

# COLLOQUE SUR LES ECOSYSTEMES DE MANGROVES

Partager des expériences pour une  
gestion durable

The Google Earth Engine  
Mangrove Mapping Methodology (GEM)



Présentée: Awa Rane Ndoye

Blue Venture



# The Google Earth Engine Mangrove Mapping Methodology (GEM)

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Natur'ELLES, Dakar, Senegal  
July 2025





# 1. Mangrove mapping

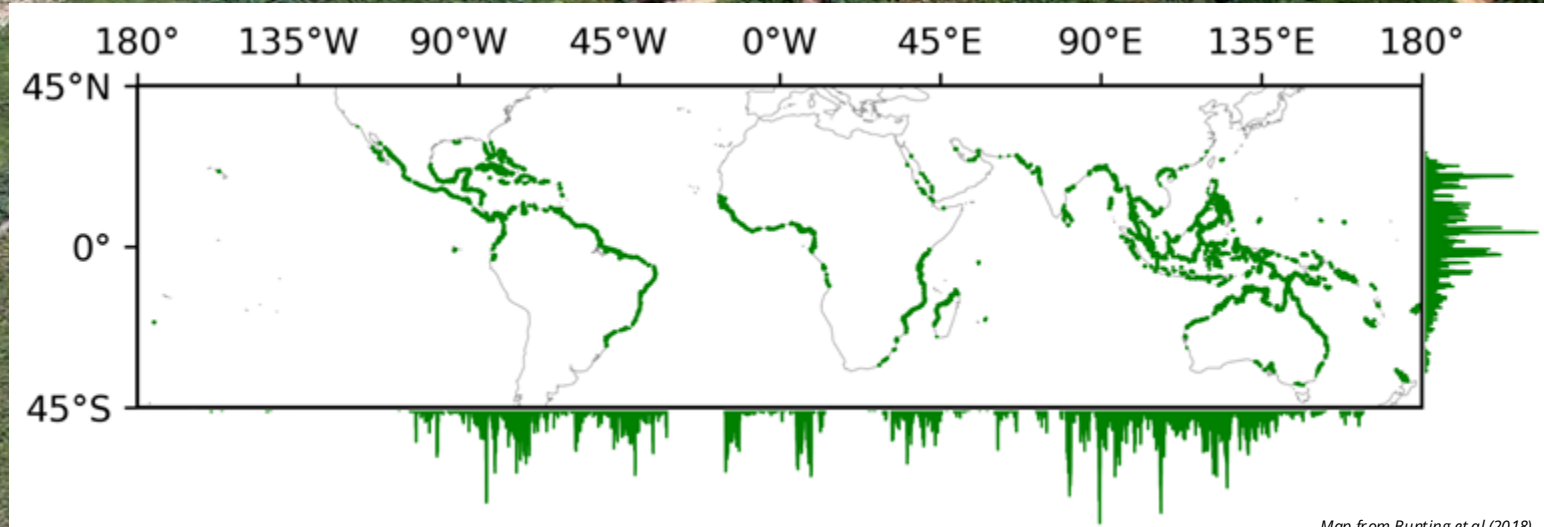
1. GEM

1. CRAs

1. Next steps

# Mangrove ecosystems (blue forests)

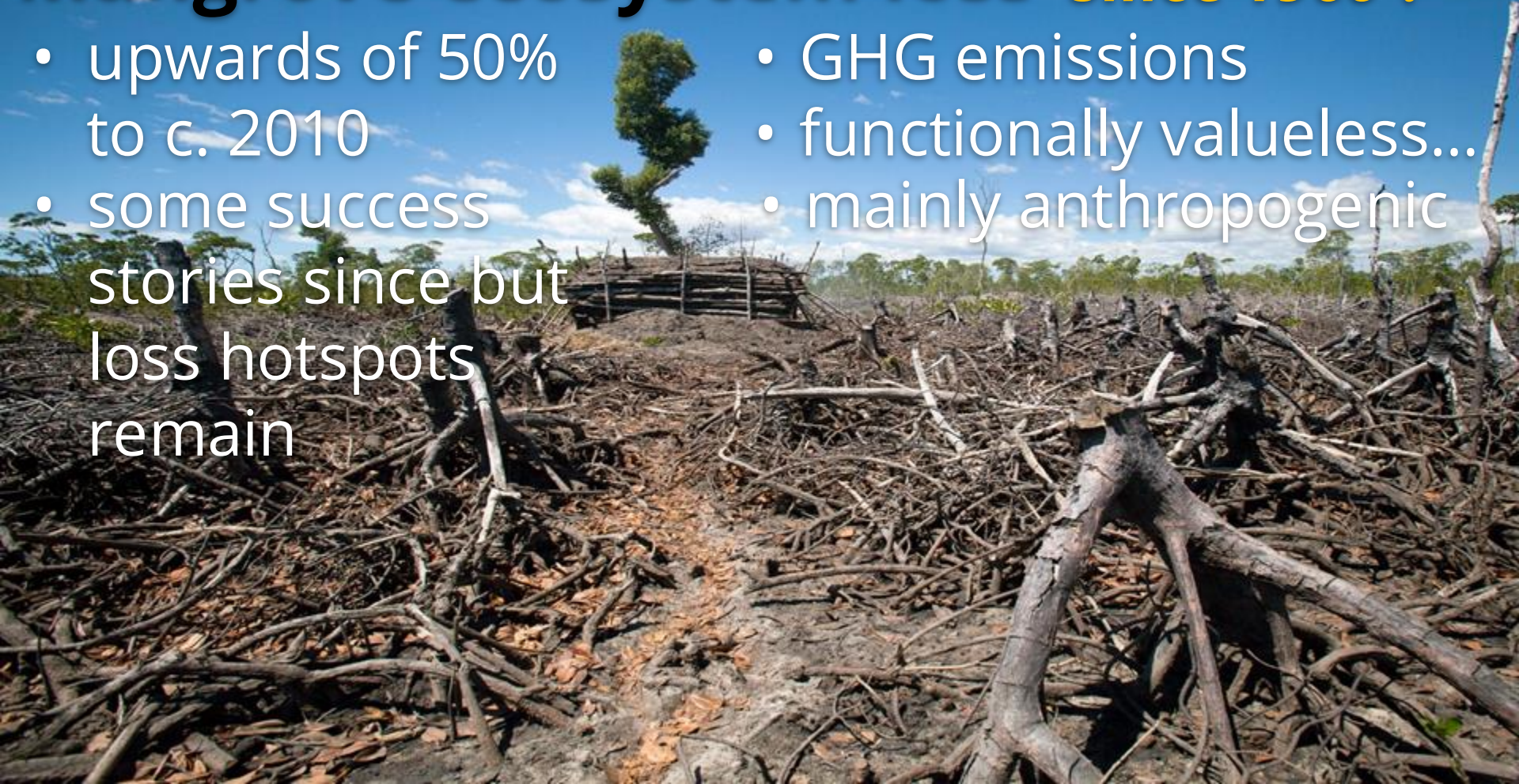
- Inter-tidal areas within >120 countries
- Ecosystem goods and services
- Floral and faunal biodiversity
- Carbon dense





# Mangrove ecosystem loss *Since 1960 ?*

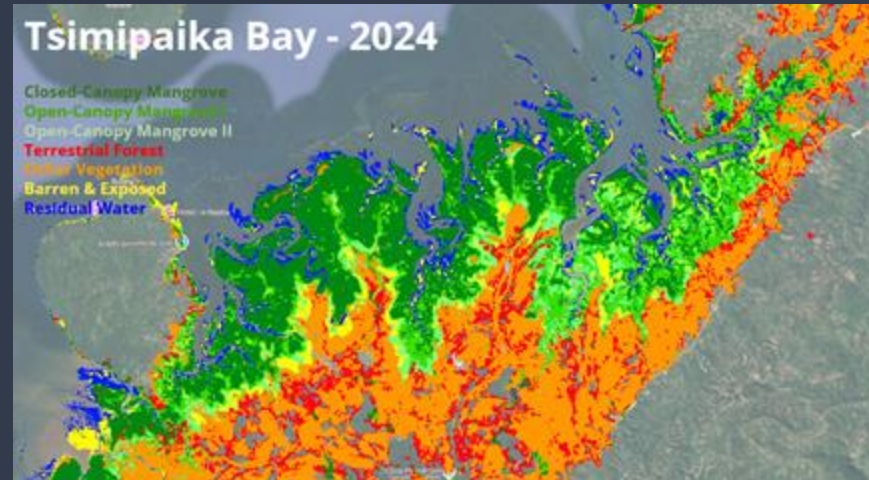
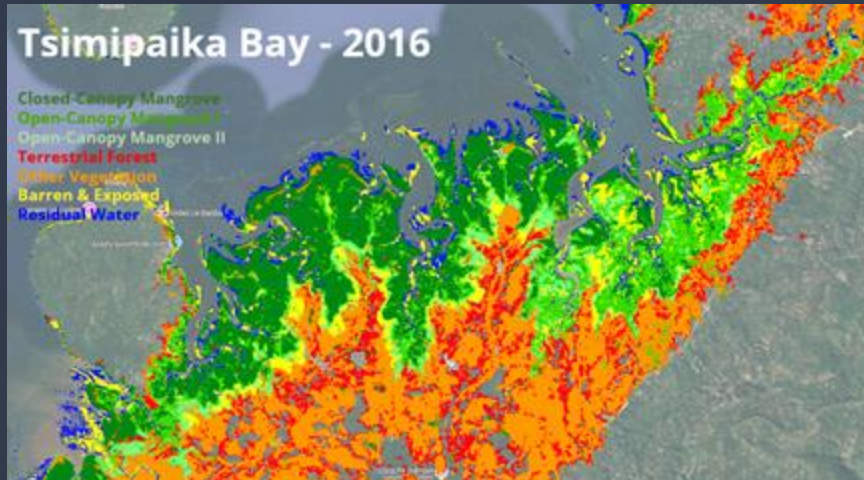
- upwards of 50% to c. 2010
- some success stories since but loss hotspots remain
- GHG emissions
- functionally valueless...
- mainly anthropogenic





