Carbon Biomass Estimates using Remote Sensing

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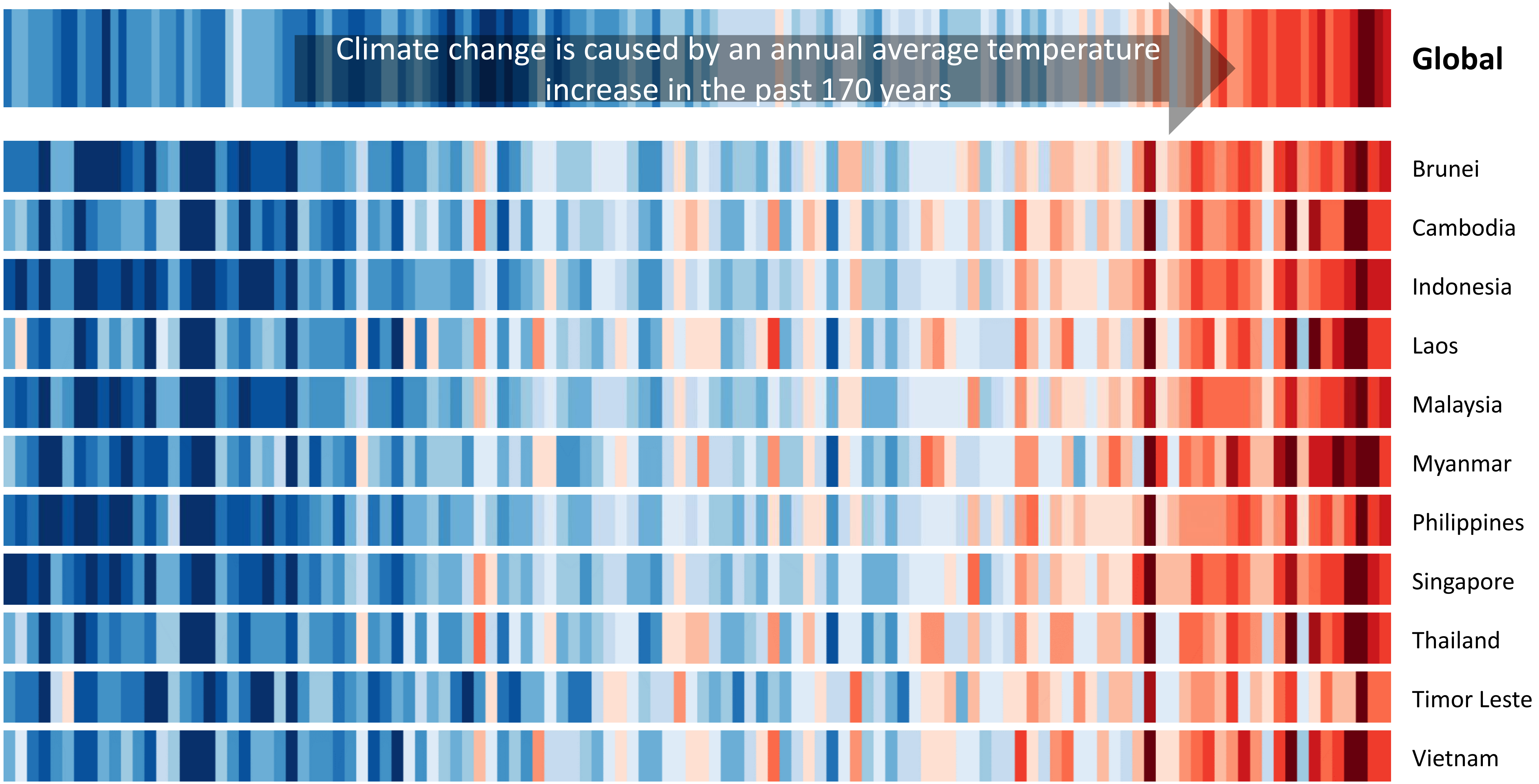
Climate Change

