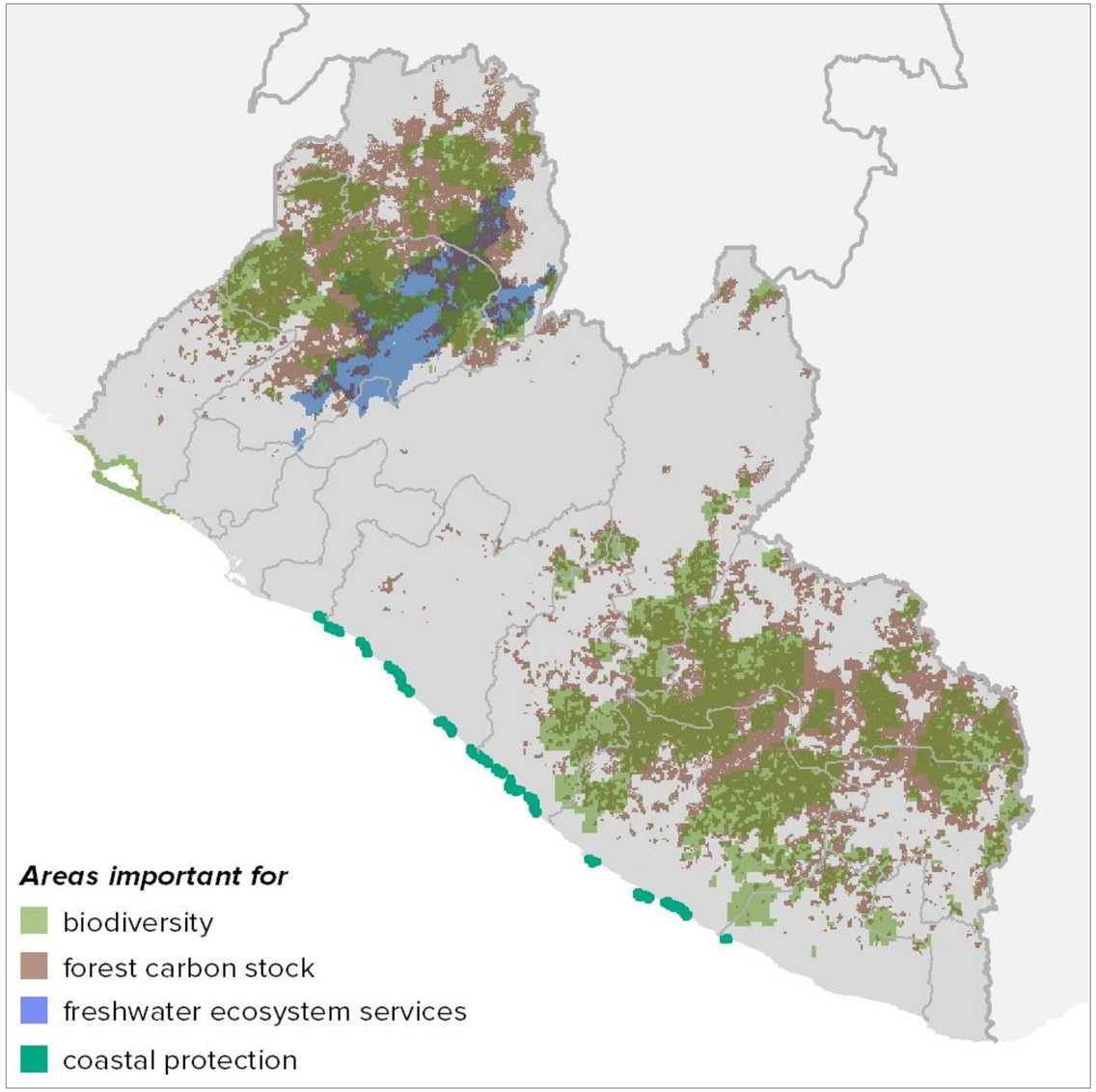




ESSENTIAL NATURAL CAPITAL

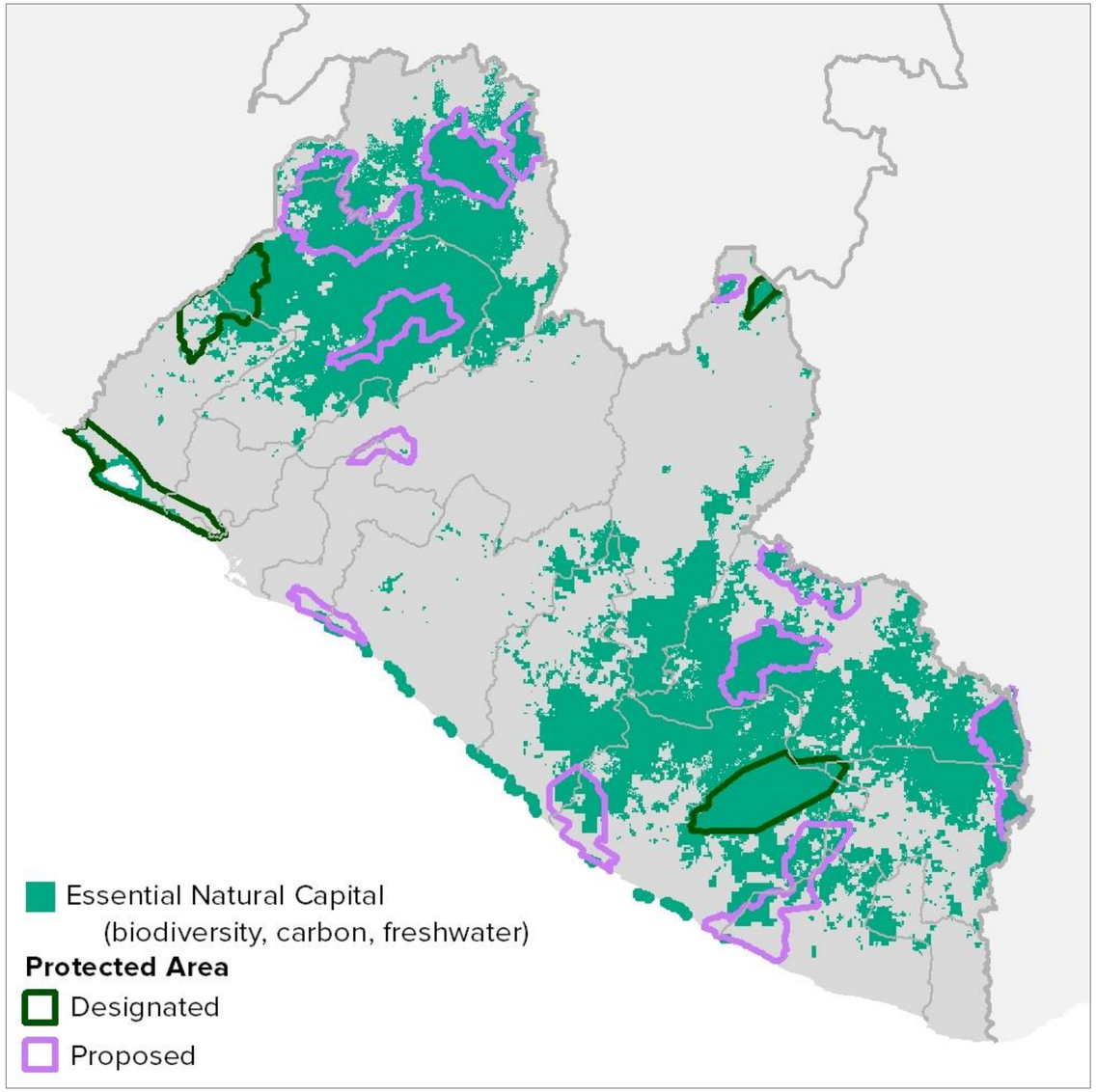
Top 30% of areas for:

- Terrestrial biodiversity
- Forest carbon stock areas
- Freshwater ecosystem services
- Mangroves for coastal protection

