



U.S. DEPARTMENT
OF THE INTERIOR
INTERNATIONAL TECHNICAL
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REGIONAL FLYWAY INITIATIVE TRAINING SERIES: From Wetland Ecosystem Services to Nature-based Solutions

ADB HQ on 27–30 June 2023





Carbon Biomass Estimates using Remote Sensing



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2021 National Geographic Explorer



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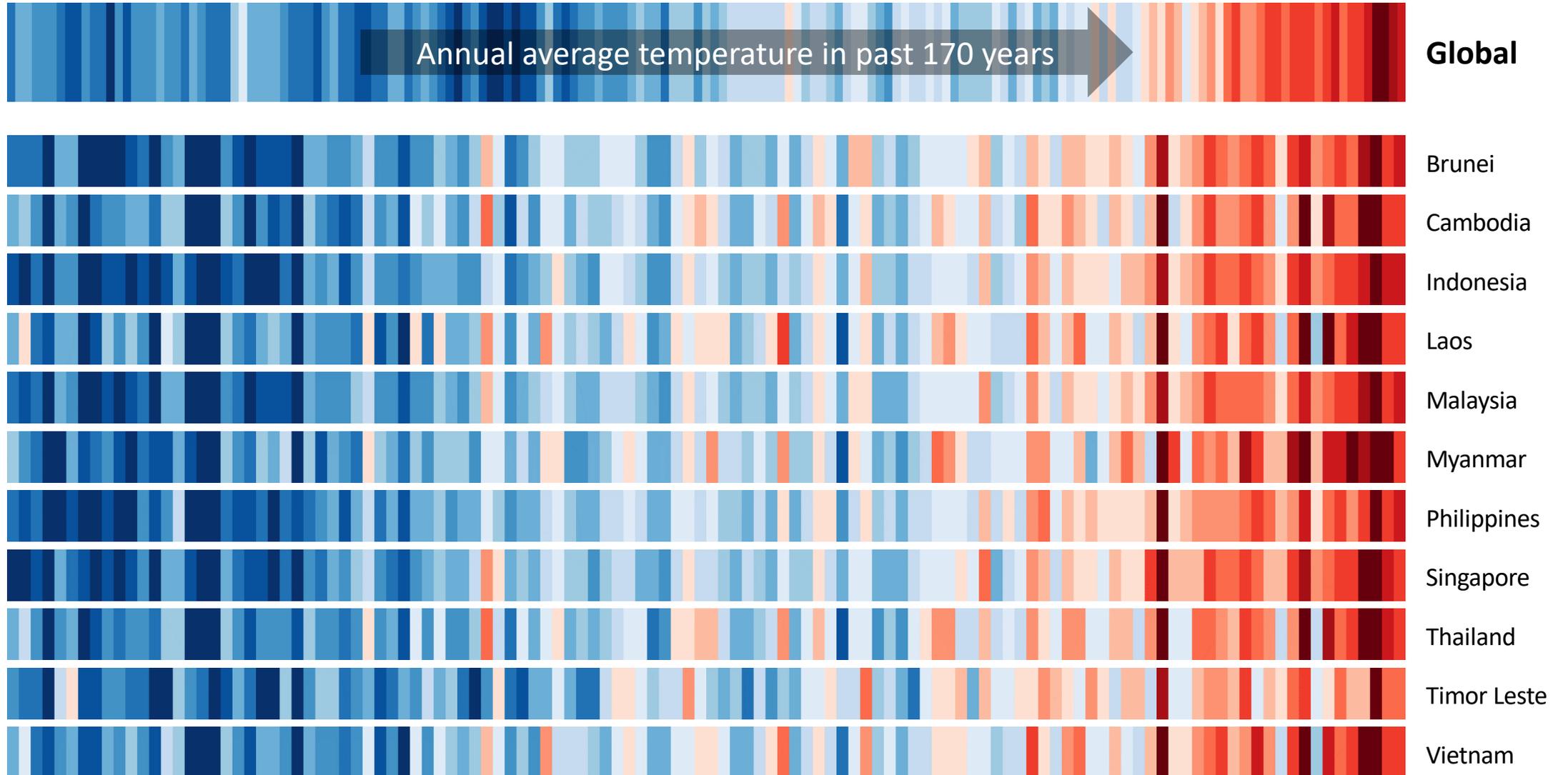
Dan Friess