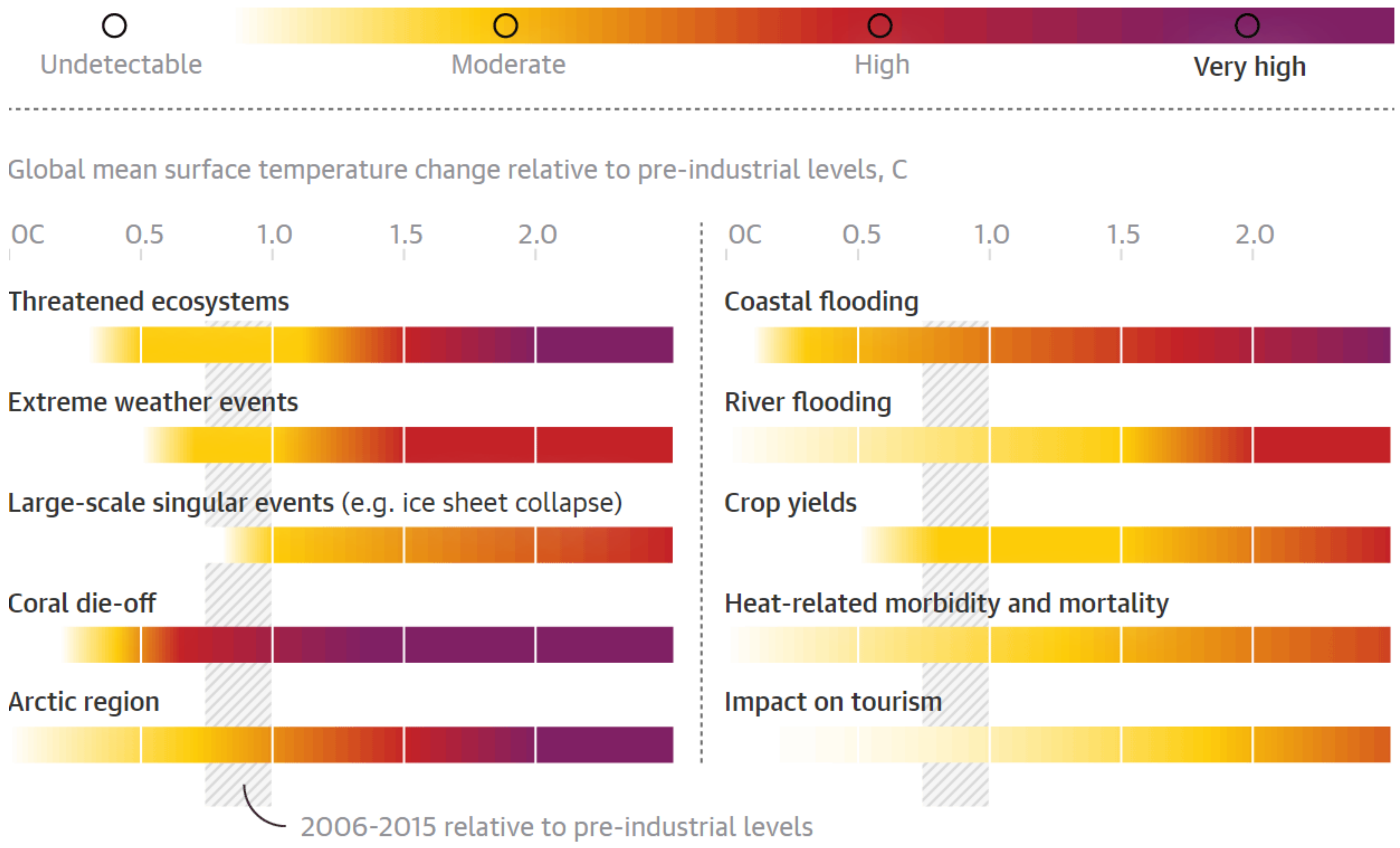


Climate Change Impacts

The impact of climate change is seen worldwide in the form of forest fires, draughts, and floods.

Future Climate Change Impacts

In the coming future, if the temperatures increase, the following are the likely impacts.



The Guardian; IPCC Special Report 2018

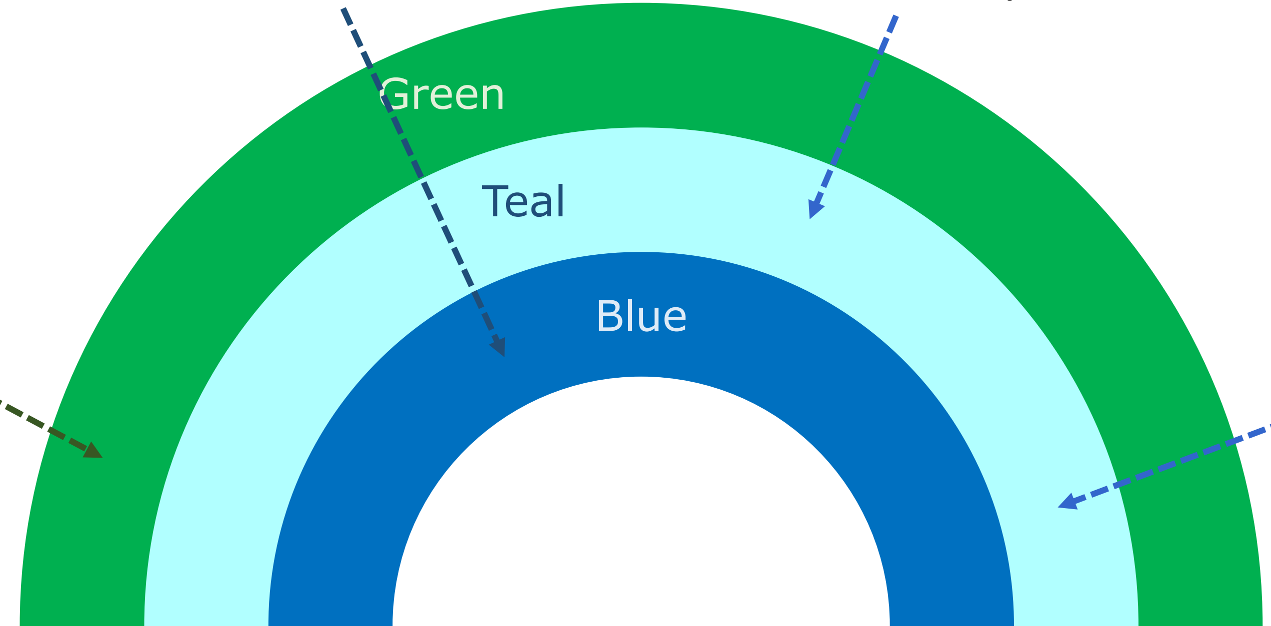
Types of Forest Carbon

To reduce the impact of climate change, climate change mitigation through carbon sequestration of different forests is utilized.