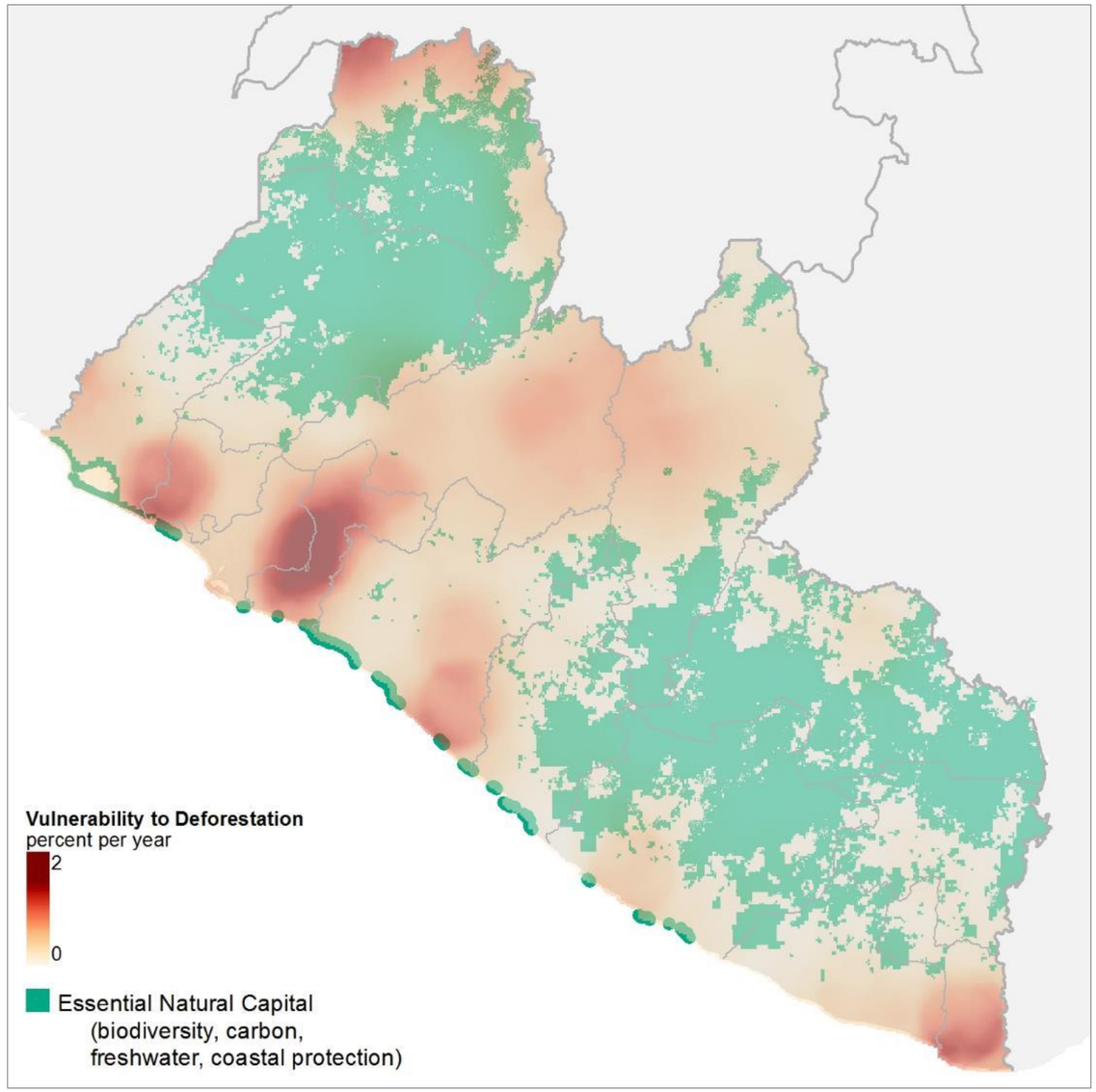


ESSENTIAL NATURAL CAPITAL & PROTECTED AREAS

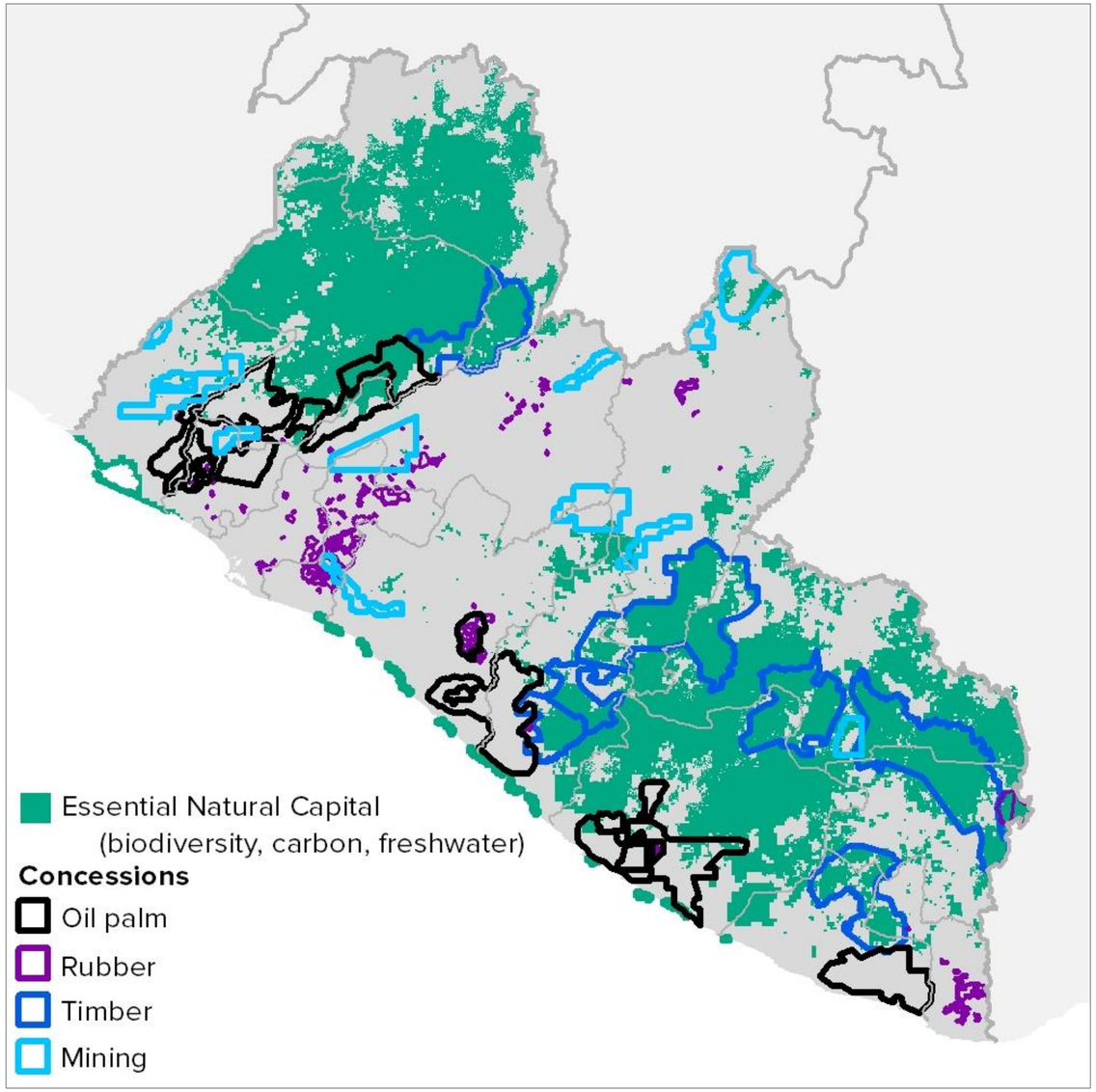
Category	Area (km^2)	Percentage
Essential Natural Capital (designated protected areas)	2545.5	7%
Essential Natural Capital (proposed protected areas)	6652.9	19%
Essential Natural Capital (unprotected)	26761.3	74%
Total Essential Natural Capital	**35959.7**	**100%**