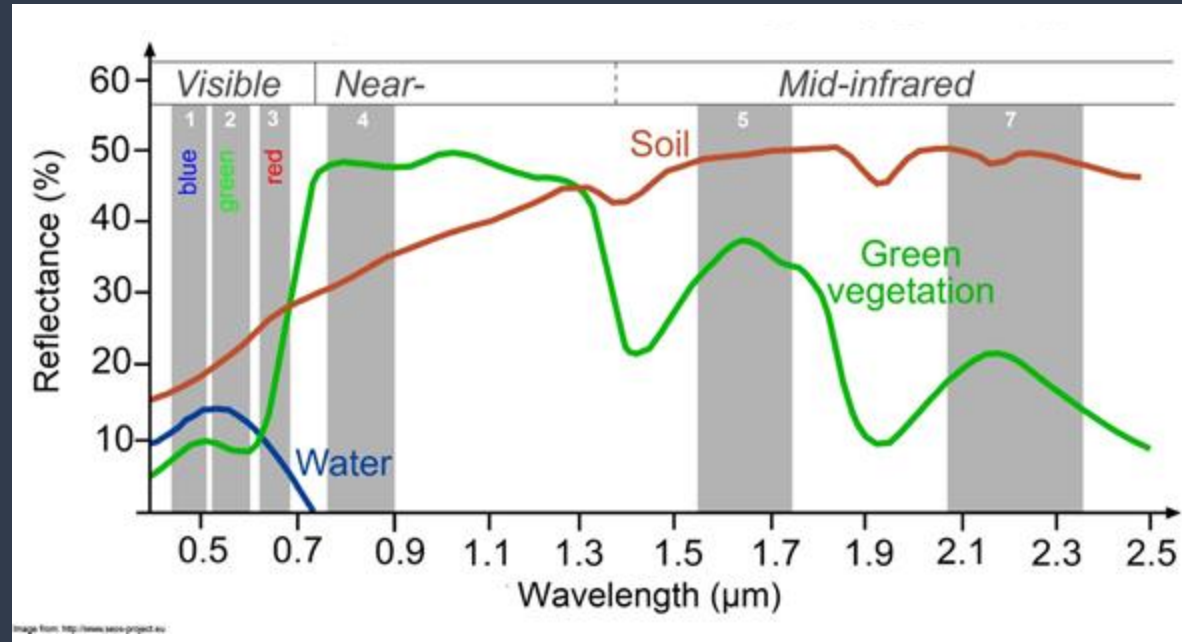
# The need for multi-date mangrove maps

- Management needed for provisioning, regulating, cultural services, biodiversity
- Maps help us manage mangroves
  - A single mangrove map tells us mangrove extent
  - Multi-date maps give us dynamics (change over time)



# Remote sensing

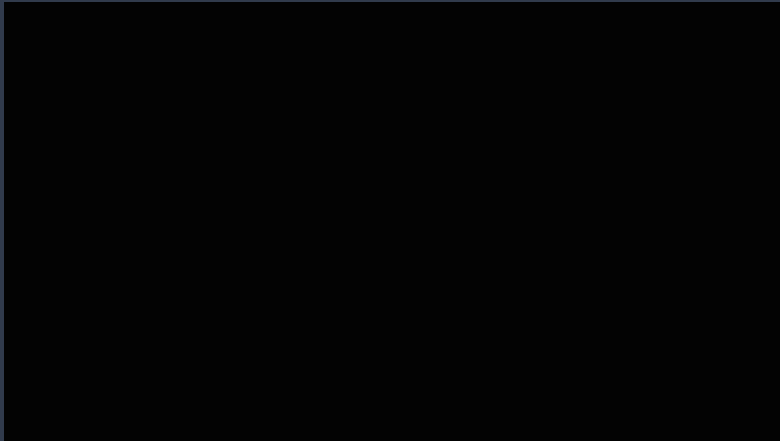
- Acquiring information about an object or phenomenon without making contact with the observation target
- The electromagnetic spectrum - wavelengths of light from the sun
- Typical wavelengths used for vegetation:
- Bands measure regions of wavelengths within the electromagnetic spectrum
  - Visible (BGR)
  - Near-infrared
  - Short-wave infrared



# Satellite sensors available in GEM

## Landsat (NASA)

- 9 satellites since the 1970s
- Landsat 8 and 9 currently operational
- 30 m spatial resolution



*GIF from [NASA](#)*

## Sentinel-2 (ESA)

- Launched in 2015
- Constellation of 2 satellites
- 10 m spatial resolution



*Image from [GIM International](#)*

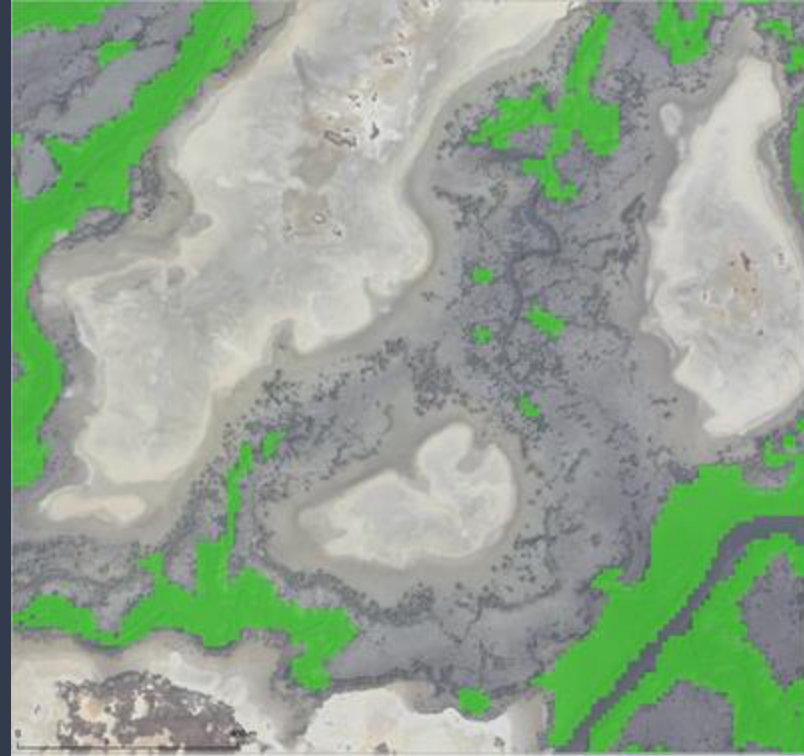




**The southern edge of Somone Lagoon**

# Limitations with existing datasets

- National and regional maps at limited time intervals
- Global products (e.g., GMW) have unprecedented detail, time steps, coverage
- But: limited use when applied to local scale
- Typically only one mangrove class
- No nuance re: ecological variability (sub-types)
- No distinction between mangrove forest and wider ecosystem (including non-forest)
- Definition? What constitutes mangroves?
- Often underrepresents true mangrove extent
- Typically ignore tidal conditions



*Map from Global Mangrove Watch v4*



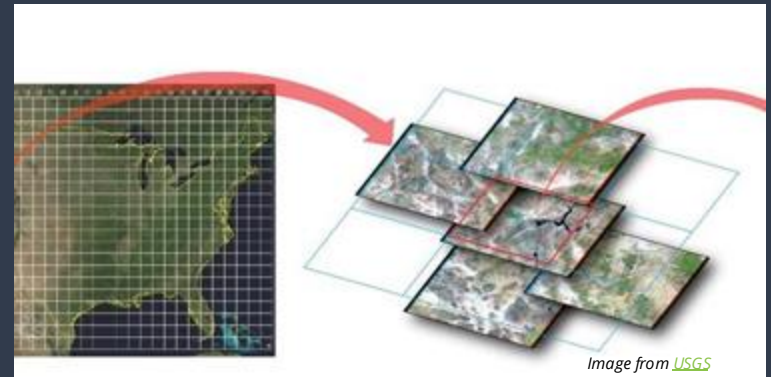
# The need for local mapping

- Overcome limitations in global products
- Make high quality local-level maps
- Overcome traditional barriers:
  - Technical capacity
  - Data access/storage
  - Data processing

There are many satellites...



taking many images...





**1. Mangrove  
mapping**

**1. GEM**

**1. CRAs**

**1. Next steps**



# MEET

## Google Earth Engine

# GEM: An Introduction

What is it?