Mangroves

Freshwater swamp forest

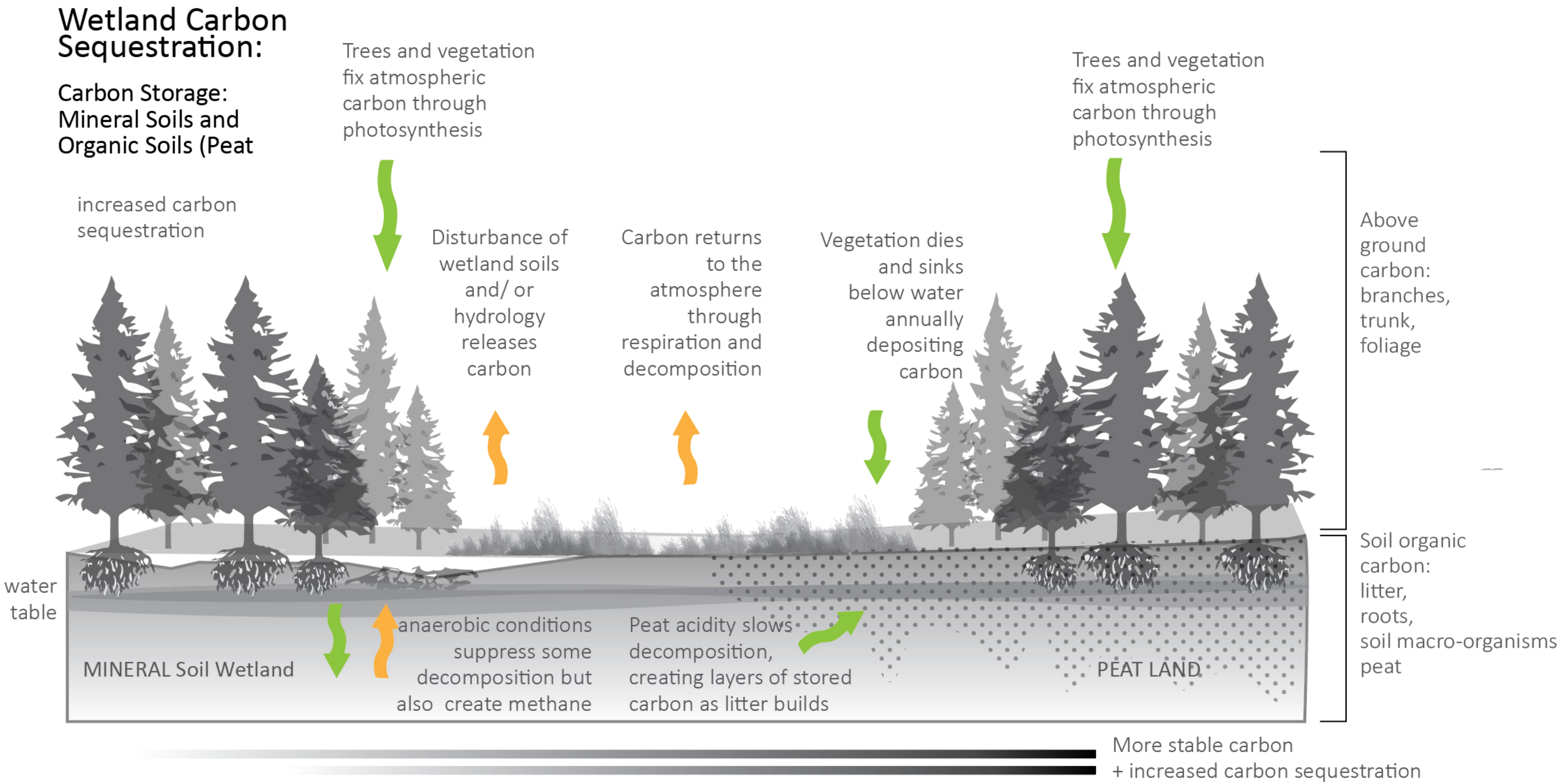
Terrestrial forests
(Deciduous & evergreen)