THREATS



PROJECTED TREE COVER LOSS

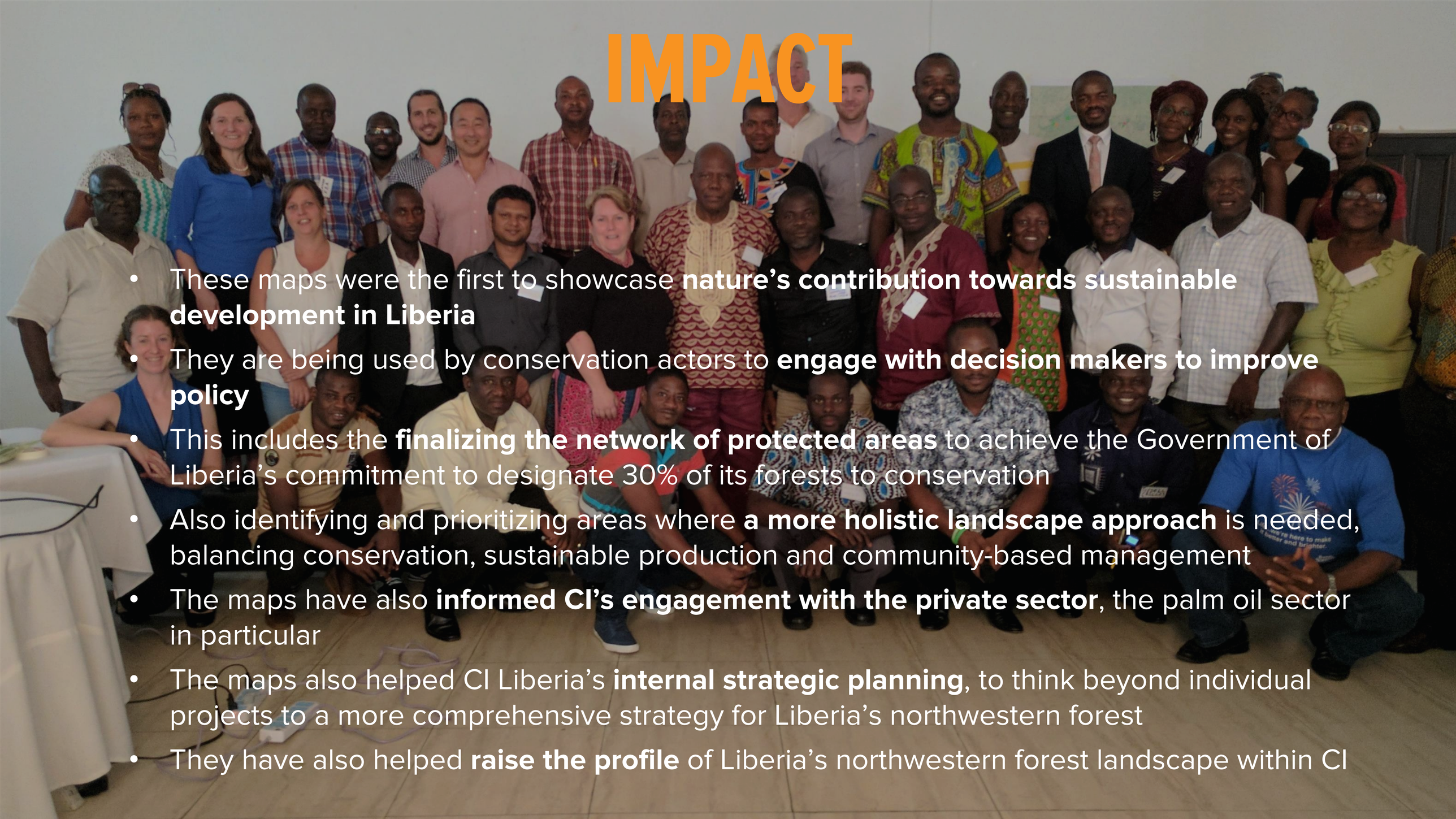


CONCESSIONS

LIMITATIONS

1. Lack of local data, reliance on global data
2. Limited data on human use of ecosystem services
3. Criteria for defining “essential” natural capital are subjective
4. Modeling based on assumptions
5. Limited time & resources for validation of model results, stakeholder engagement
6. Missing ecosystem services, e.g. cultural services
7. Need to combine ES with other information (threats, costs, opportunities for conservation) for prioritization & spatial planning

IMPACT



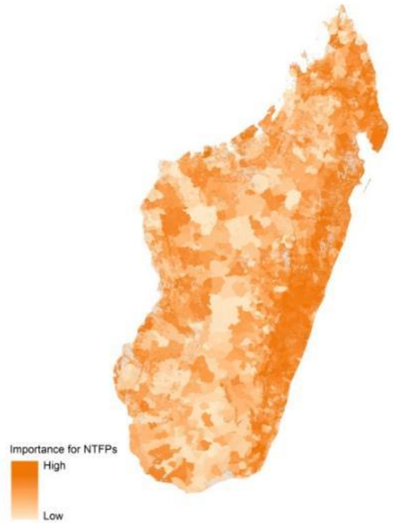
- These maps were the first to showcase **nature's contribution towards sustainable development in Liberia**
- They are being used by conservation actors to **engage with decision makers to improve policy**
- This includes the **finalizing the network of protected areas** to achieve the Government of Liberia's commitment to designate 30% of its forests to conservation
- Also identifying and prioritizing areas where **a more holistic landscape approach** is needed, balancing conservation, sustainable production and community-based management
- The maps have also **informed CI's engagement with the private sector**, the palm oil sector in particular
- The maps also helped CI Liberia's **internal strategic planning**, to think beyond individual projects to a more comprehensive strategy for Liberia's northwestern forest
- They have also helped **raise the profile** of Liberia's northwestern forest landscape within CI

