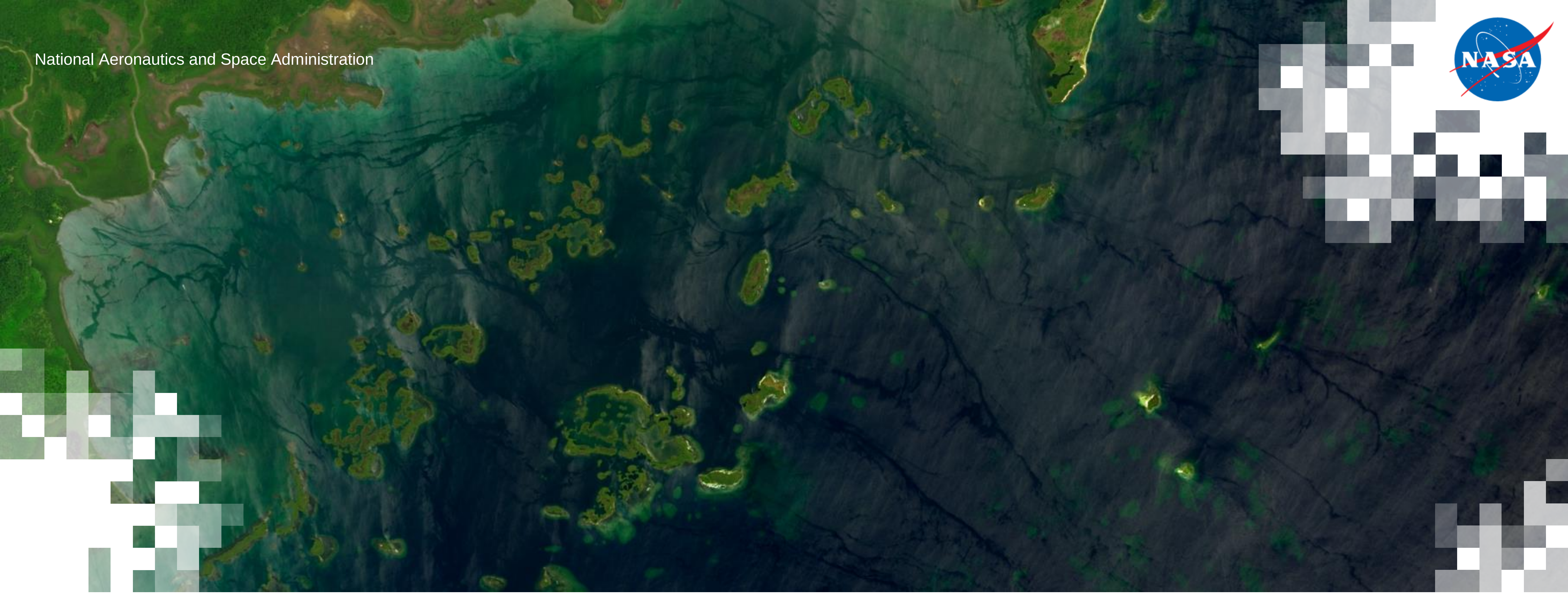
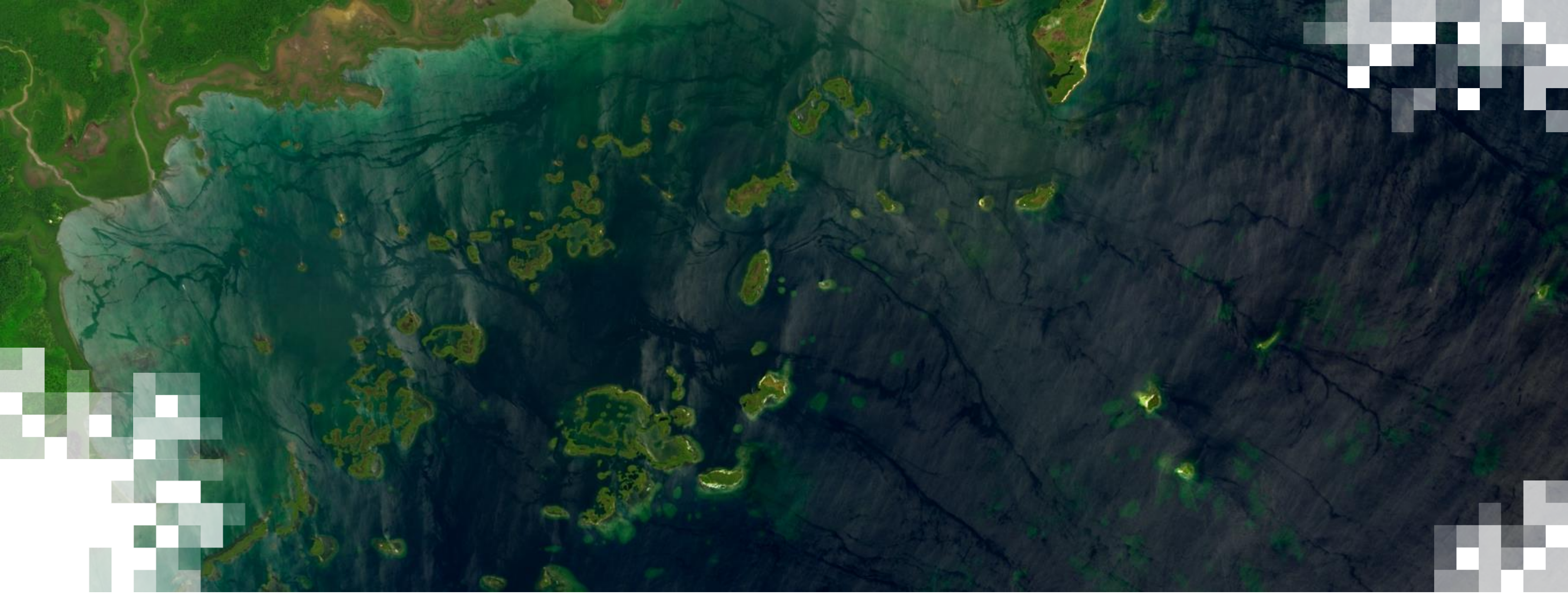


Earth Observations of Blue Carbon Ecosystems

Part 1: Overview of Blue Carbon Ecosystems & Mapping Mangrove Ecosystems with Earth Observations

Brock Blevins (NASA ARSET), Dr. Adia Bey (NASA Goddard Space Flight Center), Dr. Lola Fatoyinbo (NASA Goddard Space Flight Center), and Lynette Ying (International Blue Carbon Institute)

December 3, 2024



About ARSET

About ARSET

- **ARSET provides accessible, relevant, and cost-free training on remote sensing satellites, sensors, methods, and tools.**
- Trainings include a variety of applications of satellite data and are tailored to audiences with a variety of experience levels.

AGRICULTURE

CLIMATE & RESILIENCE

DISASTERS

ECOLOGICAL CONSERVATION

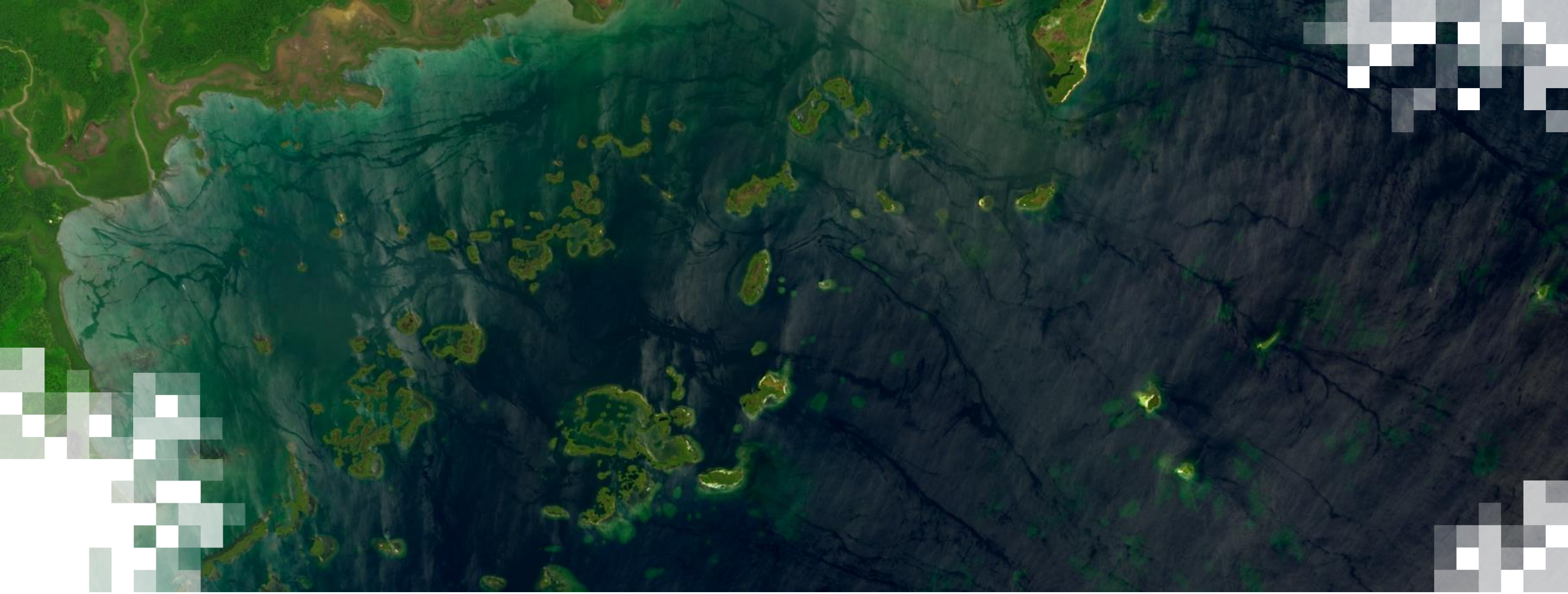
HEALTH & AIR QUALITY

WATER RESOURCES

About ARSET Trainings

- Online or in-person
- Live and instructor-led or asynchronous and self-paced
- Cost-free
- Bilingual and multilingual options
- Only use open-source software and data
- Accommodate differing levels of expertise

- Visit the ARSET website to learn more.



Earth Observations of Blue Carbon Ecosystems
Overview

Training Learning Objectives

By the end of this training, participants will be able to:

- Identify blue carbon ecosystems and the role they play in the global carbon budget
- Map the extent of blue carbon ecosystems using satellite observations
- Measure the carbon stock of mapped blue carbon ecosystems
- Identify contexts in which earth observation data of carbon stocks in blue carbon ecosystems can inform reporting, monitoring, accounting and advocacy.

Training Outline

Part 1

Overview of Blue Carbon Ecosystems & Mapping Mangrove Ecosystems with Earth Observations

December 03, 2024

14:00-15:30 EST (UTC-5)

Part 2

Mapping Salt Marsh and Seagrass with Earth Observations

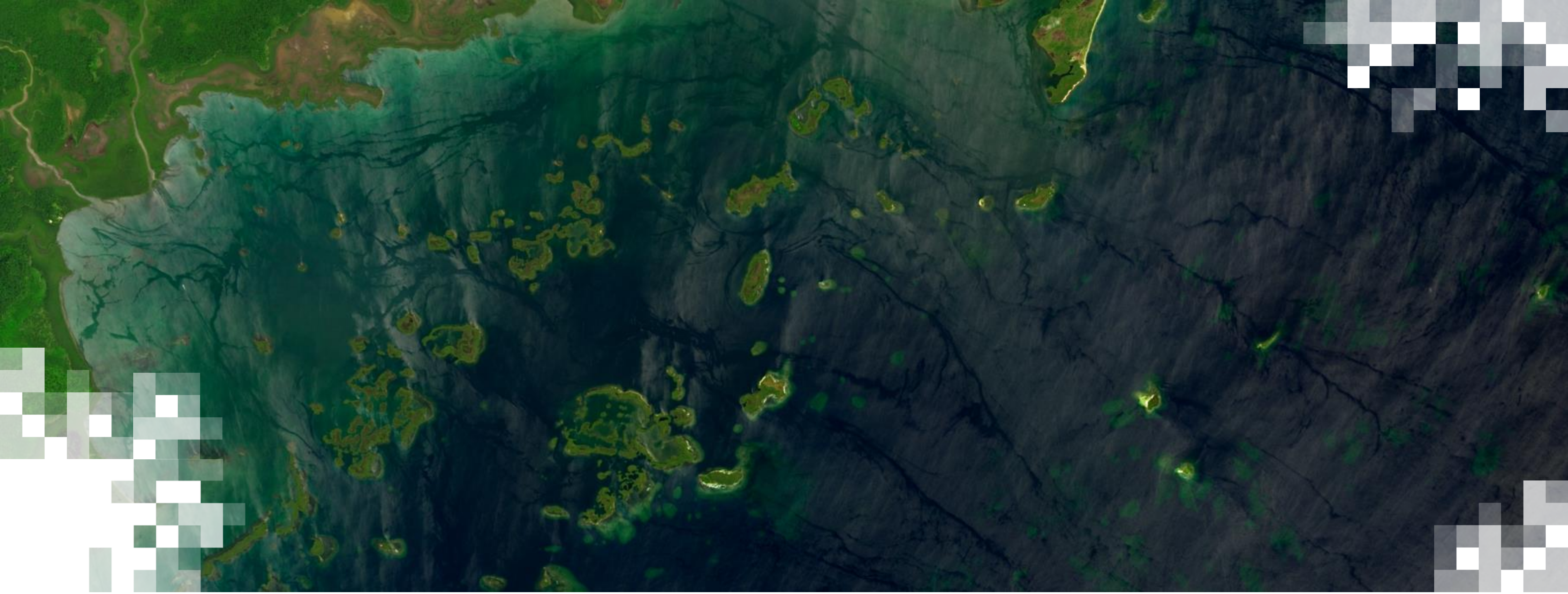
December 05, 2024

14:00-15:30 EST (UTC-5)

Homework

Opens December 5, 2024 – Due December 19, 2024 – Posted on Training Webpage

A certificate of completion will be awarded to those who attend all live sessions and complete the homework assignment(s) before the given due date.



Earth Observations of Blue Carbon Ecosystems

Part 1: Overview of Blue Carbon Ecosystems & Mapping Mangrove Ecosystems with Earth Observations

Part 1 – Trainers

Dr. Siti Maryam Yaakub

Senior Director

International Blue Carbon Institute

Dr. Adia Bey

Assistant Research Scientist & Geospatial Analyst

NASA Goddard Space Flight Center

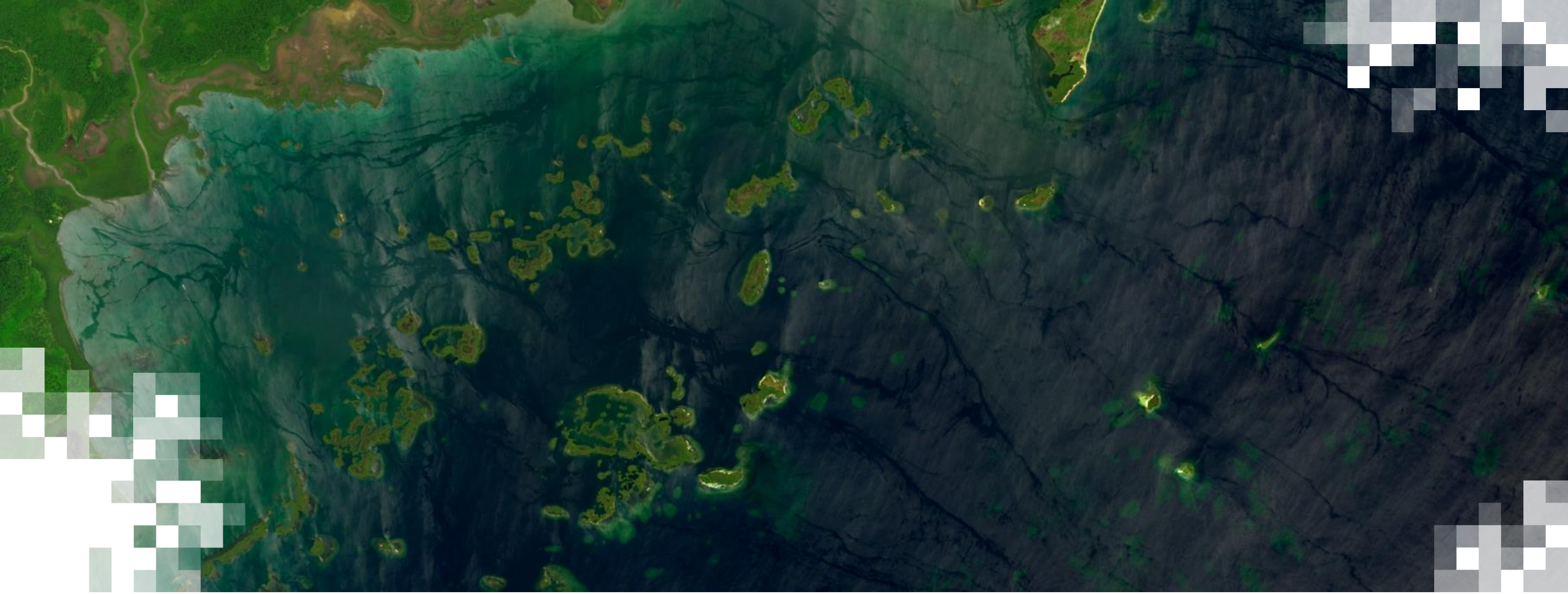
Dr. Lola Fatoyinbo

Research Scientist

NASA Goddard Space Flight Center

How to Ask Questions

- Please put your questions in the Questions box and we will address them at the end of the webinar.
- Feel free to enter your questions as we go. We will try to get to all of the questions during the Q&A session after the webinar.
- The remainder of the questions will be answered in the Q&A document, which will be posted to the training website about a week after the training.



INTERNATIONAL BLUE CARBON INSTITUTE

CONSERVATION INTERNATIONAL

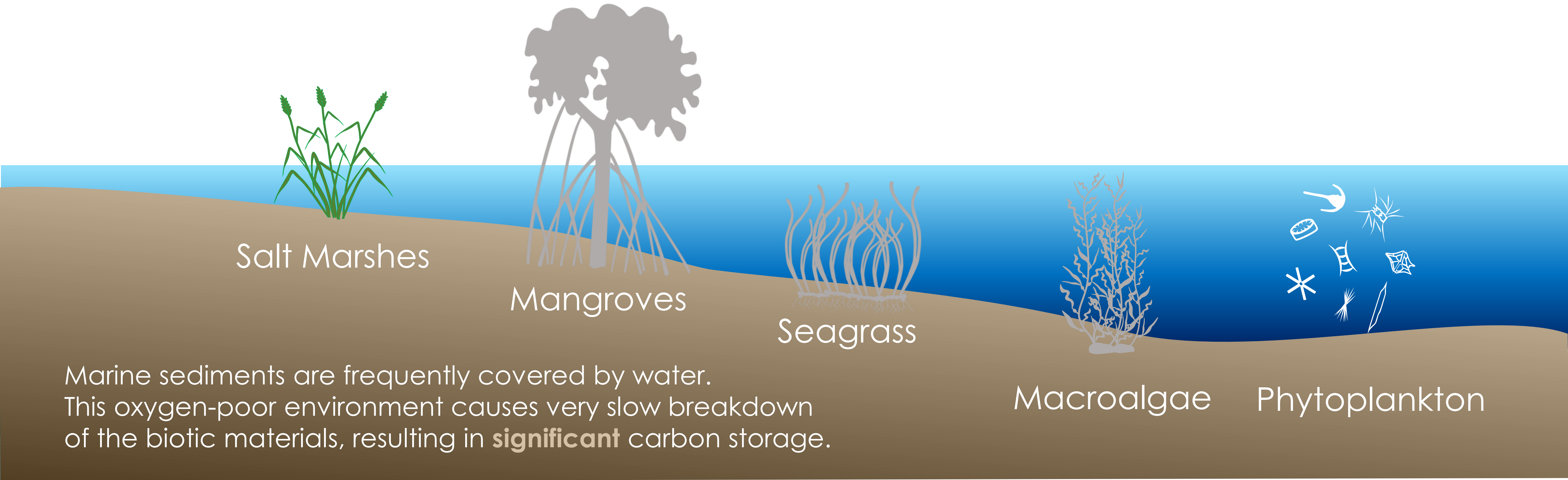
Part 1:
What are Blue Carbon Ecosystems?

What is blue carbon?

Blue carbon is carbon that is captured or removed by ocean systems.

Coastal ecosystems, such as **mangroves, seagrass** and **salt marshes** play an **outsized role** in the removal and storage of carbon.

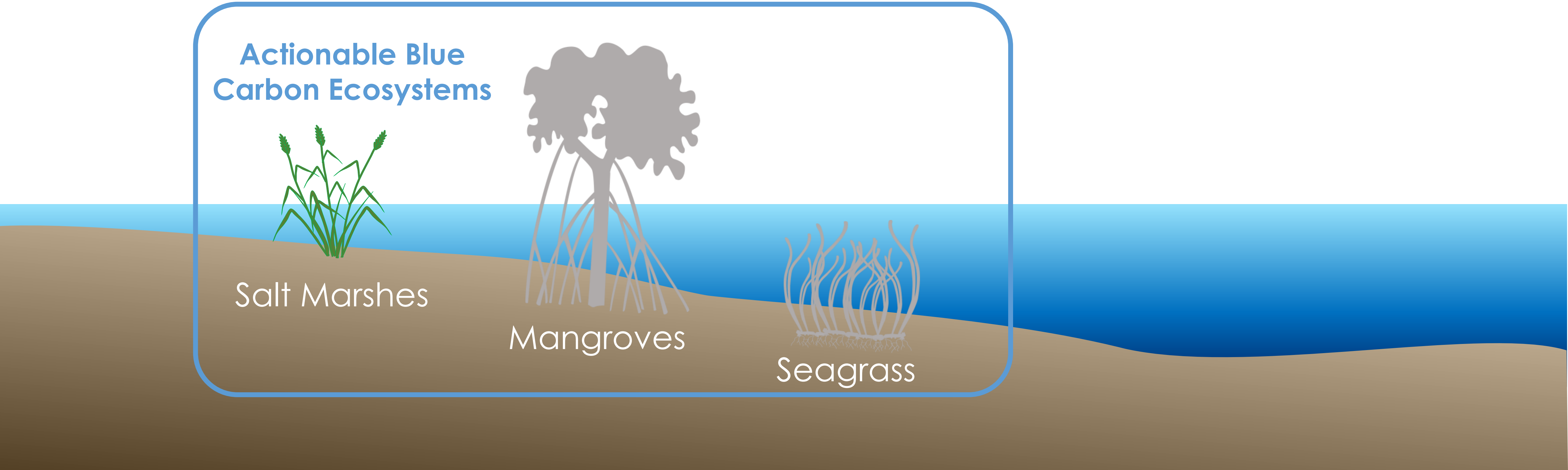
Carbon in these coastal ecosystems are **captured both in the biotic and abiotic components**.