- Conceived in 2016
- Google Earth Engine Mangrove Mapping Methodology (GEM)
- New tool: produce maps of + assess change in mangroves

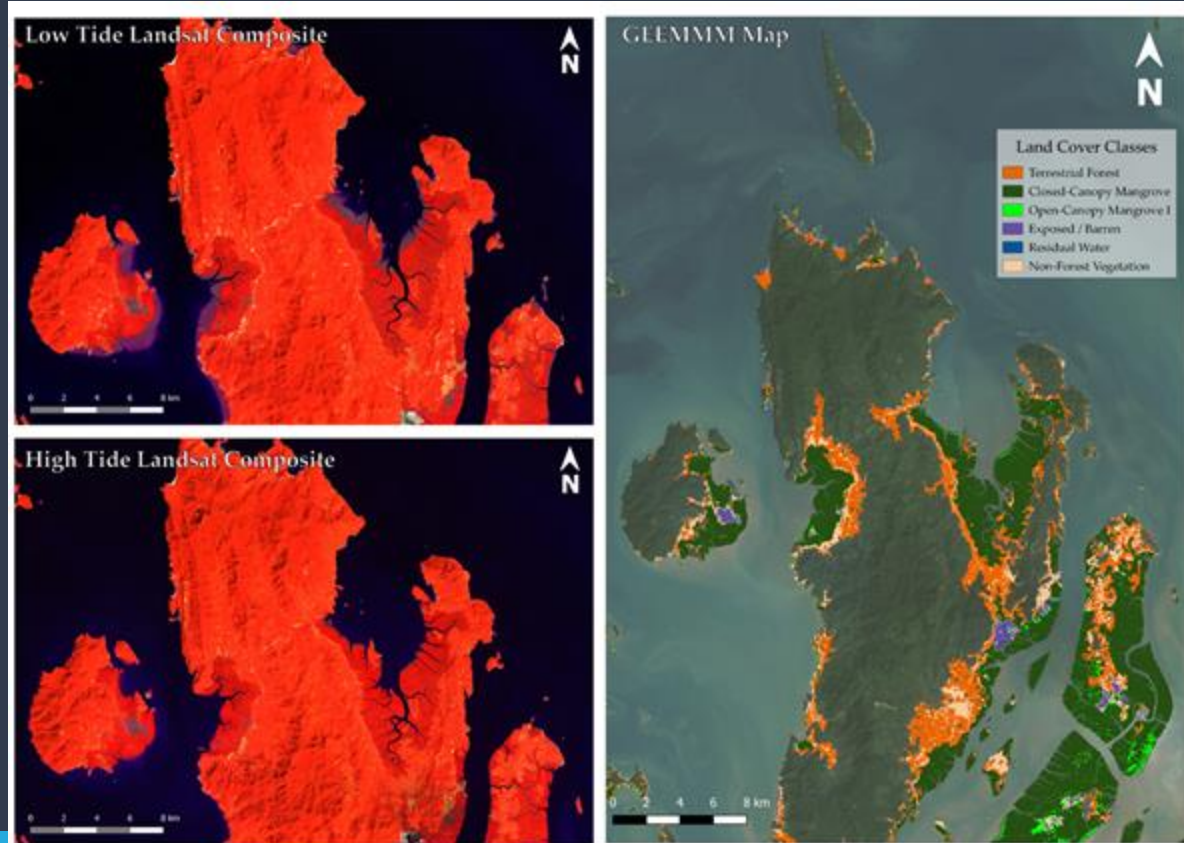
Why it's needed:

- Fill gaps in data availability for smaller areas
- Open-access, free-to-use, accessible, semi-automated
- Uses cloud-based storage and processing
- Overcomes: data access, processing, and software barriers
- Outputs: accurate, reliable, timely, and locally relevant



# GEM makes maps

Using a novel methodology ensuring images are captured at high and low tide



# GEM assesses dynamics

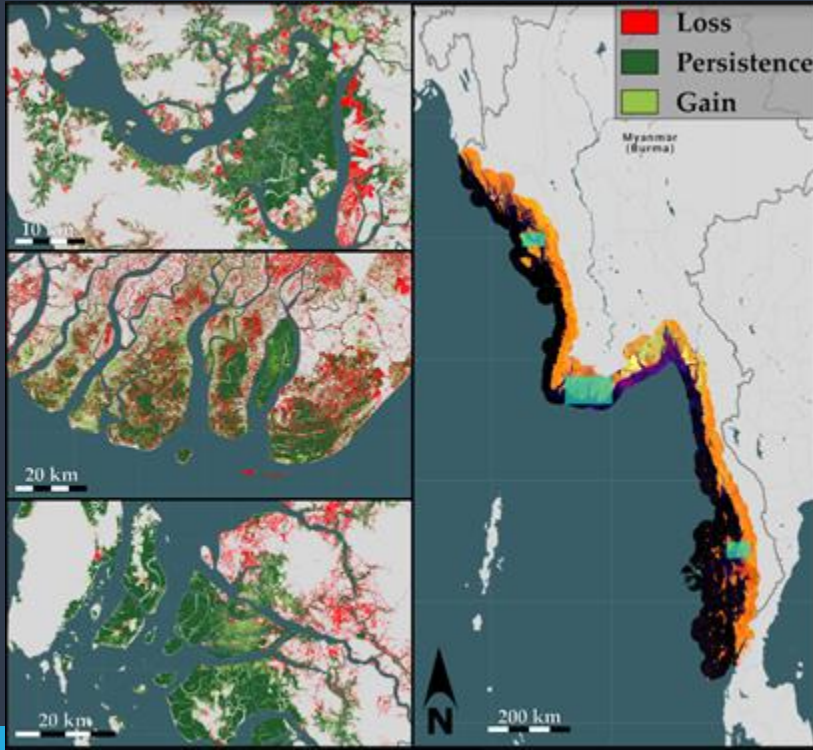
Using maps based on comparable tidal inputs



# 2020 Publication: Myanmar

# 2021: *The Conversation* Article

The Google Earth Engine Mangrove Mapping Methodology (GEM), Yancho et al, 2020, Remote Sensing Journal



**THE CONVERSATION**  
Academic rigour, journalistic flair

Search analysis, research, academics...

Climate Arts, Culture • Society Business • Economy Education Environment • Energy Health • Medicine Politics Science • Tech TC Ablique

**New mangrove forest mapping tool puts conservation in reach of coastal communities**

Published: January 14, 2021 11:56pm SAST

Mangroves, like these in Madagascar, provide a range of benefits, including protection from storms and the prevention of coastal erosion. (Louise Jaspert/Blue Ventures)  
Author provided

**Author**  
Trevor Garforth Jones  
Adjunct Professor of Forest Resources Management and WCDM Program Advisor  
University of British Columbia

**Disclosure statement**  
Trevor Garforth Jones works for Blue Ventures Conservation, the conservation NGO in charge of this project.

Mangroves are salt-tolerant plants found in intertidal areas throughout much of the world's tropical and subtropical coastlines. Mangrove ecosystems are highly variable, ranging from sparse, stunted shrubs to dense stands of thick-stemmed tall trees.

These ecosystems provide habitat for an incredibly diverse range of species including fish (from snapper to shark), invertebrates (such as shrimp and crab), reptiles (from snakes to crocodiles), birds (from kingfishers to hawks), primates (such as macaques



# 2022 Trialing GEM at the local level (Madagascar)

## GEM Trials Internal Summary

Samir Gandhi, Max Yanchio, Trevor Jones  
March 2022

The GEM tool was created in 2020 and piloted for all of Myanmar's coastline. In 2021, we carried out a series of trials to hone in on the optimal settings for applications to smaller areas of interest in Madagascar. This summary is intended for anyone on the BV team, and overviews the details of the trials and optimal GEM settings. These lessons can be applied around the world to any sub-national areas of interest containing mangrove ecosystems.

### The GEM: what it is, why it's needed and who it's for

The GEM (Google Earth Engine Mangrove Mapping Methodology) tool was first published in 2020 by the Blue Forests team. The tool's primary utility is producing current and historical maps of mangrove extent and calculating change over time. Compared to conventional mapping methods, it's relatively accessible and intuitive.

The GEM reduces the significant hurdles resource managers face when producing reliable mangrove maps at the local level. Accurate mapping requires extensive and typically costly expertise in satellite imagery analysis, data processing, and coding. Existing mangrove maps, such as those offered by [Global Mangrove Watch](#), provide critical data but are not intended for smaller areas of interest (AOIs). In contrast to "force-fitting" global datasets to local applications, the GEM can be used to generate maps for specific AOIs following a step-by-step workflow. The tool taps into an online cloud-based analysis platform called Google Earth Engine (GEE), which removes most of the conventional data processing burdens.

### The Myanmar pilot

The GEM was initially assessed (in 2020) at the national-level for all of Myanmar for contemporary (2014-2018) and historical (2004-2008) time periods. The results were compared with 11 previously published studies that had mapped mangrove distribution in Myanmar over similar periods. Although direct comparisons between datasets are challenging for various reasons (e.g., different mapping methodologies, misaligned time periods, different definitions of "mangrove"), the GEM results broadly agreed with overall trends observed across other studies (see Figure 1), identifying a 35% overall loss in mangroves.

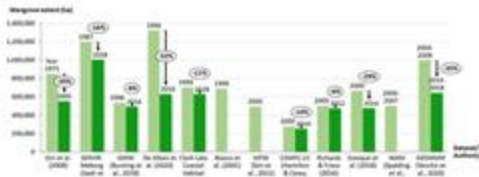
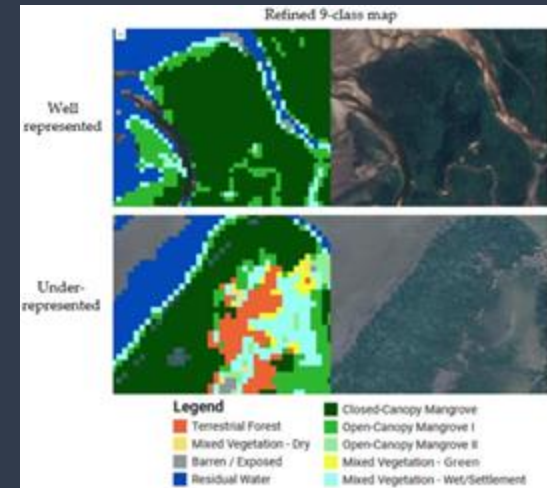


Figure 1: Results of mangrove extent and change from published studies and the GEM pilot.