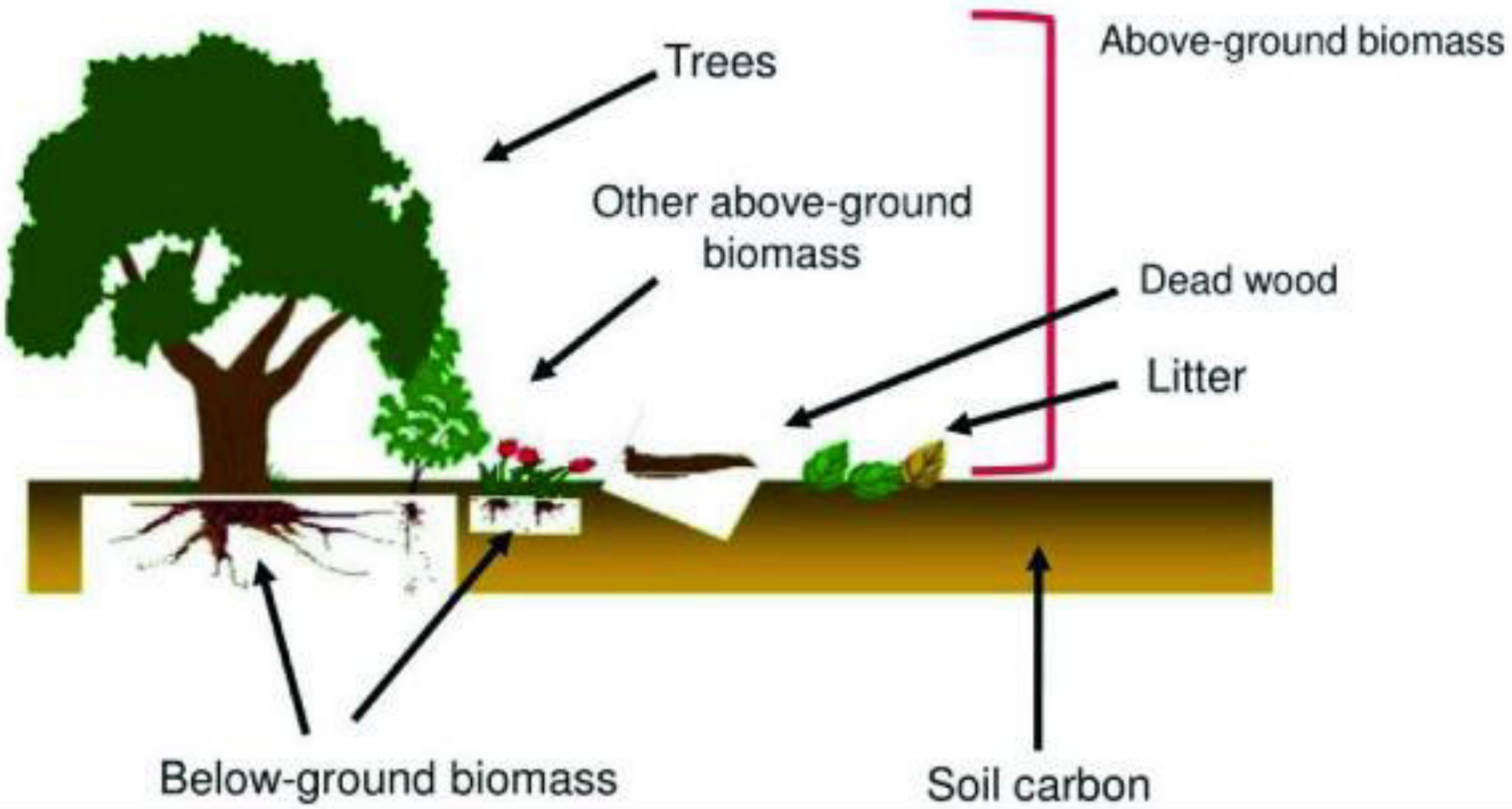
Peat swamp forest

Credit: Tasya Sarira

Storage, emissions, and sequestration of carbon



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



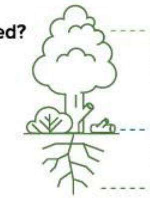
Carbon Storage in Earth's Ecosystems

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.