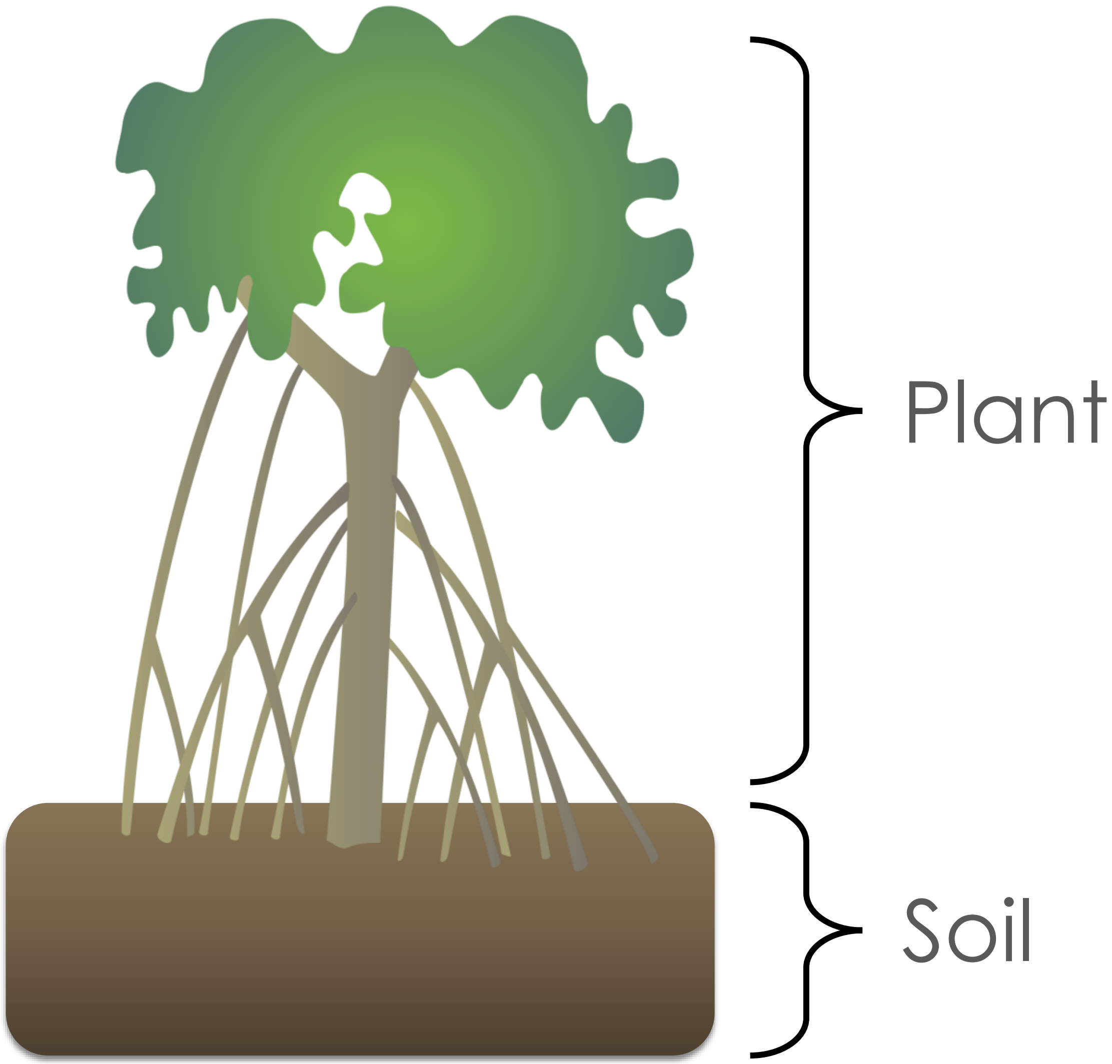
What makes ecosystems actionable for climate mitigation?

Factors for inclusion in climate mitigation policy:

- Presence of high carbon stocks
- Evidence of long-term carbon storage
- Capacity for people to manage and effectively measure greenhouse gas emissions (GHG) and removals



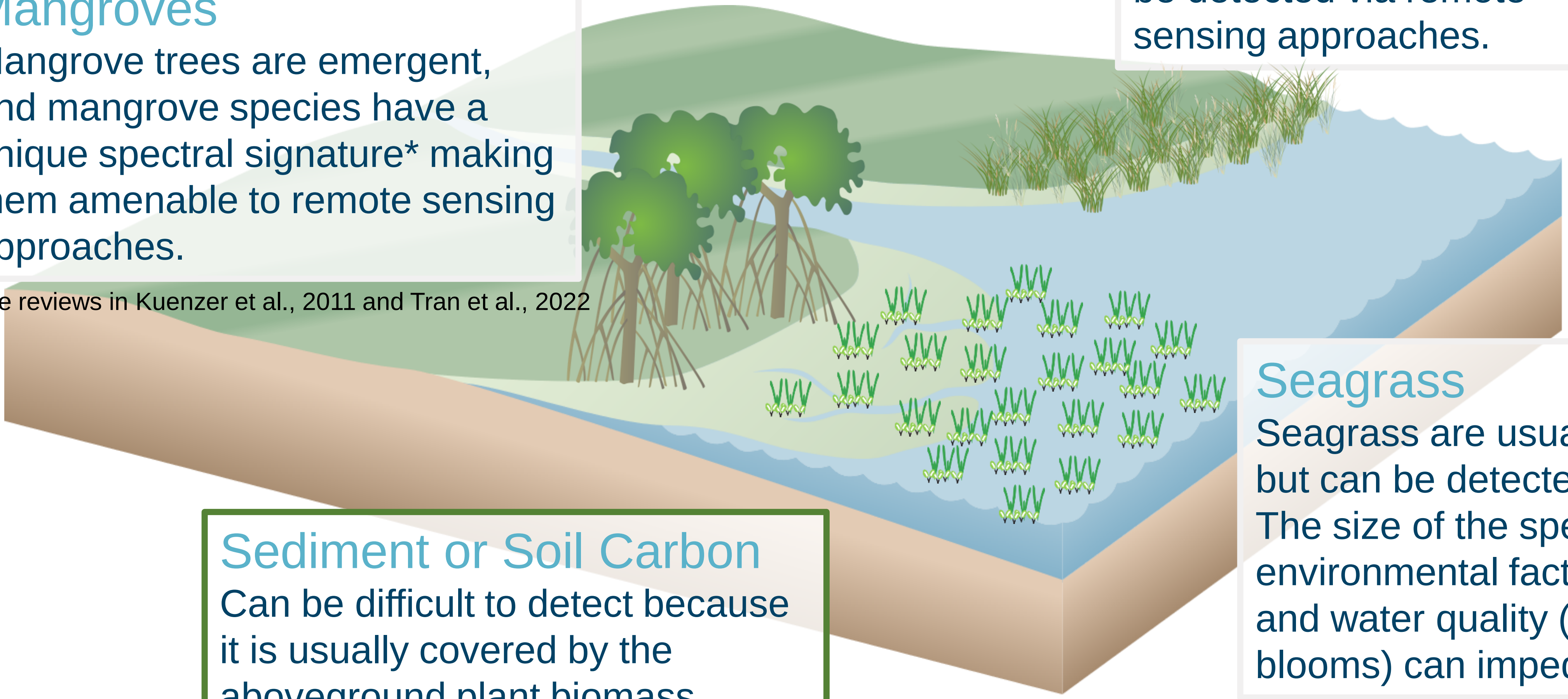
Components of blue carbon



Percentage of total carbon stock **aboveground** (plant biomass):
Mangroves ~40%
Seagrass & Salt Marsh >5%

Percentage of total carbon stock **belowground** (roots & sediments):
Mangroves ~60%
Seagrass & Salt Marsh ~95%

Detecting blue carbon from space



Salt Marshes

Salt Marshes are rarely fully submerged and can usually be detected via remote sensing approaches.

Mangroves

Mangrove trees are emergent, and mangrove species have a unique spectral signature* making them amenable to remote sensing approaches.

*See reviews in Kuenzer et al., 2011 and Tran et al., 2022

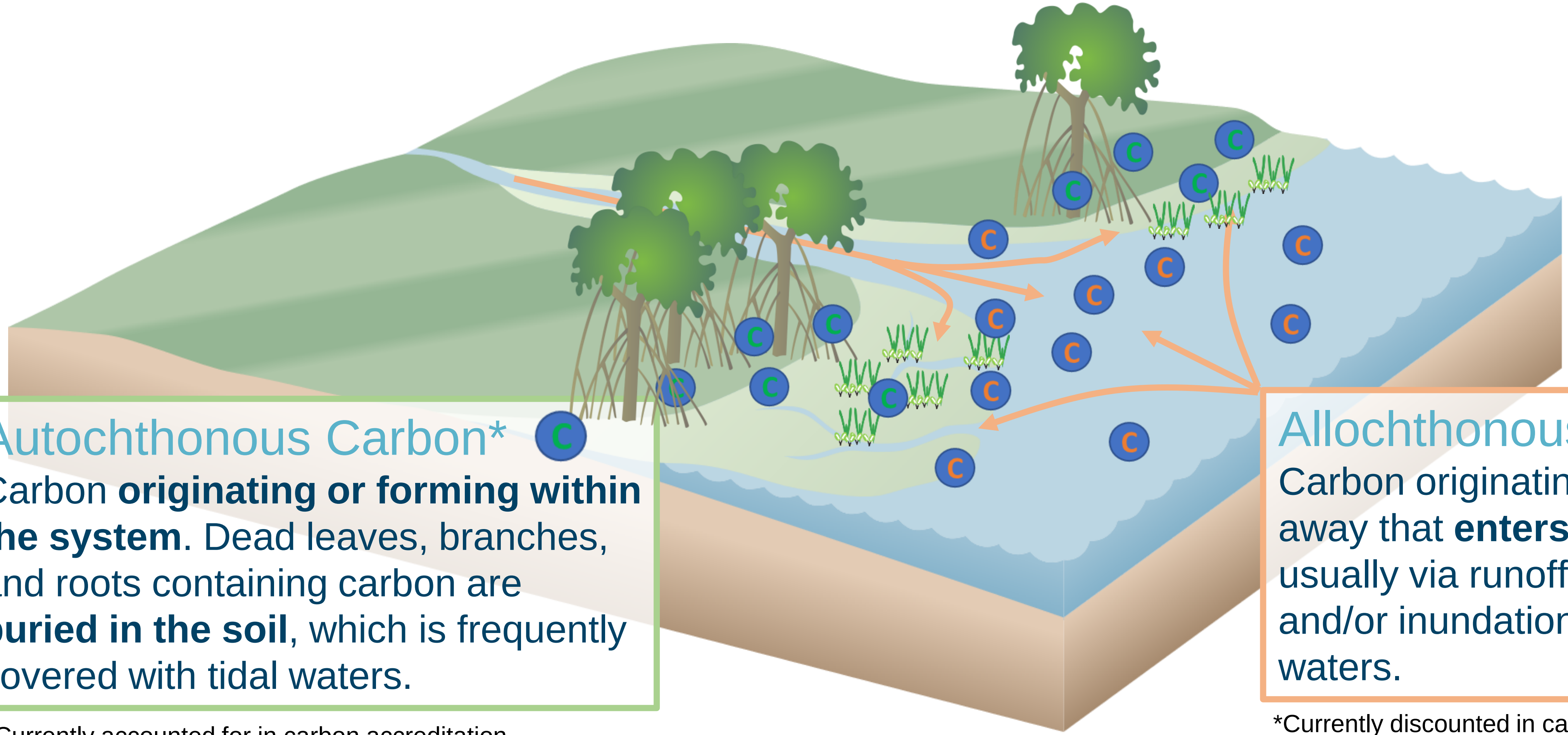
Seagrass

Seagrass are usually submerged but can be detected from space. The size of the species, and environmental factors like turbidity and water quality (e.g., algal blooms) can impede detection.

Sediment or Soil Carbon

Can be difficult to detect because it is usually covered by the aboveground plant biomass.

More on soil carbon



Autochthonous Carbon*

Carbon **originating or forming within the system**. Dead leaves, branches, and roots containing carbon are **buried in the soil**, which is frequently covered with tidal waters.

*Currently accounted for in carbon accreditation methodologies

Allochthonous Carbon

Carbon originating from further away that **enters the system**, usually via runoff up stream and/or inundation by marine waters.

*Currently discounted in carbon accreditation methodologies due to lack of certainty in tracing additionality from outside sources

Mangroves

Mangroves are a type of tropical forest, found at the edge of land and sea and flooded regularly by tidal water. Mangroves are among the most carbon-rich forests in the tropics.

- **Sequestration Rate**: About 6-8 tonnes of CO_2 per hectare per year
- **Total Carbon Storage**: 900 to 1,100 tonnes of CO_2 per hectare in their biomass and soils

Mangroves sequester and store the most carbon overall due to their large biomass and deep root systems. They provide at least US $1.6 billion each year in ecosystem services.

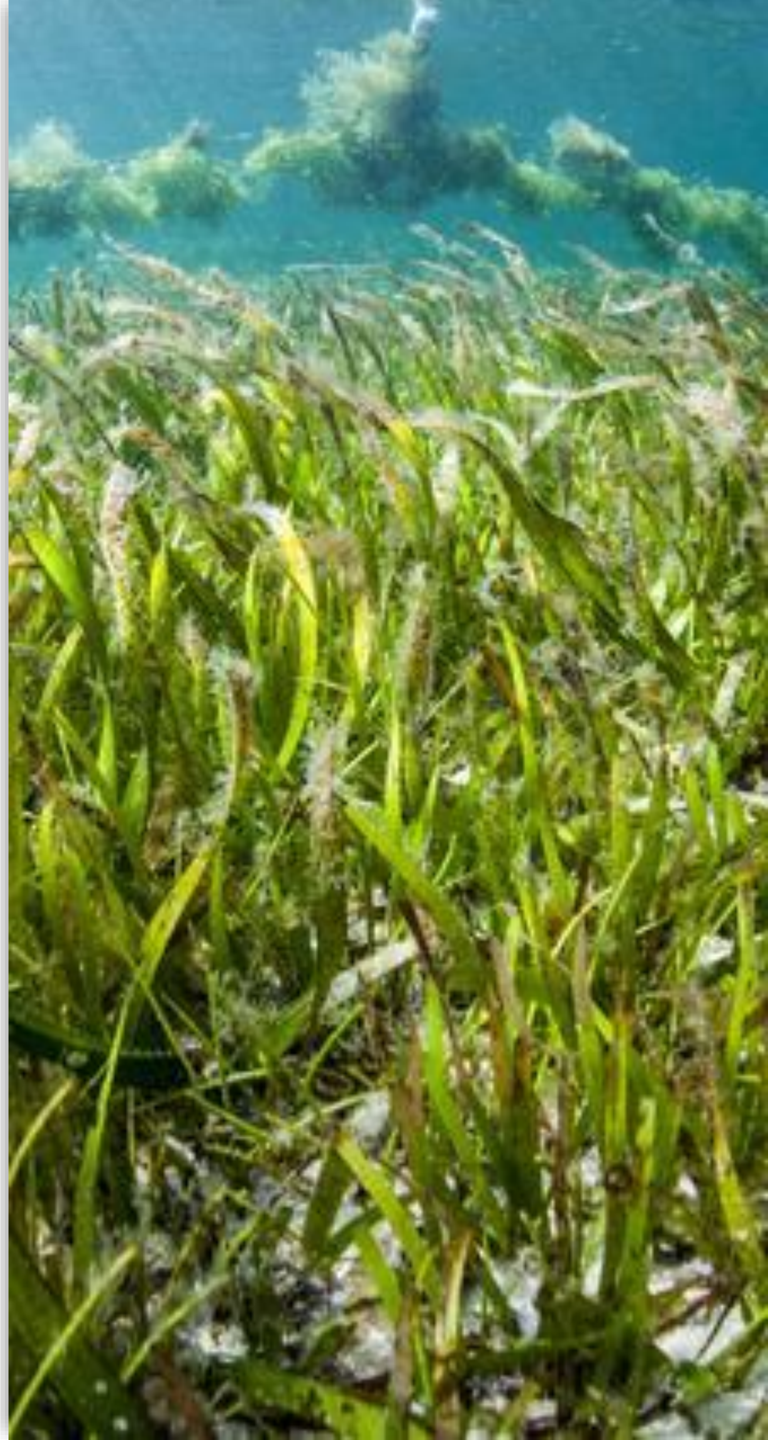
Seagrass

Seagrasses are submerged flowering plants with deep roots that are found in meadows along the shore of every continent except Antarctica.

Carbon accumulates in seagrasses over time and is stored almost entirely in the soils, which have been measured up to four meters deep.

- **Sequestration Rate**: About 1.5 to 4.4 tonnes of CO_2 per hectare per year
- **Total Carbon Storage**: Up to 500 tonnes of CO_2 per hectare.

Seagrasses sequester less carbon directly but are efficient in trapping both autochthonous and allochthonous carbon, particularly near mangroves.



Salt marshes

Salt marshes are coastal wetlands characterized by saline conditions and the gradual accumulation of sediment. They are typically found in intertidal zones along the shores of oceans, seas, and brackish bodies of water. Most of the carbon stored in salt marsh ecosystems is found in the soil, which can be several meters deep.

- **Sequestration Rate**: 2-6 tonnes of CO_2 per hectare per year.
- **Total Carbon Storage**: 200 to 600 tonnes of CO_2 per hectare (similar to seagrasses).

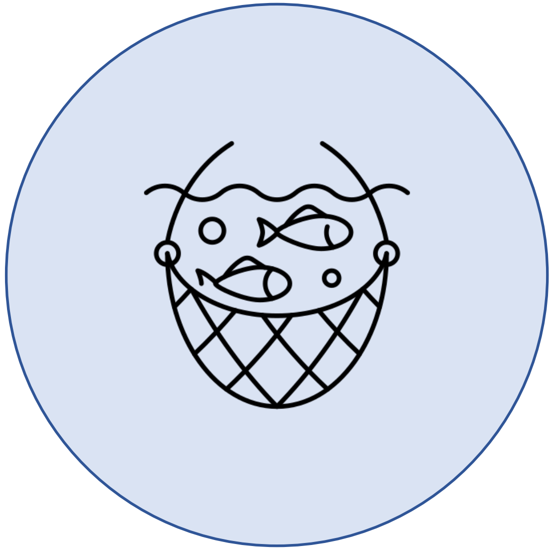
Salt marshes provide a steady sequestration rate and are excellent at long-term carbon burial, especially through the trapping of carbon from other sources.

Beyond carbon…

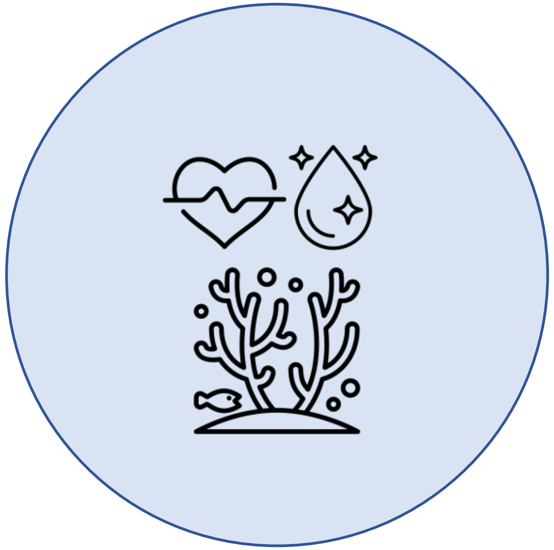
Blue carbon ecosystems also provide numerous other benefits:

Supports Biodiversity
Provides shelter, food and nurseries for marine fauna and flora

Protects Coastlines
Protects coastal communities from storm surges, floods and coastal erosion



Provides Livelihoods
Provides food and livelihoods for coastal communities through fisheries, tourism



Ocean Health
Supports overall ocean health through nutrient cycling and bio-remediation

Status of blue carbon ecosystems

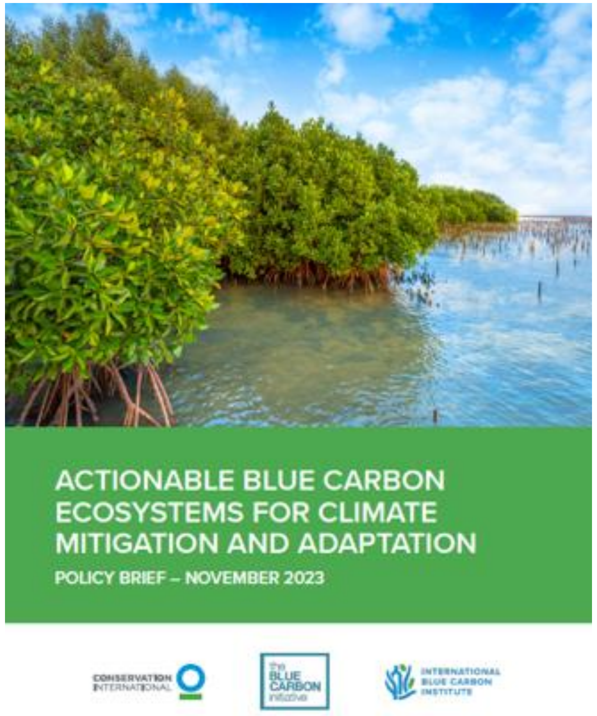
Despite their important role, blue carbon ecosystems are at risk.

- Estimates suggest that globally **50% of salt marshes, 35% of mangroves, and 29% of seagrass meadows** have been degraded or lost since the mid-20th century.
- The main causes of **conversion** and **degradation** of blue carbon ecosystems vary around the world but are largely driven by human activities. Common drivers are **aquaculture**, **agriculture**, **mangrove forest exploitation**, terrestrial and marine sources of **pollution** and industrial and urban **coastal development**.
- These impacts are expected to continue and be exacerbated by **climate change**.

Policy trends

International, national and regional policy mechanisms being developed for climate mitigation can offer an additional route for effective management of blue carbon ecosystems and scaling up their protection.

- In global climate frameworks like the **Paris Agreement**, with countries beginning to recognize blue carbon in their **Nationally Determined Contributions** (national climate policy commitments).
  - Around 151 countries around the world contain at least one coastal blue carbon ecosystem, and 71 countries contain all three.
- Coastal blue carbon ecosystems can also be included in **National Greenhouse Gas inventories**, which will require regular monitoring of these ecosystems.



Finance trends

- Various financing approaches exist for coastal blue carbon, including both **market** and **non-market** approaches.
  - Market approaches primarily refer to the **carbon market** – the generation of carbon credits that enter voluntary or compliance carbon markets.
  - Non-market approaches include approaches that does not involve the transfer/trade of carbon credits from one party to another. Some examples include:
    - **Payments for Ecosystem Services:** paying environmental stewards for protection to conserve the services ecosystems provide (fisheries, flood protection).
    - **Debt-for-Nature Swaps:** forgiving or refinancing part of a country's debt to another with condition of these finances being used for specific climate or nature outcome

Applications of remote sensing

Applications of remote sensing include:

- In policy: Understanding of the areal extent and existence of blue carbon ecosystems, monitoring for national GHG inventories
- In carbon projects: identifying project areas, setting baseline rates of ecosystem degradation or loss, estimations of biomass, monitoring effectiveness and project implementation.
- In management: Monitoring and surveillance of illegal destruction/logging across a large scale, remote detection of health and condition of plants.