# 2024 GEM Desktop v2 released

- GEM v1 used 30 m pixels
  - Landsat-based
  - Best available option at the time for assessing dynamics
- GEM v2 adds 10 m pixels
  - Sentinel-2 launched in 2015
  - 10 year archive of imagery
  - GEM reconfigured to use smaller pixels
- Increase in spatial resolution (30 to 10 m)
- Better data inputs
- Improved dynamics
- Less bugs

# 2025 GEM App launched





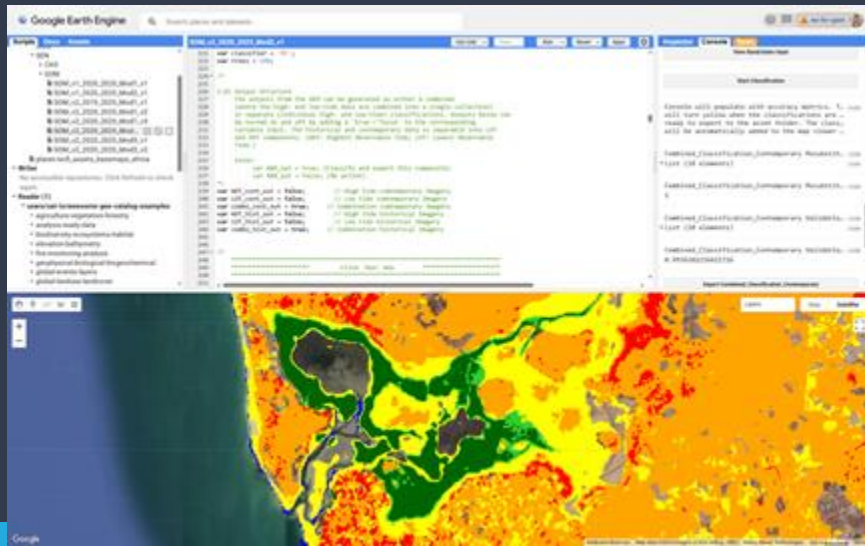
# Accessing GEM



# GEM is available in two formats

## GEM Desktop

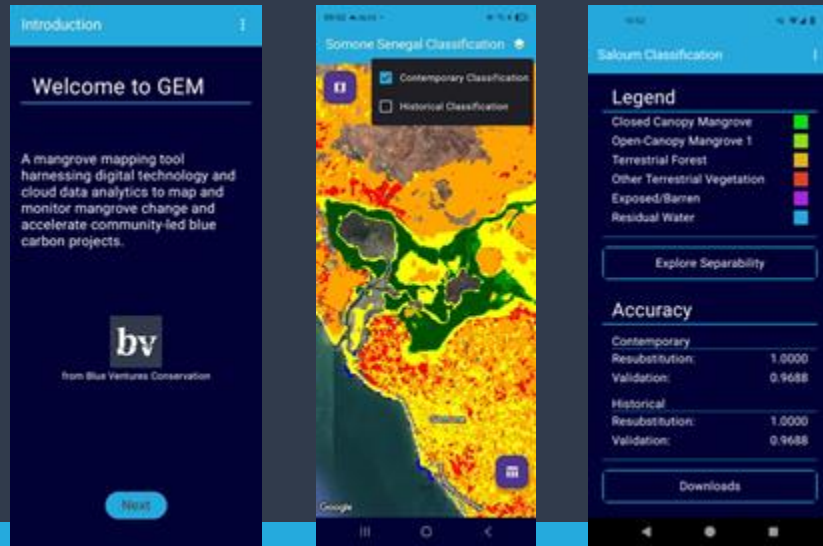
- The easiest format to develop, GEM Desktop came first in 2020
- Best for expert geospatial users
- Has advanced features
- Can be tailored for their own purposes
- Where the GEM Team build new GEM versions




## GEM App

- Launched in 2024 for Android devices
- Designed for less technical users
- More accessible, user-friendly and intuitive
- Automates many of Desktop's decision points
- Available in 10 languages

English, French, Malagasy, Swahili, Portuguese, Spanish, Cebuano, Indonesian, Tetun, Tagalog




# Access both from the BV website



beyond conservation


[What we do](#) [Where we work](#) [Who we are](#) [Latest](#)

## Learn more



New research: A new tool for mapping and monitoring mangroves

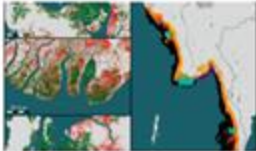
[Read more](#)



THE CONVERSATION


New mangrove forest mapping tool puts conservation in reach of coastal communities

[Read more](#)




Remote sensing: The Google Earth Engine Mangrove Mapping Methodology (GEM)

[Read more](#)



Hear from the developers in this webinar

[Watch](#)



Access the GEM on Github

[Visit site](#)

Access GEM App on Google Play Store

# GEM Desktop is on GitHub

The screenshot shows the GitHub repository page for 'Blue Ventures Conservation / GEM'. The repository is a public project with 18 forks and 66 stars. The main content area displays the repository's structure, including files like `.github/workflows`, `functions`, `LICENSE`, `README.md`, `module_1`, `module_2`, and `module_3`. The `README.md` file is selected, showing the title 'GEM\_v2.0', the subtitle 'Google Earth Engine', and the main heading 'Mangrove Mapping Methodology v2.0'. The introduction text describes the tool as an intuitive, accessible, and replicable tool for coastal managers and decision makers, designed to map multi-date mangrove distributions and quantify dynamics anywhere in their global distribution. The right sidebar contains information about the repository, including a description, links to the website ([blueventures.org/](https://blueventures.org/)), a list of releases (the latest being 'Mangrove Extents, Water Mask...' from May 8, 2024), and a list of contributors (mar-yacho, zbinik, and thejollygen).

Blue Ventures Conservation / GEM

Code Issues Pull requests Discussions Actions Projects Wiki Security Insights Settings

1 master 1 branch 5 tags

Go to file Add file Code

File	Commit Message	Time
zbinik Update README.md	7069c	15 hours ago
.github/workflows	Update lock.yml	last year
functions	Delete functions/fringe_mang no longer used	13 hours ago
LICENSE	Add files via upload	5 years ago
README.md	Update README.md	13 hours ago
module_1	Update module_1 fix 2.7 fringing mangrove input description	13 hours ago
module_2	Update module_2 reduce scatter plot points when over max ...	13 hours ago
module_3	Change 'historic' to 'historical' in comments	6 months ago

README GPL-3.0 license

## GEM\_v2.0

### Google Earth Engine

### Mangrove Mapping Methodology v2.0

#### INTRODUCTION

The Google Earth Engine Mangrove Mapping Methodology (GEM) provides an intuitive, accessible and replicable tool which caters to a wide audience of non-specialist coastal managers and decision makers. This tool reflects a thorough review and incorporation of relevant mangrove remote sensing literature, and harnesses the power of cloud computing, including a simplified image-based tidal calibration approach. The GEM is freely accessible for non-profit use and runs on comprehensive and thoroughly commented code within GEE.

The GEM is designed specifically to map multi-date mangrove distributions and quantify dynamics anywhere in their global distribution. Currently available tools and methods fall short of fully utilizing the wealth of local expertise typically held by coastal managers - the GEM works towards filling this gap, helping to combine local expertise with GEE's cloud processing capabilities. While not a decision support tool, it provides a means to generate maps of mangrove distribution and dynamics.

This repository stores the code for the Google Earth Engine Mangrove Mapping Methodology. It is best used by following the links located in the ReadMe file. The GEM is owned and managed by Blue Ventures Conservation.

[blueventures.org/](https://blueventures.org/)

Readme

GPL-3.0 license

Activity

Custom properties

66 stars

2 watching

18 forks

Report repository

#### Releases 5

Mangrove Extents, Water Mask... [Latest](#)

on May 8, 2024

+ 4 releases

#### Packages

No packages published

[Publish your first package](#)

#### Contributors 3

mar-yacho Mar Yacho

zbinik Zbinik

thejollygen Sam Gandhi



# Where the 3 modules of GEM Desktop are found

README GPL-3.0 license

coding, the tool is designed with the assumption that users have basic computer skills and are familiar with the key steps in mapping mangroves and assessing dynamics.

A pilot study (i.e., [Yancho et al. 2020](#)) published in a special issue on "Remote Sensing in Mangroves" in the journal Remote Sensing demonstrates an application of the GEM for the entire coast of Myanmar (Burma) - a global mangrove loss hotspot. The published manuscript not only demonstrates one application for GEM, but also describes in detail the various parameters, options, outputs, and user-interface features included in the tool. The manuscript walks potential users, step-by-step, through the three modules which comprise the tool:

## Module 1: Defining the Region of Interest (ROI) and Compositing Imagery

This module helps the user to define customized Region of Interest (ROI) boundaries, and select the input imagery to make multi-date (i.e., historical and contemporary) composites. The user adjusts several parameters according to their specific project requirements and preferences (e.g. years of interest, months of interest, cloud cover, etc.). It is in Module 1 that the user can choose to calculate a number of mangrove and non-mangrove specific spectral indices. All imagery is sourced from the Landsat archives (Missions 4, 5, 7, 8, & 9).

