Pacific Community
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Digital Earth PACIFIC

GIS and Remote Sensing approaches in Mapping Coastal Habitats

Maivunijale Waqa

Geospatial Assistant

Wider MACBLUE team members:

- Nick Metherall
- Shyam Lodhia
- Elenoa Biukoto
- Kamsin Raiju
- Samantha Krawczyk

Advisors:

- Alex Leith
- James Simpson
- Jesse Anderson
- Sachindra Singh

Pacific Geospatial and Remote Sensing Conference

25 - 29 November 2024

USP, Suva, Fiji

Outline of presentation

Maivunijale Waqa	Nick Metherall
Overview and intro to SPC's work on coastal marine spatial planning and habitat mapping	Digital Earth Pacific (DEPacific)
Field data collection – QField, GoPro	Wider workflow overviews
Use of drones for calibration and validation	Updates on mangrove extents
Case studies – Leluvia, Yanuca	Updates on seagrass extents – workflows
Benthic and non-benthic masks	Plans for capacity building

Overview

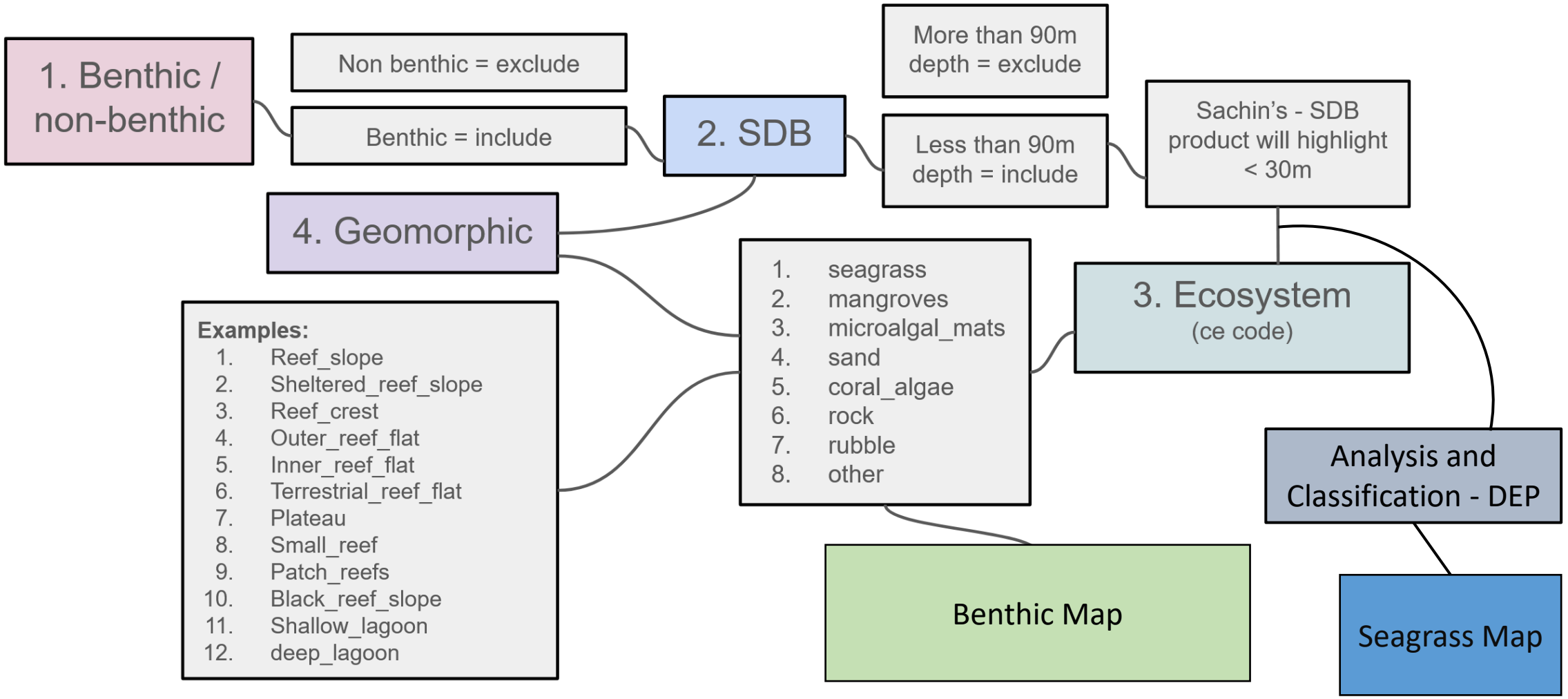
- Builds on the information presented in Shyam's presentation this morning that was shared from 8.50am today
- Seagrass meadows and mangrove forests sequester carbon faster and store more carbon per hectare than terrestrial forests.
- Mapping reveals how habitats are responding to climate change, such as rising sea levels and ocean warming.
- Provides the data needed to quantify ecosystem services, supporting arguments for conservation funding and action.
- Collaboration between DEP and MACBLUE project focusing on 4 pacific island countries including Fiji, PNG, Solomon and Vanuatu.