EXAMPLES FROM MADAGASCAR

Coastal fisheries

Key Biodiversity Areas

Non-timber forest products



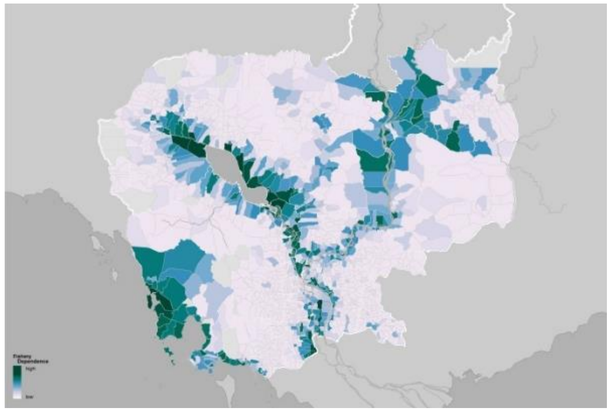
Biomass carbon stocks

Forest cover and loss

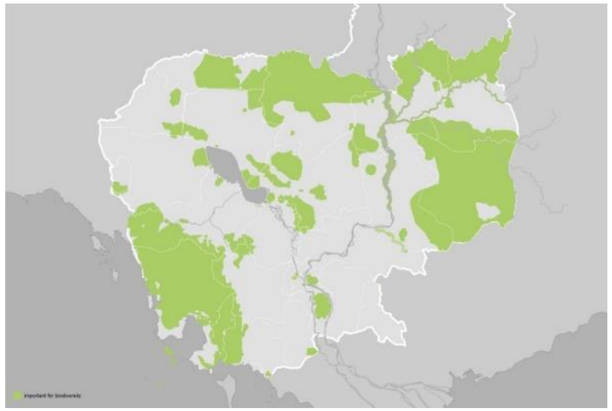
Fresh water services

EXAMPLES FROM CAMBODIA

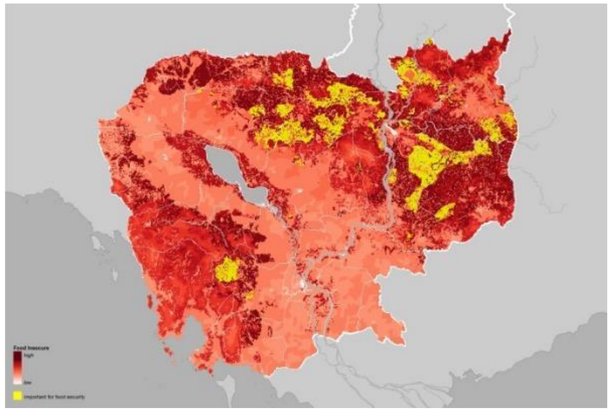
Fisheries



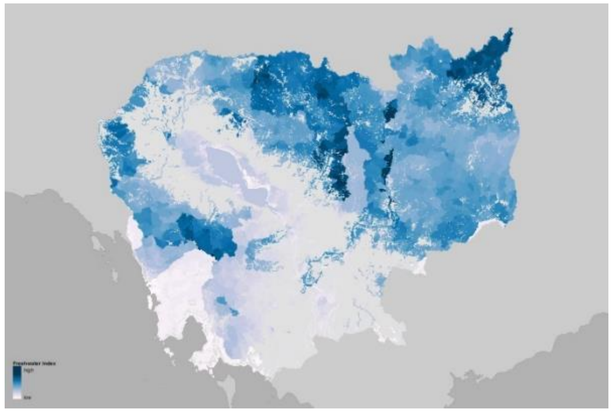
Biodiversity



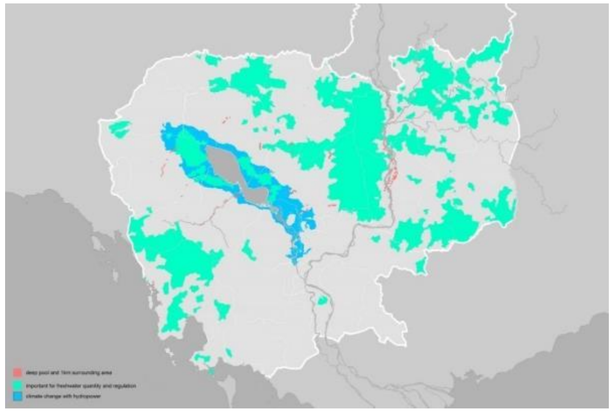
Non-timber forest products



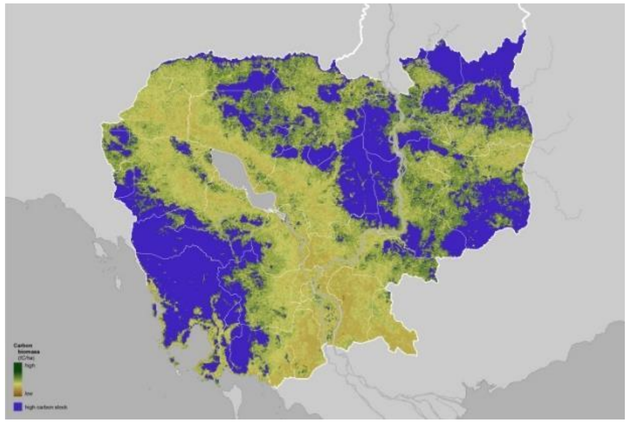
Freshwater



Flood risk reduction

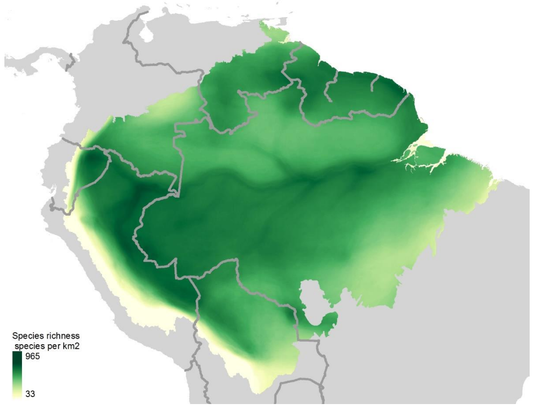


Forest biomass carbon

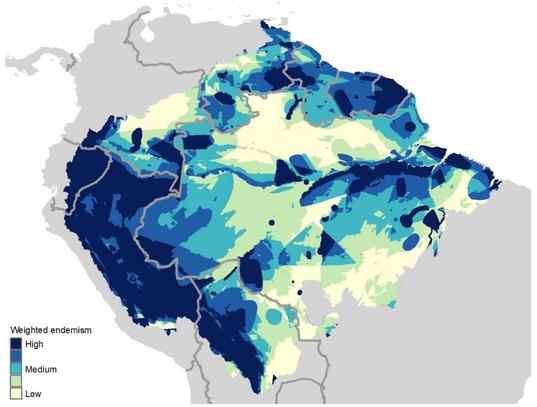


EXAMPLES FROM AMAZONIA

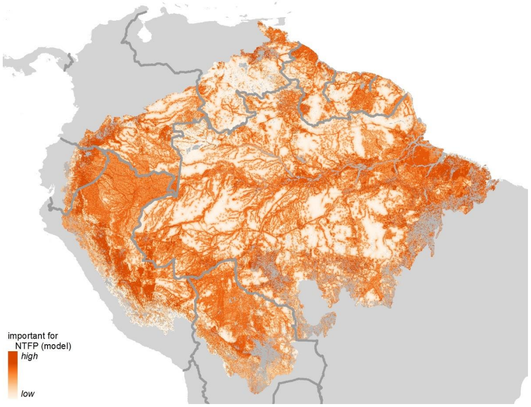
Biodiversity - richness



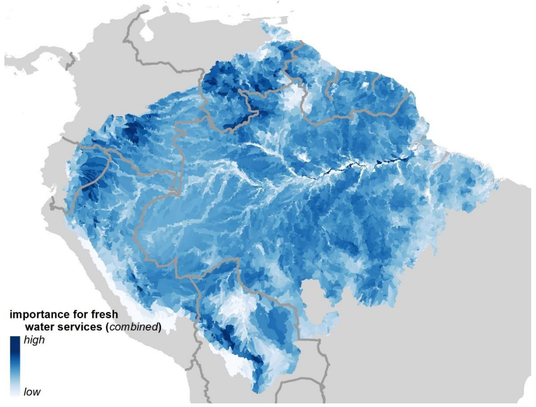
Biodiversity – weighted endemism



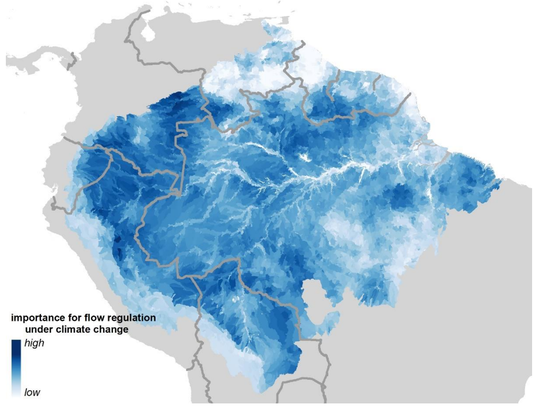
Non-timber forest products



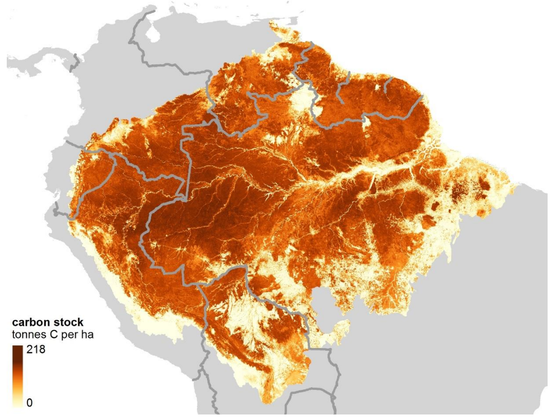
Freshwater



Flood regulation under climate change



Forest biomass carbon



APPLICATIONS: NATURAL CAPITAL ACCOUNTING (LIBERIA)