## Module 2: Spectral Separability, Classifications, and Accuracy Assessment

This module enables the user to choose from the calculated spectral indices (from Module 1) to use as classification inputs, explore the spectral relationships within and between user-defined map classes, undertakes multi-date (i.e., historical and contemporary) supervised classifications, and assesses land cover map accuracies. Exploring spectral relationships is very interactive, and includes the option to examine correlation between potential spectral indices and separability of classification reference areas (CRAs) across all potential classification inputs. Following classification, accuracy assessments are automatically produced for each output map.

## Module 3: Dynamics and Qualitative Accuracy Assessment (QAA)

This module uses multi-date mangrove maps to automatically calculate and subsequently explore mangrove dynamics (i.e., loss, persistence and gain), and provides an optional qualitative accuracy assessment (QAA) tool. The QAA goes above and beyond standard accuracy metrics.

Separate from the three modules of the GEM, there is also a 'Functions' folder which contains some of the back-end support code used by the tool. None of the scripts in this folder will produce any outputs or maps if run independently in GEE. These scripts have been included for potentially interested users to understand how certain intermediate products are generated or statistics calculated. The inclusion of these scripts is further discussed in the 'OPERATION' section of this document (below), which also provides further detail on how to best run the GEM for your own personal use. The most convenient way will be to follow the three hyper-links and use the captured code. However, this Git repository can also be copied and saved as scripts in your own personal GEE script library. The latter of these two options is more complicated, but would allow the user to more comprehensively understand GEM functionality - this is not required to actually use the tool.

## Module 1

- Defines the Area of Focus (AOF)
- Generates satellite image composites

## Module 2

- Assesses spectral separability
- Produces map classifications
- Calculates accuracy assessments

## Module 3

- Dynamics (table and maps)

# GEM App is on the Google Play Store

The screenshot shows the Google Play Store interface for the 'Blue Ventures: GEM' app. At the top, the Google Play logo and navigation tabs (Games, Apps, Books, Children) are visible. The app title 'Blue Ventures: GEM' is prominently displayed, followed by the subtitle 'Blue Ventures Conservation'. Below this, the app's rating is shown as '10+' with 'Downloads' and 'PES 3.0' icons. A red rectangular box highlights the green 'Install' button, which is accompanied by a 'Share' icon. To the right of the app title is the app's icon, a dark blue square with the white letters 'bv'. Below the 'Install' button, a message states 'This app is available for your device' and 'You can share this with your family. Learn more about Family Library'. A row of six app preview images follows, showing various maps and data visualizations. To the right of the preview images, the 'App support' section is visible, followed by a 'More apps to try' section listing several other apps: Duolingo: Language Lessons, Speak: Language Learning, Coursera: AI Tools Mastery, Impulse - Brain Training Games, Snapchat, and Photoshop Express Photo Editor. At the bottom, the 'What's new' section mentions 'A couple small bug fixes' and 'Adding excluded regions with a hand-drawn project boundary'. The 'Data safety' section indicates 'No data shared with third parties'.

Google Play Games Apps Books Children

## Blue Ventures: GEM

Blue Ventures Conservation

10+ Downloads PES 3.0

**Install** Share

This app is available for your device You can share this with your family. [Learn more about Family Library](#)

**App support**

**More apps to try**

- Duolingo: Language Lessons  
Duolingo 4.5
- Speak: Language Learning  
Speakery Labs 4.6
- Coursera: AI Tools Mastery  
Coursera Limited 4.5
- Impulse - Brain Training Games  
GMRD Apps Limited 4.3
- Snapchat  
Snap Inc 4.2
- Photoshop Express Photo Editor  
Adobe 4.5

**What's new**

A couple small bug fixes:  
Adding excluded regions with a hand-drawn project boundary should now correctly display the area of the excluded regions in the overview.  
Fixed an issue with the starting date of Landsat imagery (Landsat 4 - 1992) and surrounding error messages when imagery is not found.

**Data safety**

Safety starts with understanding how developers collect and share your data. Data privacy and security practices may vary based on your use, region and age. The developer provided this information and may update it over time.

No data shared with third parties



## Using GEM App



# Refer to the GEM App User Manual

**blue ventures**  
beyond conservation

Blue Ventures Conservation  
The Old Library, Trinity Road, Bristol, BS2 0NW, UK  
+44 (0)117 3144 661  
info@blueventures.org  
www.blueventures.org

## GEM App User Manual

The Google Earth Engine Mangrove Mapping Methodology

Published April 2025

Last major update: 7 May 2025; Last minor update: 7 May 2025

Version 1.2.0



- Link [here](#)
- Updated regularly
- Lengthy document - no need to read all!
- Refer to sections you require guidance

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[General description of CRA format](#)

# Using GEM App to map mangroves in Somone



- 130 ha mangrove in the Marine Protected Area of Somone
- Some degradation
  - Sedimentation
  - Rising sea-levels
  - Climate change
- Key impact is increased salinity

# The GMW map under-represents mangrove



- GMW v4 = 125 ha of mangrove in the MPA of Somone
- GEM: 130 ha of mangrove forest
  - 108 ha of CCM
  - 22 ha of OCM
- GMW under-represents mangroves
- Extend 4 km further upstream
- Only uses one broad class
- No insight regarding the surrounding classes immediate to the mangroves



# GMW under-represents open mangrove



# Setting up a project

- Naming your project
- Select your timesteps
- Draw or upload your AOI
- Add excluded areas
- Choose satellite sensor

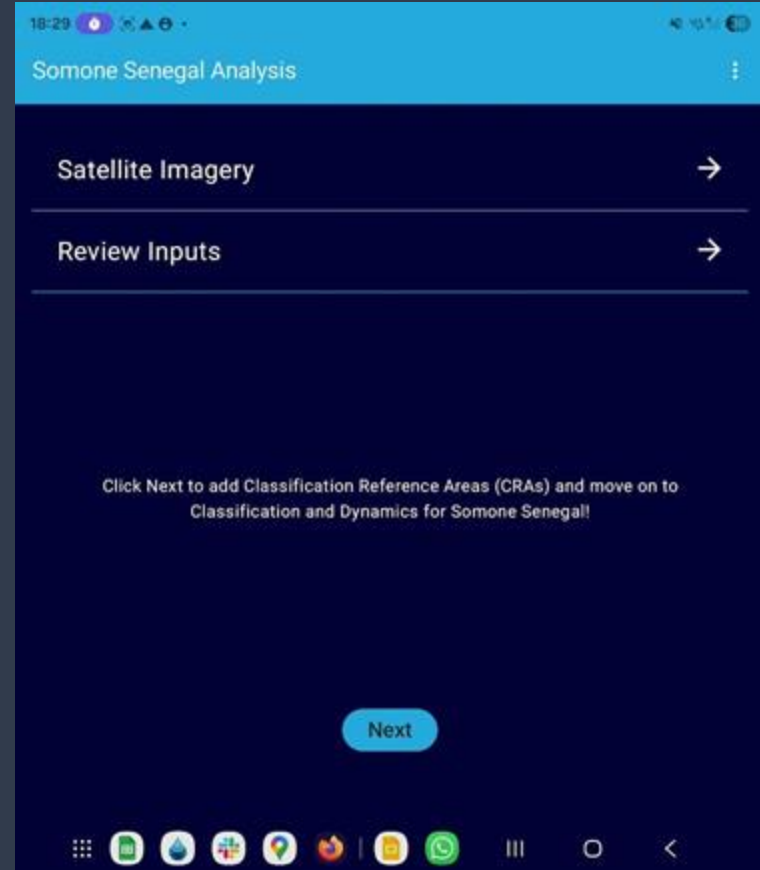
The screenshot shows a mobile application interface for creating a project. At the top, there is a status bar with the time 18:17 and various icons. Below it is a blue header with the text 'Create Project' and a three-dot menu icon. The main content area has a dark blue background and is titled 'Overview'. It contains a table of project settings:

Project Name:	Somone Senegal
Historical Years:	2020 - 2020
Historical Months:	2, 3
Contemporary Years:	2025 - 2025
Contemporary Months:	2, 3
Coarse Boundary Area:	1,593 ha
Excluded Regions:	0 polygons
Satellites:	Sentinel-2

At the bottom of the form is a large, light blue button labeled 'Done'. The very bottom of the screen shows a standard Android home indicator bar with various app icons like Google, Maps, and Messages.

# Review satellite image composites

- Contemporary high tide
- Contemporary low tide
- Historical high tide
- Historical low tide
- Are they fit-for-purpose?
  - Low tide: exposed tidal flats
  - High tide: Water inundating mangroves + mudflats
- Onto CRAs...