Approach

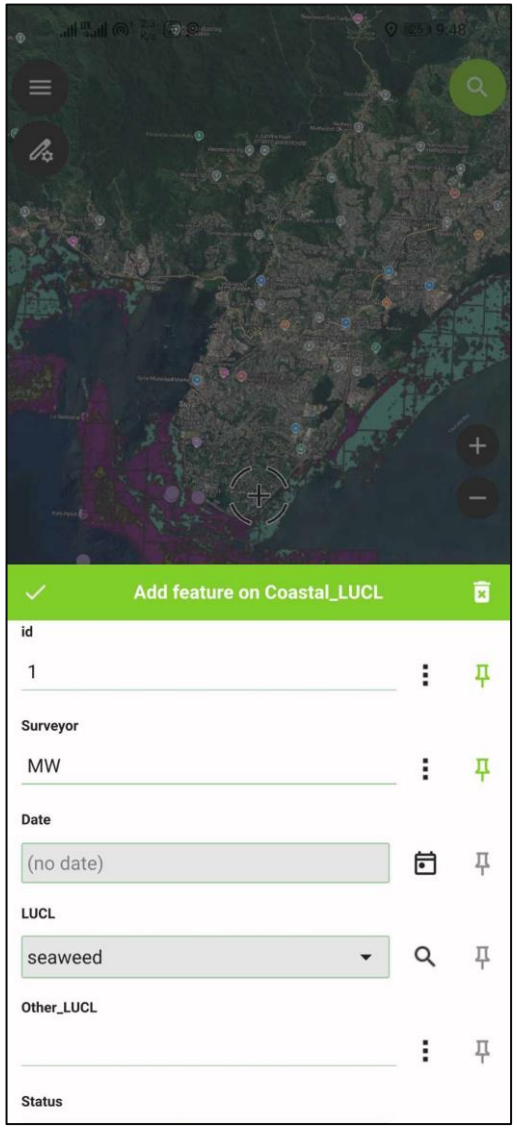
1. Binary mask (benthic / non-benthic)
2. Bathymetry - potential incorporation of Sachin's SDB product or GEBCO threshold
3. Ecosystem classifier –DEP Tool
4. Potential incorporation of geomorphic zone (may not be necessary)
5. Output (Benthic Map)

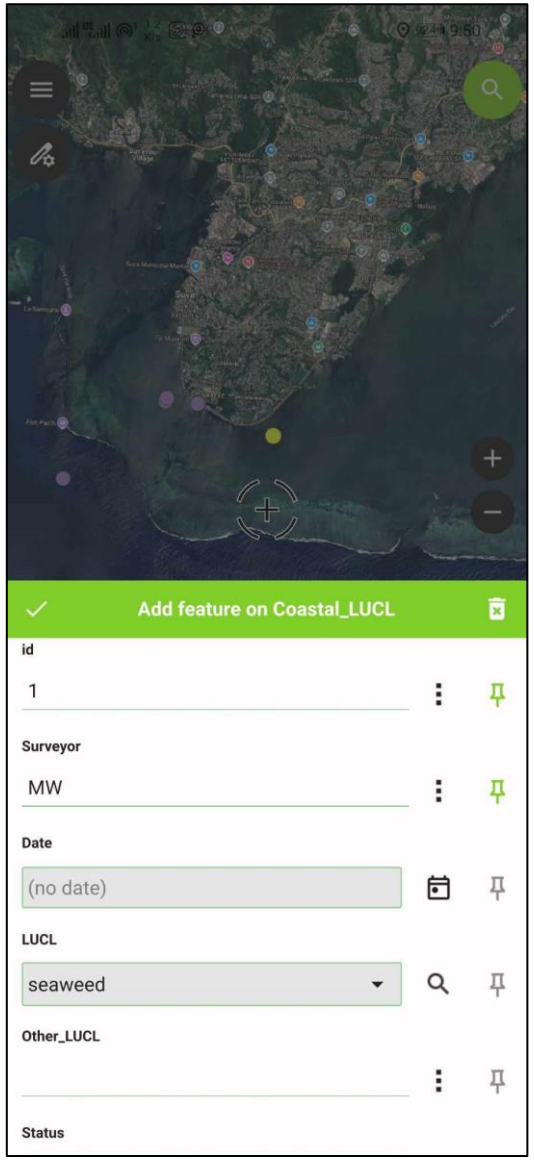
	benthic_class
1	seagrass
2	mangrove
3	micoralgal_mats
4	sand_shallow
5	coral
6	rubble
7	rock
8	other