Professor, Tulane University



Centre for Nature-based
Climate Solutions
Faculty of Science

Climate Change



Climate Change Impacts

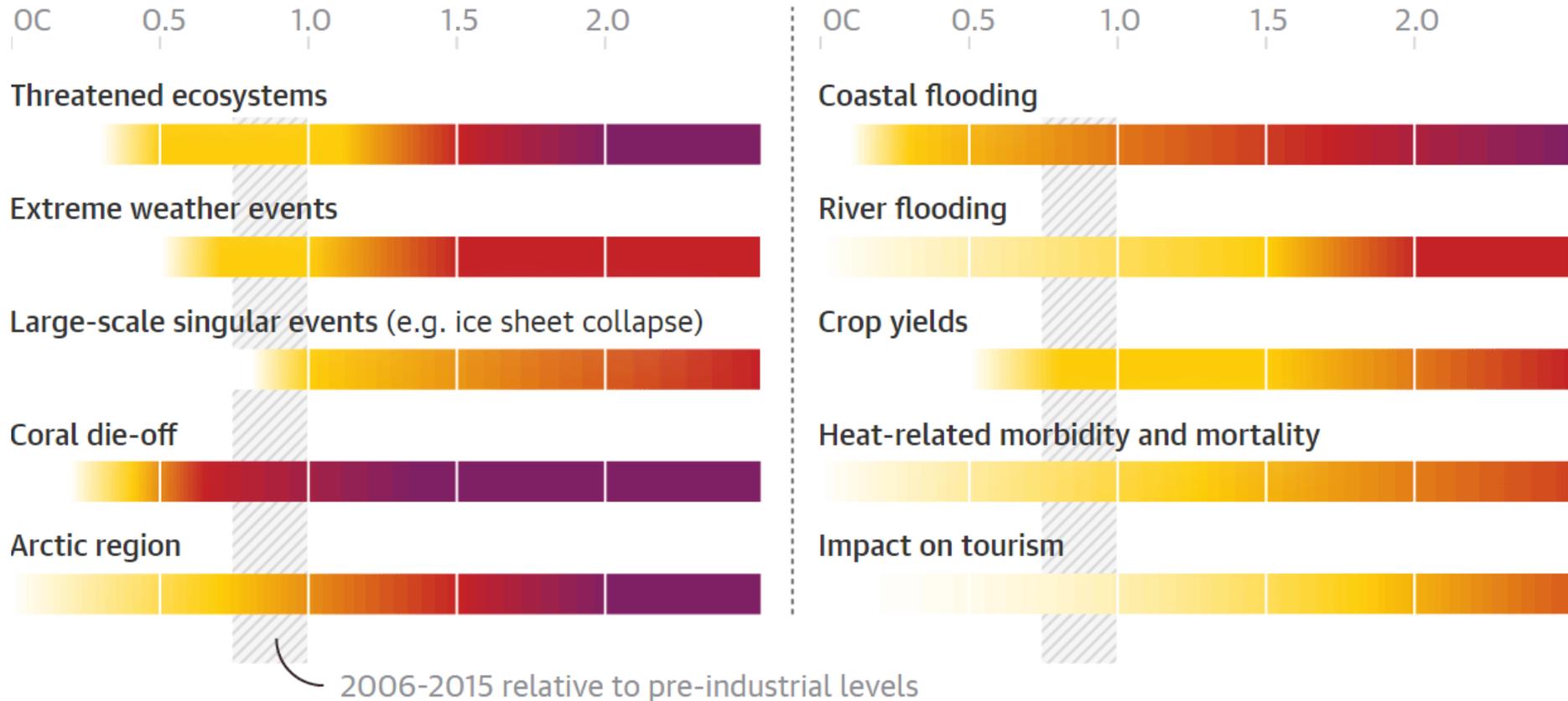




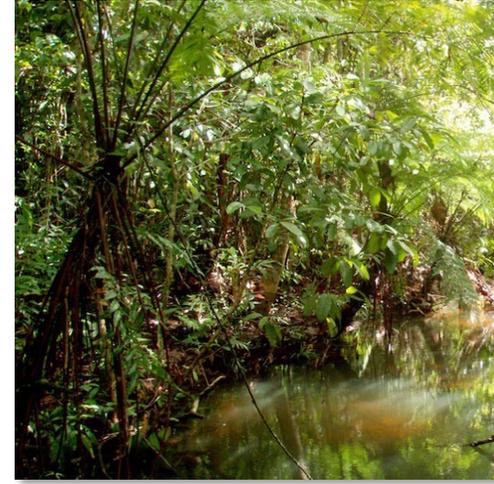
Future Climate Change Impacts



Global mean surface temperature change relative to pre-industrial levels, C



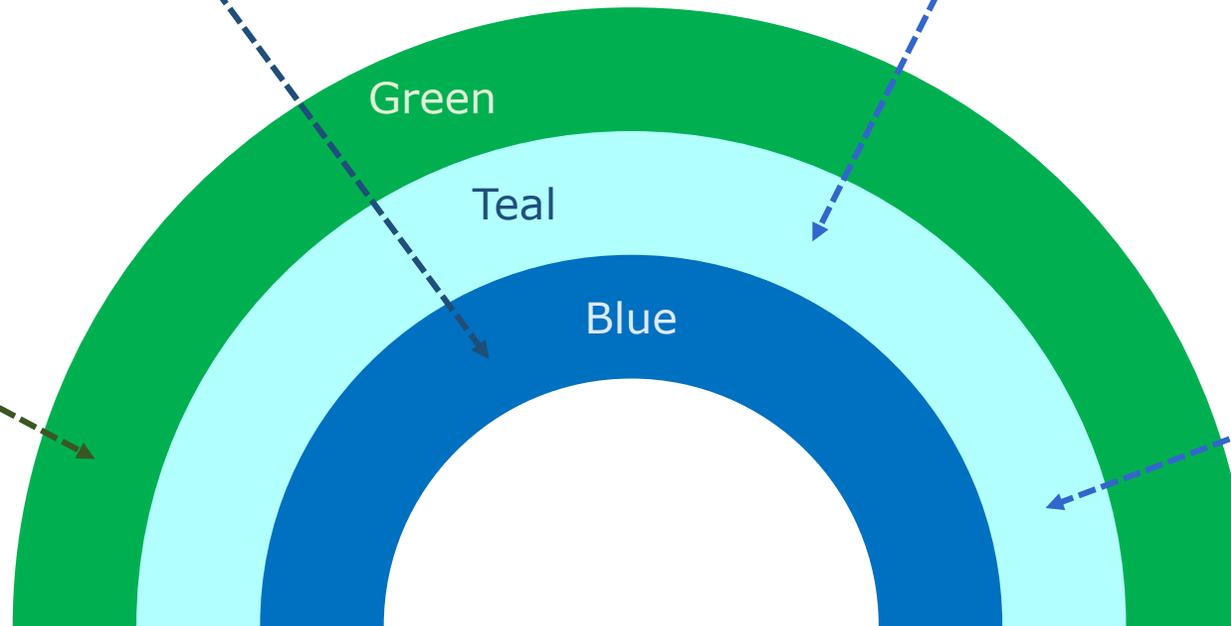
Types of Tropical Forests



Mangroves

Freshwater swamp forest

Terrestrial forests
(Deciduous & evergreen)