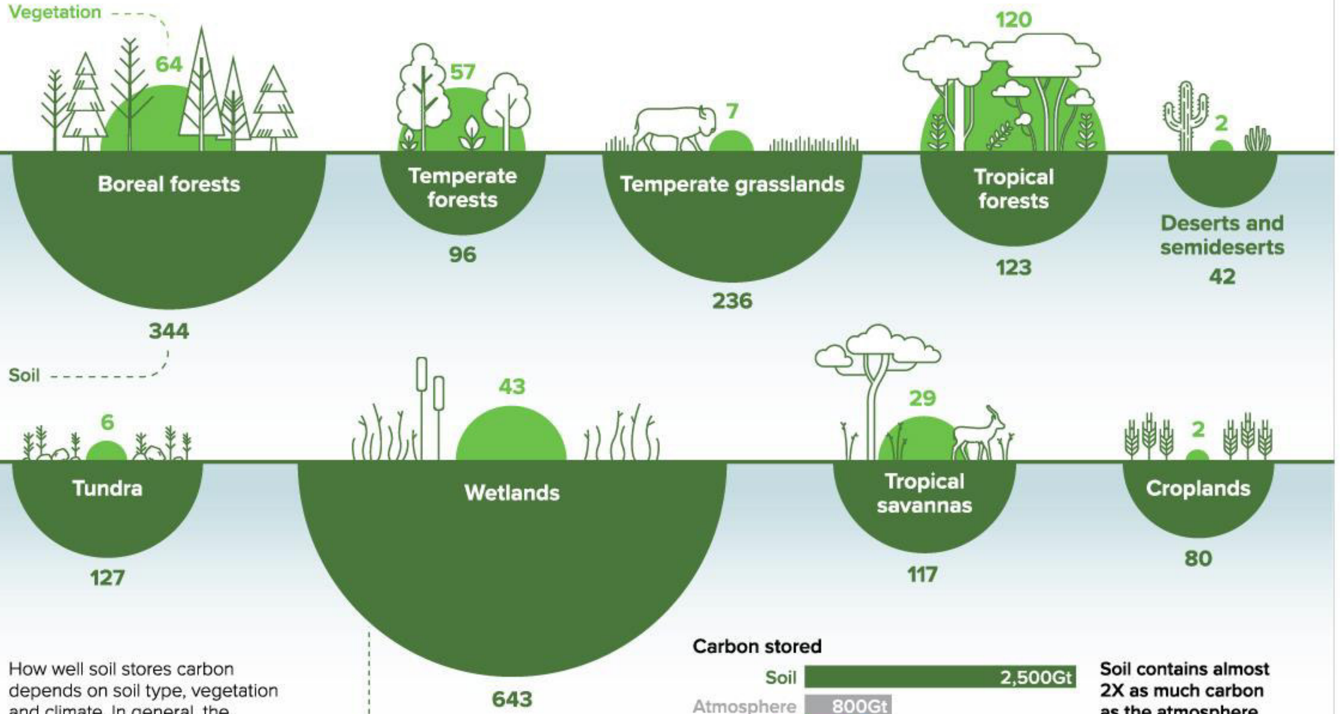


Carbon Storage

Tonnes of Carbon

The world's forests absorb around **15.6 gigatonnes** of CO_2 each year. That's around 3X the annual CO_2 emissions of the United States.

However, around **8.1 gigatonnes of CO_2 leaks back into the atmosphere** due to deforestation, fires and other disturbances.



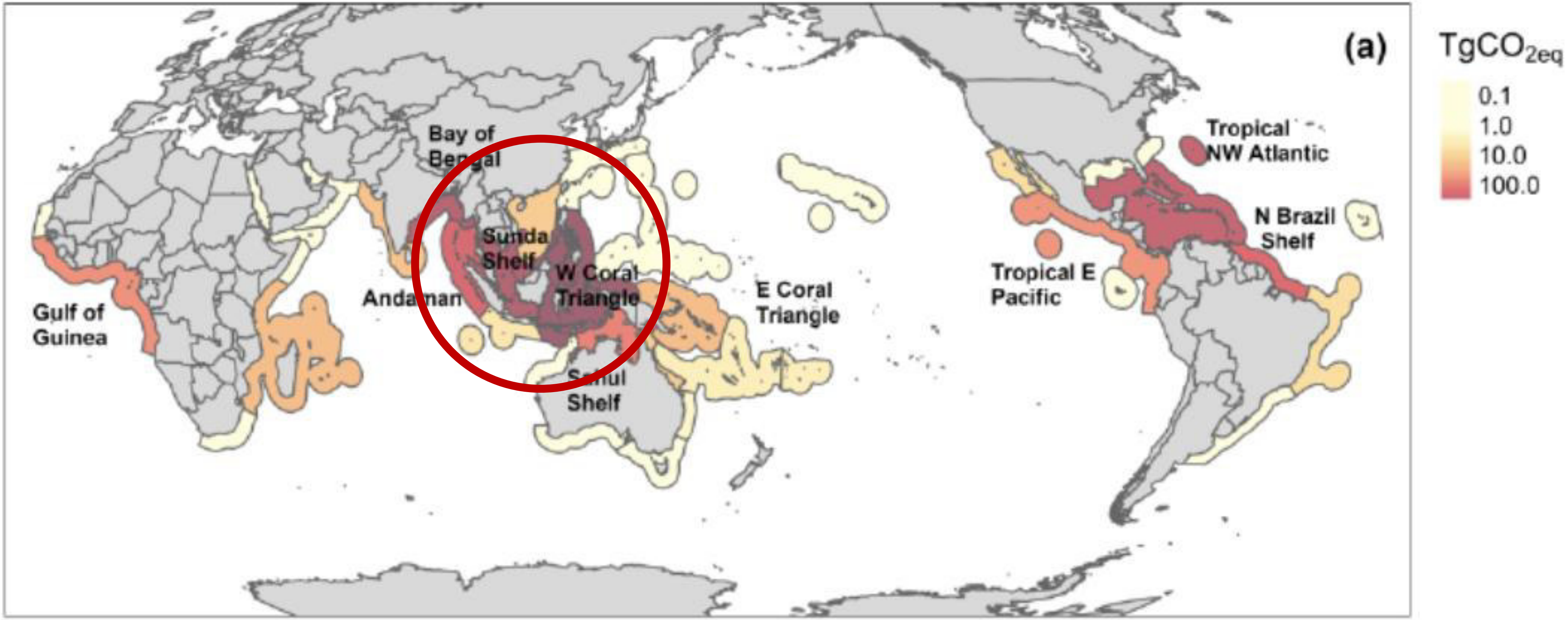
How well soil stores carbon depends on soil type, vegetation and climate. In general, the **wetter and colder**, the better.

Soil contains almost 2X as much carbon as the atmosphere and living flora and animals combined.