Approach Workflow



Data Collection – QField & GoPro



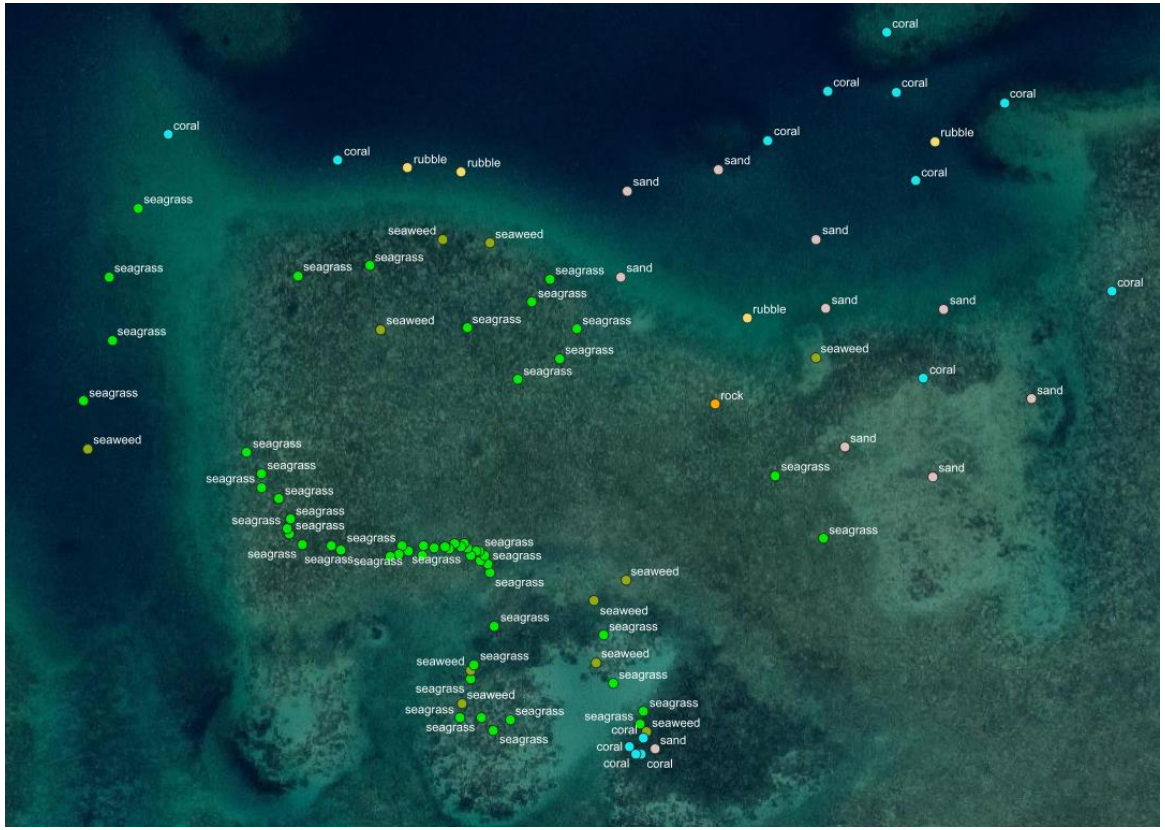


Benthic Points

- GoPro images geotagged and converted to point features.
- Qfield points extracted from the application.
- Explore around the island and collect points using the Qfield with real ground observation.
- Merging the points from Qfield and GoPro geotagged images in Qgis.