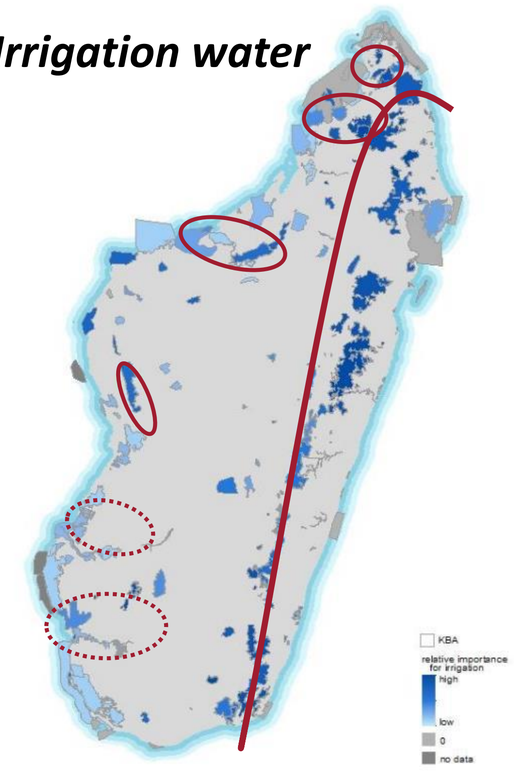
Sector	2015 total economic contribution (US$)		
	Chainsaw	Concession	Total
Government	484,874	20,983,610	21,468,484
Businesses	4,030,320	96,300,086	100,330,406
Households	3,068,868	65,959,244	69,028,112
Others	1,283,844	28,954,712	30,238,556
Total	**8,867,906**	**212,197,651**	**221,065,558**

- Roughly 11% of GDP can be attributed to the timber industry
- This is an under-estimate of the total contribution of the forestry sector to Liberia's economy, as data were not available for timber harvested for local use

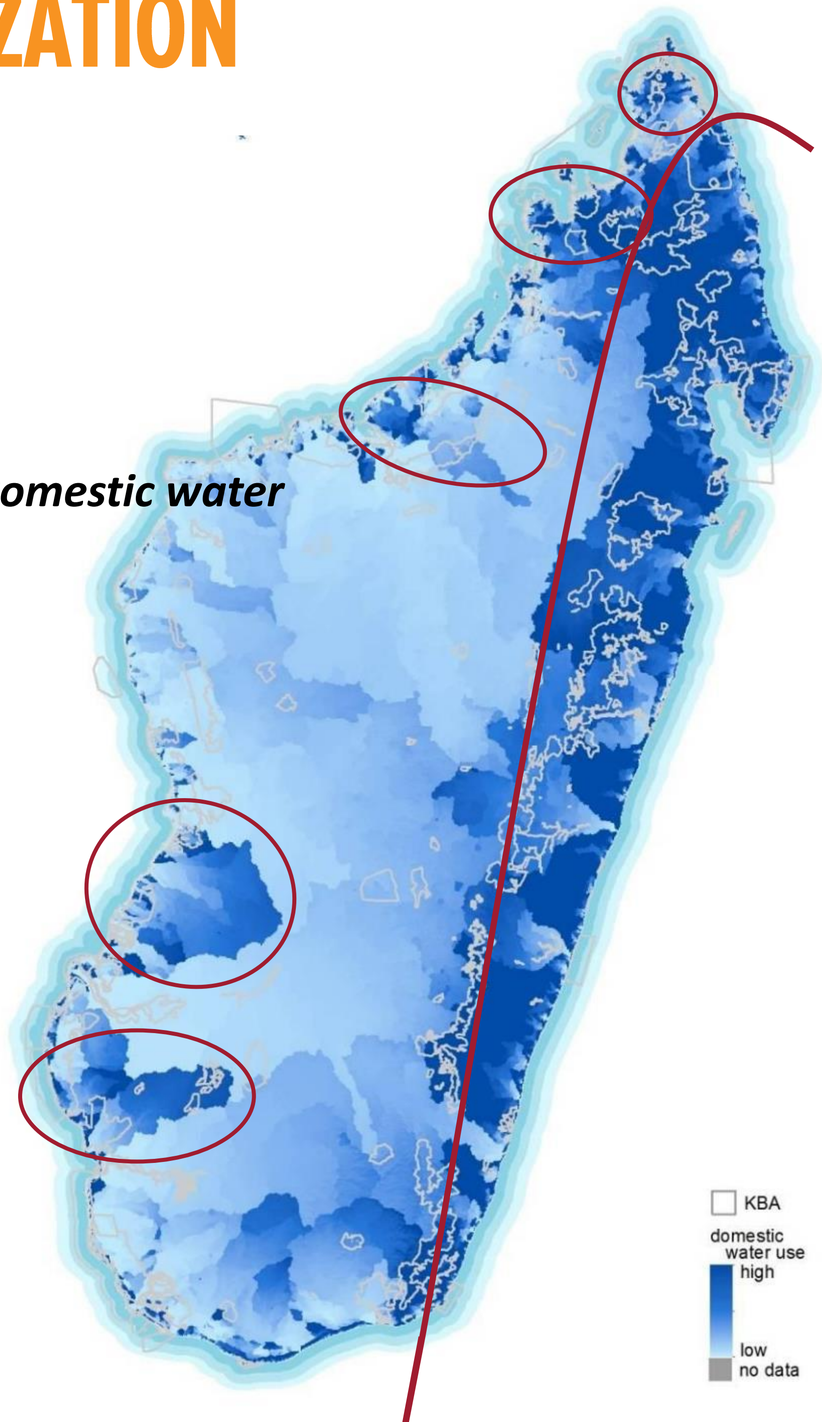
APPLICATIONS: SITE PRIORITIZATION (MADAGASCAR)

CRITICAL ECOSYSTEM PARTNERSHIP FUND

Irrigation water



Domestic water



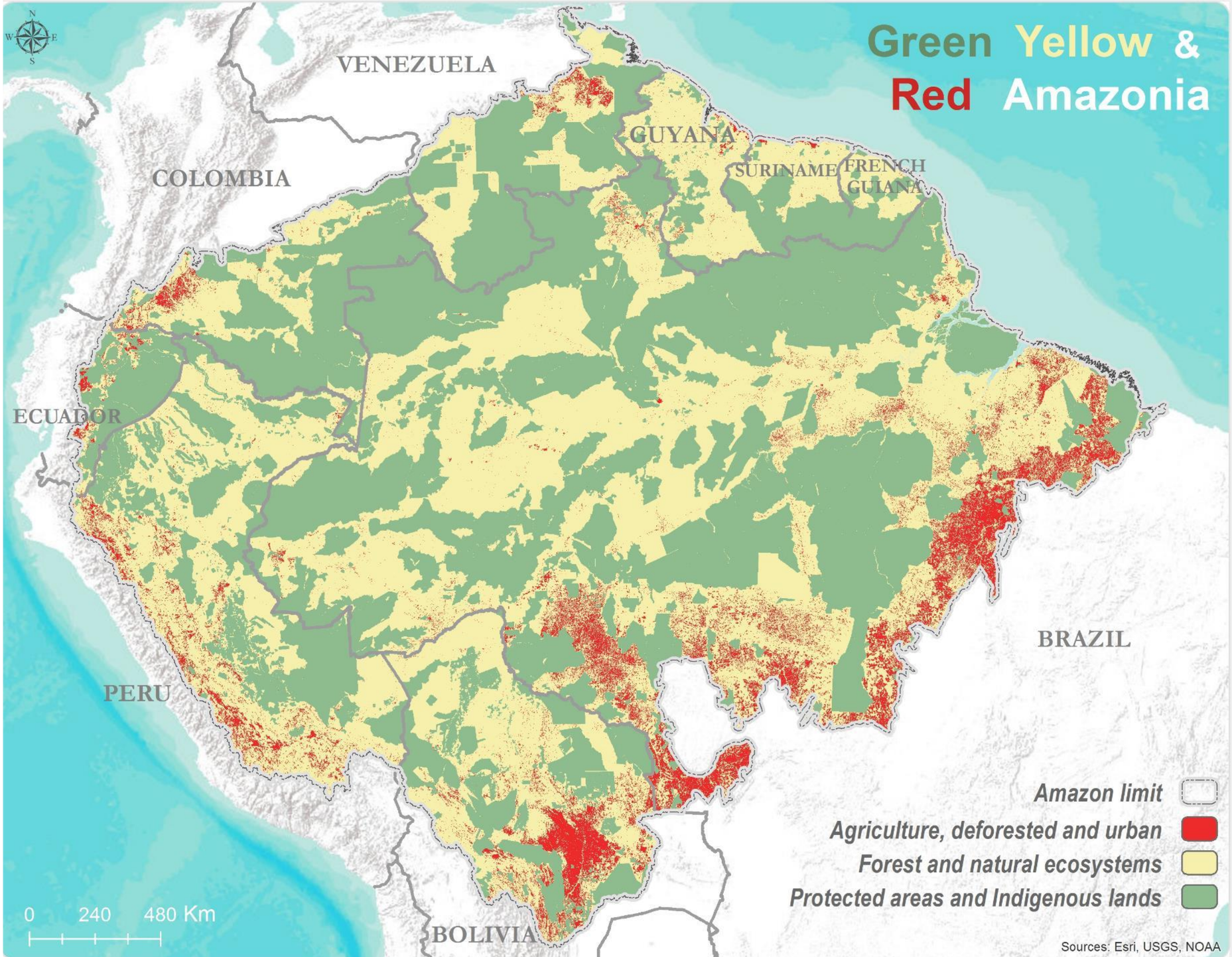
APPLICATIONS: CI STRATEGY (AMAZONIA)