APPLIED REMOTE SENSING TRAINING PROGRAM

TRAIN - EMPOWER - ADVANCE

In collaboration with:

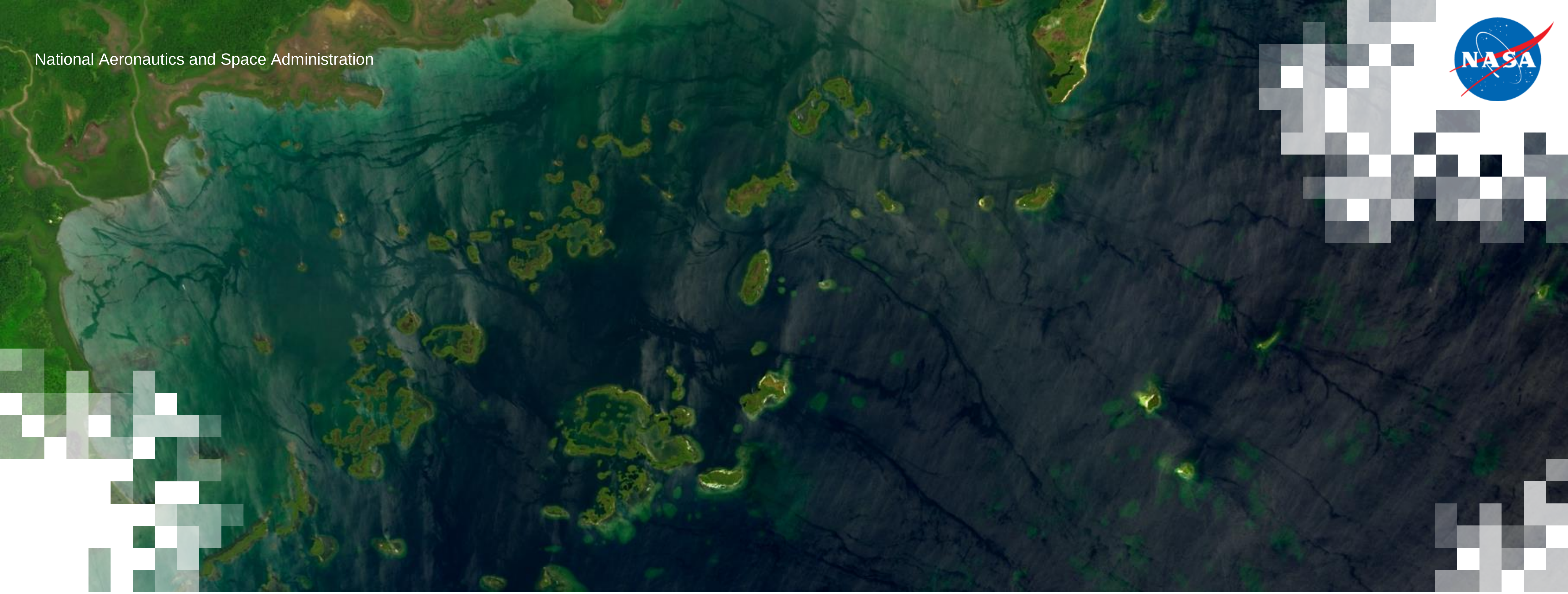
INTERNATIONAL BLUE CARBON INSTITUTE

CONSERVATION INTERNATIONAL

Resources

- https://www.thebluecarboninitiative.org/manual
- https://www.thebluecarboninitiative.org/policy-guidance
- https://www.thebluecarboninitiative.org/about-blue-carbon
- https://oceanservice.noaa.gov/ecosystems/coastal-blue-carbon/
- https://www.nasa.gov/centers-and-facilities/goddard/new-partnership-aids-sustainable-growth-with-earth-observations/
- https://www.theoceanagency.org/toolkits/mangroves
- https://www.theoceanagency.org/toolkits/seagrass
- https://www.wri.org/insights/what-is-blue-carbon-benefits-for-people-planet
- https://link.springer.com/article/10.1007/s40725-018-0077-4

National Aeronautics and Space Administration

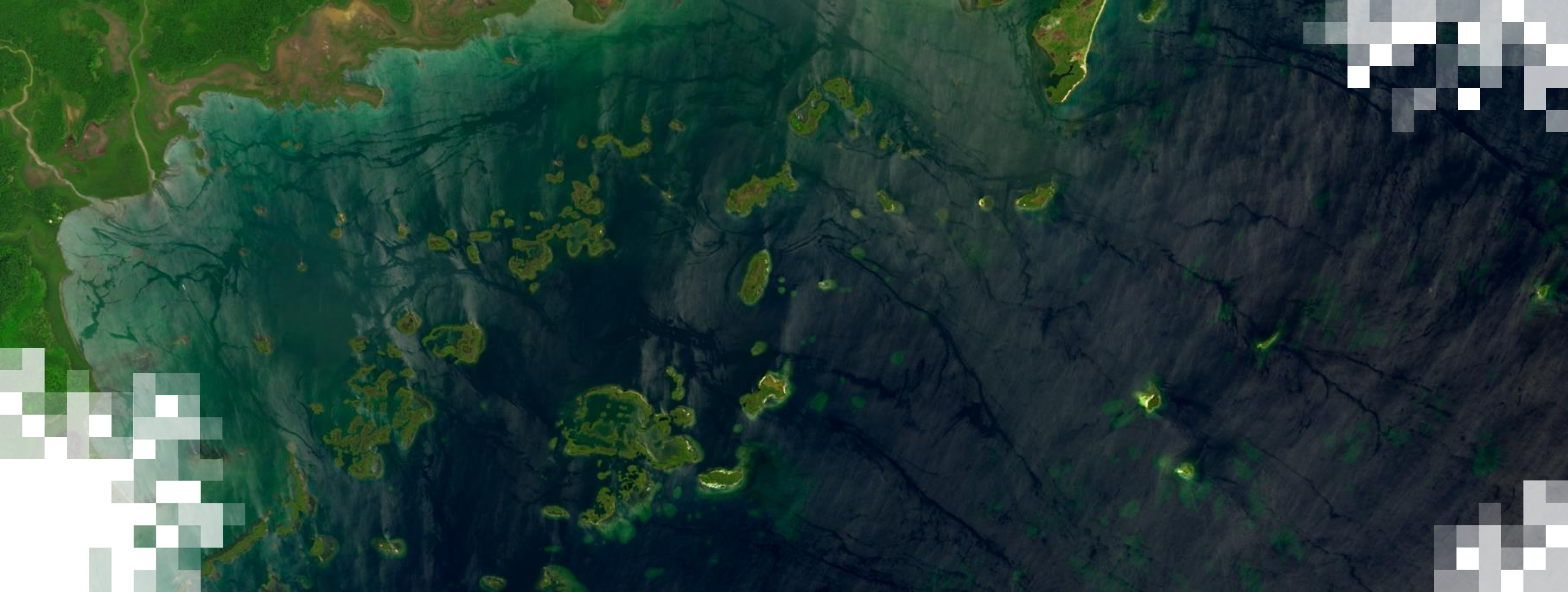


Mapping Mangrove Ecosystems with Earth Observations

Part 1: Using Earth Observations to Measure Mangrove Blue Carbon Ecosystems

Dr. Adia Bey (NASA Goddard Space Flight Center) &
Dr. Lola Fatoyinbo (NASA Goddard Space Flight Center)

December 3, 2024



Mapping the extent of Mangrove Ecosystems

Part 1: Using Earth Observations to Measure Mangrove Blue Carbon Ecosystems

Learning Objectives

By the end of this presentation, you will

- Define a blue carbon ecosystem based on ecosystem characteristics
- Map the extent of mangrove ecosystems using satellite observations
  - Explore existing global datasets showing mangrove extent, canopy height and biomass
  - Use Google Earth Engine to generate mangrove extent data
- Calculate the carbon stock of mapped mangrove ecosystems
  - Apply basic criteria for accessing the suitability of data for your purposes
  - Estimate mangrove canopy height, biomass and carbon stocks in your area of interest
  - Evaluate data sources for a more precise mangrove ecosystem carbon stock estimate

Prerequisites and Resources

Prerequisites

- ARSET - Fundamentals of Remote Sensing
- Getting Started with Google Earth Engine
- Introduction to JavaScript for Earth Engine

Additional resources

- Google Earth Engine Beginner's Cookbook
- Managing Assets in Google Earth Engine
- ARSET - Remote Sensing for Mangroves in Support of the UN SDGs
- ARSET - Using Google Earth Engine for Land Monitoring Applications
- Cloud-Based Remote Sensing with Google Earth Engine: Fundamentals and Applications
- Mangrove Change Mapping

The Mangrove Science Team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Abigail Barenblitt


Cheryl Doughty Ph.D.


Adia Bey, Ph.D.


Anthony Campbell, Ph.D.

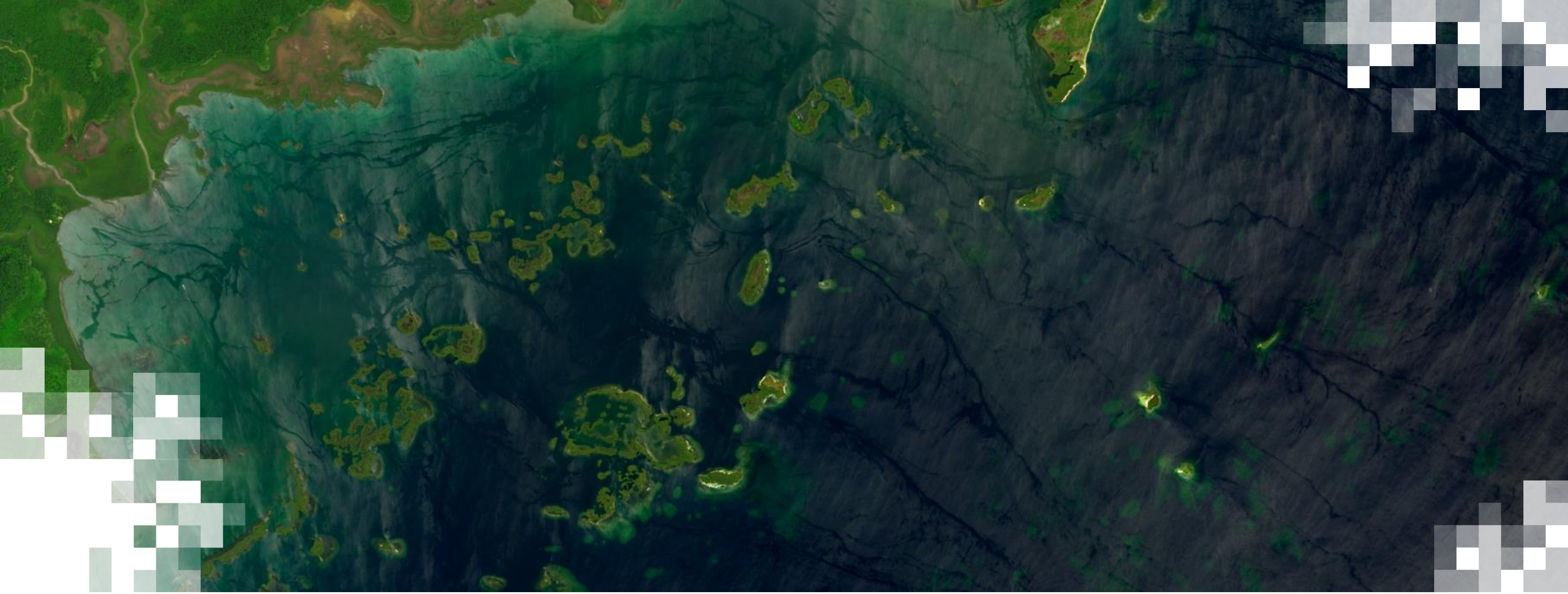

Liza Goldberg


David Lagomasino, Ph.D.


Nathan Thomas, Ph.D.

Outline

1. The need for mangrove-specific data
2. Key considerations for mapping ecosystems
3. Overview of existing mangrove datasets
4. Mapping mangrove ecosystems in Google Earth Engine
5. Understanding and using mangrove canopy height data
6. Estimating mangrove ecosystem carbon stock



The Need for Mangrove-specific Data

The Need for Mangrove-specific Data

Mangroves provide essential ecosystem services & underpin the livelihoods of 4.1 million people

Ecosystem services

- Nutrient Cycling
- Water Quality
- Fishery Support
- Flood Control
- Coastline Stabilization
- Carbon Sequestration
- Stabilization of coastlines reduces damage from hurricanes

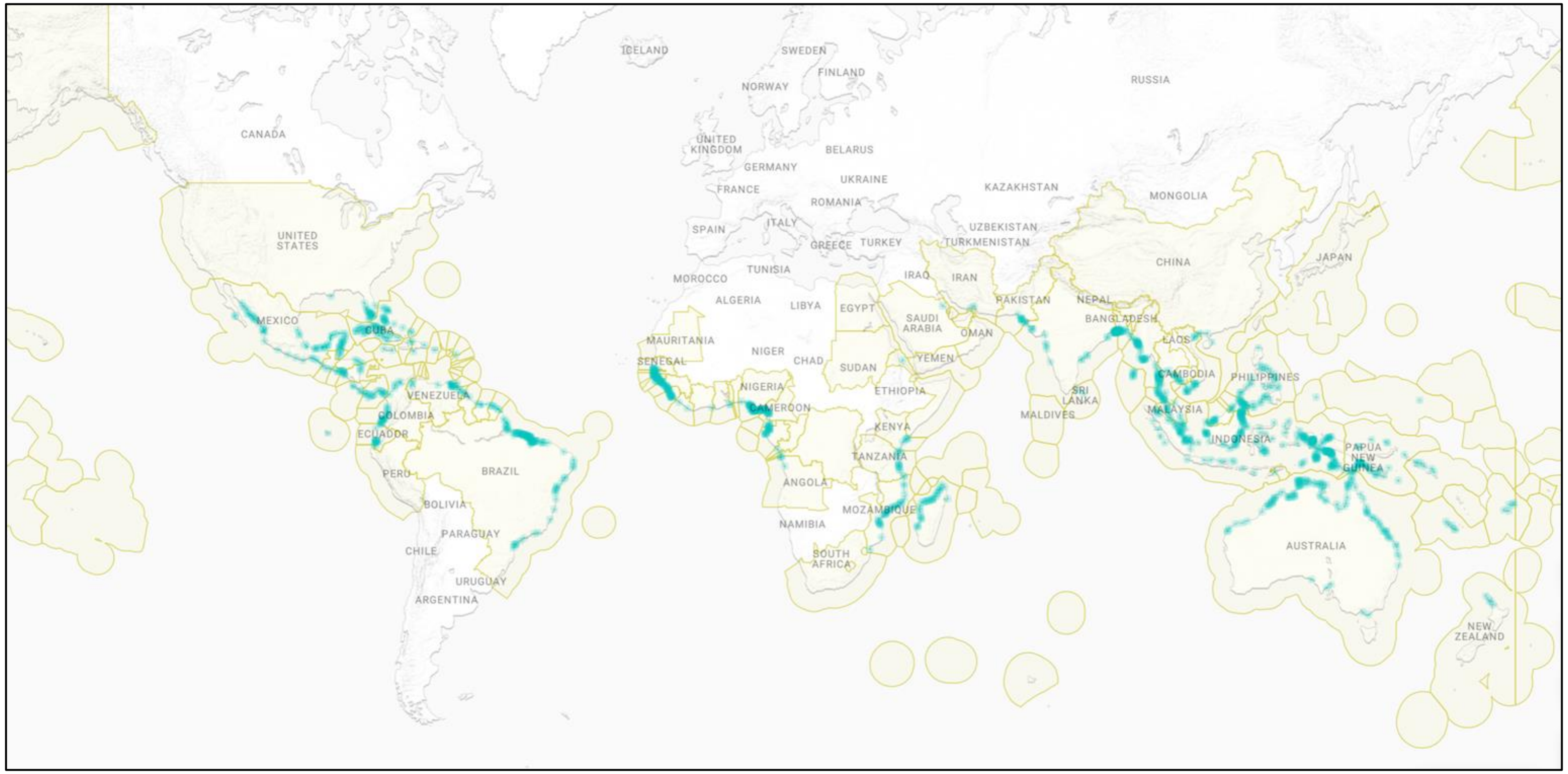
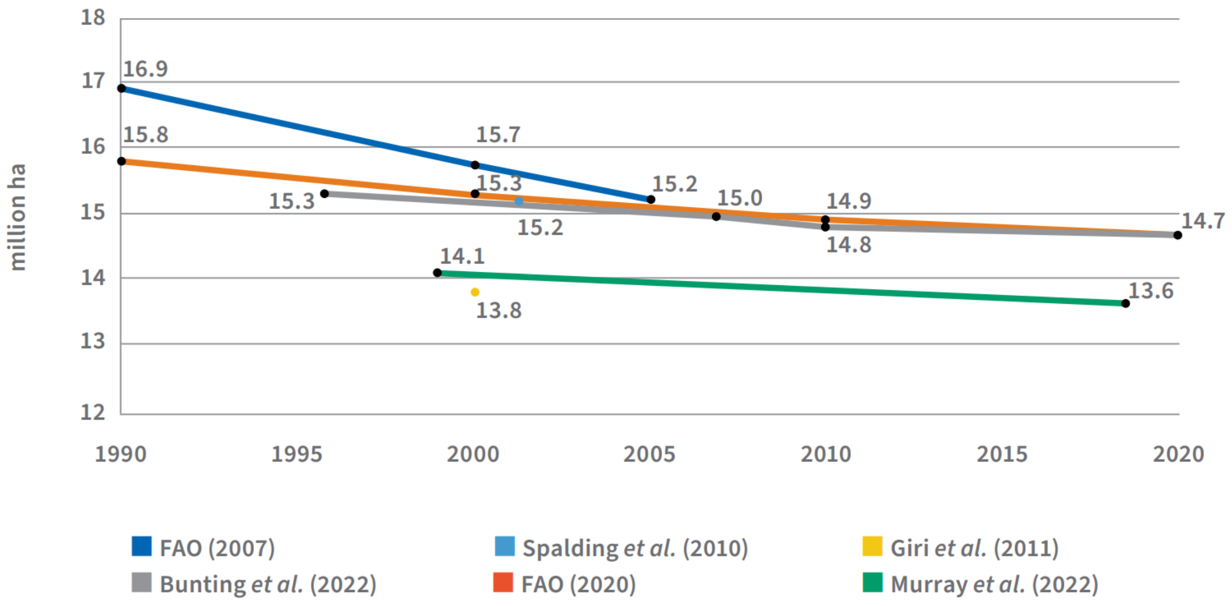


Image credit: Global Mangrove Watch

Key Considerations for Mapping Ecosystems

Around 2% of mangroves are lost per year. Half of mangrove ecosystems are threatened.



Global drivers of mangrove loss, 2000–2020 (FAO 2023)

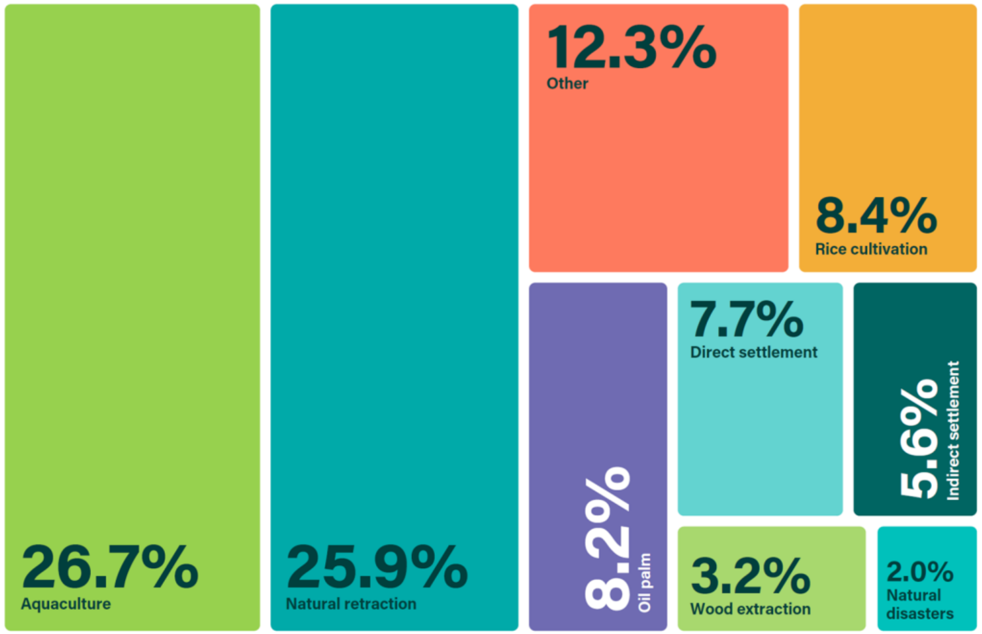


Image credits: Leal and Spalding (2024)

Addressing the Need for Mangrove-specific Data

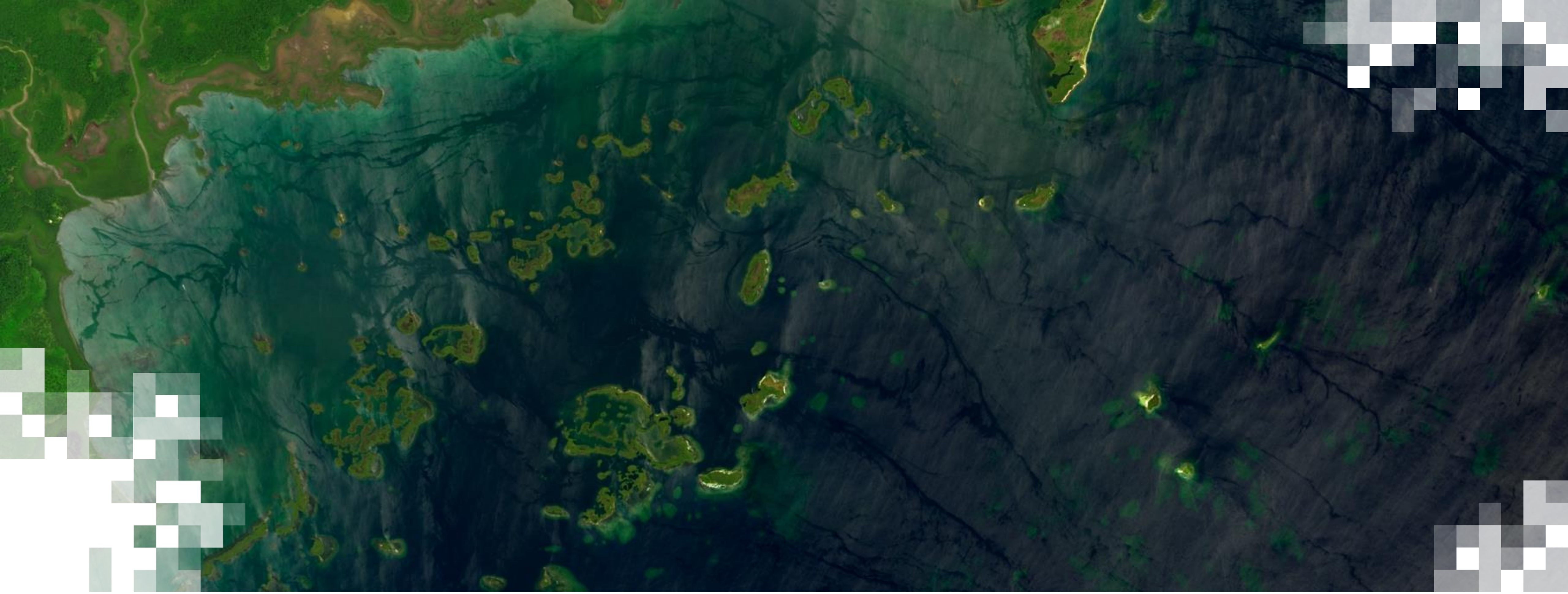
Several major international agreements support the conservation & restoration of mangroves

United Nations
Framework Convention on
Climate Change

Convention on
Biological Diversity

SUSTAINABLE
DEVELOPMENT
GOALS

Ramsar
Convention
on Wetlands



Key Considerations for Mapping Ecosystems

Key Considerations for Mapping Ecosystems

What are we mapping and why? How will maps and results be used?