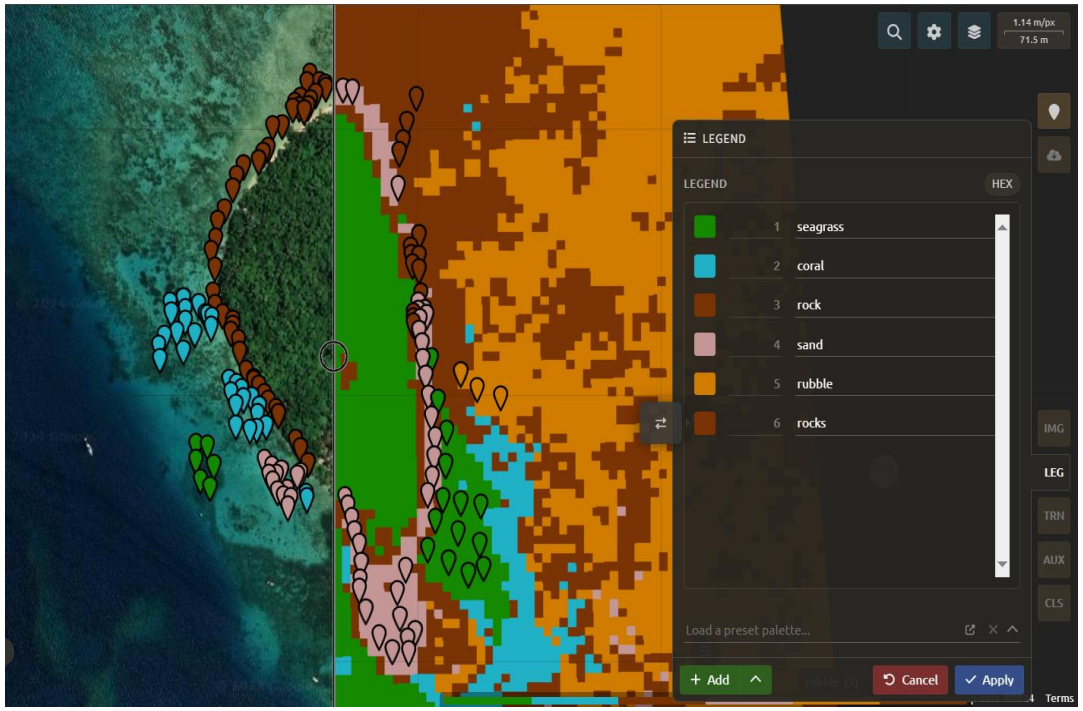
Suva South Coast & Yanuca

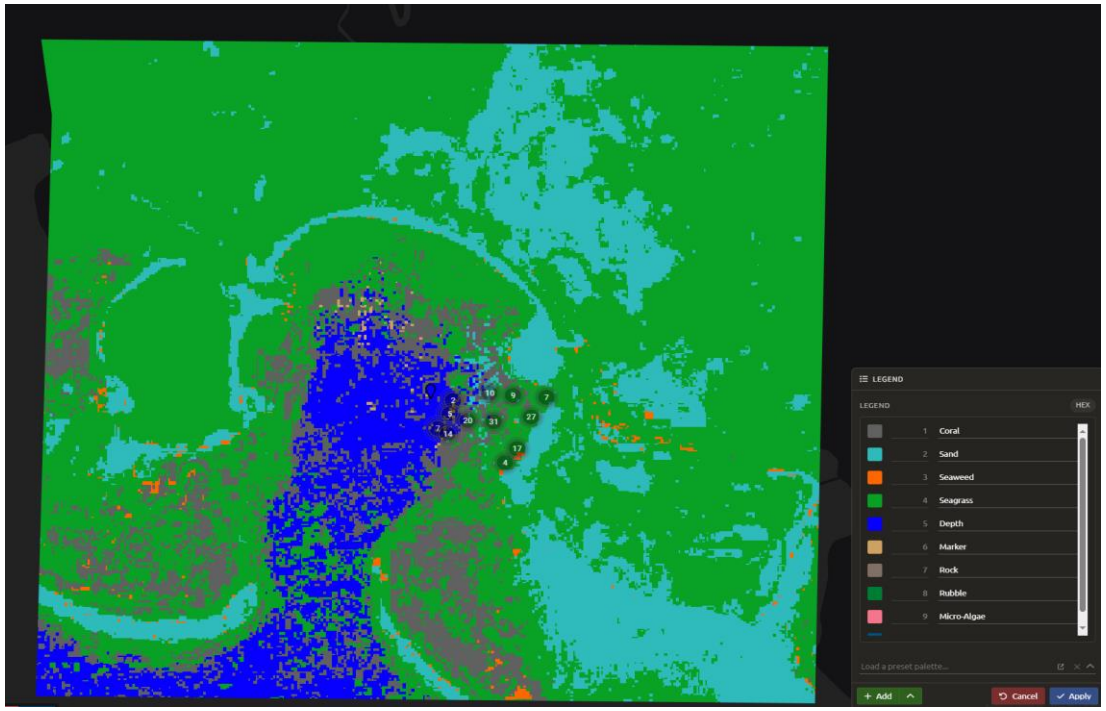
- Points was collected using Qfield and GoPro camera.
- GoPro images were geotagged in QGIS to extract the gps location data of the images and converted in point data.



Experimental Analysis

- Data points from qfield imported and classified in SEPAL.
- Run a coastal benthic analysis using ground truth benthic points
- Supervised Classification, training data points using ML