Peat swamp forest

Storage, emissions, and sequestration of carbon



Wetland Carbon Sequestration:

Carbon Storage:
Mineral Soils and
Organic Soils (Peat)

Trees and vegetation
fix atmospheric
carbon through
photosynthesis

Trees and vegetation
fix atmospheric
carbon through
photosynthesis

increased carbon
sequestration

Disturbance of
wetland soils
and/or
hydrology
releases
carbon

Carbon returns
to the
atmosphere
through
respiration and
decomposition

Vegetation dies
and sinks
below water
annually
depositing
carbon

Above
ground
carbon:
branches,
trunk,
foliage

water
table

MINERAL Soil Wetland

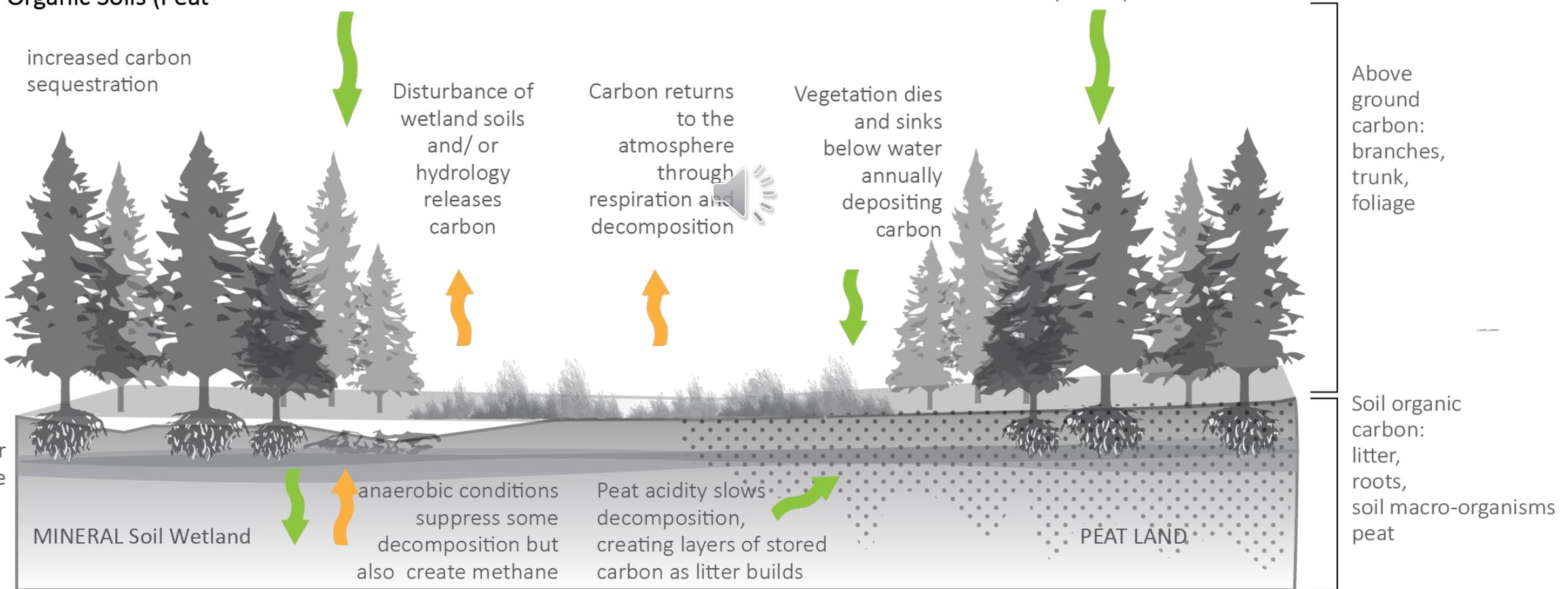
anaerobic conditions
suppress some
decomposition but
also create methane

Peat acidity slows
decomposition,
creating layers of stored
carbon as litter builds