What we can map with remote sensing data

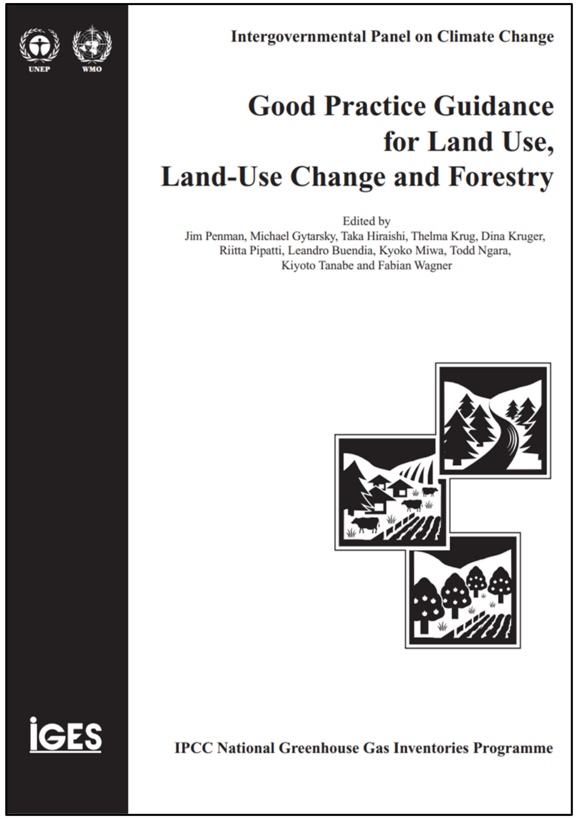
- **Extent** (current & historic)
- Condition (e.g. intact vs. degraded)
- **Height** & other traits
- Biomass
- Environmental drivers

Mapping objectives (examples)

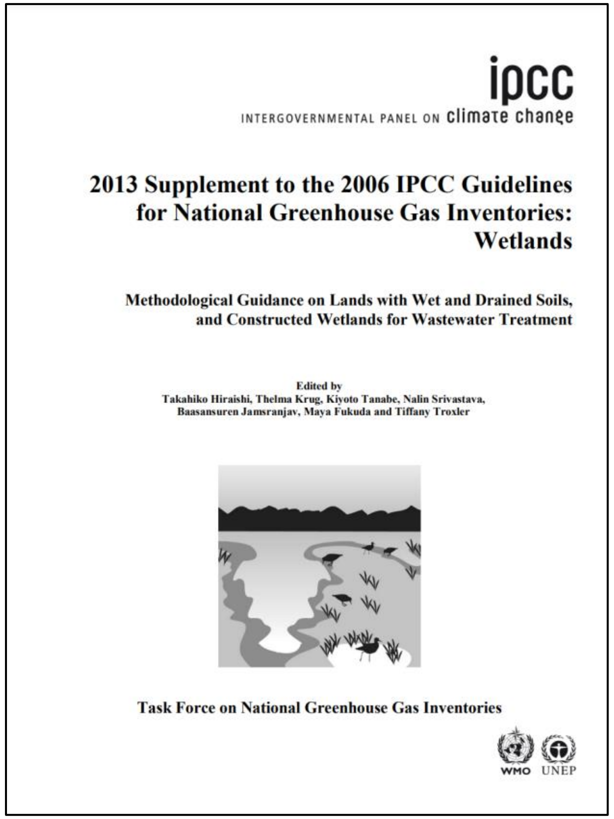
- Estimate carbon stocks
- Bolster climate change mitigation efforts
- Identify hotspots of mangrove loss
- Understand fauna and flora habitat changes
- Inform biodiversity conservation efforts
- Select sites for mangrove restoration
- Improve coastal land use planning
- Understand and mitigate risks due to extreme weather

Key considerations for mapping ecosystems

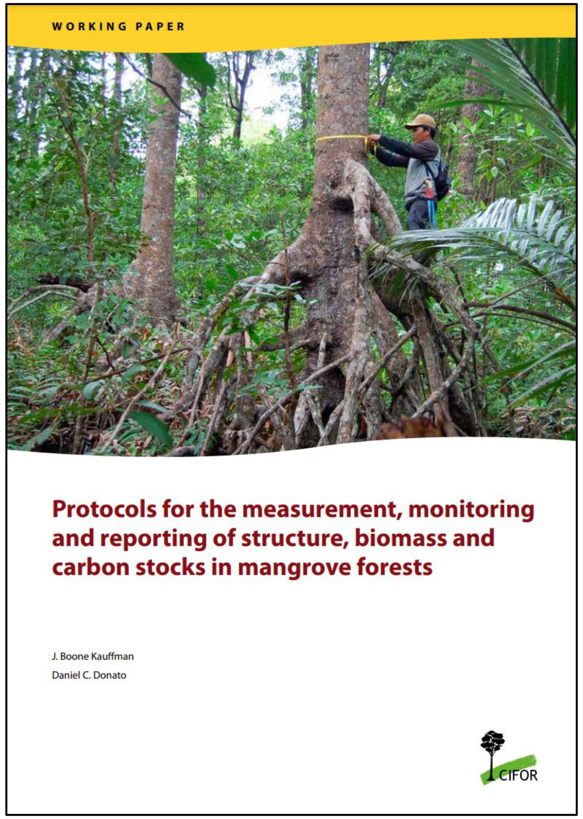
The mapping objective will impact the methods used



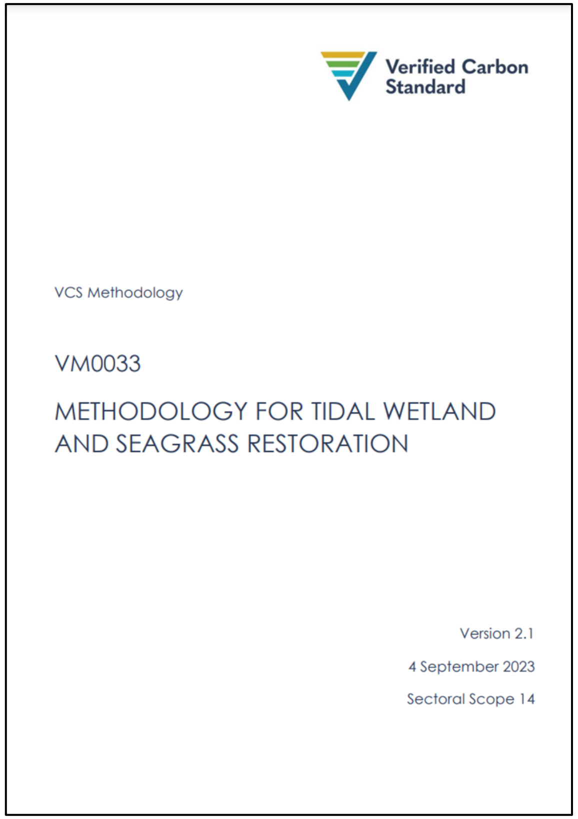
IPCC Good Practice Guidelines



IPCC Wetlands Supplement



CIFOR Mangrove Protocols



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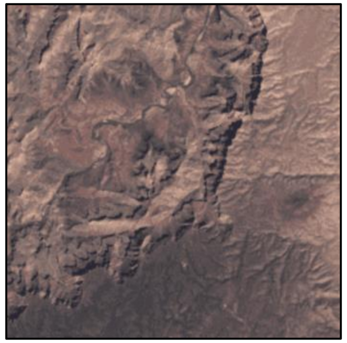
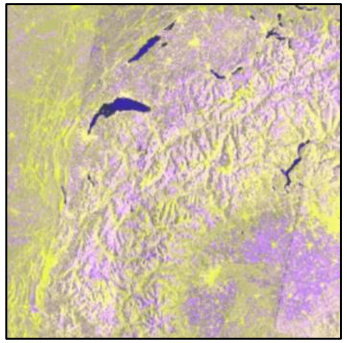
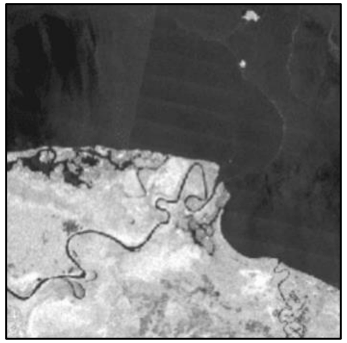
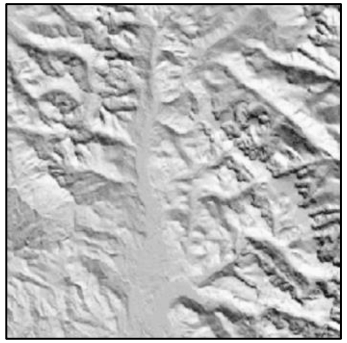
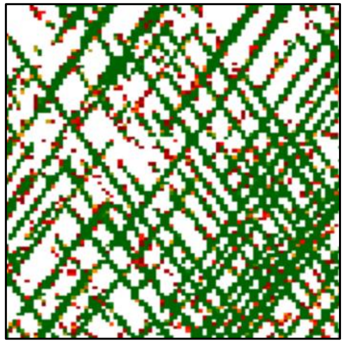
Key considerations for mapping ecosystems

The mapping objective will impact the input data selected
Consider spatial, spectral & temporal resolution

Landsat 8	Sentinel-2	WorldView	Sentinel-1	PALSAR	SRTM	GEDI LB4
						
Passive			Active			
Optical			Radar			LiDAR
USGS 30m 11 bands[1] 16 days	ESA 10m 13 bands[1] 5 days	Digital Globe 0.46m 8 bands 1.1 days	ESA 10, 25, 0r 40m 5 bands 12 days	JAXA 25m 4 bands 14 days	NASA 90m 1 band	NASA 1000m 10 bands* 5 years *

Key resource: ARSET - Fundamentals of Remote Sensing

Image credits: Google Earth Engine

Key considerations for mapping ecosystems

The mapping objective may impact the "tier" of data required

Excerpts from IPCC (2003) Good Practice Guidance for LULUCF, Ch. 3

Tier 1 Use of default / Global data	Methodologies usually use activity data that are spatially coarse, such as nationally or globally available estimates.
Tier 2 Use of country-specific data	Tier 2 applies emission factors and activity data which are defined by the country; Higher resolution activity data are typically used
Tier 3 Use of advanced methods and detailed country-specific data	Tier 3 – including models and inventory measurement systems tailored to address national circumstances, repeated over time, and driven by high resolution activity data and disaggregated at sub-national to fine grid scales.

Key considerations for mapping ecosystems

The mapping objective may impact the "tier" of data required

Tier 1
Use of default / Global data

Tier 2
Use of country-specific data

Tier 3
Use of advanced methods and detailed country-specific data

Mean and range values of soil organic carbon stocks (to 1 m depth) for mangrove, tidal marsh, and seagrass ecosystems and CO2 equivalents.

Ecosystems	Carbon Stock Mg/ha	Range Mg/ha	CO_2 Mequiv/ha
Mangrove	386	55 – 1376	1415
Tidal Salt marsh	255	16 – 623	935
Seagrass	108	10 – 829	396

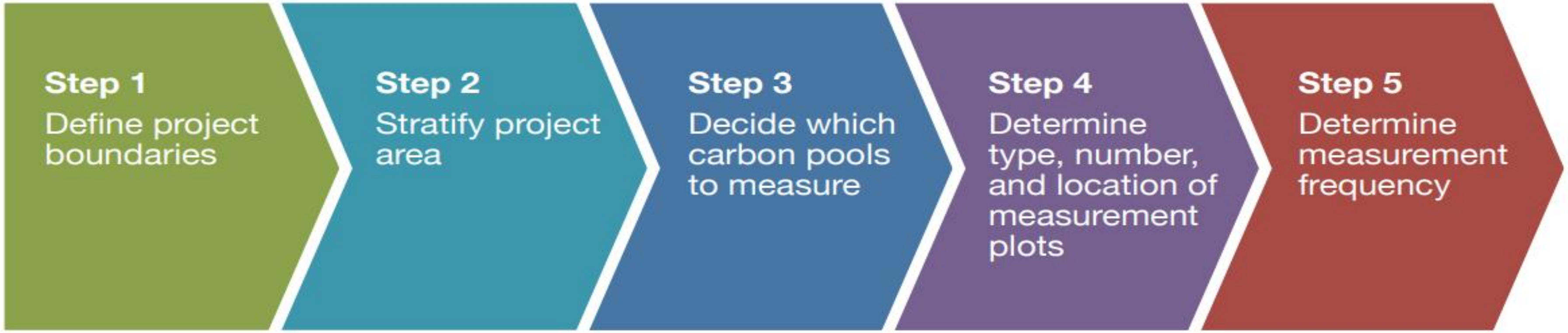
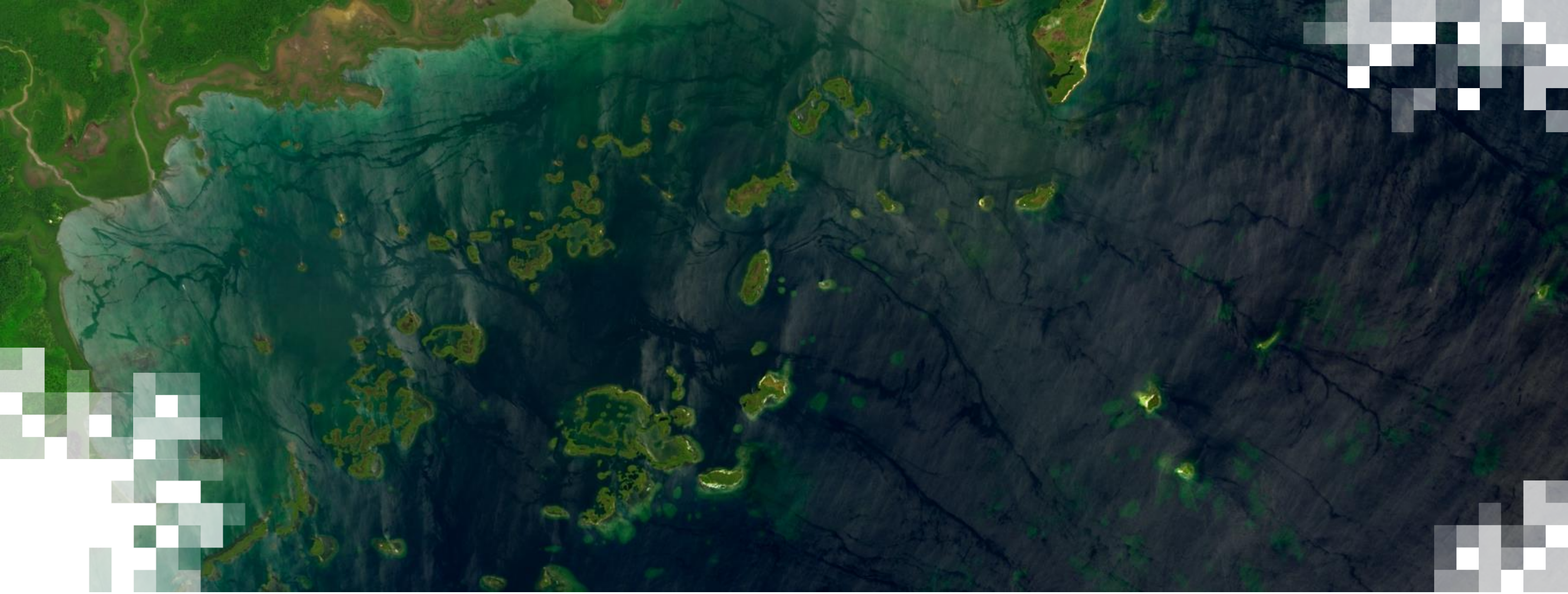


Image credits: The Blue Carbon Initiative & IPCC 2013



Overview of Existing Mangrove Datasets

Overview of Existing Mangrove Datasets

Data on mangrove extent, height, biomass and carbon stocks are readily available

- Mangrove Science Lab (MSL) Google Earth Engine Apps

- Advantages
  - Access results without coding
  - Download only the data needed
  - Quickly process information to inform decision-making and management

- Disadvantages
  - Accuracy is often unknown for user's specific region of interest (ROI)
  - Calibration data might not be representative of ROI
  - Little or no control over processing parameters, methods, and dates

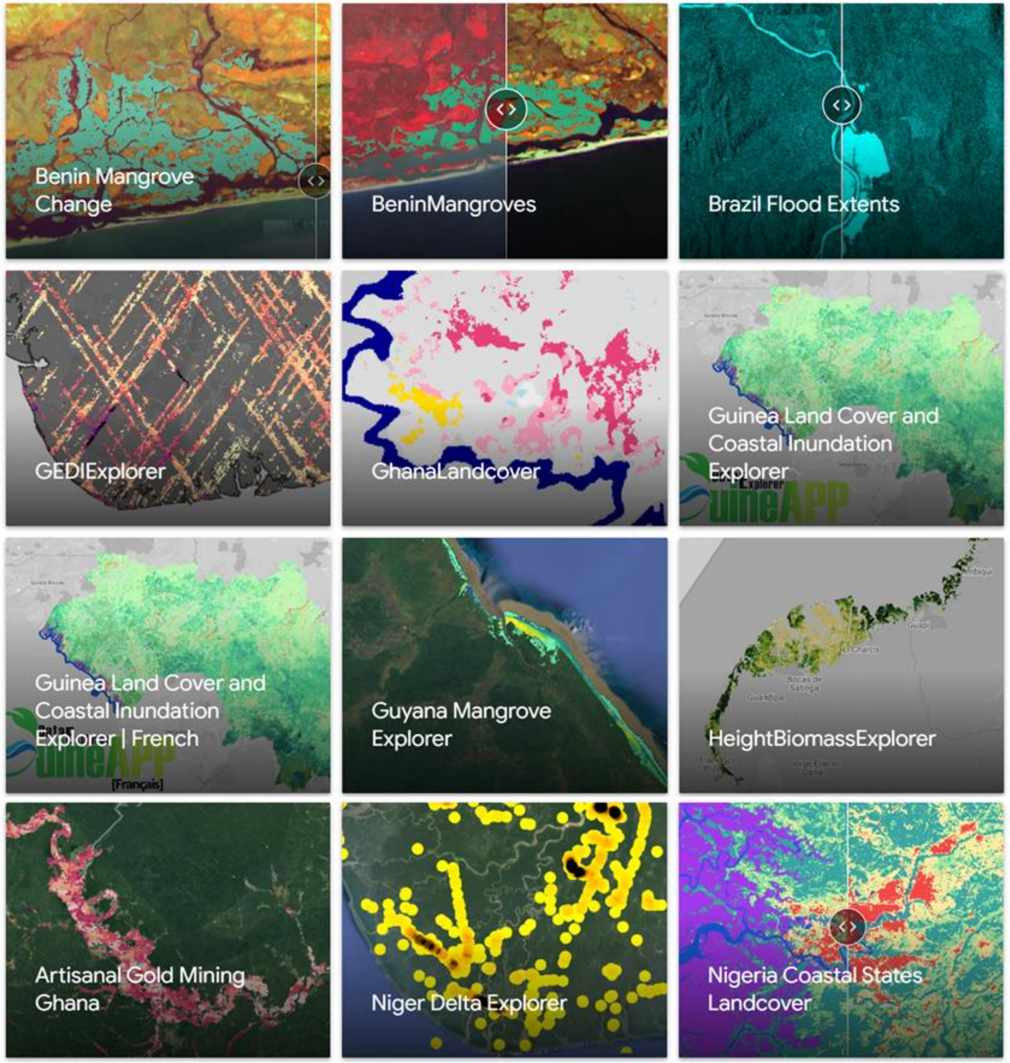
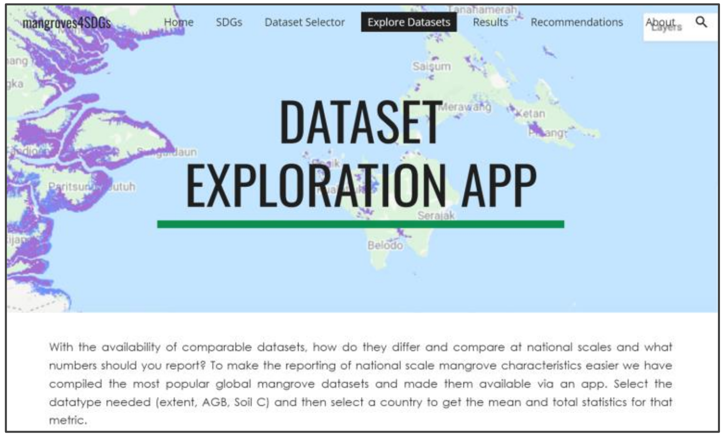


Image credit: Mangrove Science Team

Overview of existing mangrove datasets

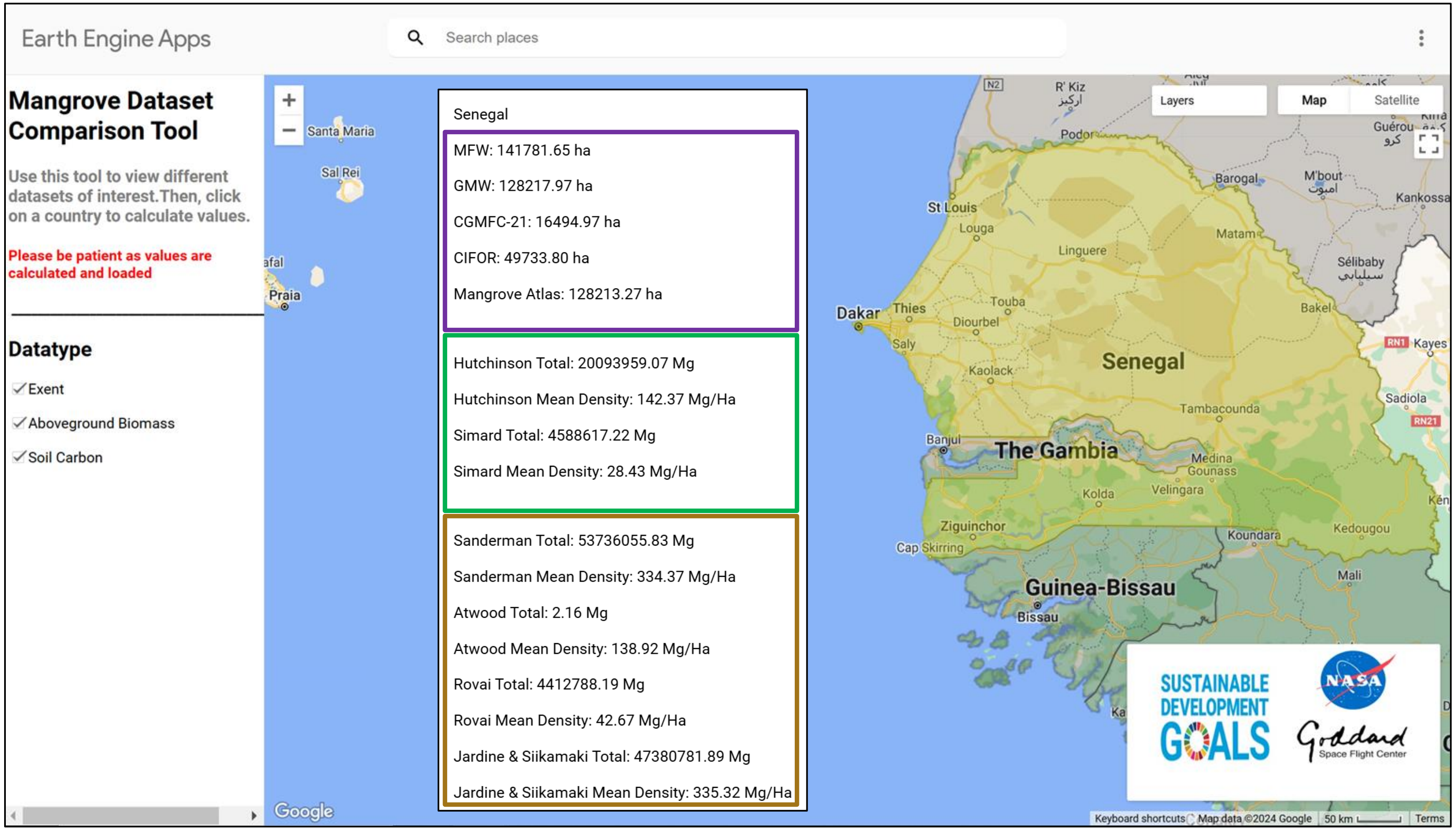
Different methods = similar, but different results. Which works best in your area of interest?