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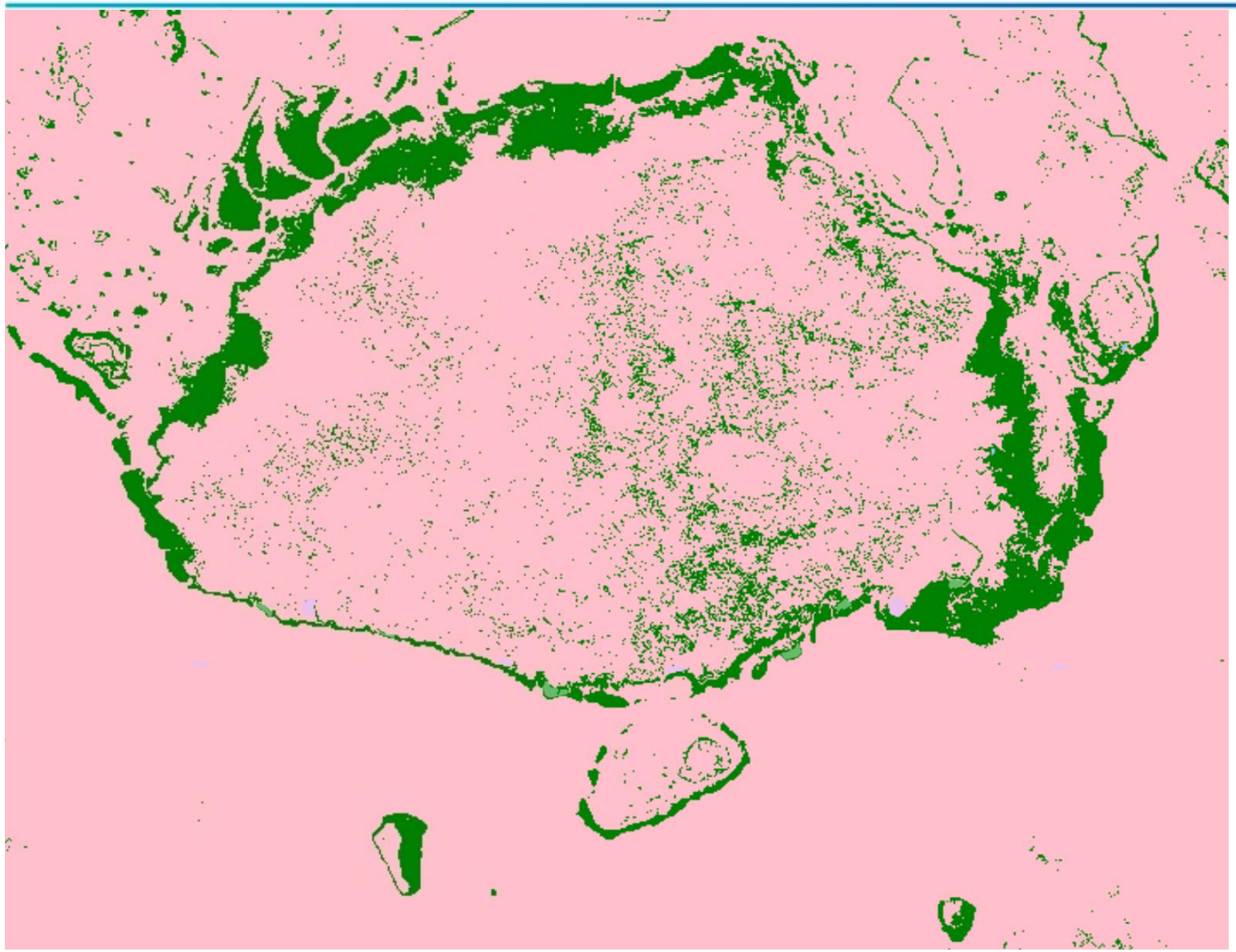
GEE Iteration – Create data points