**1. Mangrove mapping**

**1. GEM**

**1. CRAs**

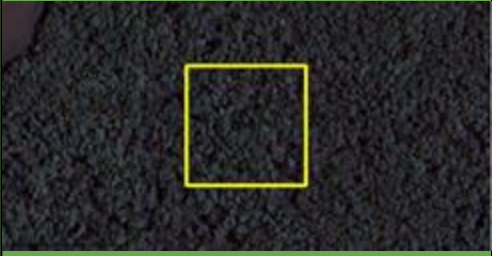





**1. Next steps**

# What is a CRA?

- **C**lassification **R**epresentation **A**rea
- Train the classifier and validate maps
  - 70% used for training
  - 30% used for validation
- CRAs required for each class
- Each class should be ecologically and spectrally distinct
- CRAs for each class should represent full spectral and ecological variability across AOI



# Classification structure - Somone

Class	Example	Class	Example
1. Closed-Canopy Mangrove		4. Other Vegetation E.g. grassland, shrubland, cropland	
2. Open-Canopy Mangrove		5. Barren Exposed E.g. soil, mud	
3. Terrestrial Forest		6. Residual Water	



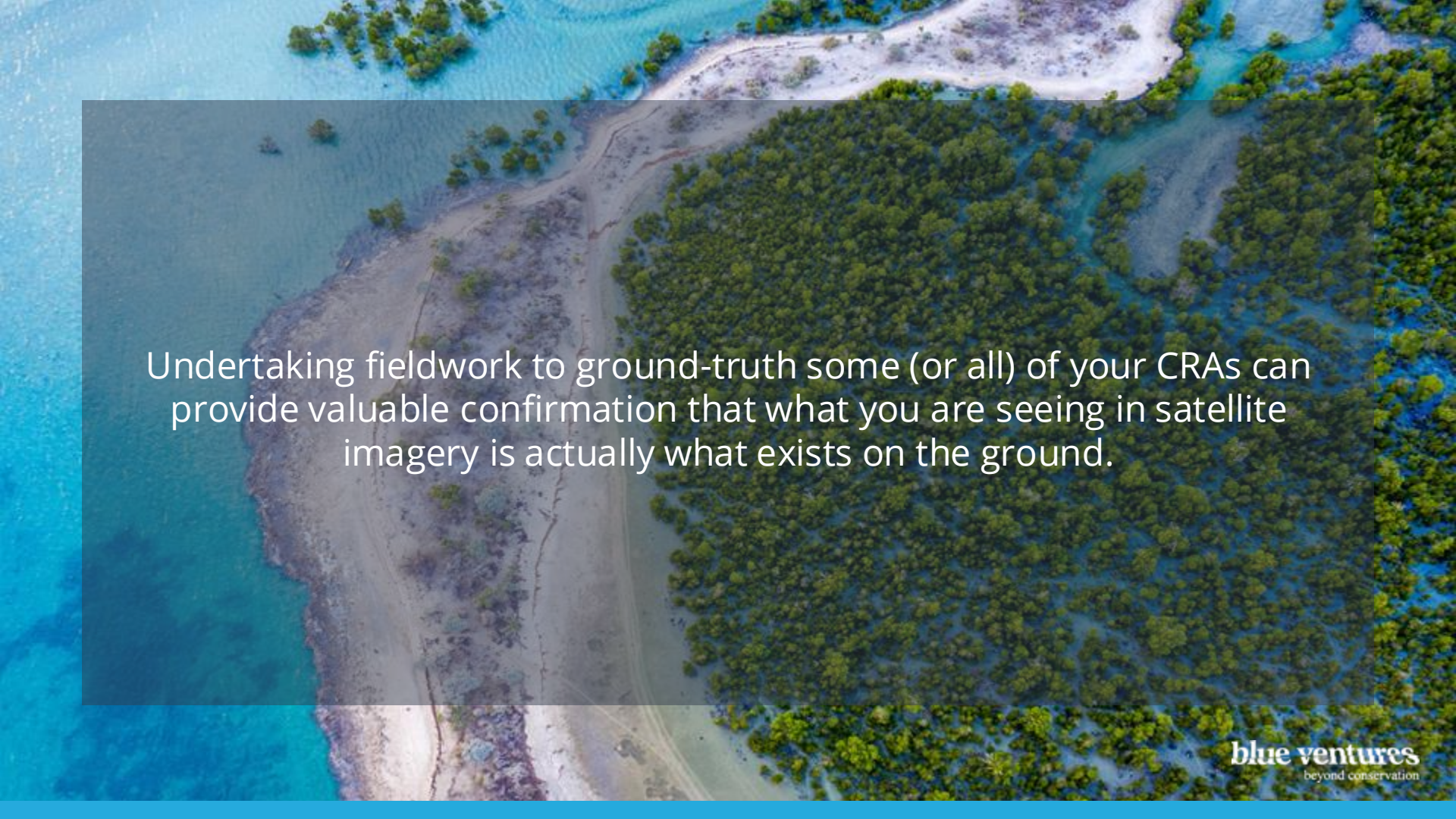
# Why are CRAs important?

- CRAs define the spectral (EMS) values which represent your map classes
- GEM assigns class membership to each pixel
- Map accuracy tested using 30% of the CRAs "held back"
- The maps made by the GEM are only as good as the examples you provide!
- True for mangrove classes AND surrounding non-mangrove classes



# GEM Fieldwork



An aerial photograph of a coastal mangrove forest. The image shows a dense green mangrove forest on the right, with a sandy path or road running through it. To the left of the path is a body of turquoise water, and further left is a sandy beach. The overall scene is a mix of green, brown, and blue tones.

Undertaking fieldwork to ground-truth some (or all) of your CRAs can provide valuable confirmation that what you are seeing in satellite imagery is actually what exists on the ground.



## ▼ Places

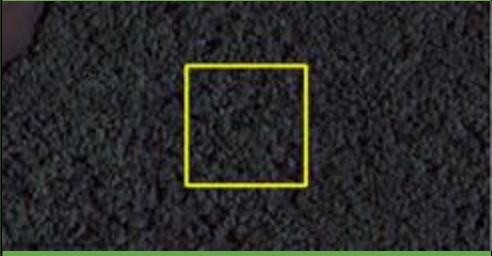




- My Places
  - someone\_cras\_2020\_sdm...
  - Someone fieldwork
    - Zone A
    - Zone B
    - OCM
    - OV
    - BE
    - OCM1 - backup
    - OCM7 - backup
    - OCM
    - CCM13 - fieldwork ba...
    - CCM
    - Reserve dam
    - Road dam
    - Drop-off point
    - Drop-off point
    - Boardwalk
    - Viewing platform
    - Chinese building
    - Our introduction, they ask
    - Working the trees
    - Bardia Reserve
      - Refuge - giraffe
      - Coastal area in the reserve
    - Ecological site OCM
    - Upstream max of Avic...
    - TF
    - es

## ▼ Layers

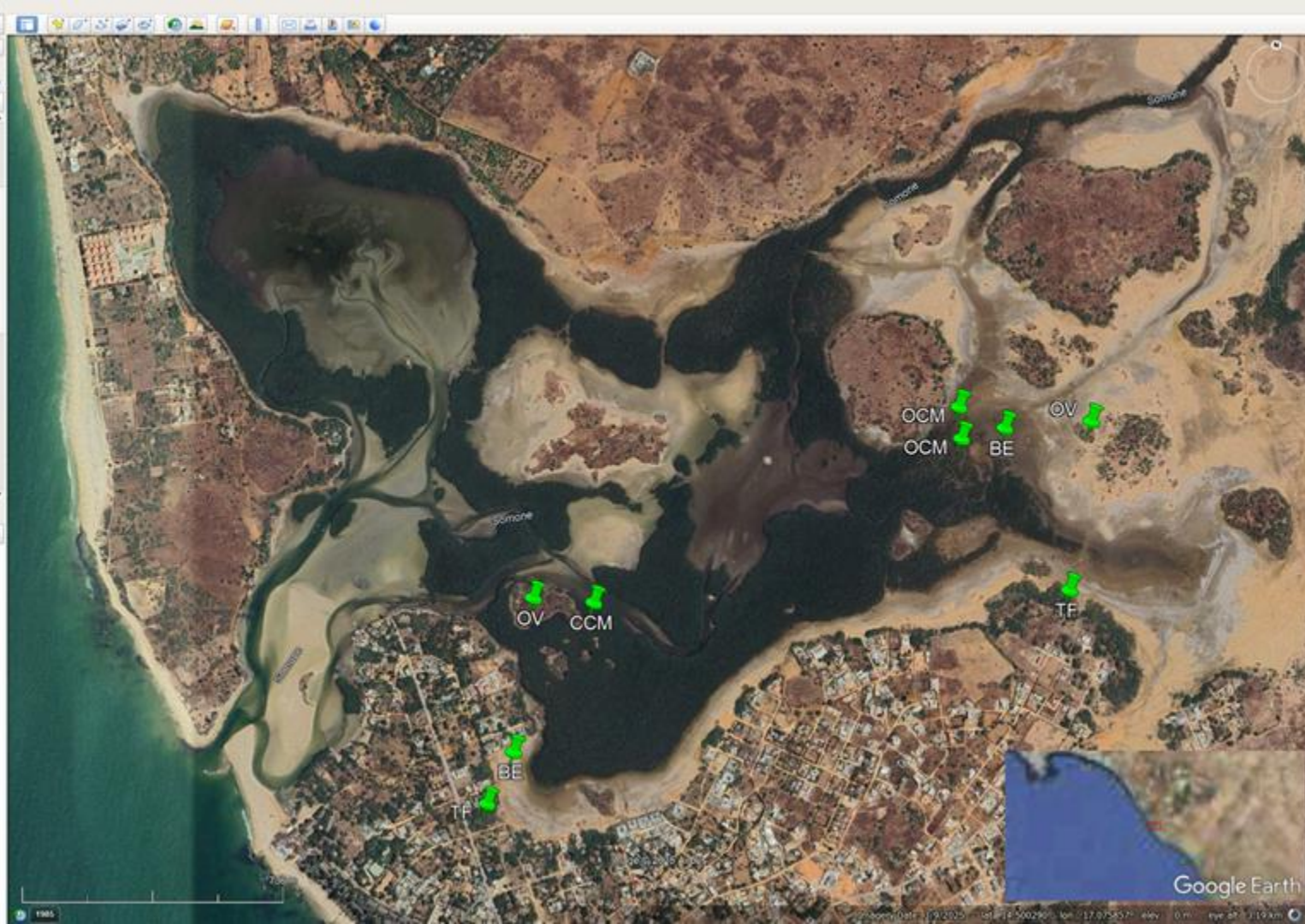
- Primary Database
- Announcements
- Borders and Labels
  - Places
  - Photos
  - Roads
  - 3D Buildings
  - Weather
  - Gallery
  - More
- Terrain