Link to app

Click on country for data overview

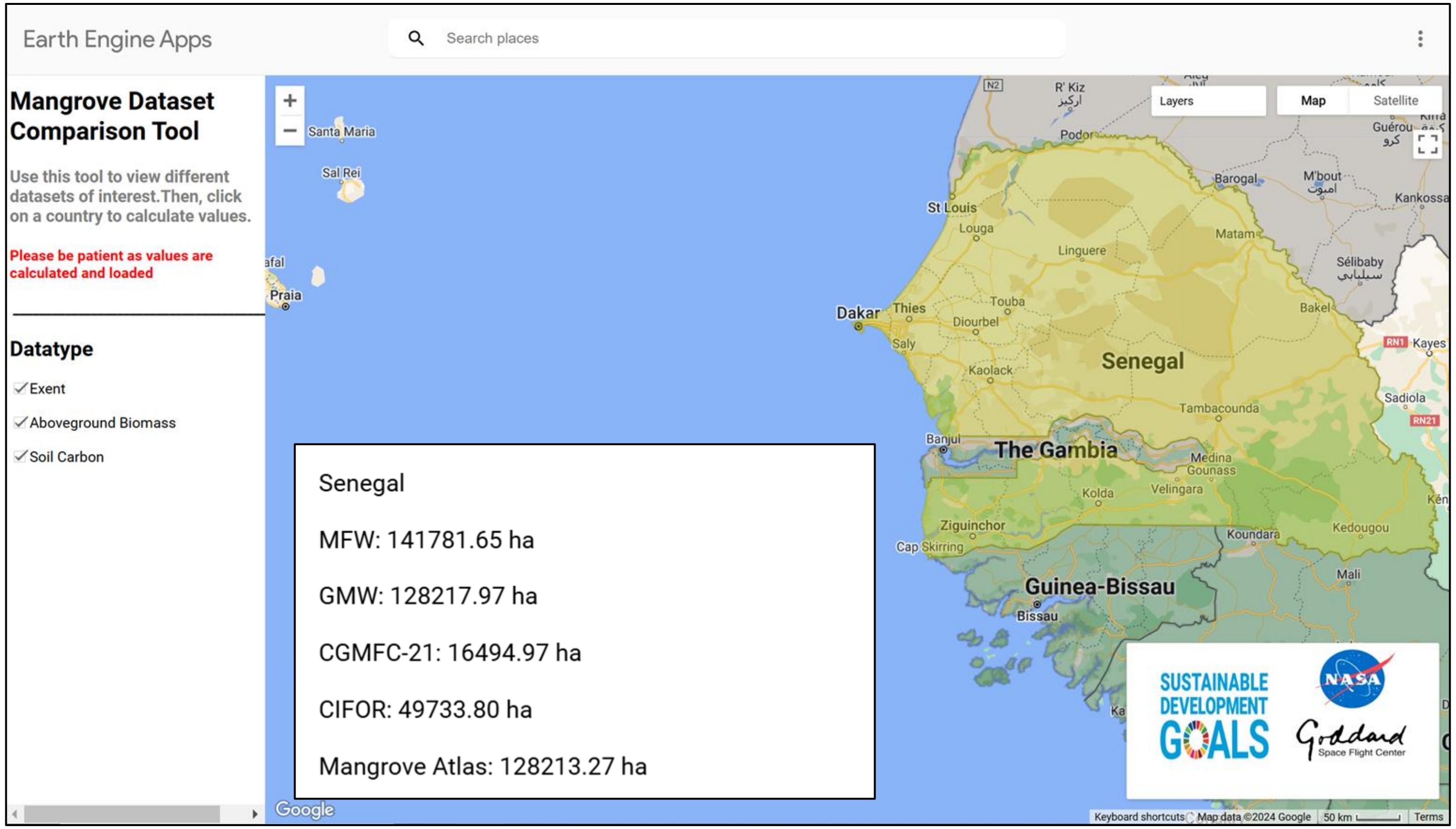
- Extent (5 datasets)
- AGB (2 datasets)
- Soil C (4 datasets)



Overview of existing mangrove datasets

Mangrove extent

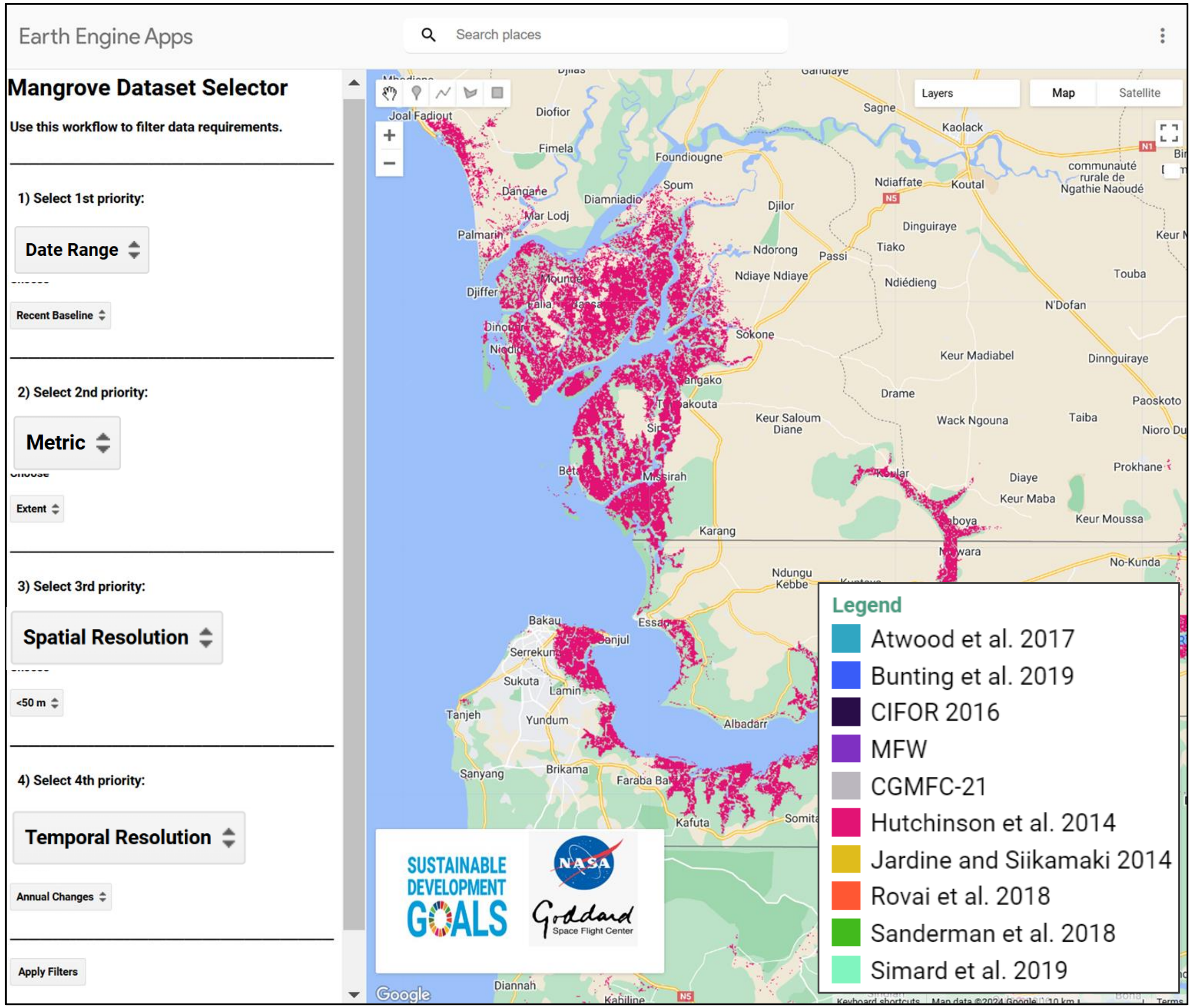
- Mangrove Forests of the World
  MFW, [Giri et al. 2010]
- Global Mangrove Watch
  GMW, [Bunting et al. 2022]
- Continuous Global Mangrove Forest Cover for the 21st Century
  GCMFC-21, [Hamilton and Casey 2016]
- Global Wetlands Distribution
  [CIFOR]
- Mangrove Atlas
  [Spalding et al. 2010]



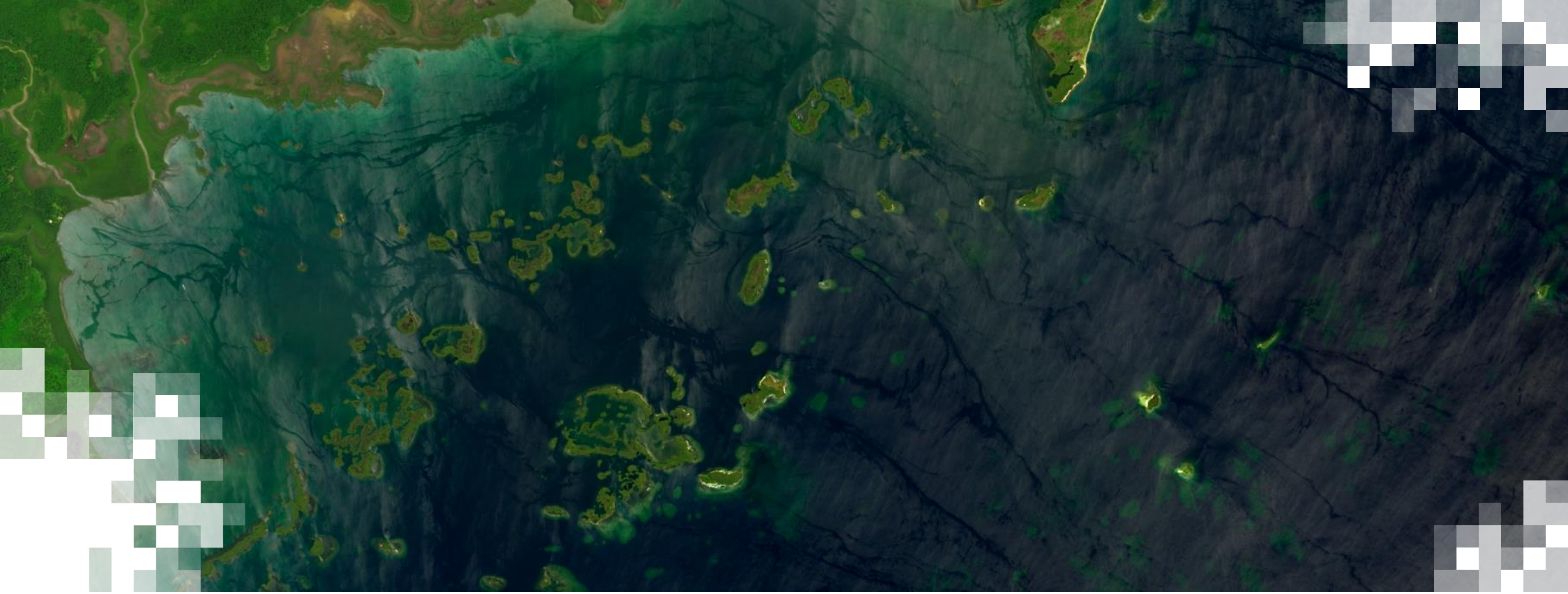
Overview of existing mangrove datasets

Criteria for choosing a dataset

- Date range
  - Multi-decadal
  - Decadal
  - Recent baseline
- Metric
  - Extent
  - Soil carbon
  - Aboveground biomass
- Spatial resolution
  - <50m
  - >50m
  - National
- Temporal resolution
  - No changes
  - Annual
  - Decadal
- Accuracy in your priority metric(s) & area of interest
  - Extent
  - Change
  - Height
  - Carbon stocks



Link to app

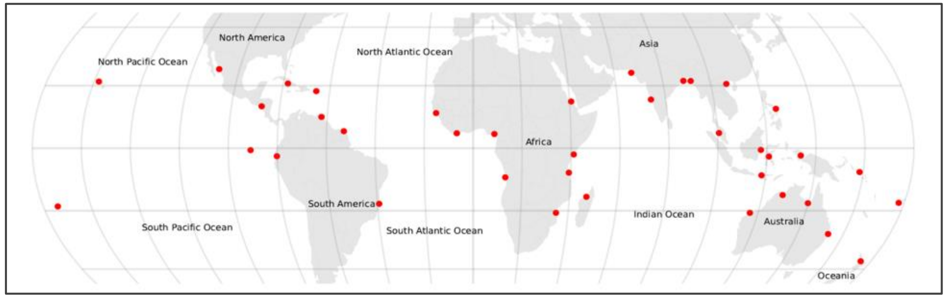


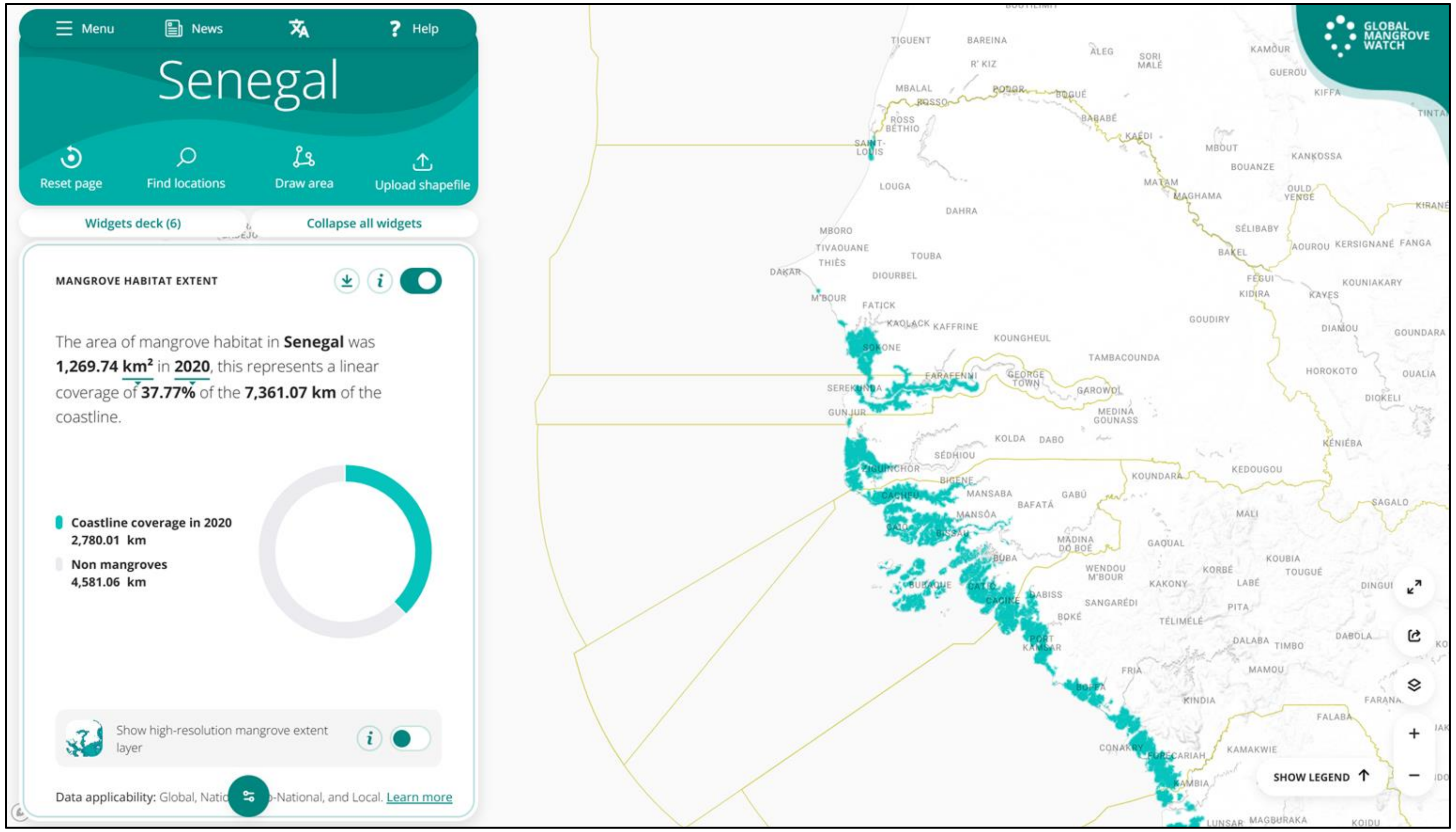
Mangrove Extent with Global Mangrove Watch

Mangrove extent with Global Mangrove Watch

High spatial resolution, temporal resolution, and extent accuracy with global validation data

Version 3: 1996-2020	Version 4 2020
L-band SAR	Sentinel-2
25m	10m
Extent accuracy: 86.2-88.6%	Extent accuracy: 95.3%
Change accuracy: 58.1%-60.6%	



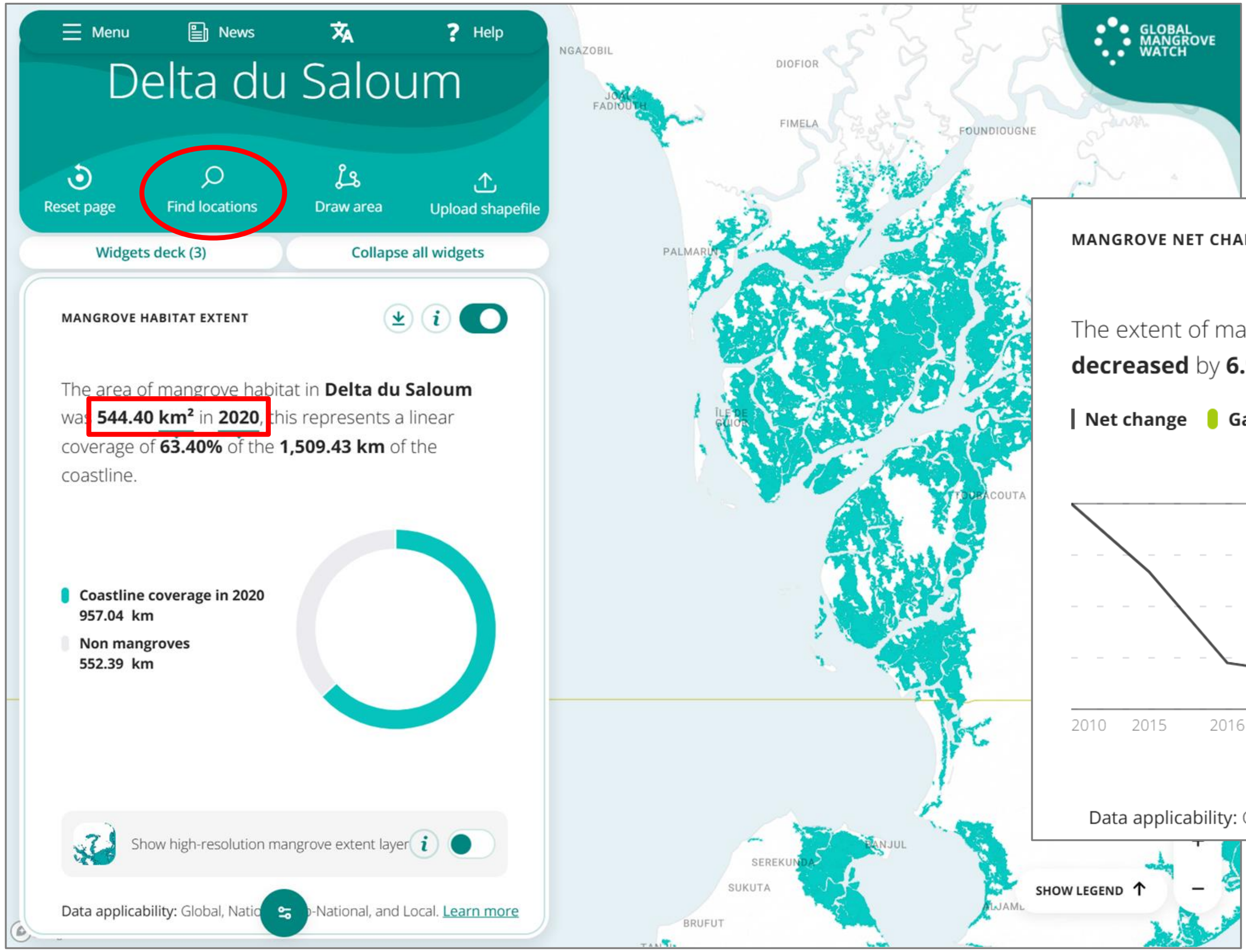


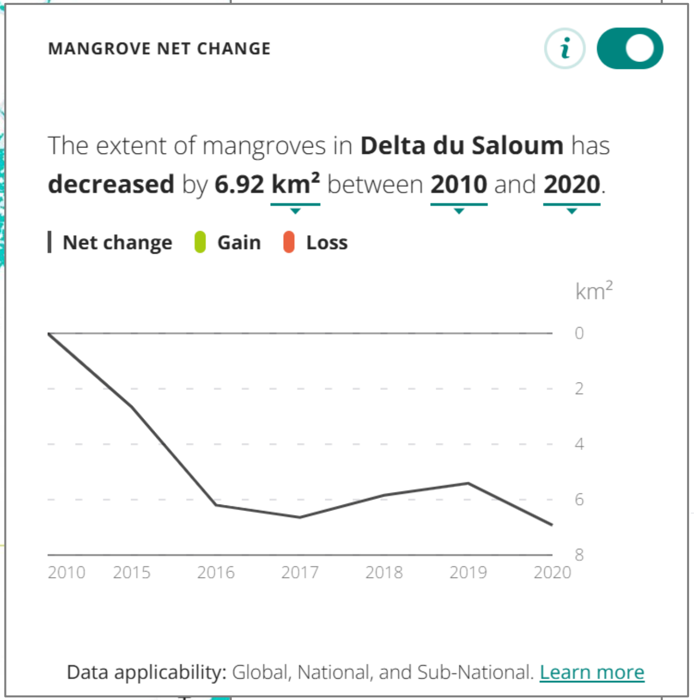
Link to app

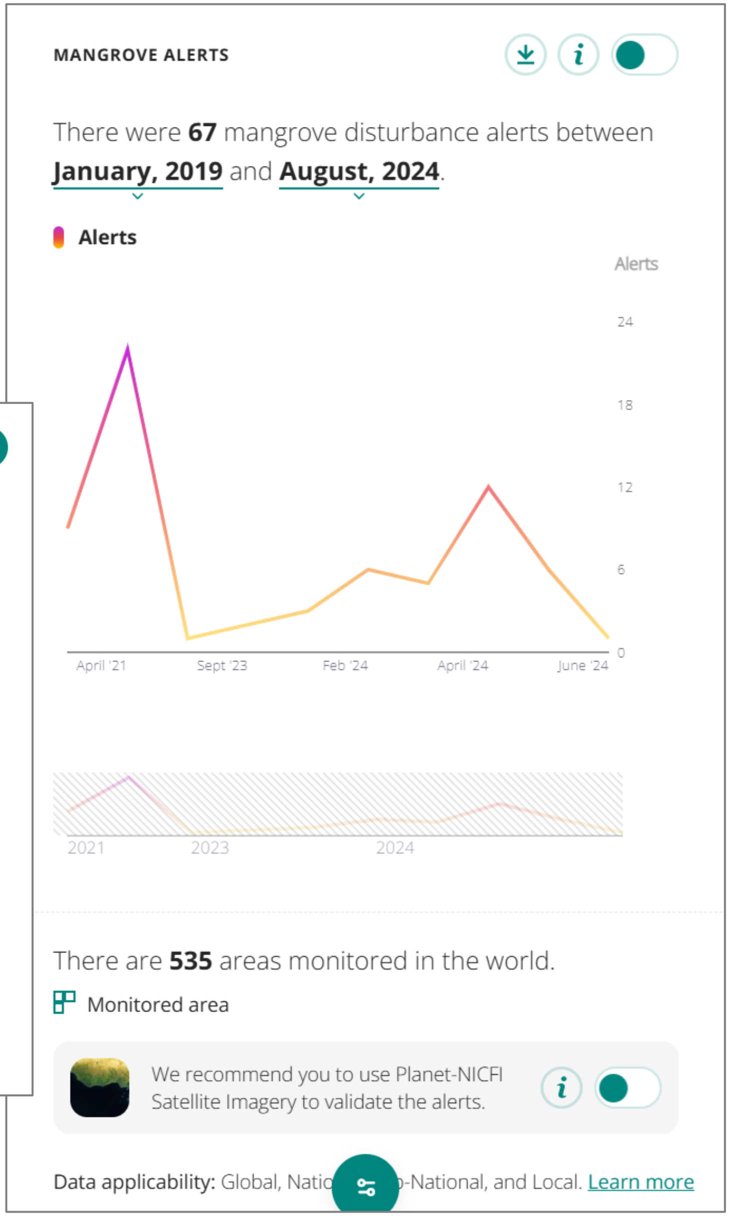
Mangrove extent with Global Mangrove Watch