Average stored carbon in tonnes per hectare at a ground depth of one meter

Sources: IPCC; NASA

Carbon Emissions due to Mangrove Deforestation

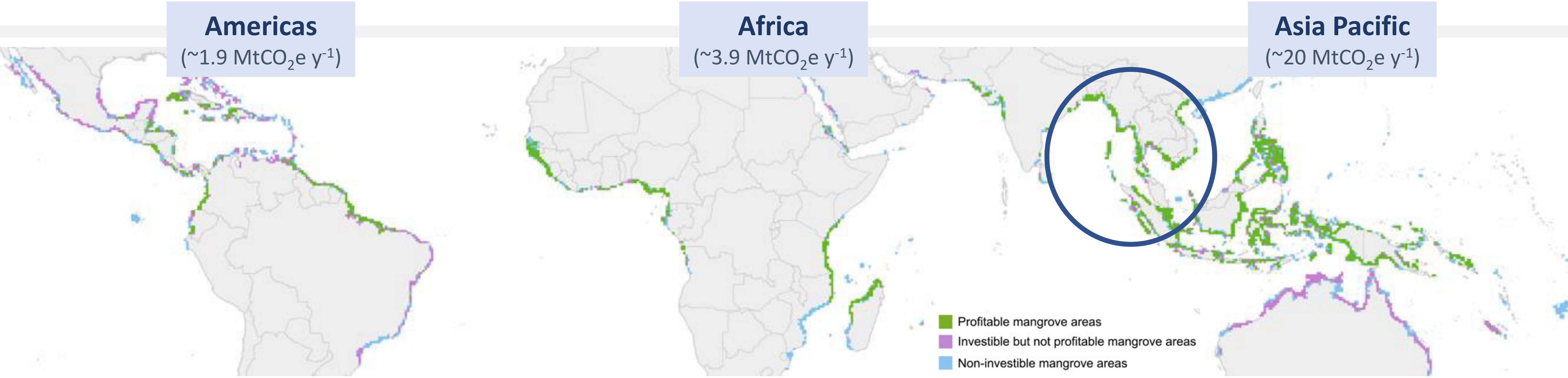


Adame et al. 2021. **Global Change Biology** 27, 2856-2866.

Mangrove deforestation emissions + lost sequestration could be 3392 $TgCO_2$-e by 2100

Where are the Opportunities for NCS?

Southeast Asia has tremendous potential for profitable blue carbon



Blue Carbon Prospecting

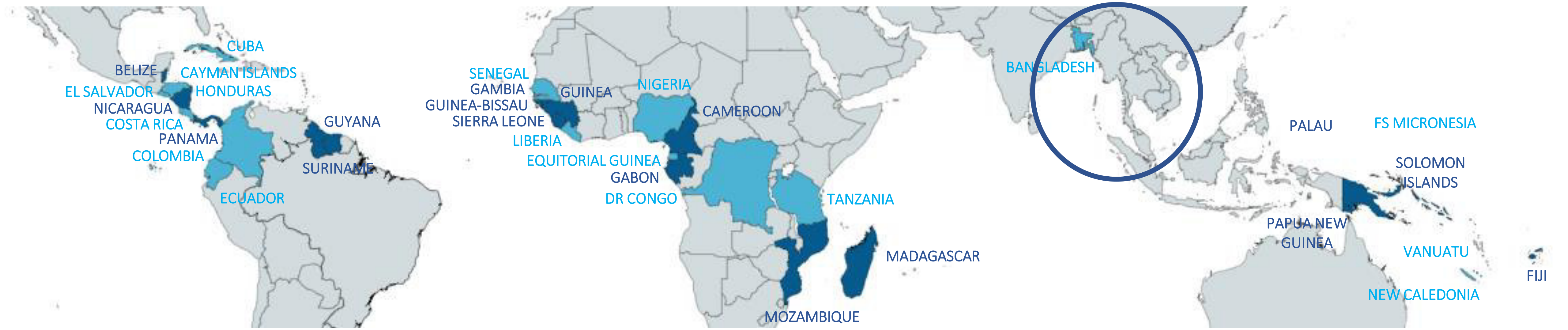
(Protecting Threatened Mangroves)

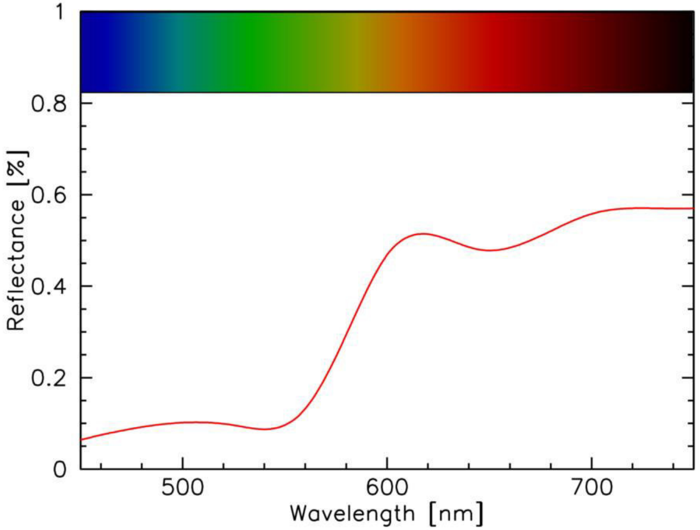
Zeng et al., *Current Biology*(2021)

United Nations
Framework Convention on
Climate Change

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

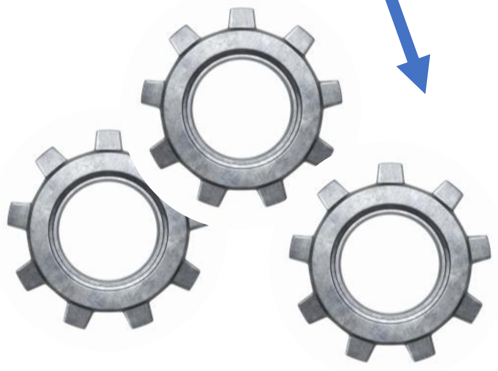
- 17 countries where **mangrove** carbon sequestration offsets >5% of national greenhouse gas emissions
- 17 countries where **mangrove** carbon sequestration offsets 1-5% of national greenhouse gas emissions