Green Amazonia –
demonstrate the multiple benefits of protected areas and indigenous lands

Red Amazonia –
target areas for restoration and agricultural intensification

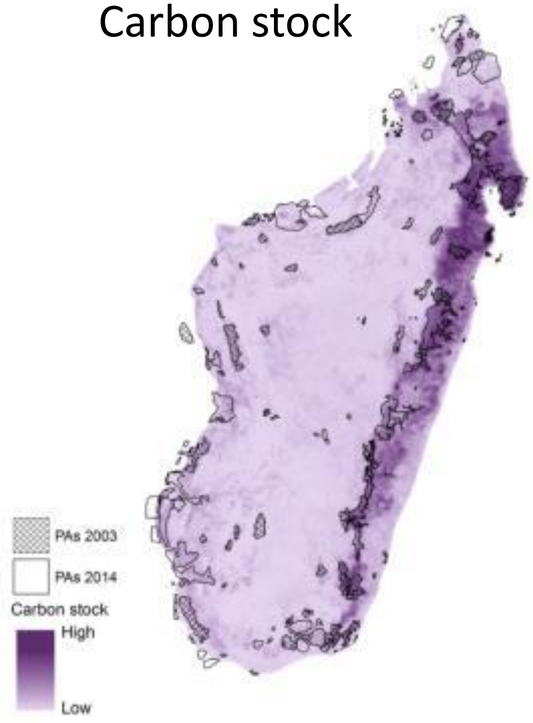
Yellow Amazonia –
Not yet formally assigned use - target areas to protect or implement other strategies such as conservation agreements, PES schemes, integrated conservation & poverty alleviation projects

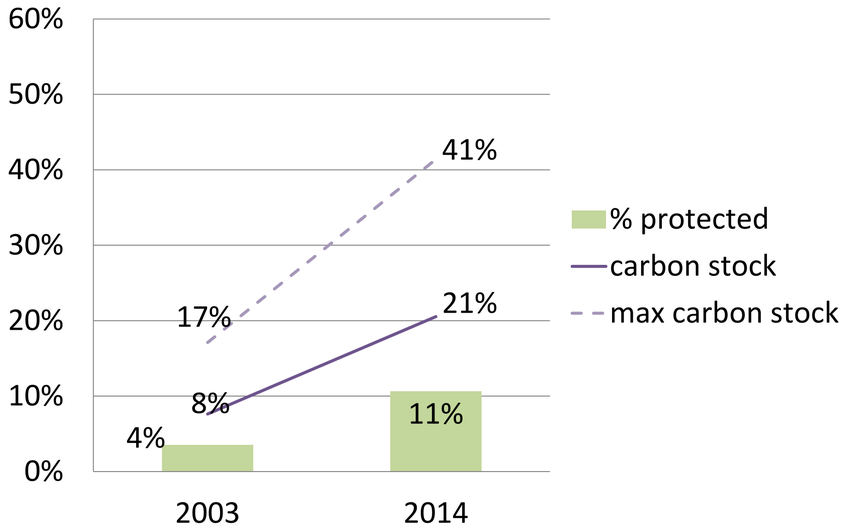
Map: Juan Carlos Ledezma



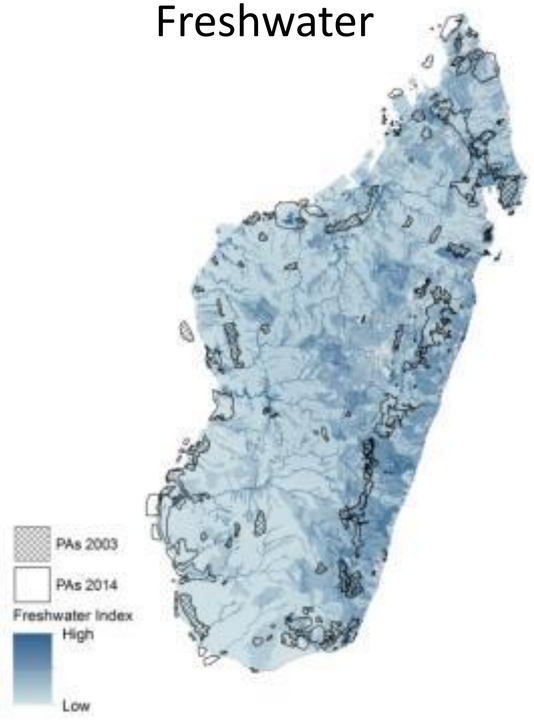
PROTECTED AREA REPRESENTATION (5 COUNTRIES)