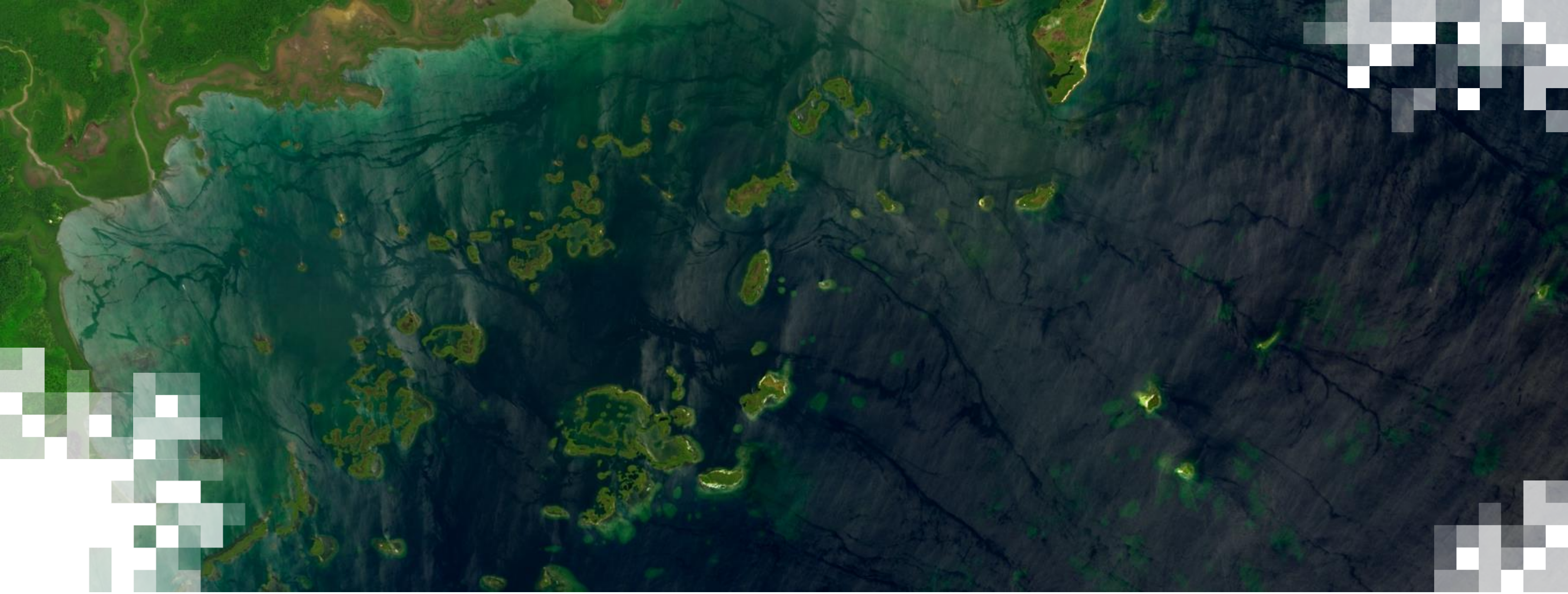
Delta du Saloum, Senegal

Link to app







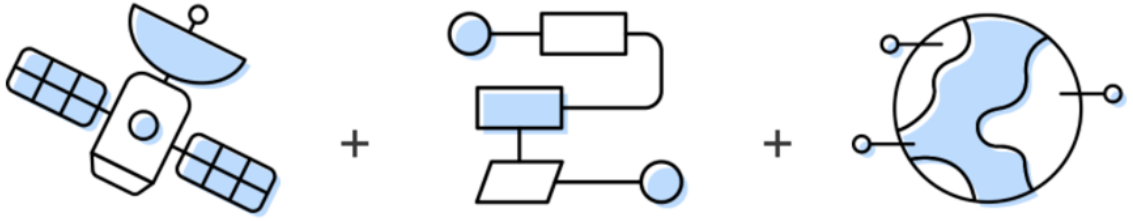


Mapping with Google Earth Engine

Mapping with Google Earth Engine

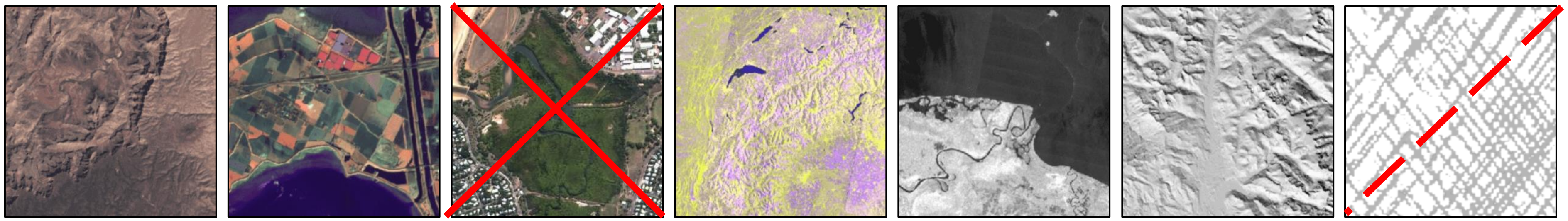
Meet Earth Engine

Google Earth Engine combines a multi-petabyte catalog of satellite imagery and geospatial datasets with planetary-scale analysis capabilities and makes it available for scientists, researchers, and developers to detect changes, map trends, and quantify differences on Earth's surface.



Satellite Imagery + Your Algorithms + Real World Applications

Landsat 8 | Sentinel-2 | WorldView | Sentinel-1 | PALSAR | SRTM | GEDI LB4

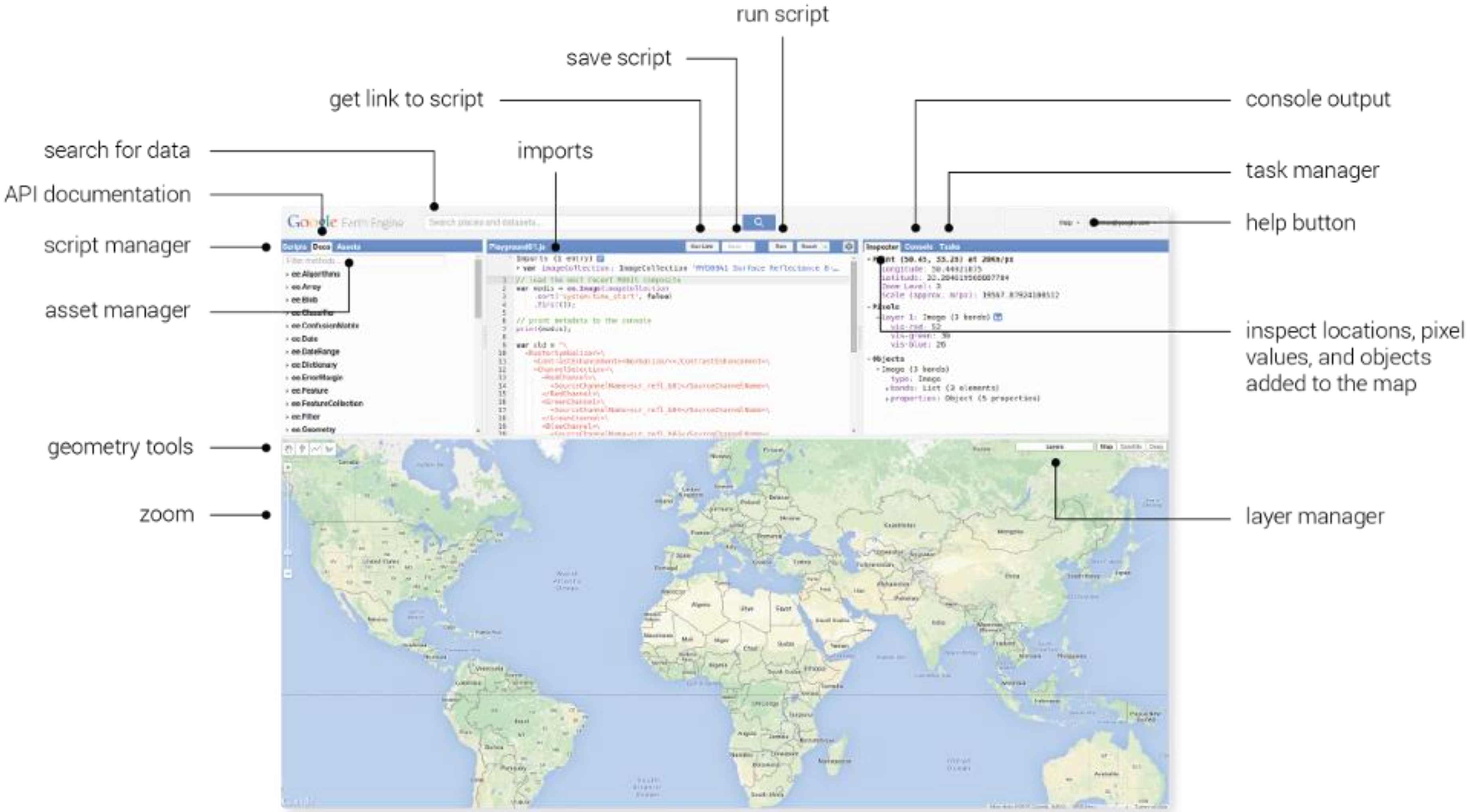


Google Earth Engine

Mapping with Google Earth Engine

Key resources

- Getting Started with Google Earth Engine Video Tutorial
- Introduction to JavaScript for Earth Engine
- ARSET - Using Google Earth Engine for Land Monitoring Applications