Preliminary run: GEE

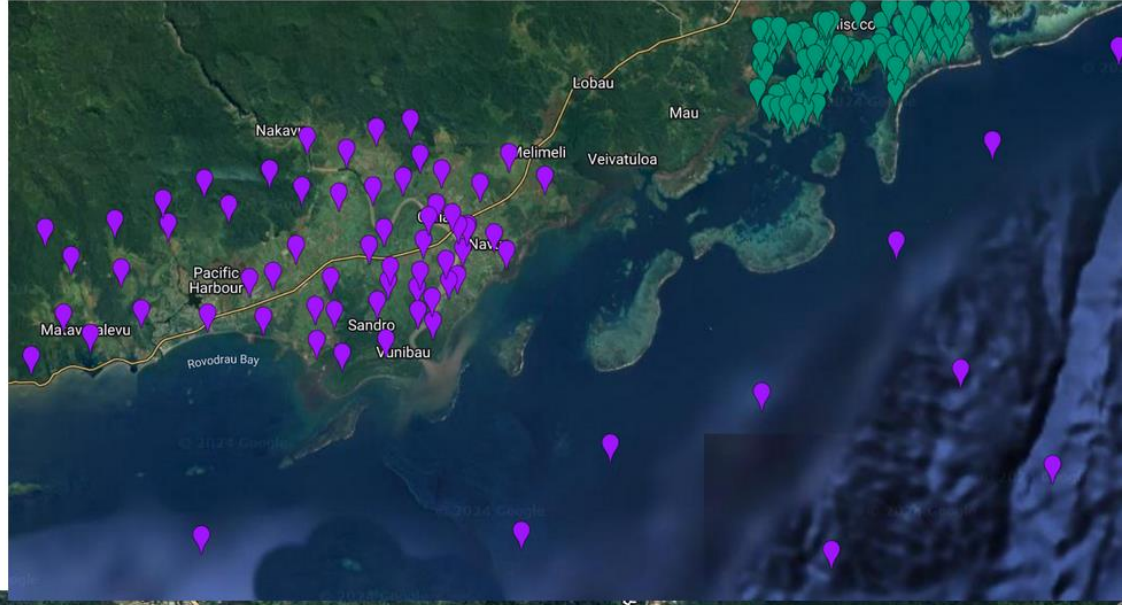


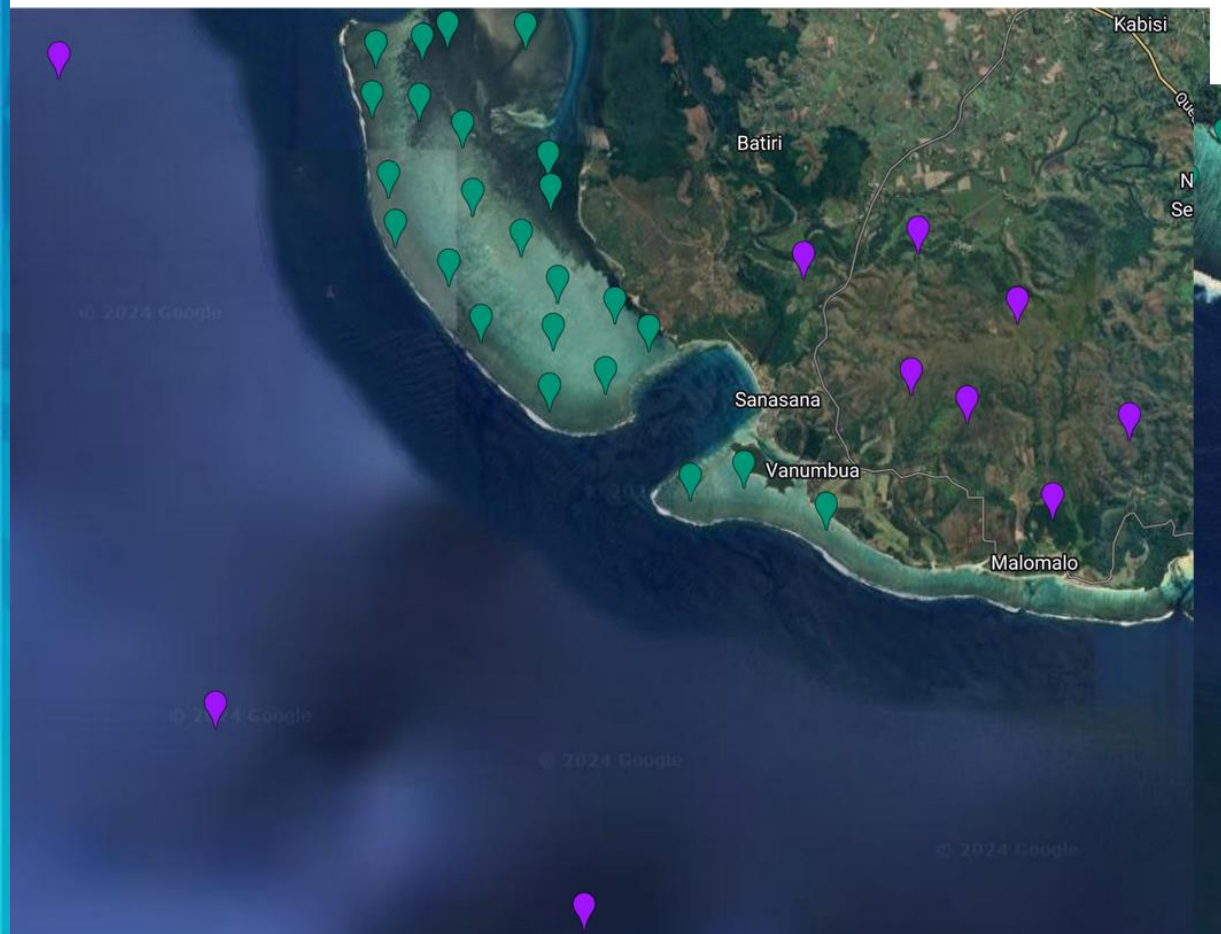
- First iteration of the binary mask
- Noise over the terrestrial areas
- ML confused by the similarities of spectral signatures between some benthic and non-benthic classes

Revised training data (points > polygons)