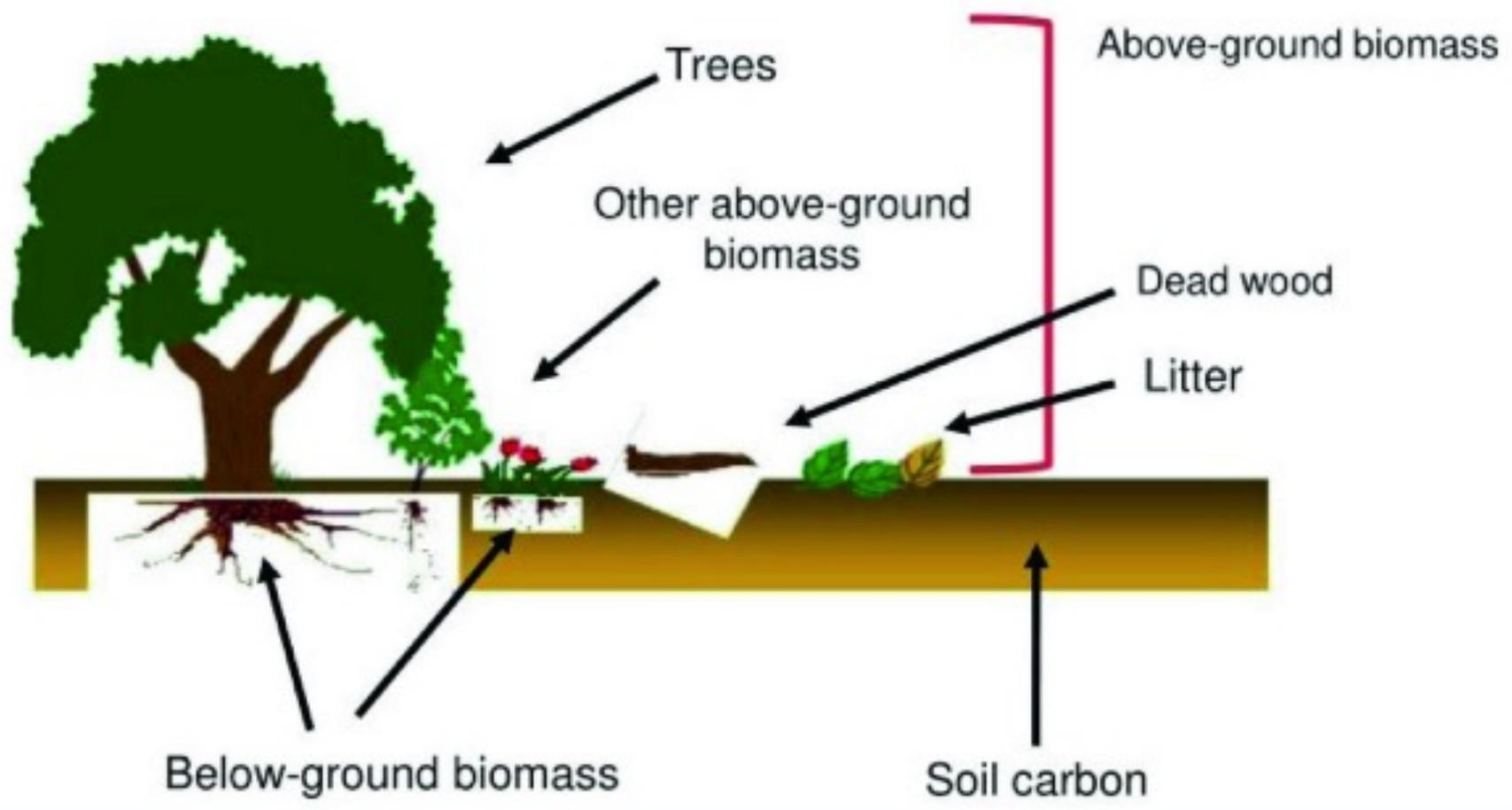
PEAT LAND

Soil organic
carbon:
litter,
roots,
soil macro-organisms
peat

More stable carbon
+ increased carbon sequestration



- The IPCC GPG (2003) - five carbon pools:
aboveground biomass, belowground biomass, litter, dead wood, and soil organic carbon



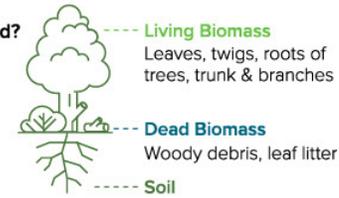
Carbon Storage in Earth's Ecosystems

Achieving net-zero by 2050 depends on the Earth's natural carbon sinks.

Forests play a critical role in regulating the global climate. They absorb carbon from the atmosphere and then store it, acting as natural carbon sinks.

Where is Carbon Stored?

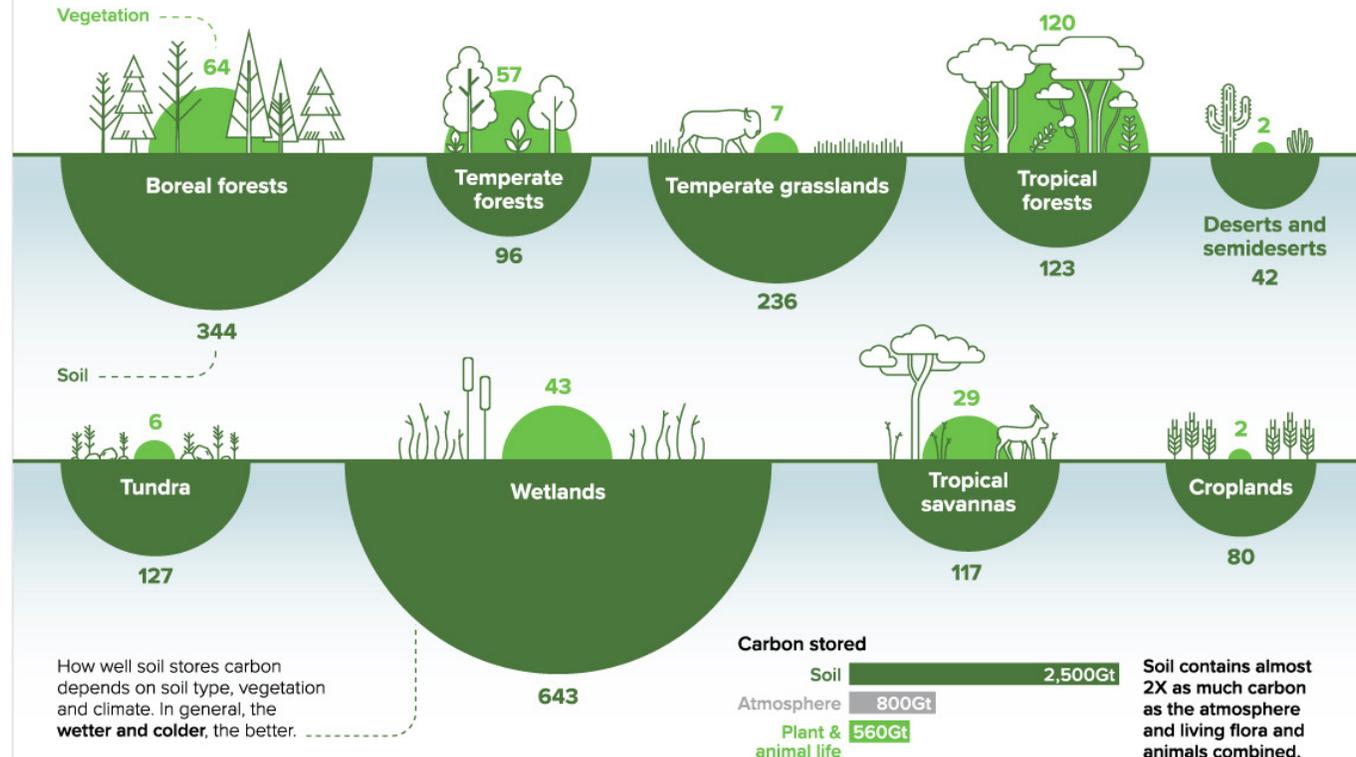
There are various carbon pools in a forest ecosystem.