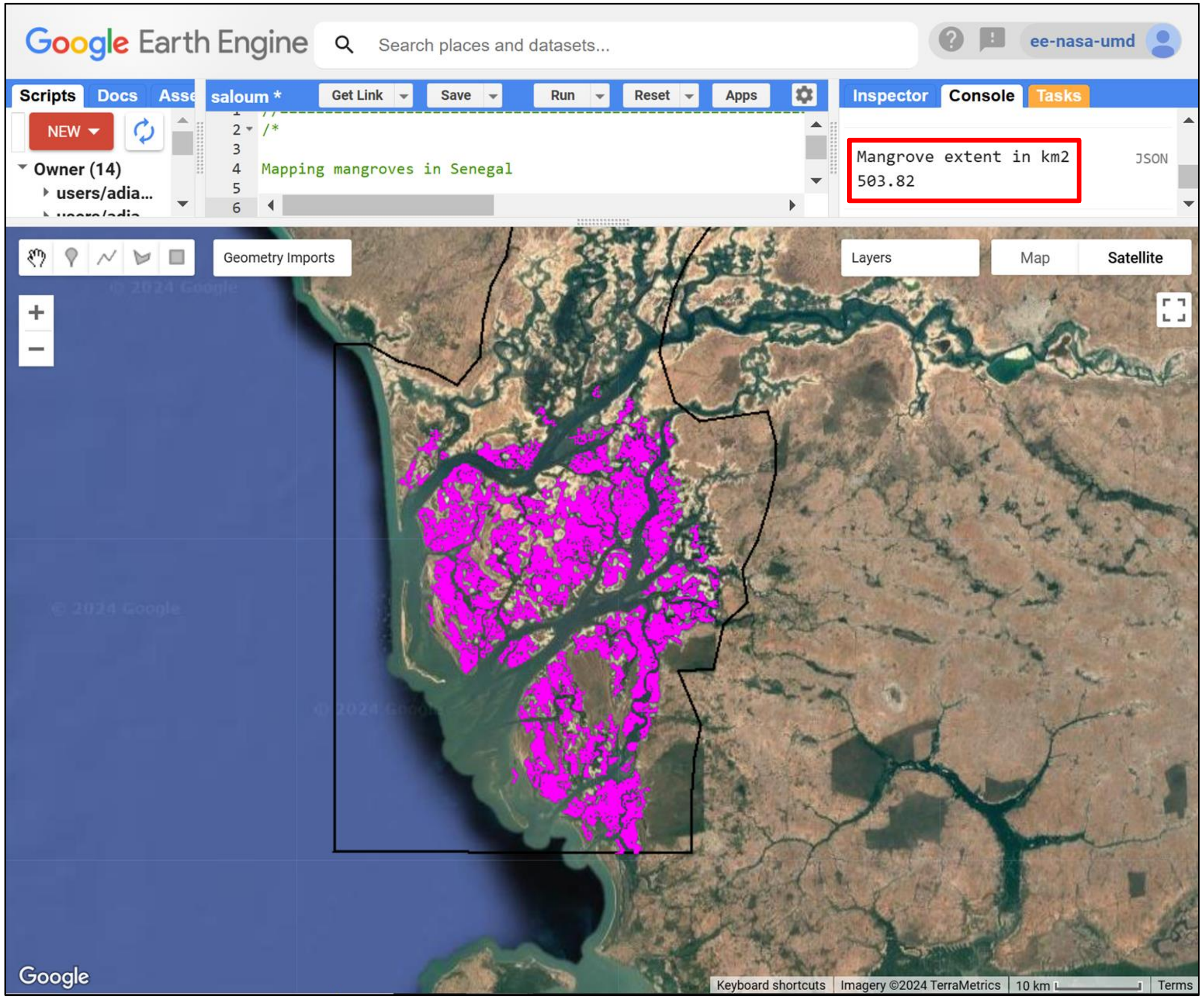


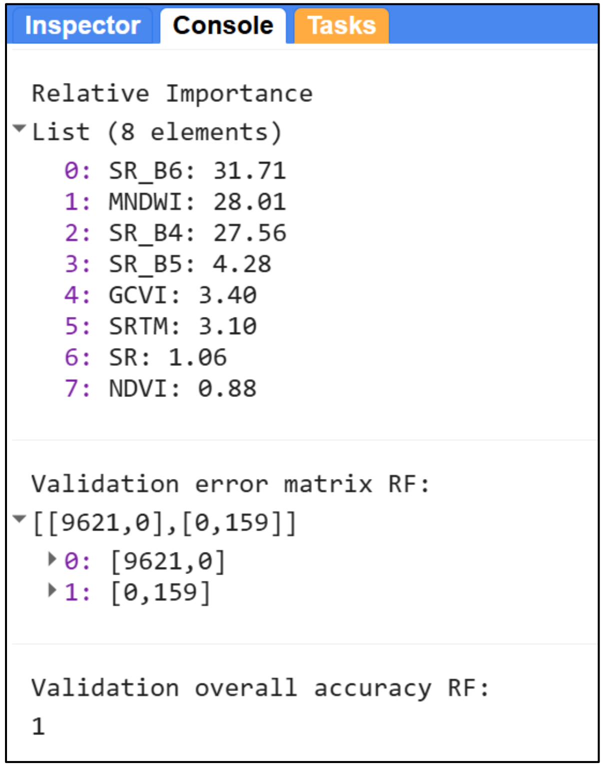
Google Earth Engine

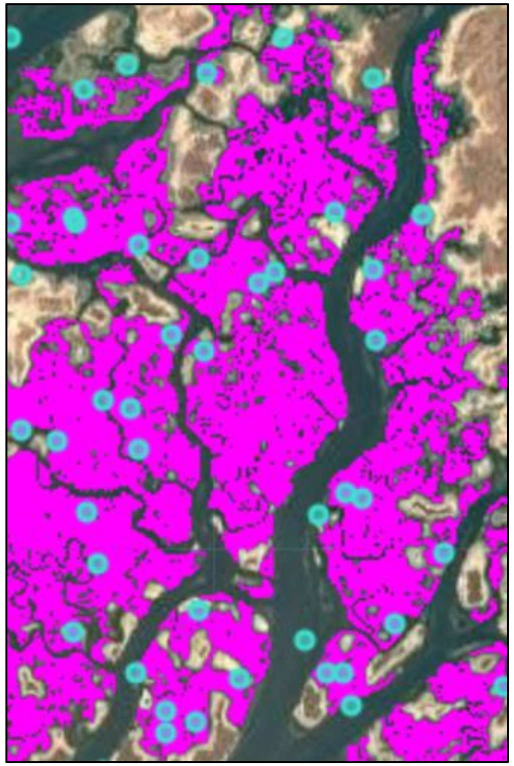
Mapping extent with Google Earth Engine

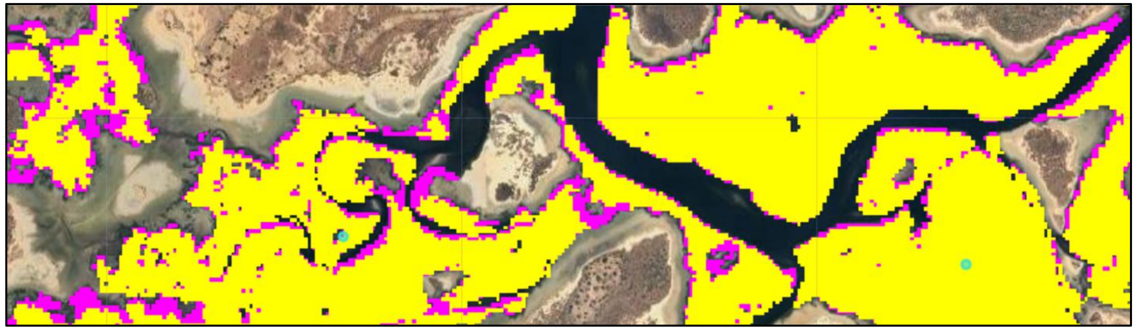
Delta du Saloum, Senegal

Link to script



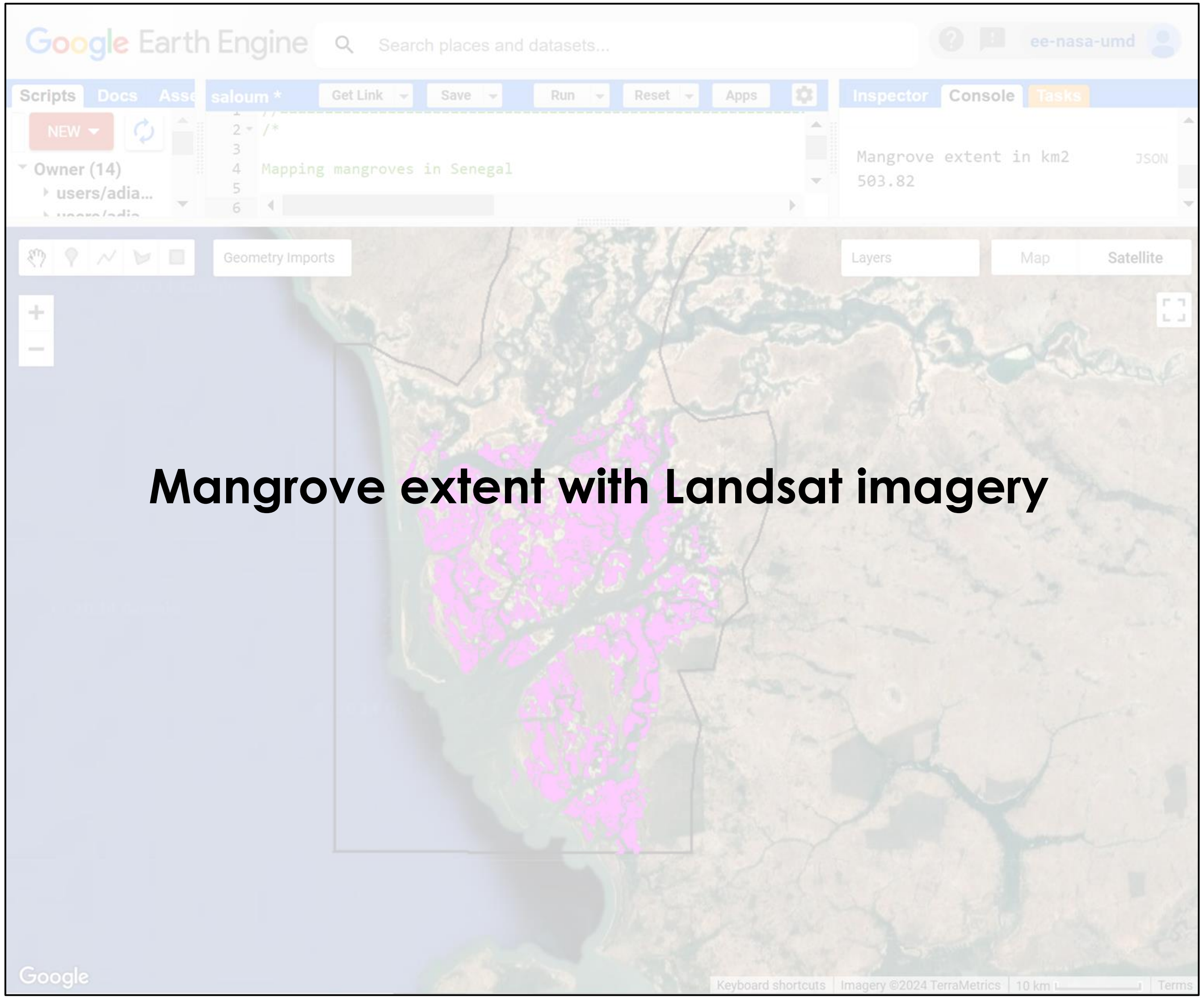


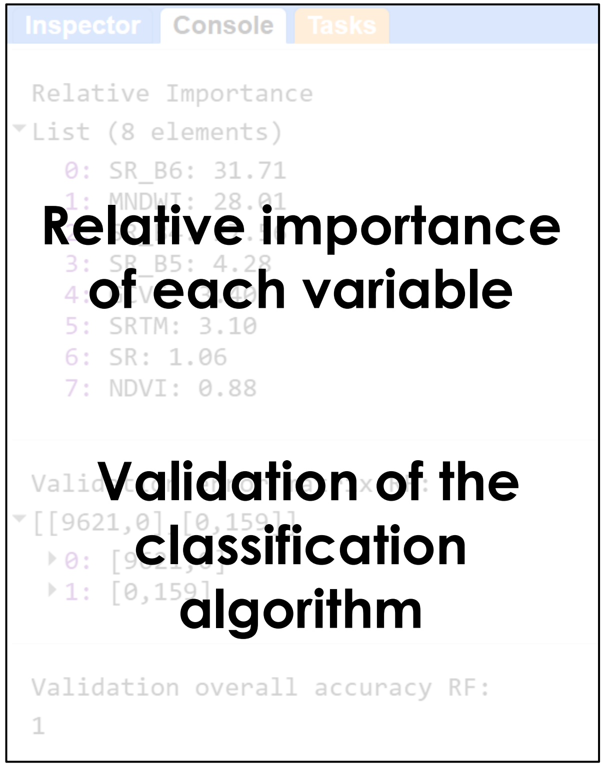


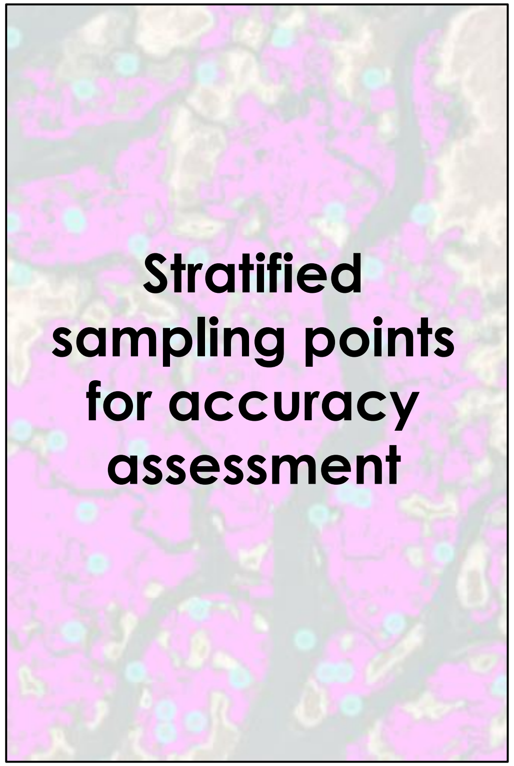


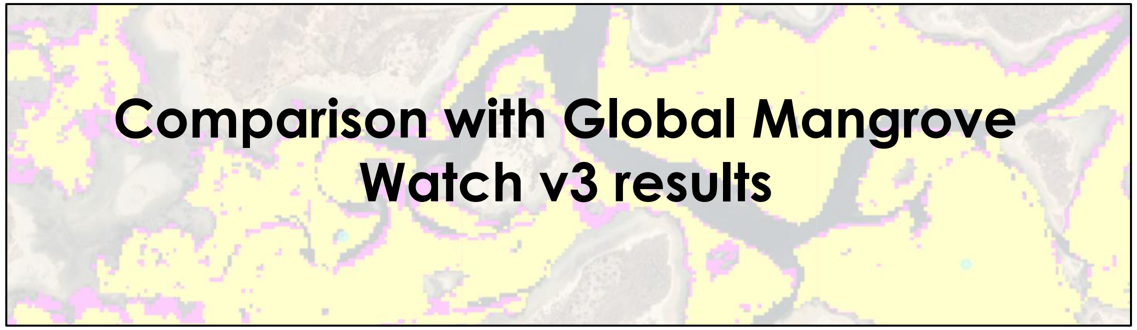
Mapping extent with Google Earth Engine

Delta du Saloum, Senegal









Mapping extent with Google Earth Engine

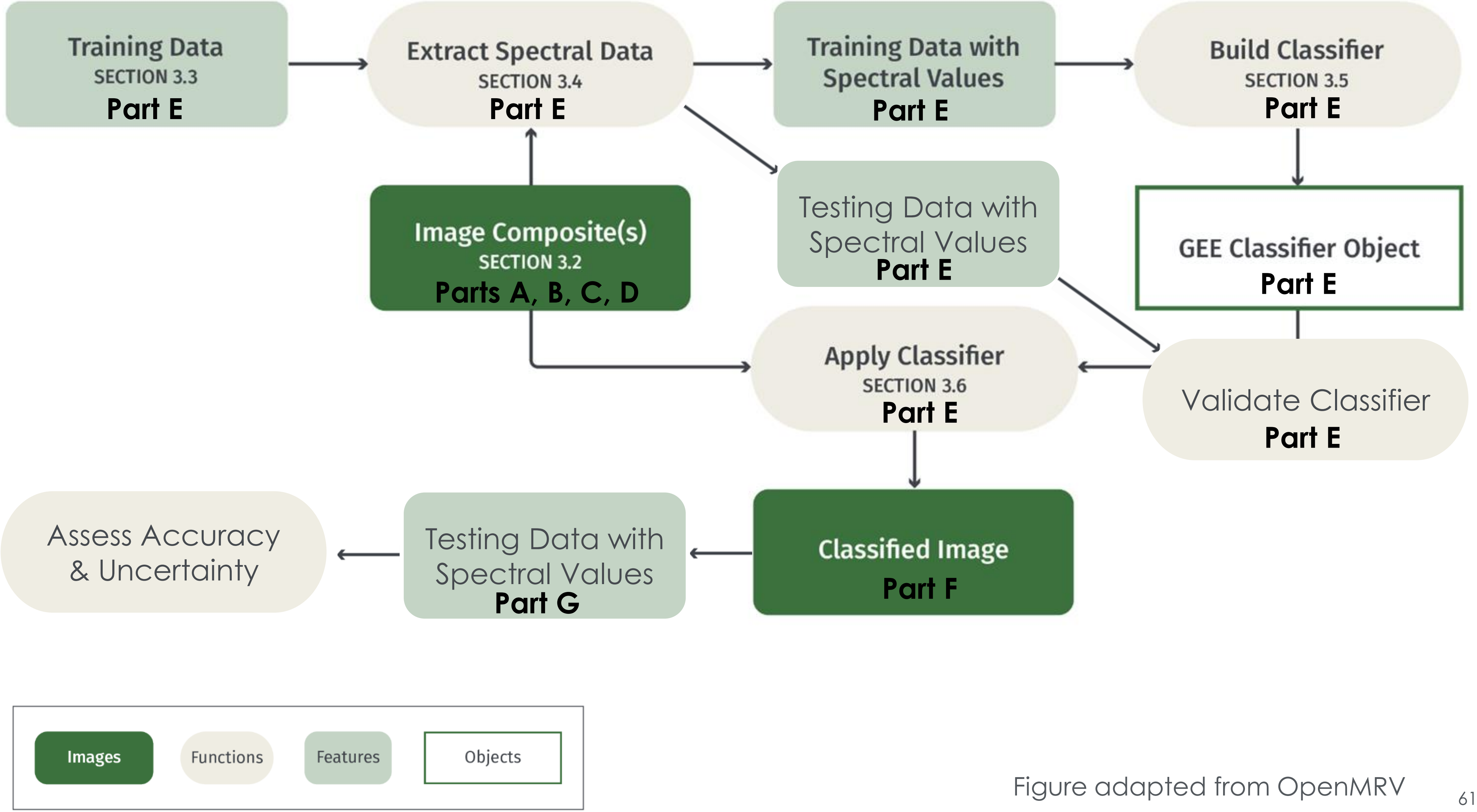


Figure adapted from OpenMRV

Mapping extent with Google Earth Engine

```
//==========================================================================================
ee.String('Part A: Define your area of interest & set up the map')

//==========================================================================================
ee.String('Part B: Choose the start and end dates of your compositing period')

//==========================================================================================
ee.String('Part C: Prepare your input imagery - Landsat')

//==========================================================================================
ee.String('Part D: Add elevation data');

//==========================================================================================
ee.String('Part E: Prepare training and testing data, and run a RandomForests classification algorithm')

//==========================================================================================
ee.String('Part F: Compare your mangrove extent to Global Mangrove Watch results');

//==========================================================================================
ee.String('Part G: Generate sampling point to conduct an accuracy assessment');

//==========================================================================================//
ee.String('Part H: Export layers of interest to Google Drive');
```

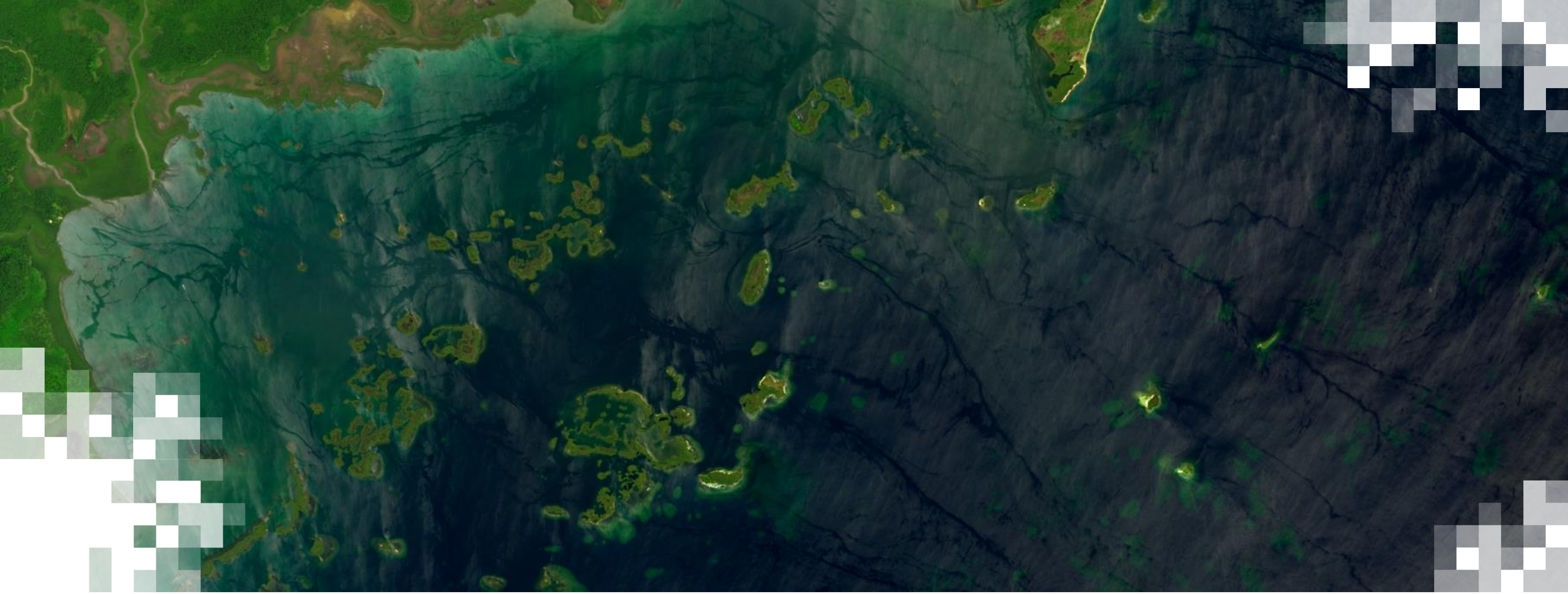
Mangrove extent with Landsat imagery

Classification, validation, comparison

Stratified sampling points

Key resources for mapping mangrove dynamics

- ARSET - Remote Sensing for Mangroves in Support of the UN Sustainable Development Goals
- Mangrove Change Mapping
- Map Accuracy Assessment and Area Estimation



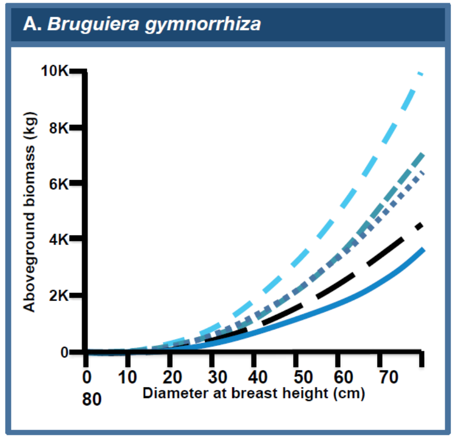
Mapping mangrove height, structure, biomass and carbon stock

Toward a Tier 2 estimate of mangrove ecosystem carbon stock

Factors that influence aboveground biomass

- Vegetation height & structure
- Vegetation condition
- Tree species diversity, composition & abundance
- Tree density
- Basal area
- Salinity
- Age

Comparison of tree biomass estimates for *Burguiera gymnorrhiza*



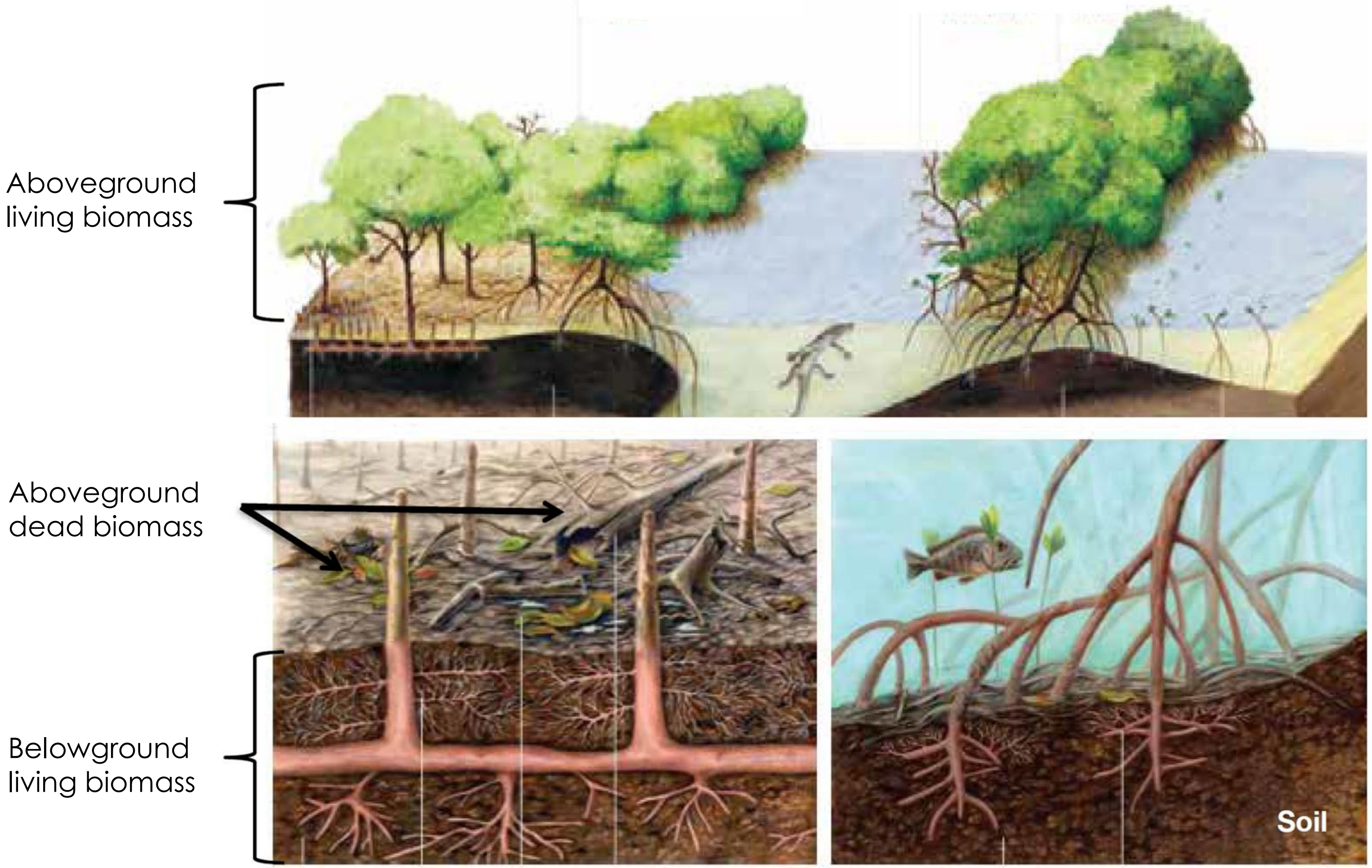
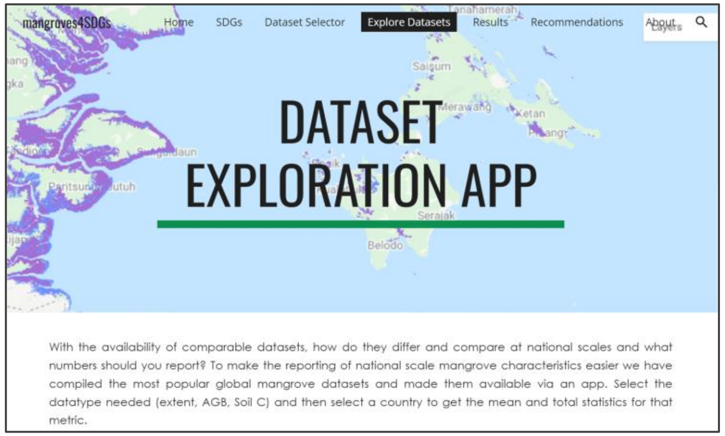


Image credits: The Blue Carbon Initiative

Overview of existing mangrove datasets

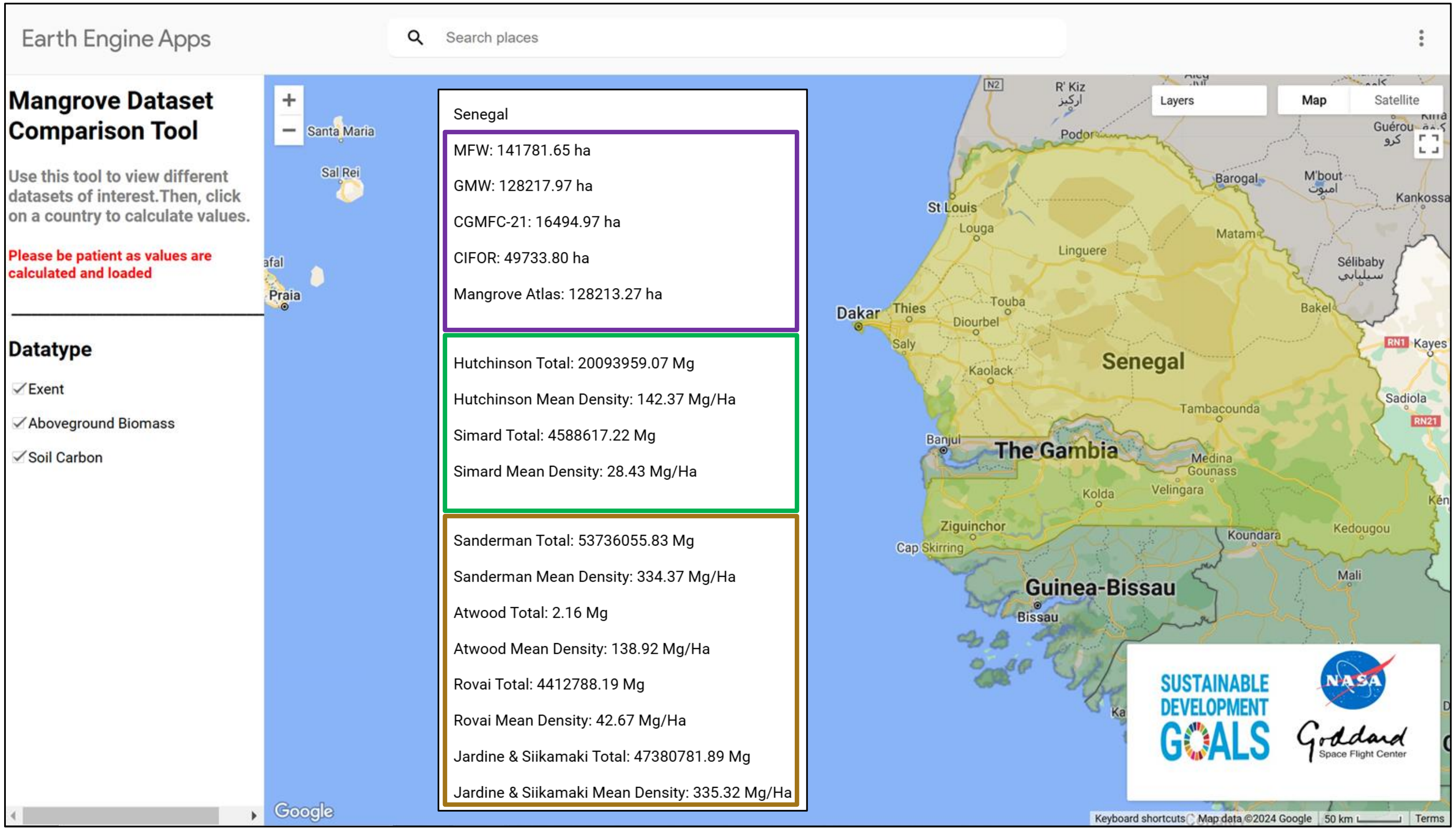
Different methods = similar, but different results. Which works best in your area of interest?



Link to app

Click on country for data overview

- Extent (5 datasets)
- AGB (2 datasets)
- Soil C (4 datasets)



Overview of existing mangrove datasets: Aboveground biomass

Mangrove aboveground biomass

- Hutchison et al. 2014

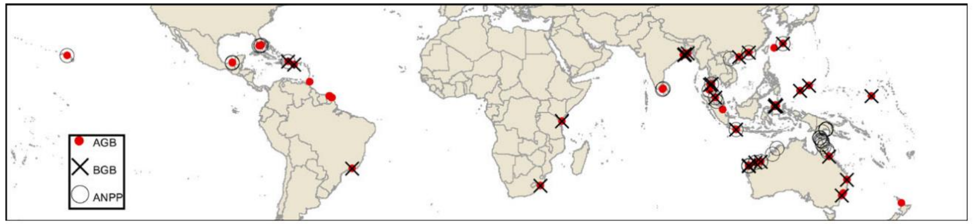
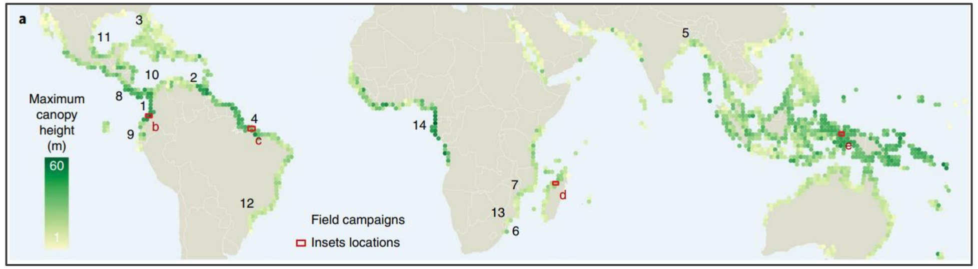
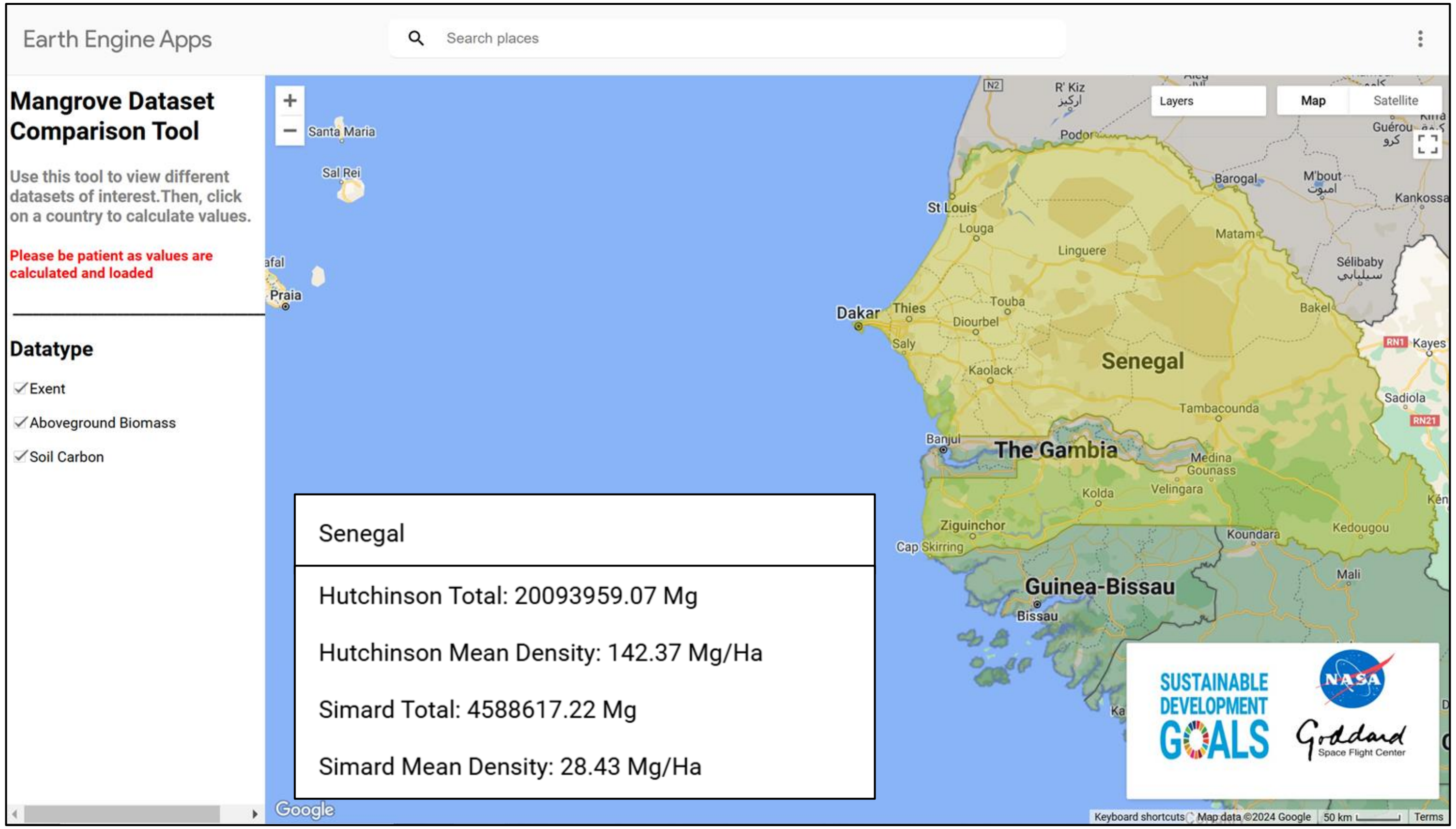


Figure 1 Global map of mangroves showing the locations where data were obtained for one or more measures of carbon stocks and fluxes.