Benthic - green

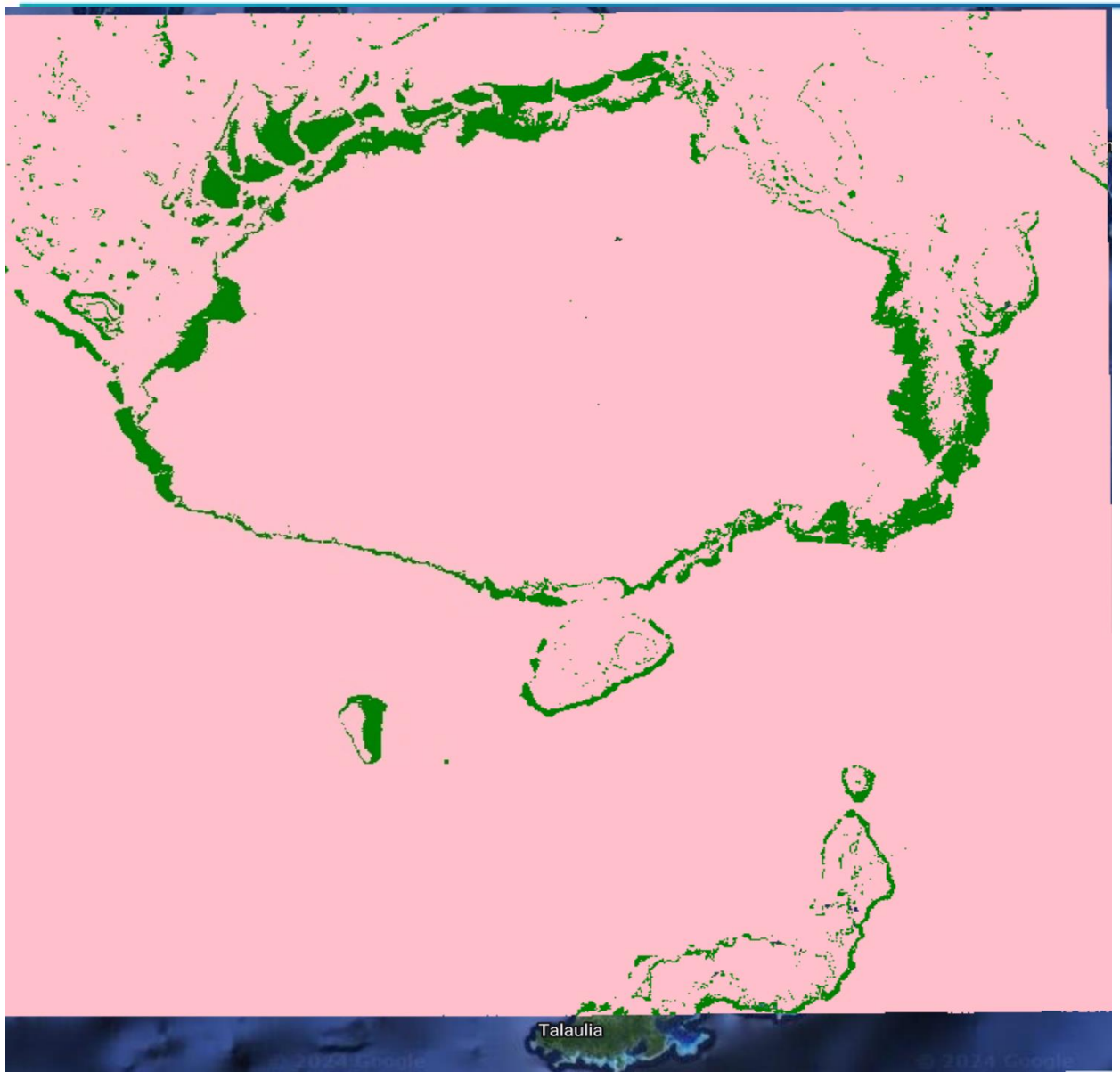
Non-benthic purple






Tavua Bay
Drauniivi
Tavua
Natunuku
Balata
Navuniivi
Barotu
Nailaga
Ba
Matawalu
Vitogo
Lautoka
Delaiyadua
Naingani
Dawasamu
Rukuruku
Lawaki
Natovi
Viseisei
Nasaga
Nadi Bay
Lodoni
Nadi
Korovou
Yako
Nalovo
Momi
Korokula
Cautata
Dromuna
Malomalo
Nabud
Korotogo
Tagaqe
Deuba