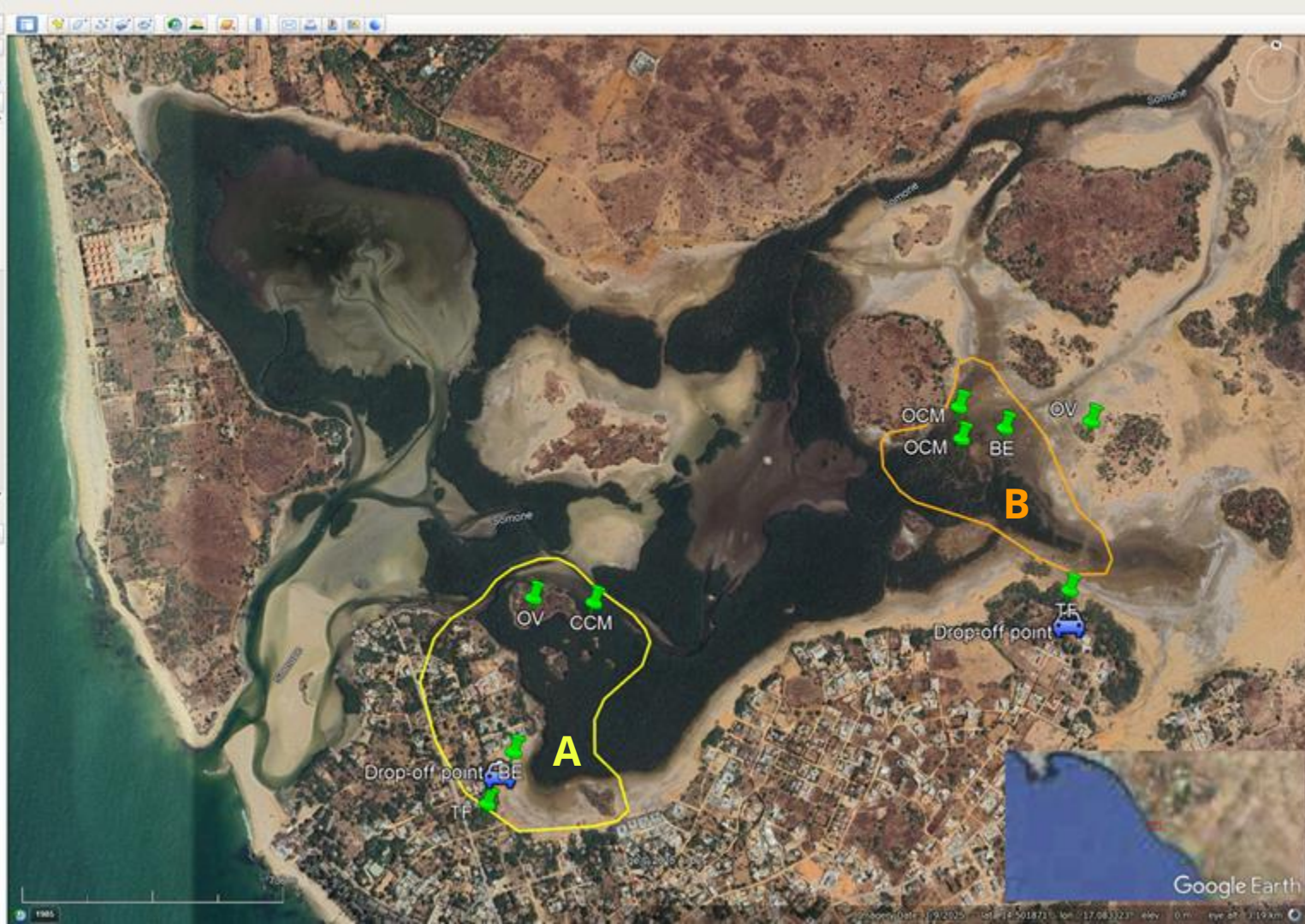
# Targeting 5 plots representing 5 classes

Class	Example	Class	Example
1. Closed-Canopy Mangrove		4. Other Vegetation E.g. grassland, shrubland, cropland	
2. Open-Canopy Mangrove			
3. Terrestrial Forest		5. Barren Exposed E.g. soil, mud	











- Zone B
- OCM
- OV
- BE
- OCM11 - backup
- OCM7 - backup
- OCM
- OCM13 - fieldwork ba...
- CCM
- Reserve dam
- Road dam
- Drop-off point
- Drop-off point
- Boardwalk
- Viewing platform
- Choose building
- Randia Reserve
- Ecological site CCM
- Upstream mas of A...
- TF
- BE
- OV
- TF
- Somone\_2025
- Autonomous administration

- Primary Database
- Announcements
- Borders and Labels
- Places
- Photos
- Roads
- 3D Buildings
- Weather
- Gallery
- More
- Terrain





Search

Places

- My Places
  - someone\_cras\_2020\_sdm...
  - Someone fieldwork
    - Zone A
    - Zone B**
    - OCM
    - OV
    - BE
    - OCM1 - backup
    - OCM7 - backup
    - OCM
    - OCM13 - fieldwork ba...
    - OCM
    - Reserve dam
    - Road dam
    - Drop-off point
    - Drop-off point
    - Boardwalk
    - Viewing platform
    - Chinese building
    - Banda Reserve
    - Ecological site OCM
    - Upstream max of Avic...
    - TF
    - es

Layers

- Primary Database
  - Announcements
  - Borders and Labels
    - Places
    - Photos
    - Roads
    - 3D Buildings
    - Weather
    - Gallery
    - More
  - Terrain



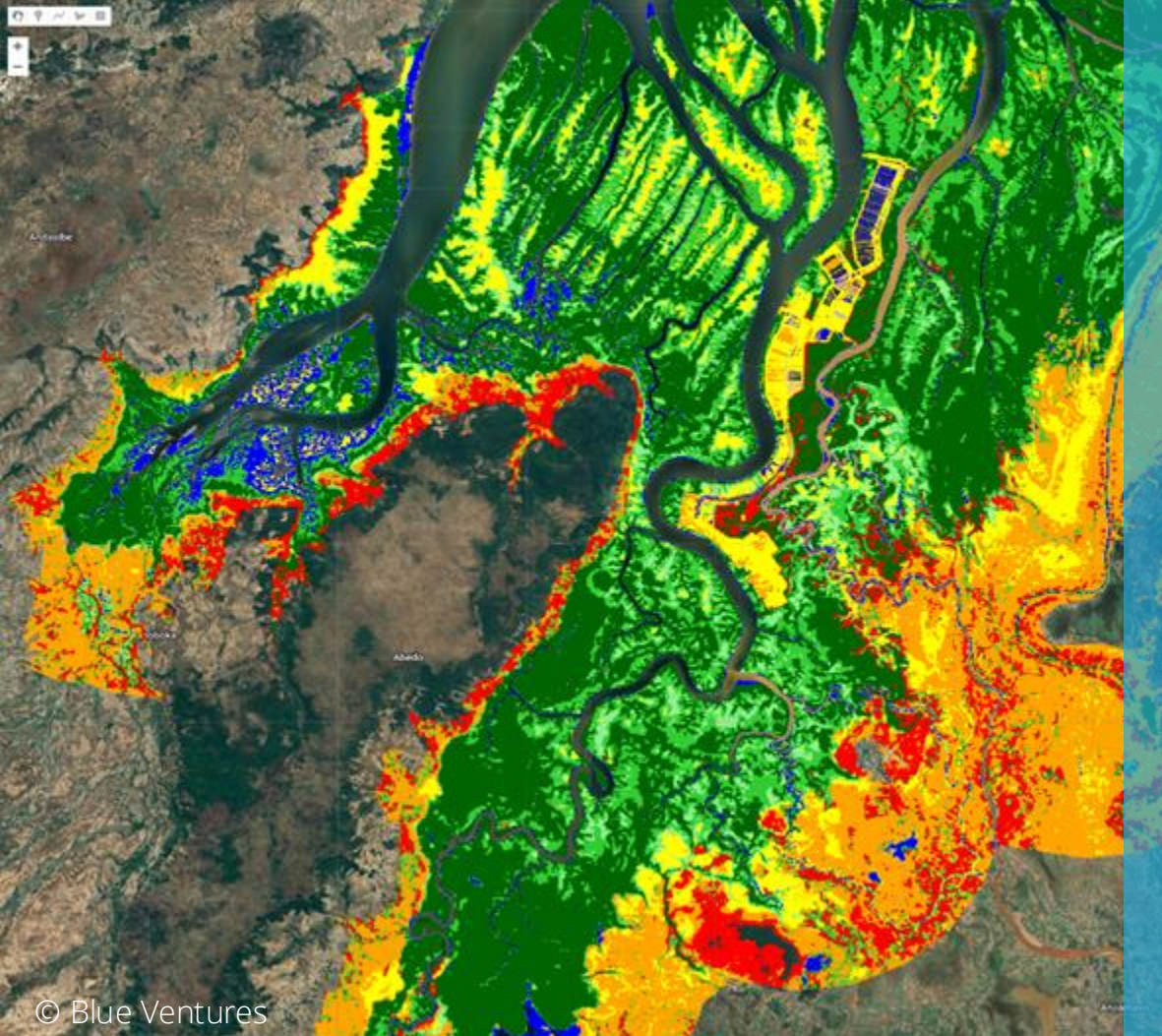


Field safety - please read!