- Simard et al. 2019 (data)

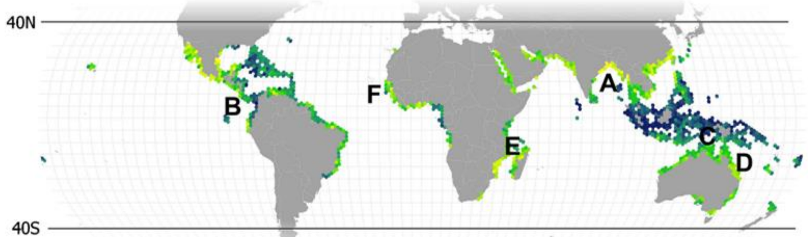




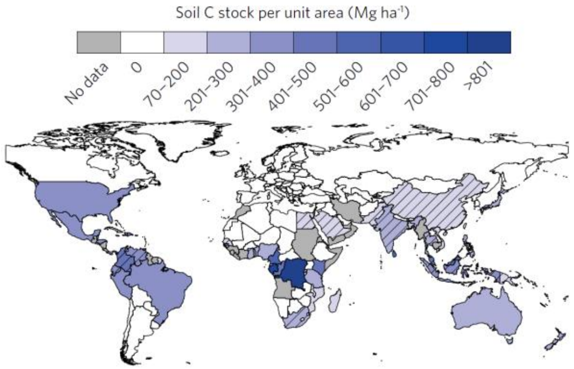
Overview of existing mangrove datasets: Soil organic carbon

Mangrove soil organic carbon

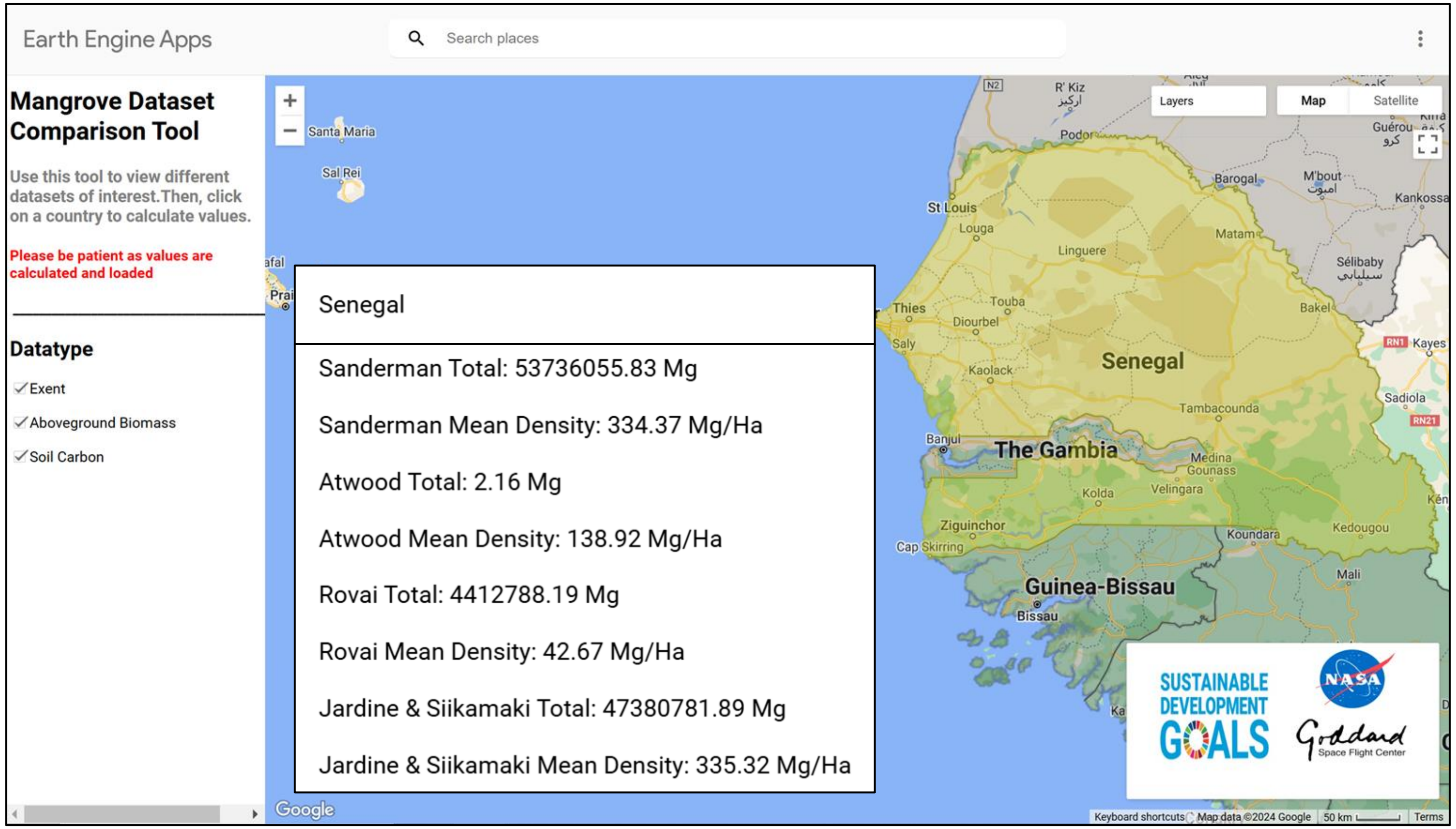
- Sanderman et al. (2018)



- Atwood et al. (2017)



- Rovai et al. (2018)
- Jardine and Siikamaki (2014)



Overview of existing mangrove datasets: Simard et al. 2019

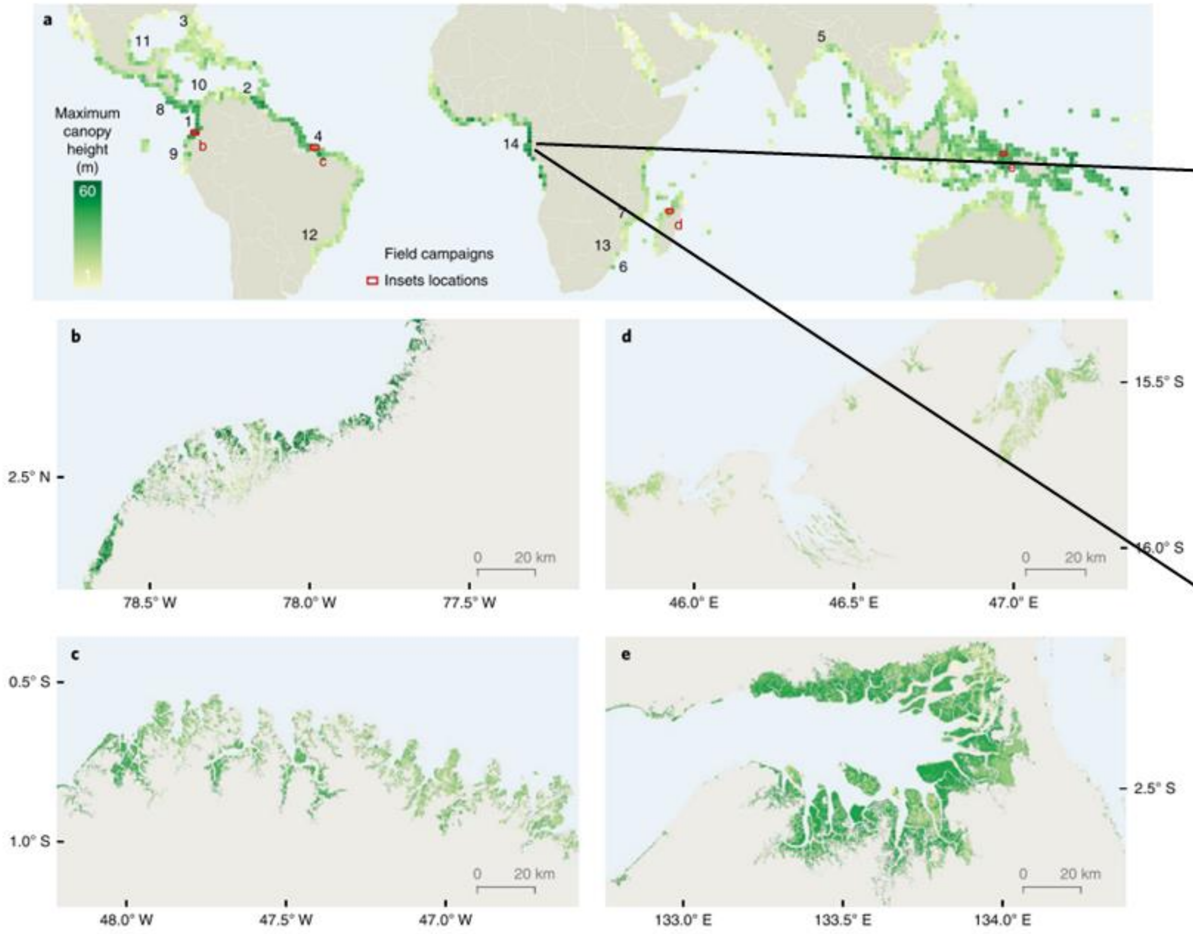
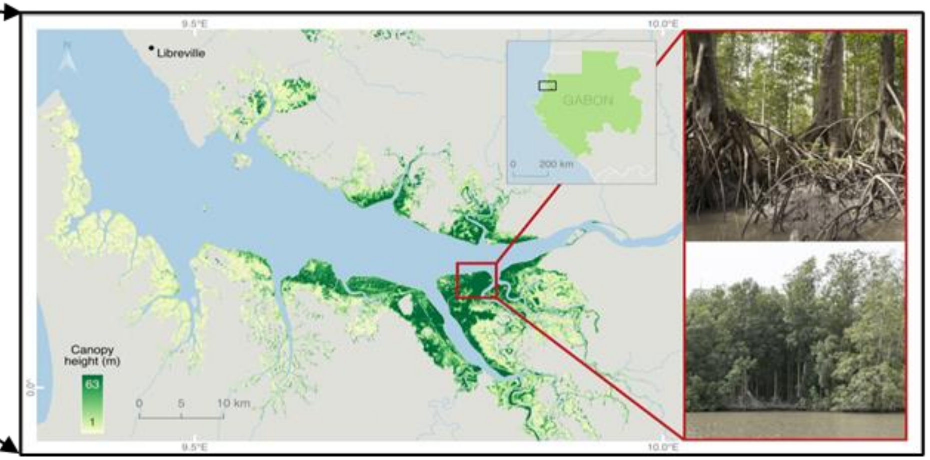
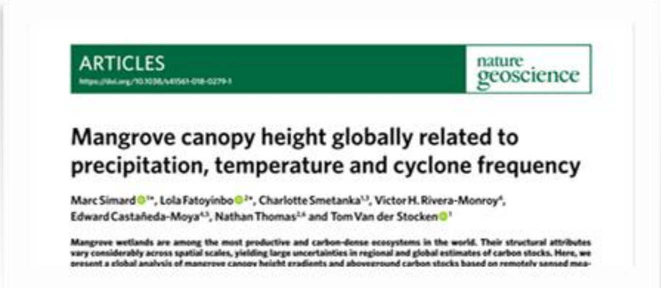


Fig. 1 | Global map of mangrove maximum canopy height and location of sampling sites (numbers) where in situ data were collected. a, Green colours show tallest maximum mangrove canopy height found within 1° cells. The map also shows the locations of the field sites and the locations of the high-resolution insets in **b**–**e**. **b**, Coastal Nariño and Cauca (Colombia). **c**, Coastal Pará (Brazil). **d**, Bombetoka Bay (Madagascar). **e**, Bintuni Bay (West Papua, Indonesia).




ARTICLES

nature geoscience

Mangrove canopy height globally related to precipitation, temperature and cyclone frequency

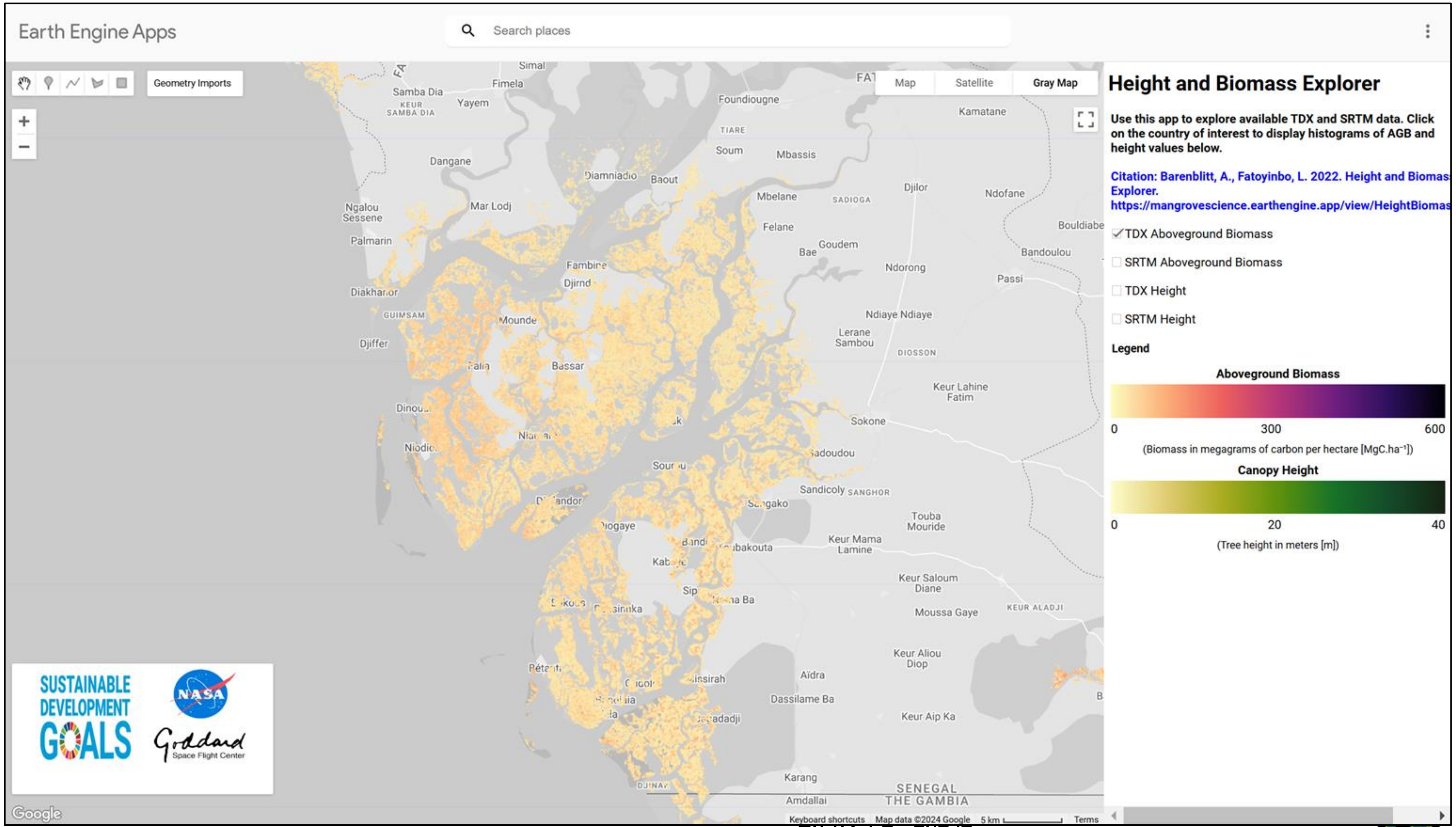
Marc Simard[1*], Lola Fatoyinbo[2*], Charlotte Smetanka[1,3], Victor H. Rivera-Monroy[4], Edward Castañeda-Moya[4,5], Nathan Thomas[2,6] and Tom Van der Stocken[7]

Mangrove wetlands are among the most productive and carbon-dense ecosystems in the world. Their structural attributes vary considerably across spatial scales, yielding large uncertainties in regional and global estimates of carbon stocks. Here, we present a global analysis of mangrove canopy height gradients and aboveground carbon stocks based on remotely sensed mea-

Simard, M., **Fatoyinbo, L.**, Smetanka, C., Rivera-Monroy, V.H., Castañeda-Moya, E., Thomas, N. and Van der Stocken, T., 2019. Mangrove canopy height globally related to precipitation, temperature and cyclone frequency. Nature Geoscience, 12(1), p.40.

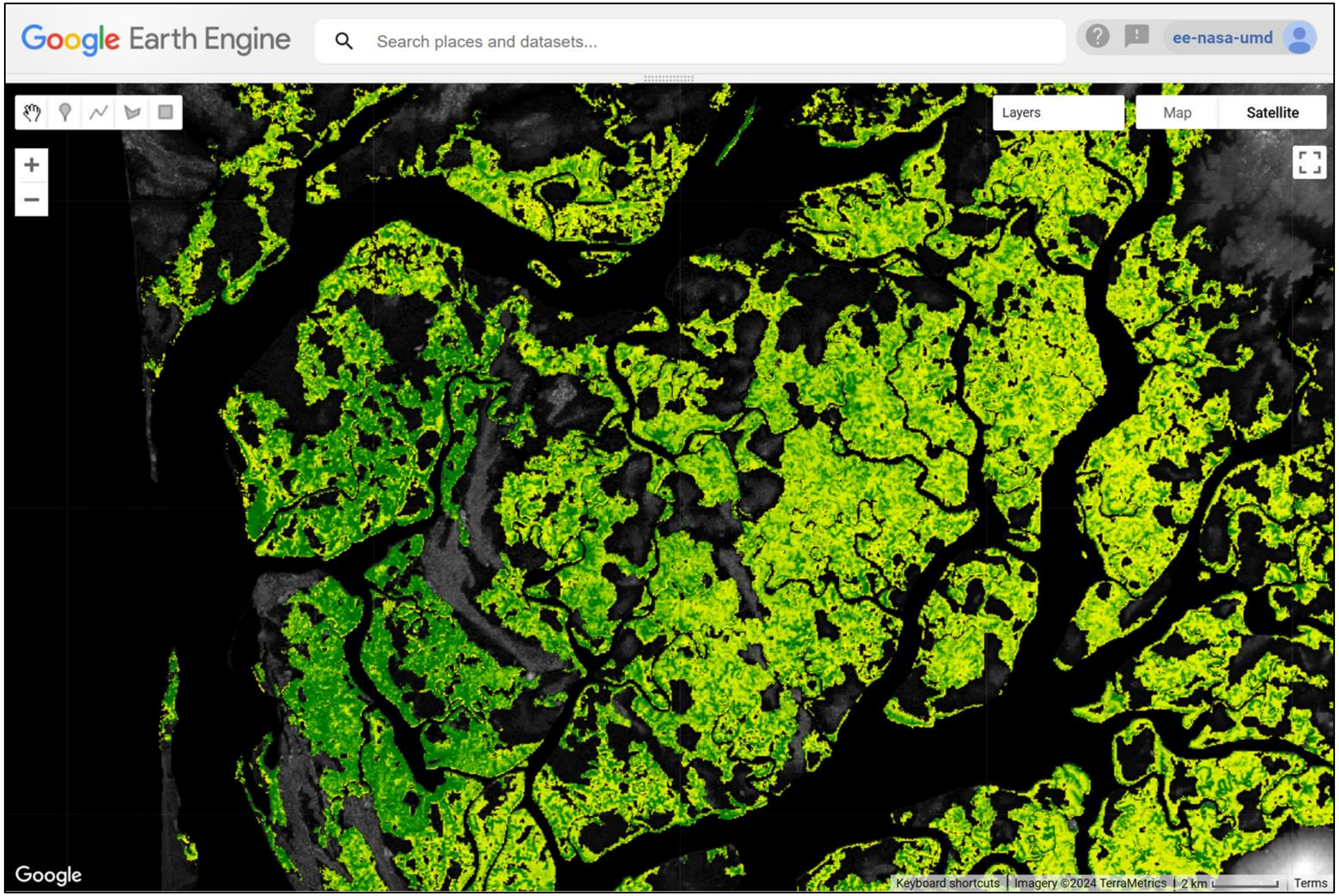
Overview of existing mangrove datasets: Height & biomass

- TerraSAR-X add-on for Digital Elevation Measurement (TandemX), 12m spatial resolution (10m vertical)
- Shuttle Radar Topography Mission (SRTM), 30m resolution

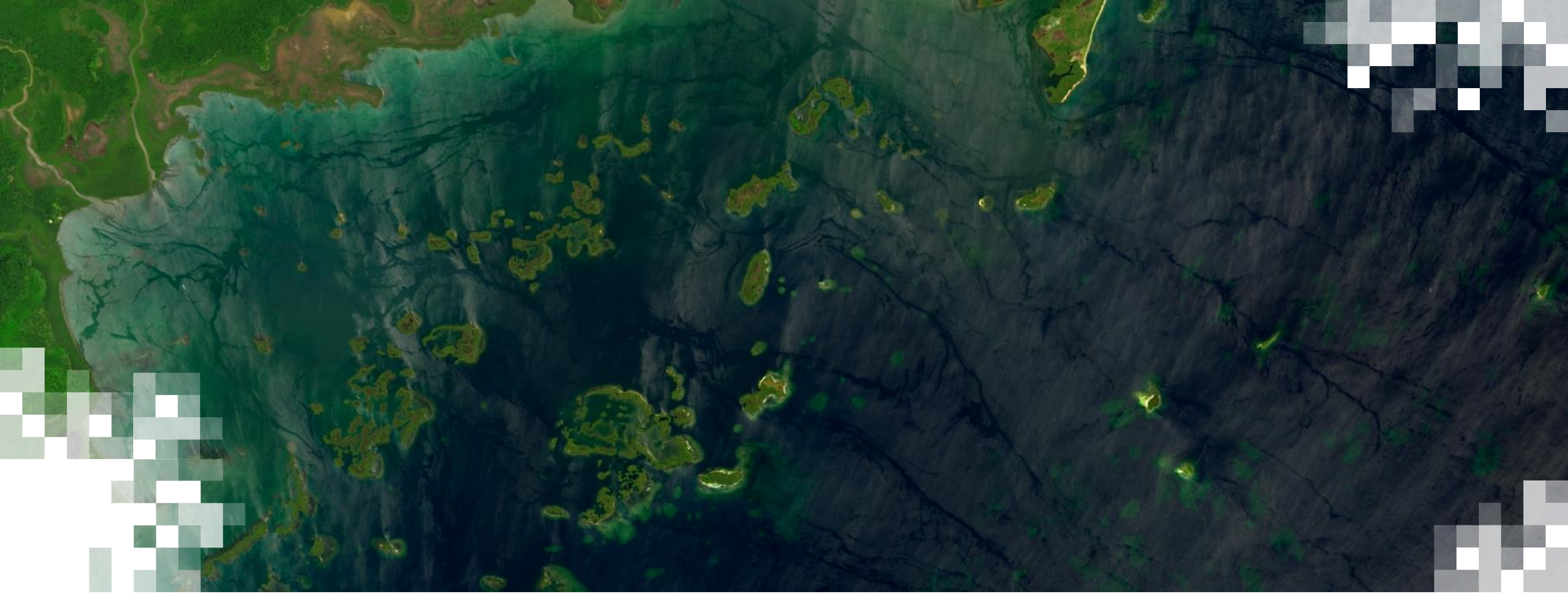


Generate your own map of mangrove height & biomass

- [Link to script]
- Estimate AGB data on mangrove canopy height
- Applies a generic equation relating canopy height to aboveground biomass (Simard et al., 2018):
- AGB = Basal area weighted height Hba ~ 1.08*SRTM
- AGB = Maximum canopy height Hmax ~ 0.93*1.7*SRTM



Thank You!



Part 1:
Summary

Summary

- Existing global data sets showing:
  - Extent
  - canopy height
  - biomass
- Understand how these datasets were produced as well as some of their limitations
- Basic criteria for assessing the suitability of existing datasets
- How to use google earth Engine to generate your own mangrove extent data
- How to estimate mangrove canopy height, biomass, and carbon stocks in your area of interest

Looking Ahead to Part 2

Demonstration of salt marsh and seagrass mapping using Earth Observations

- Map the extent of salt marsh and seagrass ecosystems using satellite observations
- Calculate the carbon stocks of mapped salt marsh and seagrass ecosystems
- Explore synthesis methods to estimate blue carbon across ecosystems

Homework and Certificates

- **Homework:**
  - One homework assignment
  - Opens on 12/05/2024
  - Access from the training webpage
  - Answers must be submitted via Google Forms
  - **Due by 12/19/2024**

- **Certificate of Completion:**
  - Attend all three live webinars (attendance is recorded automatically)
  - Complete the homework assignment by the deadline
  - You will receive a certificate via email approximately two months after completion of the course.

Contact Information

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- Dr. Adia Bey
  - contact@adiabey.com
- Dr. Lola Fatoyinbo
  - lola.fatoyinbo@nasa.gov
- Dr. Siti Maryam Yaakub
  - smaryam@conservation.org
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  - brock.blevins@nasa.gov

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Thank You!