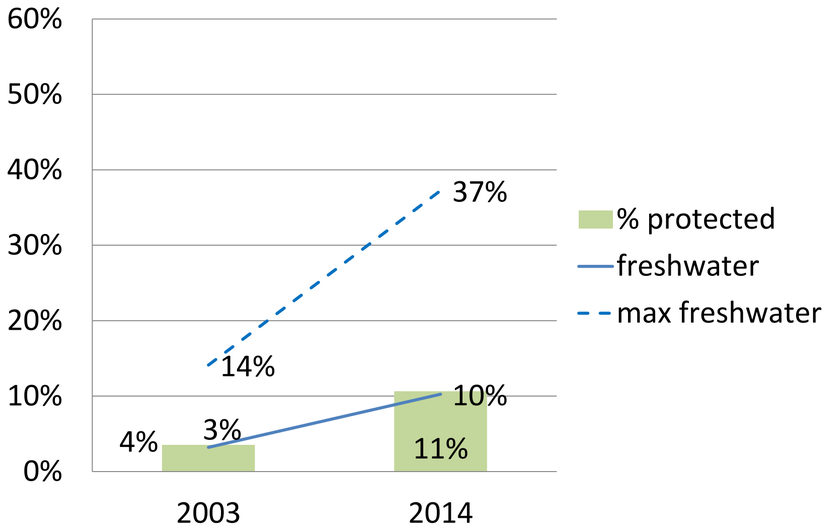
Carbon stock





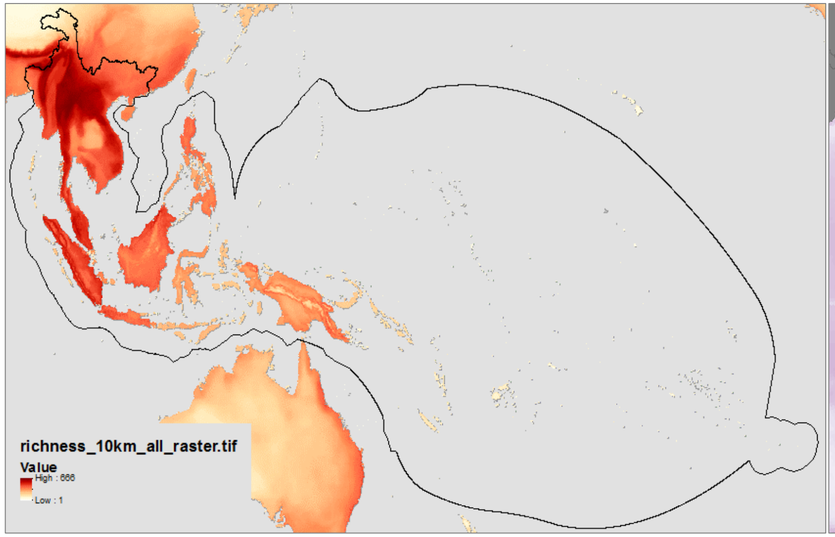
Freshwater



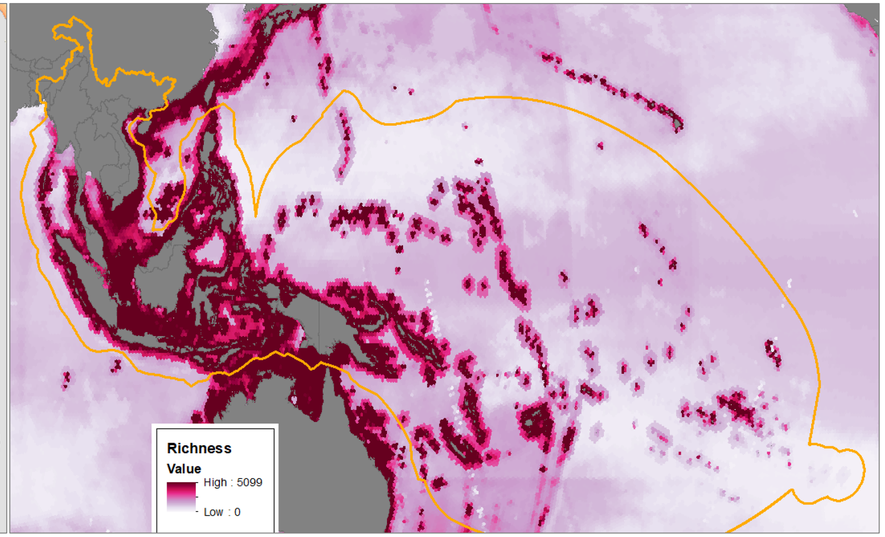


NEXT: ASIA PACIFIC & GLOBAL

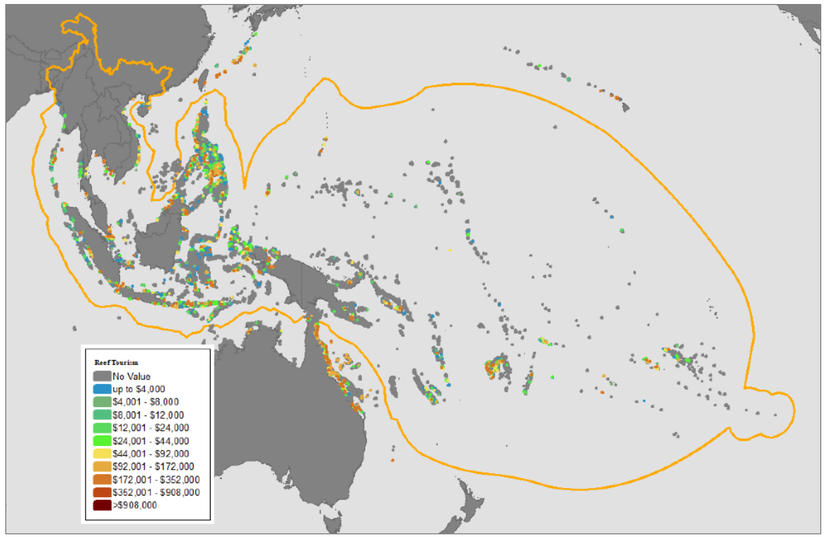
Biodiversity - terrestrial



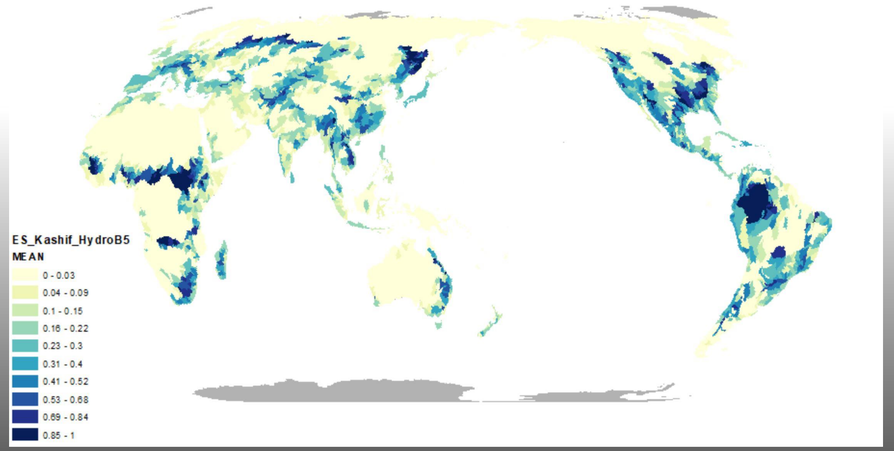
Biodiversity – marine



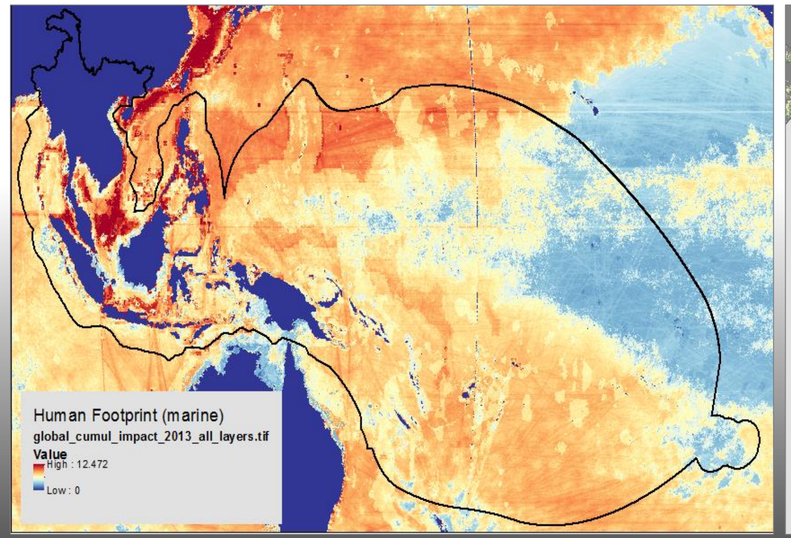
Coral reef tourism



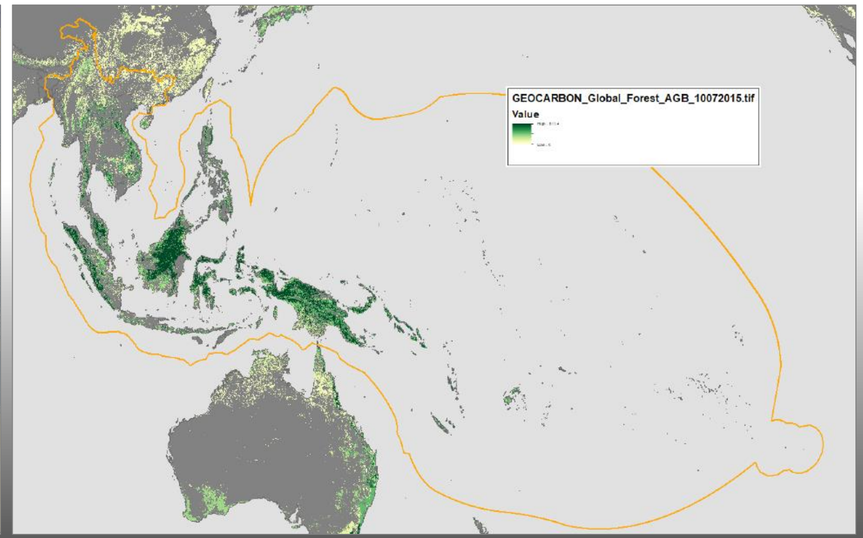
Freshwater services



Pressures - marine



Forest biomass carbon

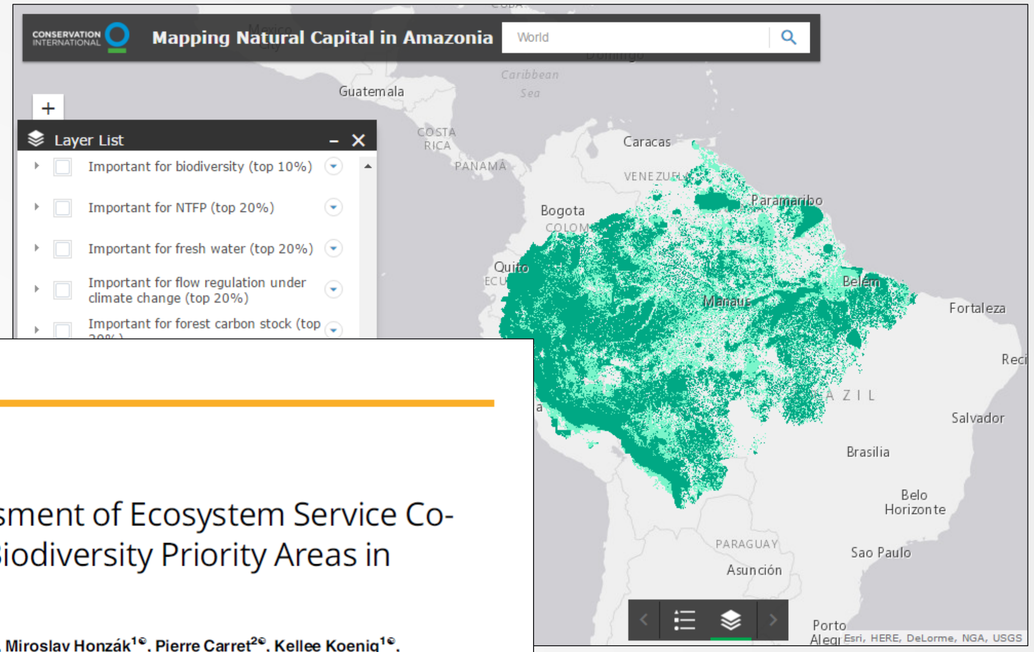


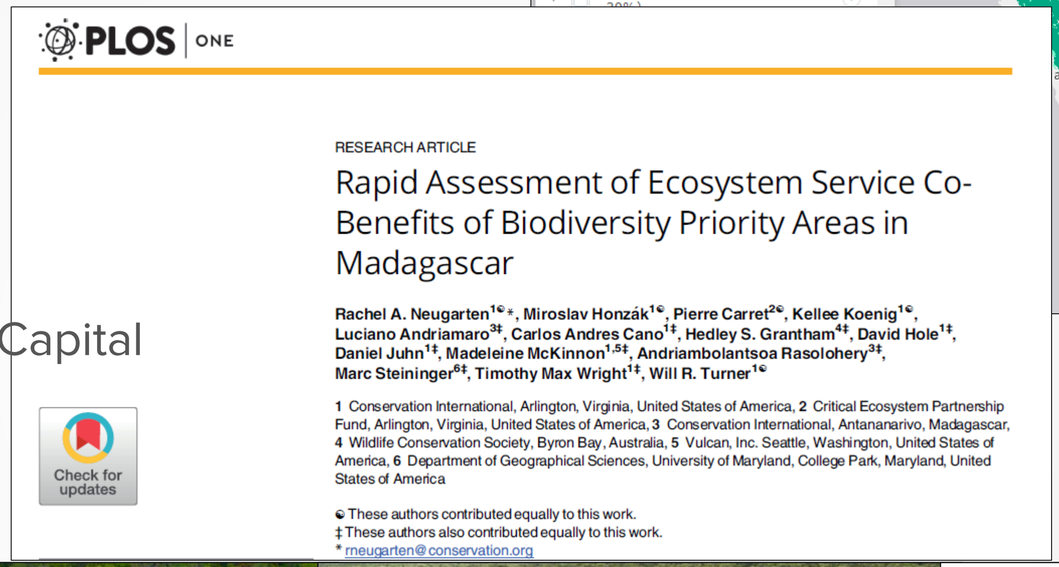
PRODUCTS

1. Madagascar case study
2. Map atlases, technical reports
3. Amazonia web maps
4. GIS map packages (upon request)

rneugarten@conservation.org

researchgate.net/project/Mapping-Natural-Capital





PLOS ONE