<http://bit.ly/40nvqFK>







# GEM Maps













Zooming in...







# Dynamics in Somone

Class	Historical	Contemporary	PercentChange	Loss	PercentLoss	Persistence	PercentPersistence	Gain	PercentGain
Mangroves (CCM+OCM)	129.7	130.5	0.6%	4.2	3.2%	125.5	96.8%	4.9	3.8%
Closed-Canopy Mangrove	107.4	108.6	1.1%	3.3	3.1%	104.1	96.9%	4.5	4.2%
Open-Canopy Mangrove	22.3	21.8	-2.0%	6.0	26.9%	16.3	73.2%	5.5	24.9%
Terrestrial Forest	221.6	140.8	-36.5%	122.4	55.2%	99.2	44.8%	41.5	18.7%
Other Vegetation	1,972.0	1,976.8	0.2%	450.5	22.8%	1,521.5	77.2%	455.3	23.1%
Barren Exposed	709.0	702.2	-1.0%	290.6	41.0%	418.4	59.0%	283.8	40.0%
Residual Water	18.5	18.8	1.7%	2.5	13.7%	15.9	86.3%	2.9	15.5%

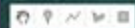
- Minimal change in mangrove extent
- 1.1% gain in CCM
- 2% fall in OCM
- Significant fall in Terrestrial Forest extent (34 ha converted to Other Vegetation)
- 170 ha of Exposed Barren converted to Other Vegetation (new suburbs in work)



Map Satellite











Map Satellite







Map

Satellite





**1. Mangrove  
mapping**

**1. GEM**

**1. CRAs**

**1. Next steps**



# How GEM outputs can be used

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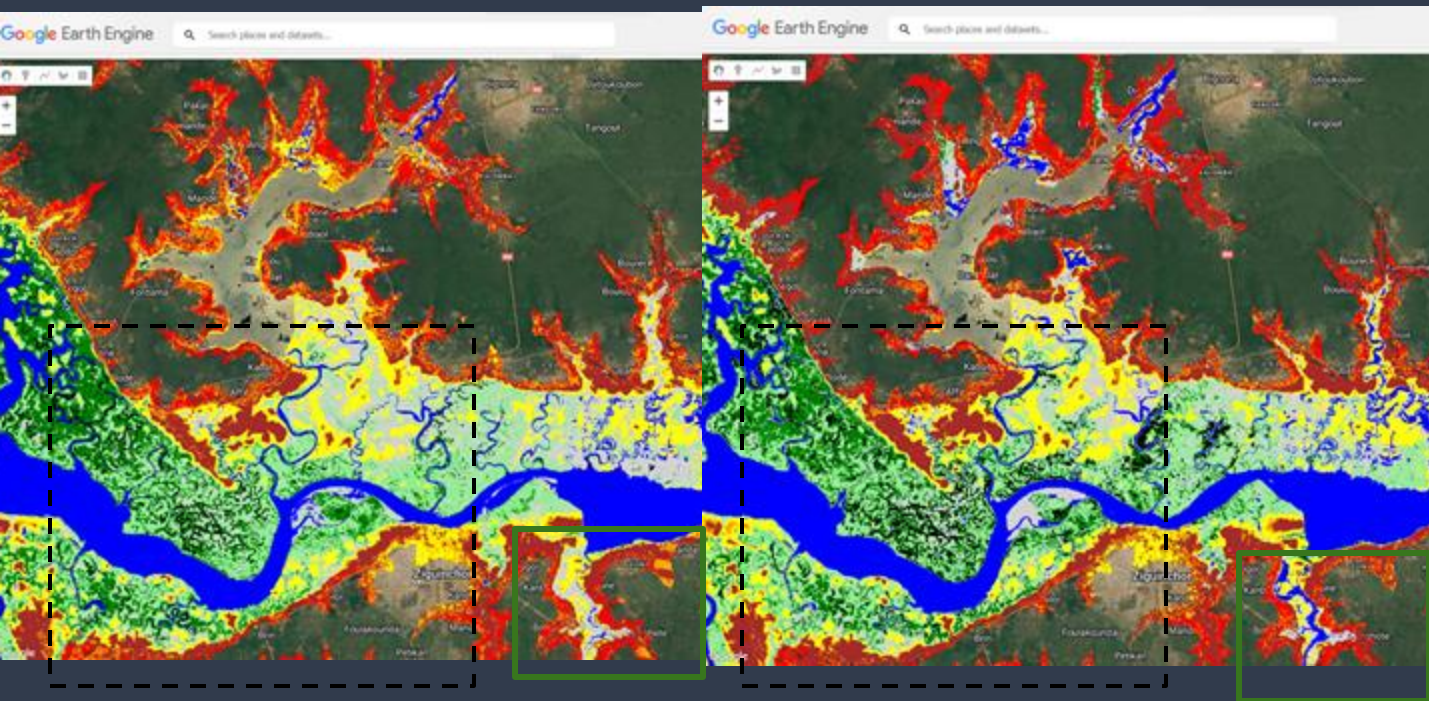
- Monitor extent and dynamics
- Help identify factors behind loss and gain
- Monitor existing / inform further management measures
- Visualising impact of management/reforestation measures
- Inform and monitor reforestation projects
- Support community engagement

## Example of Kawawana Area of considerable gain in Eastern region

Closed-Canopy Mangrove 1  
Closed-Canopy Mangrove 2  
Open-Canopy Mangrove 1  
Open-Canopy Mangrove 2  
Terrestrial Forest  
Dry Vegetation  
Wet Vegetation  
Exposed & Barren  
Residual Water

2013

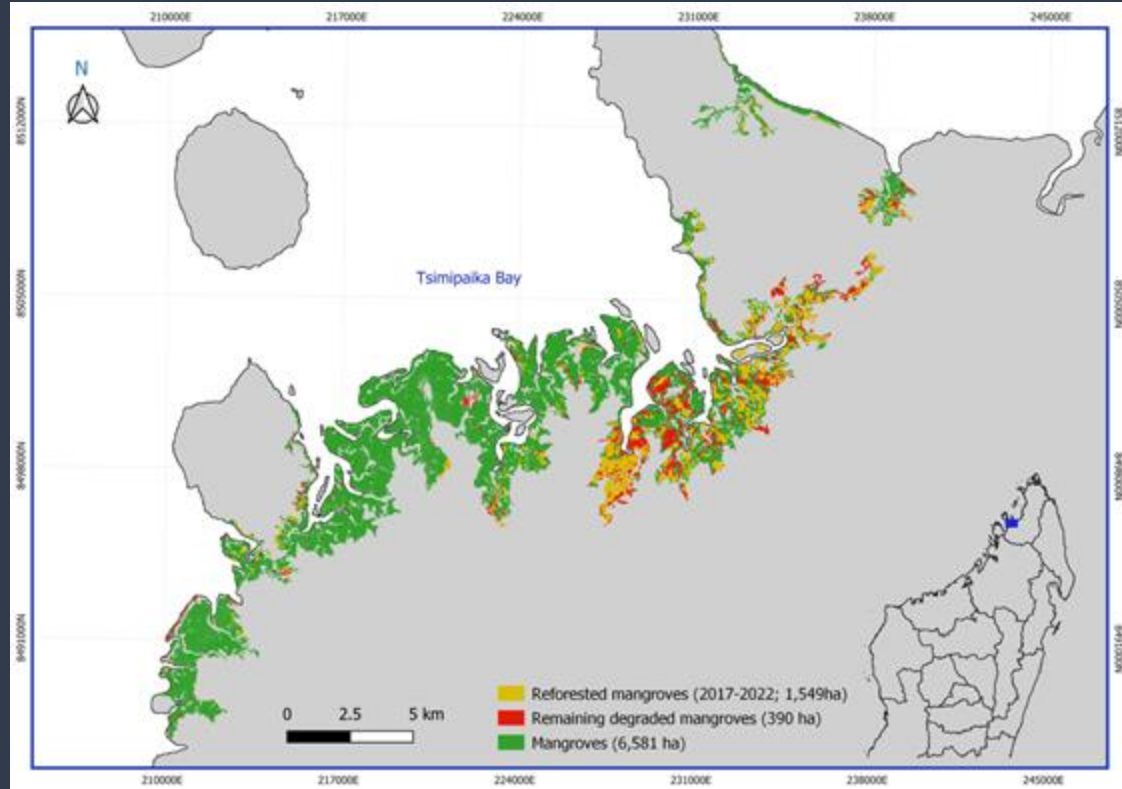
2023



Mangrove forest area  
2013 : 11152.30 ha  
Mangrove forest area  
2023 : 11701 ha  
Mangrove forest loss :  
260.88 ha  
See next slide  
Mangrove forest gain :  
818.87 ha

# Reforestation example (Tsimipaika)

- Tsimipaika Bay located in Northwest Madagascar
- Using GEM maps to inform community-led mangrove restoration projects
- 1500ha reforested by local communities





# What's coming in GEM v3?

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- Carbon data
- Link-up to partner systems (databases, dashboards, web maps)
- Drone CRA fieldwork protocol
- Please send feedback + ideas to [gem@blueventures.org](mailto:gem@blueventures.org)

# Merci beaucoup

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beyond conservation