Carbon Storage Tonnes of Carbon

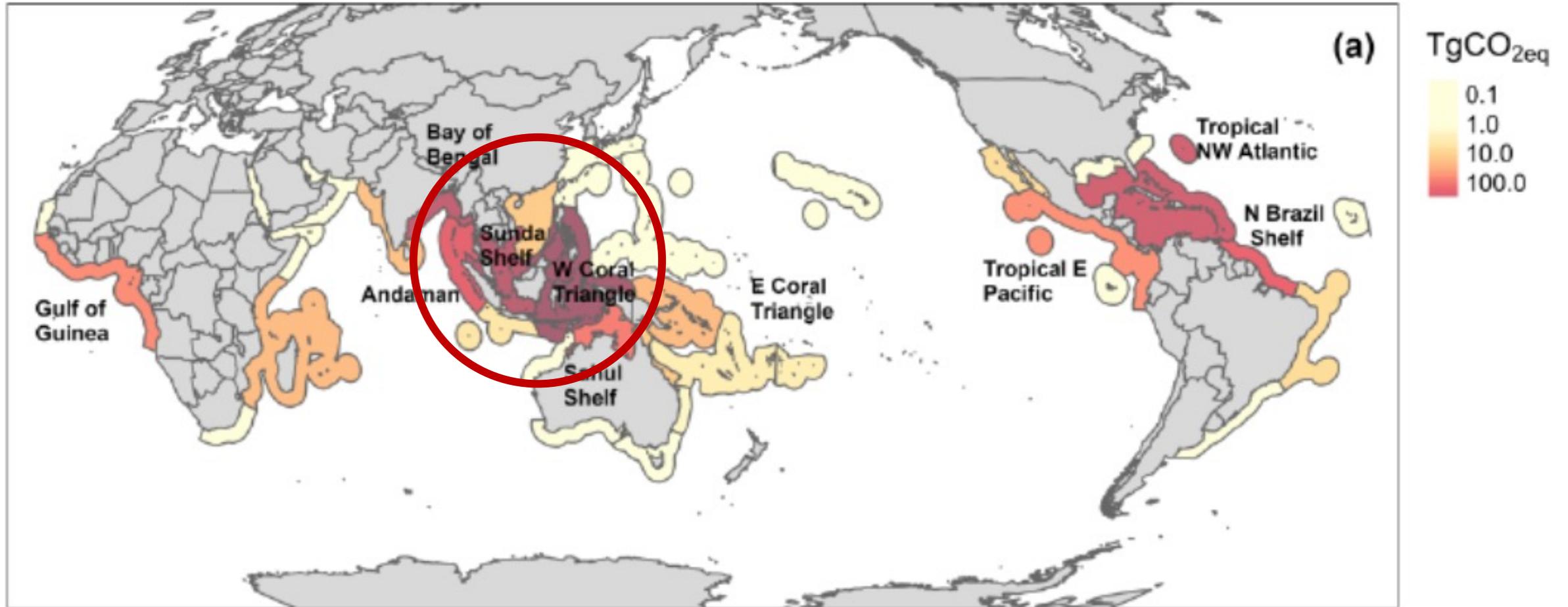
The world's forests absorb around **15.6 gigatonnes** of CO₂ each year. That's around 3X the annual CO₂ emissions of the United States.

However, around **8.1 gigatonnes of CO₂** leaks back into the atmosphere due to deforestation, fires and other disturbances.



Average stored carbon in tonnes per hectare at a ground depth of one meter
Sources: IPCC; NASA

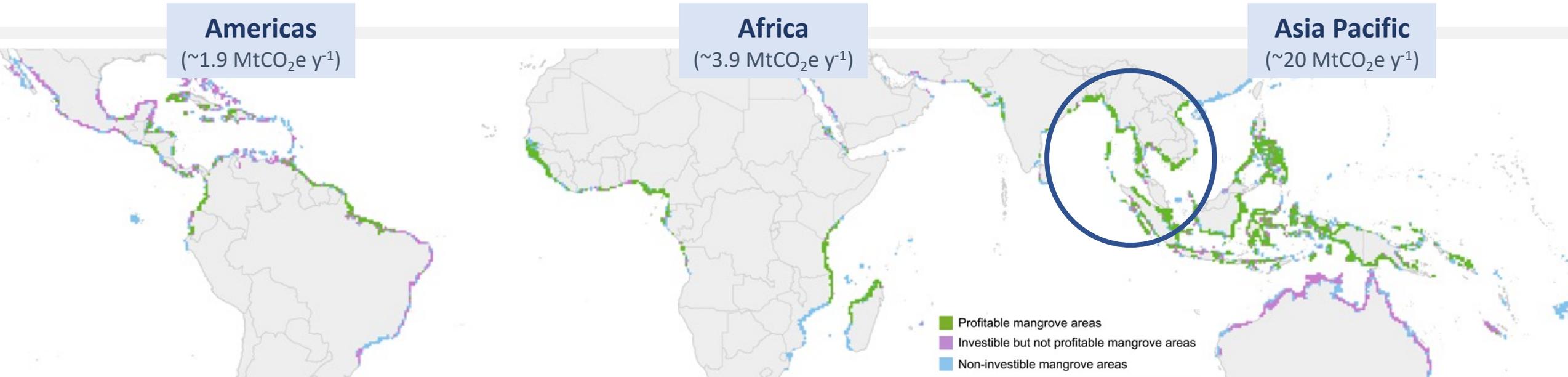
Carbon Emissions due to Mangrove Deforestation