RESEARCH ARTICLE

Rapid Assessment of Ecosystem Service Co-Benefits of Biodiversity Priority Areas in Madagascar

Rachel A. Neugarten[1☯]*, Miroslav Honzák[1☯], Pierre Carret[2☯], Kellee Koenig[1☯], Luciano Andriamaro[3‡], Carlos Andres Cano[1‡], Hedley S. Grantham[4‡], David Hole[1‡], Daniel Juhn[1‡], Madeleine McKinnon[1,5‡], Andriambolantsoa Rasolohery[3‡], Marc Steininger[6‡], Timothy Max Wright[1‡], Will R. Turner[1☯]

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☯ These authors contributed equally to this work.
‡ These authors also contributed equally to this work.
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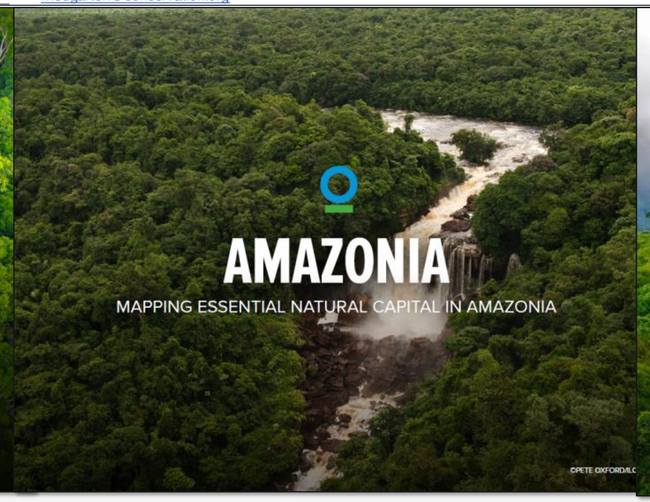
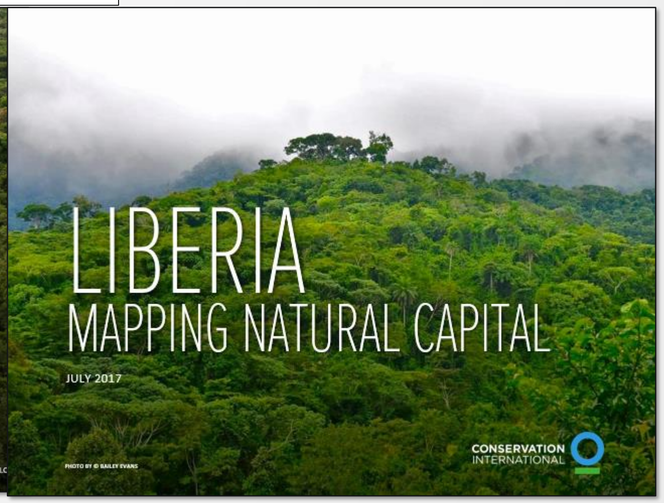
Check for updates





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