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

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



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

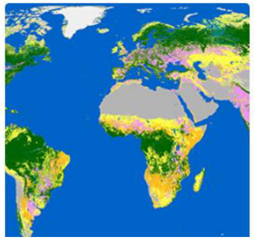
Using satellite data to estimate carbon storage in wetlands of Southeast Asia

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)

Datasets

ESA WorldCover 10m v200

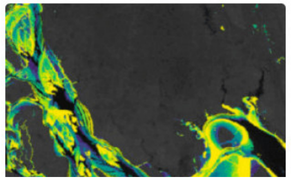


DESCRIPTION BANDS TERMS OF USE CITATIONS

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:

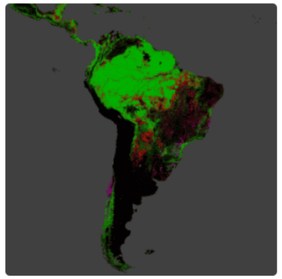
Murray Global Intertidal Change Classification



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)



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

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.

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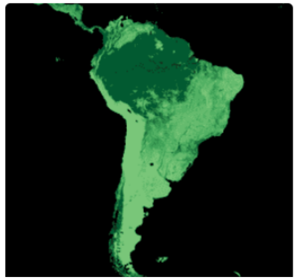
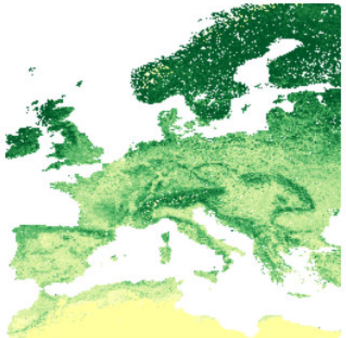
Global Aboveground and Belowground Biomass Carbon Density Maps



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



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

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

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Data analysis notes

Land use Dynamics
ESA World Cover 2021, Hansen Gain and Loss data are aggregated over the site boundaries by landcover classes
Accuracy : ~70%

Vegetative Carbon
AGB and BGB values: aggregated over landcover class areas
Uncertainty: mean for each class

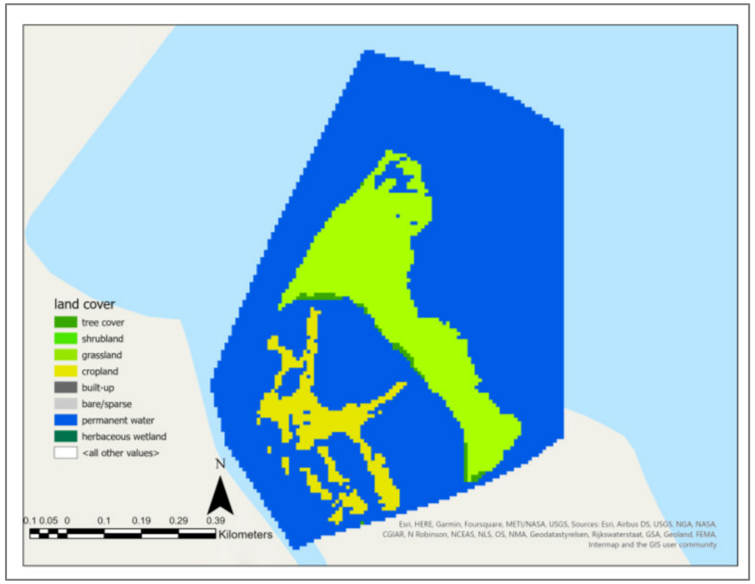
Soil Carbon
Density (g/kg) : aggregated sum for each landcover class and at each depth, presented as a range.

Biomass: aggregated mean of all points at different depths, normalized for the area of each landcover class

Carbon sequestration rate:
Normalized using global estimates per landcover class available in literature reviews

Bangrin Marine Protected Area, Philippines

Total Area: 160.6 ha
Total C: 6.3 MgC
Vegetative C: 0 +- 0 MgC
Soil C: 6.3 MgC



*The landcover dynamics are determined using global geospatial datasets. It is possible that certain landcover classes are over or under estimated or ignored due to dataset limitations. We advise that the geospatial analysis be supplemented with ground reference points.
Following additional classes were identified during stakeholder consultations:
- Estuarine waters
- Intertidal mud, sand, or saltflats
- Intertidal forested wetlands