Adame et al. 2021. *Global Change Biology* 27, 2856-2866.

Mangrove deforestation emissions + lost sequestration could be 3392 TgCO₂-e by 2100

Where are the Opportunities for NCS?



Blue Carbon Prospecting (Protecting Threatened Mangroves)



United Nations
Framework Convention on
Climate Change

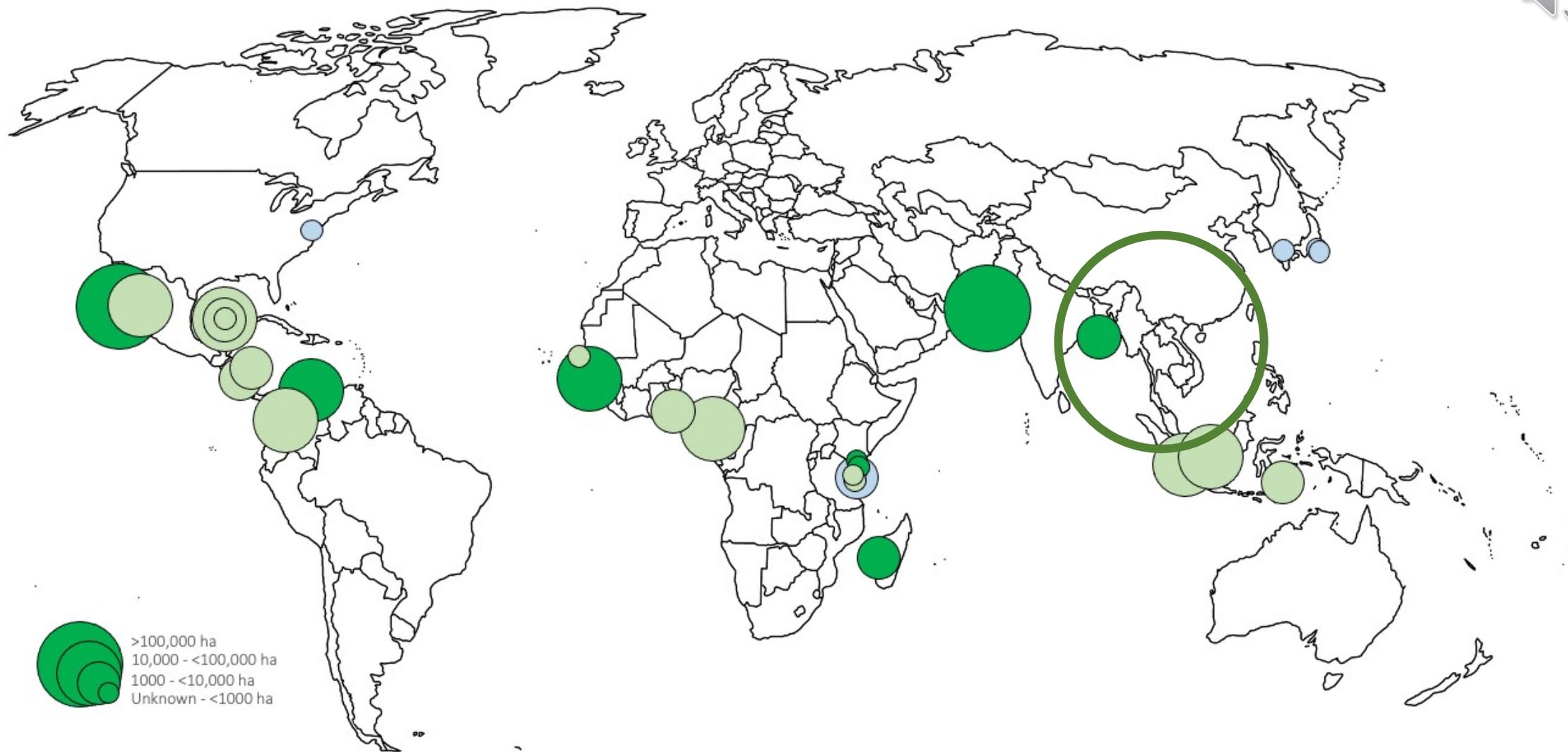


PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

- 17 countries where **mangrove** carbon sequestration offsets >5% of national greenhouse gas emissions
- 17 countries where **mangrove** carbon sequestration offsets 1-5% of national greenhouse gas emissions



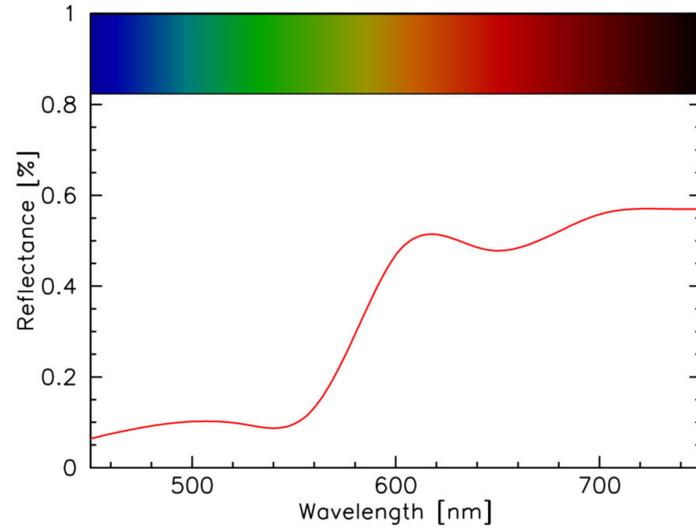
Mangrove Carbon Projects



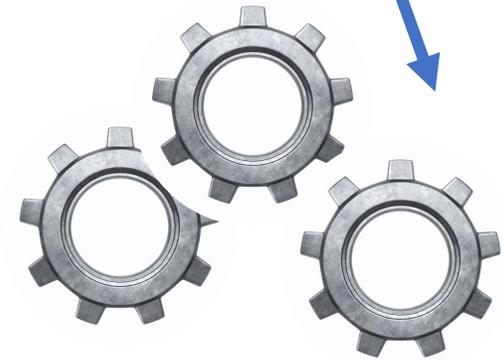
Friess et al. *in review*. PLoS Climate



Satellites revolving around the Earth emit wavelengths and detect reflectance from the Earth's surface



Using reflectance, several indices can be created which give information about Earth's surface, for example, wetlands.



These indices can be used to create models, for example to detect carbon biomass

Estimated values of stored carbon



- Above-ground biomass (MgC/hectare, uncertainty)
- Below-ground biomass (MgC/hectare, uncertainty)
- Soil Organic Carbon (5g/kg)
- Leaf Litter
- Dead Wood
- Loss in forest area (km sq.)
- Gain in forest area (km sq.)
- Loss in carbon estimated by loss in forest cover* (MgC/hectare, uncertainty)
- Gain in carbon estimated by gain in forest cover* (MgC/hectare, uncertainty)



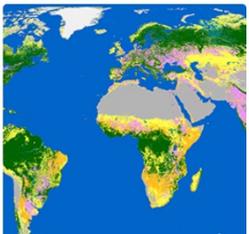
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- *Loss in carbon estimated by loss in forest cover* (MgC/hectare, uncertainty)*
- *Gain in carbon estimated by gain in forest cover* (MgC/hectare, uncertainty)*

Datasets



ESA WorldCover 10m v200

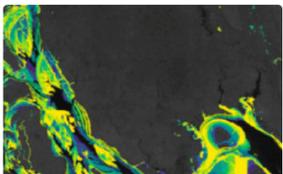


DESCRIPTION BANDS TERMS OF USE CITATIONS

The European Space Agency (ESA) WorldCover 10 m 2021 product provides a global land cover map for 2021 at 10 m resolution based on Sentinel-1 and Sentinel-2 data. The WorldCover product comes with 11 land cover classes and has been generated in the framework of the ESA WorldCover project, part of the 5th Earth Observation Envelope Programme (EOEP-5) of the European Space Agency.

See also:

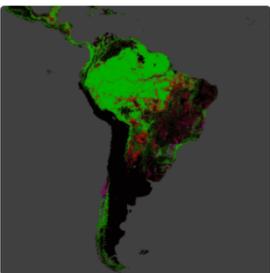
Murray Global Intertidal Change Classification



DESCRIPTION BANDS TERMS OF USE CITATIONS DOIS

The Murray Global Intertidal Change Dataset contains global maps of tidal flat ecosystems produced via a supervised classification of 707,528 Landsat Archive images. Each pixel was classified into tidal flat, permanent water or other with reference to a globally distributed set of training data.

Hansen Global Forest Change v1.10 (2000-2022)



DESCRIPTION BANDS TERMS OF USE CITATIONS DOIS

Results from time-series analysis of Landsat images in characterizing global forest extent and change.

The 'first' and 'last' bands are reference multispectral imagery from the first and last available years for Landsat spectral bands corresponding to red, NIR, SWIR1, and SWIR2. Reference composite imagery represents median observations from a set of quality-assessed growing-season observations for each of these bands.

Please see the [User Notes](#) for this Version 1.10 update, as well as the associated journal article: Hansen, Potapov, Moore, Hancher et al. "High-resolution global maps of 21st-century forest cover change." Science 342.6160 (2013): 850-853.

Dataset Availability

2000-01-01T00:00:00 - 2022-01-01T00:00:00

Dataset Provider

[Hansen/UMD/Google/USGS/NASA](#)

Collection Snippet

```
ee.Image("UMD/hansen/global_forest_change_2022_v1_10")
```

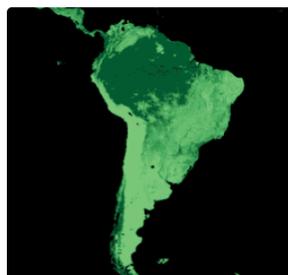
[See example](#)

Tags

CLOSE

IMPORT

Global Aboveground and Belowground Biomass Carbon Density Maps



DESCRIPTION BANDS TERMS OF USE CITATIONS DOIS

This dataset provides temporally consistent and harmonized global maps of aboveground and belowground biomass carbon density for the year 2010 at a 300-m spatial resolution. The aboveground biomass map integrates land-cover specific, remotely sensed maps of woody, grassland, cropland, and tundra biomass. Input maps were amassed from the published literature and, where necessary, updated to cover the focal extent or time period. The belowground biomass map similarly integrates matching maps derived from each aboveground biomass map and land-cover specific empirical models. Aboveground and

OpenLandMap Soil Organic Carbon Content



DESCRIPTION BANDS TERMS OF USE CITATIONS DOIS

Soil organic carbon content in x 5 g / kg at 6 standard depths (0, 10, 30, 60, 100 and 200 cm) at 250 m resolution

Predicted from a global compilation of soil points. Processing steps are described in detail [here](#). Antarctica is not included.