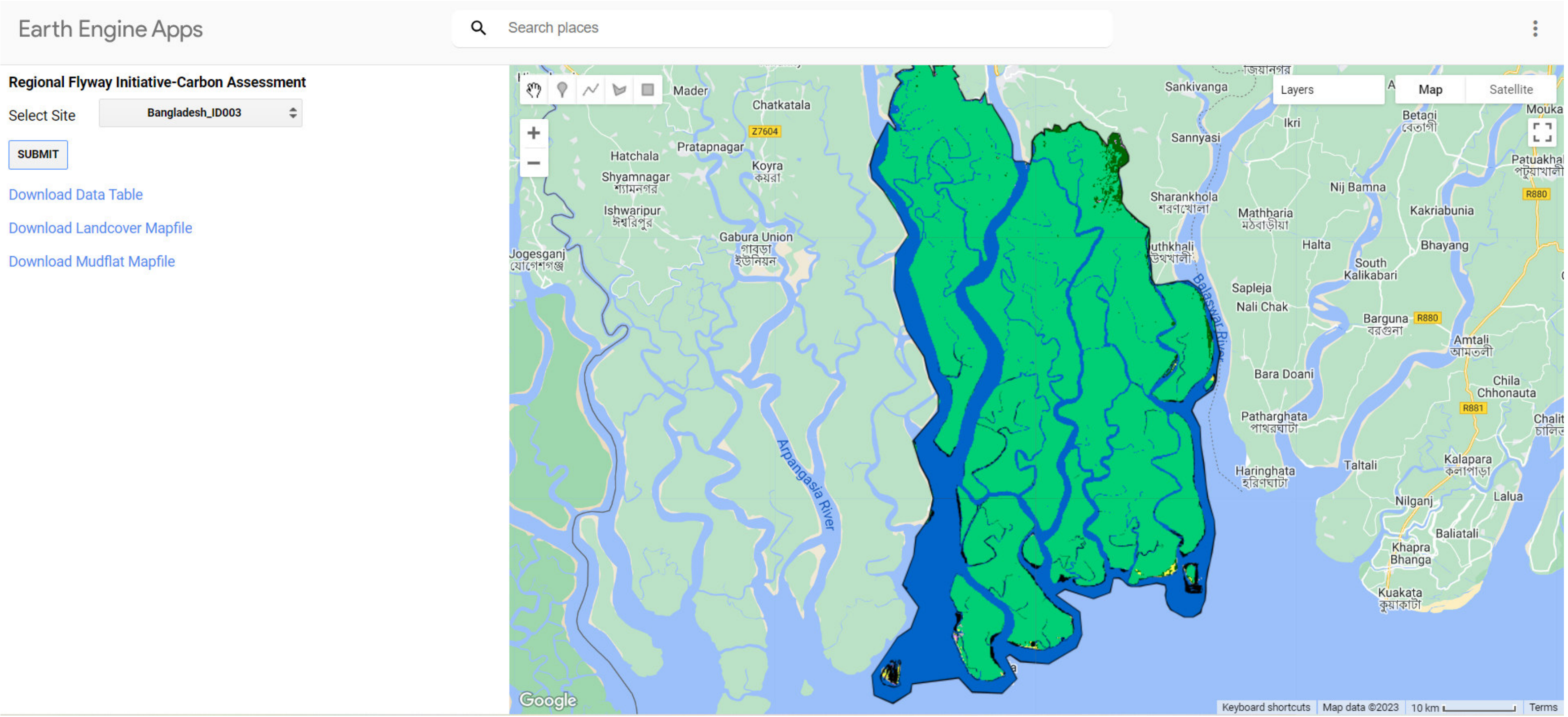
These classes could overlap or have different ways of defining current landcover classes.

Landcover Dynamics				Vegetative Carbon				Soil Carbon		Carbon sequestration Rate		
Landcover type	Area (ha)	Gain (ha)	Loss (20-75% tree cover) (ha)	AGB (MgC)	Uncertainty (MgC)	BGB (MgC)	Uncertainty (MgC)	SOC Range (g/kg)	SOC (MgC)	Total C seq MgC/y	Min C seq rate (MgC y-1)	Max C seq rate (MgC y-1)
Tree cover	0.6	0	0	0	0	0	0	155-180	0.045	0.24	0.17	0.17
Shrubland	0	0	0	0	0	0	0	0	0	No Data	No Data	No Data
Grassland	13	0	0	0	0	0	0	155-180	1.01	2.24	0.65	0.81
Cropland	5	0	0	0	0	0	0	85-105	0.23	No Data	No Data	No Data
Permanent water	60	Na	Na	Na	Na	Na	Na	Na	Na	Na	Na	Na
Herbaceous wetlands	0	0	0	0	0	0	0	0	0	0	0	0
Mangroves	0	0	0	0	0	0	0	0	0	91.52	66.80	238.58
Aquaculture	0	0	0	0	0	0	0	0	0	No Data	No Data	No Data
Tidal flat	82	0	0	0	0	0	0	110-125	5.03	0	0	0

Landcover type	Reference	Notes
Landcover Type and Area (ha) Aquaculture Tidal Flat	European Space Agency (ESA) World Cover 10m 2021 Clark Murray Global Intertidal Change Classification 2017	All landcover classes except aquaculture and tidal flat are derived from ESA dataset Clark Extent of tidal flats from the year 2017
Gain in tree cover (ha)	Hansen Global Forest Change v1.10 (2000-2022)	Gain is defined by a gain in tree cover for 2000-2012
Loss in 20-75% tree cover (ha)	Hansen Global Forest Change v1.10 (2000-2022)	Loss is presented as a loss in 20% to 75% tree cover between 2000-2022
Vegetative Carbon	Global Aboveground and Belowground Biomass Carbon Density Maps (2010)	Vegetative Carbon is a sum of aboveground and belowground carbon derived from the given dataset estimated through geospatial analysis
Soil Carbon	OpenLandMap Soil Organic Carbon Content 2018	Soil Carbon is presented as a density (g/kg) and total amount in MgC. The OpenLandMap soil carbon map predicts global values through a compilation of soil data points.
Carbon Sequestration	Taillardat et al. 2018 and Chen and Lee 2022	Taillardat et al 2018 are used for mangroves, herbaceous wetlands, tree cover, and shrubland. Chen and Lee 2022 are used for tidal flats. These are global estimates used to do a value conversion based on area per landcover.

Bangrin Tidal flats

https://ee-radb06.projects.earthengine.app/view/rfi



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Thank you!

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