To access and visualize maps outside of Earth Engine, use [this page](#).

If you discover a bug, artifact or inconsistency in the LandGIS maps or if you have a question please use the following channels:

- [Technical issues and questions about the code](#)
- [General questions and comments](#)

Dataset Availability

1950-01-01T00:00:00 - 2018-01-01T00:00:00

Dataset Provider

[EnvirometriX Ltd](#)

Collection Snippet

```
ee.Image("OpenLandMap/SOL/SOL_ORGANIC-CARBON_USDA-6A1C_M/v02")
```

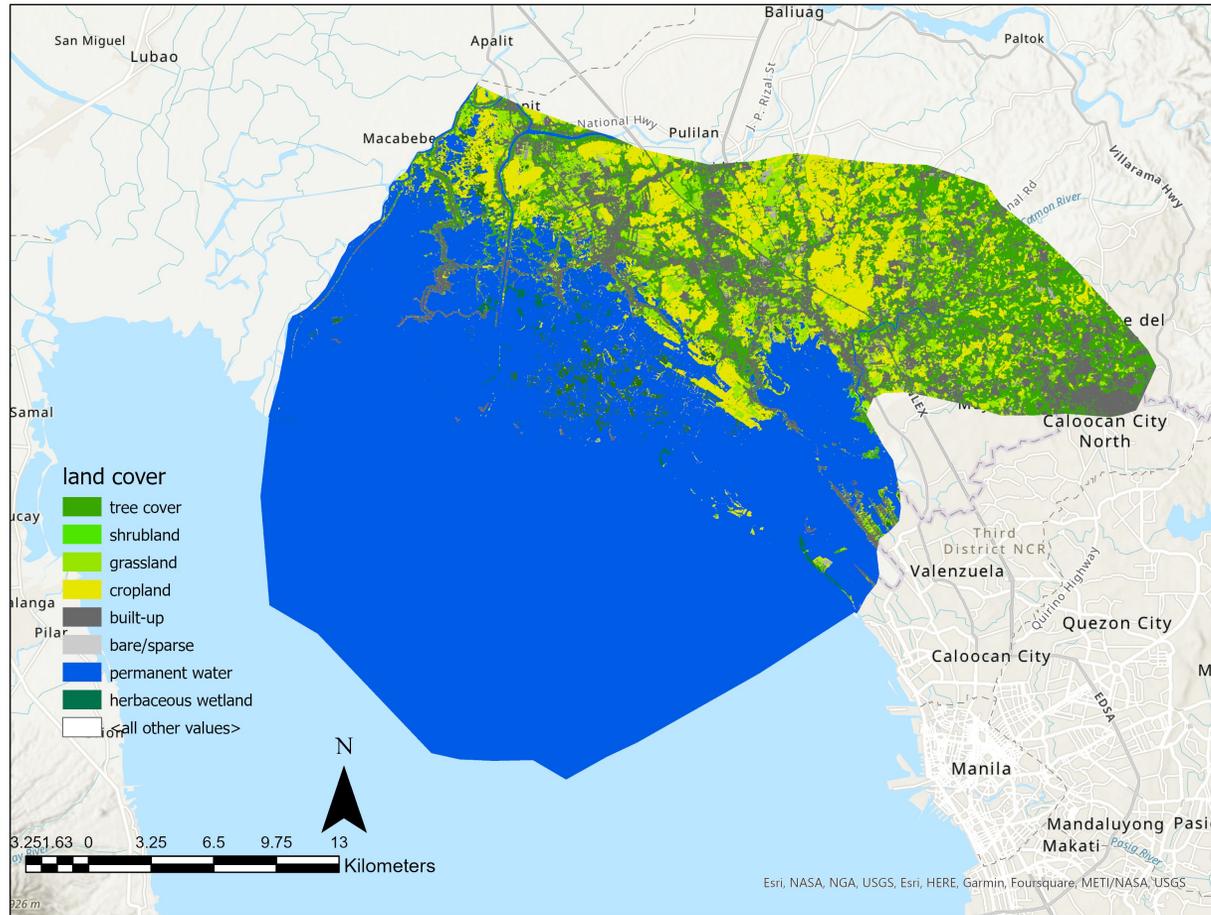
[See example](#)

Tags

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IMPORT

North Manila Bay



land cover type	Area (km ²)	AGB (MgC/hectare)	Uncertainty (MgC/hectare)	BGB (MgC/hectare)	Uncertainty (MgC/hectare)	SOC (5g/kg)	Gain (km ²)	Loss (20-75% tree cover) (m ²)
tree cover	108	13.3	1.2	3.9	4.91-5.		170.54	9-19.4
shrubland	0.2	0	0	0	05-9.		0	0
grassland	49.1	8.3	1.1	2.7	3.31-5.		402.5	9-6
cropland	82	9	1.2	2.7	3.32-6.		310.9	18.5
permanent water	631.7	na	na	na	na	na	na	na
herbaceous wetlands	10.7	4.9	0.9	1.5	1.69-14.		1	0
mangroves	2.5	13.8	5.4	4.2	3.412-17.		00	0-8
aquaculture	0	0	0	0	0	0	0	0
tidal flat	4	0.3	0.1	0.1	0.113-18		no data	no data



Carbon Biomass Estimates using Remote Sensing Thank you!

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