2nd Iteration result



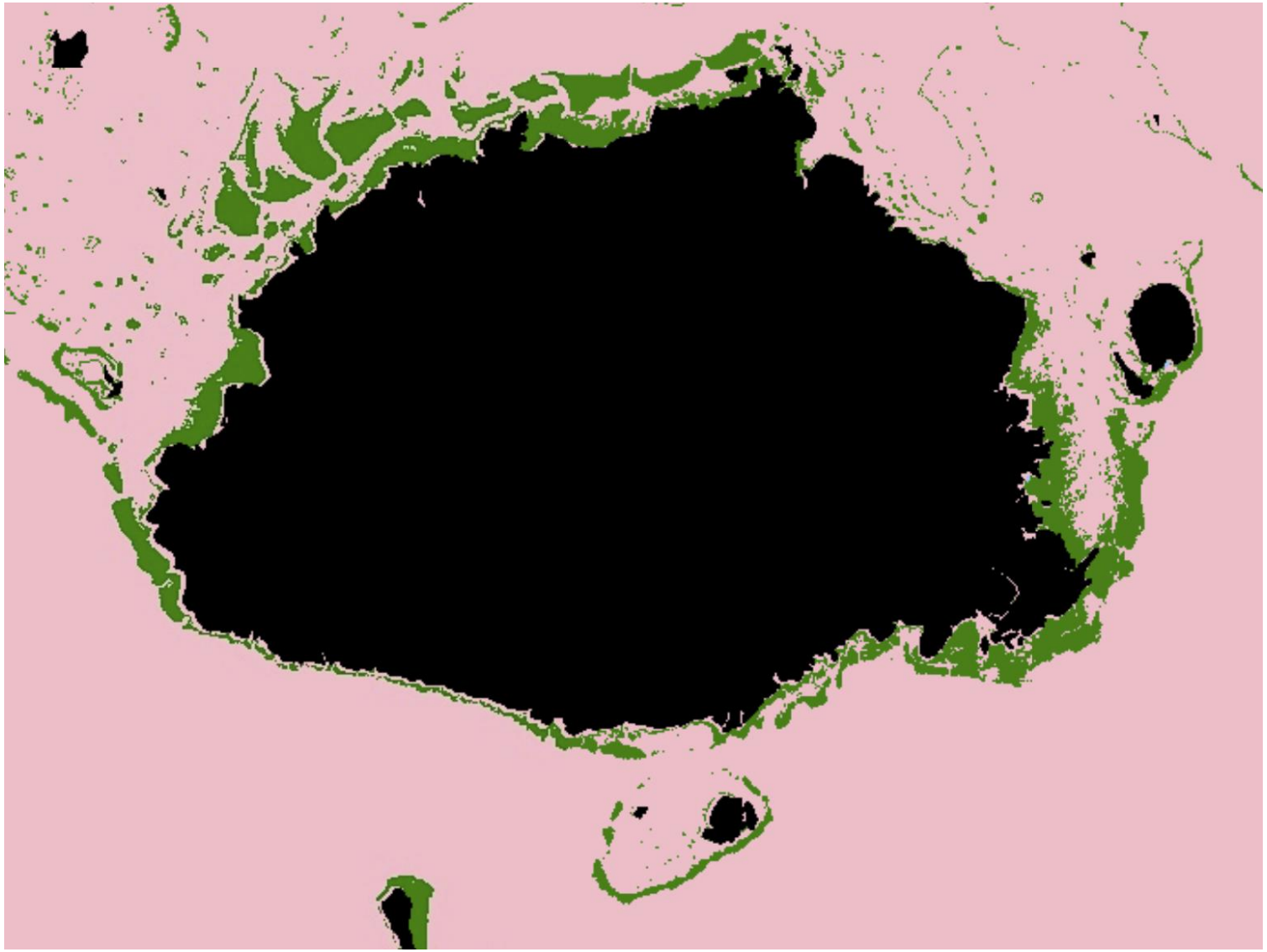
- Second iteration of the binary mask successfully masked out all the non-benthic classes especially terrestrial features.


Geometry Imports
Lodoni
Savuna
Layers
Map
Satellite
Nasesara
Nasauvuki
Uluibau
Burarua
Matacaucau
Kings Rd
Kings Rd
Korovou
Navunisole
Nakalawaca
Veinuqa
Naitutu
Naloto
Google
Keyboard shortcuts
Map data ©2024 Google Imagery ©2024 Airbus, CNES / Airbus, Landsat / Copernicus, Maxar Technologies, U.S. Geological Survey
1 km
Terms
Report a map error


Geometry Imports
Layers
Map
Satellite
Google
Keyboard shortcuts
Map data ©2024 Google Imagery ©2024 Airbus, CNES / Airbus, Landsat / Copernicus, Maxar Technologies, U.S. Geological Survey
1 km
Terms
Report a map error

Mask – out land

- Non-benthic classes are masked out using the masking function.



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Nicholas Metherall

EO Technical Officer

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Outline

Digital Earth Pacific (DEPacific)
Wider workflow overviews
Updates on mangrove extents
Updates on seagrass extents – workflows
Plans for capacity building

Overview of Earth and Ocean Observations (EOO) Team at SPC

- Geoscience Energy and Maritime (GEM) Division
- Geoscience and Energy Program (GEP) Branch
- Earth and Ocean Observation (EOO) Team

Sachindra Singh - Team Lead + Software Engineering
Nicholas Metherall – Hydrology, Forestry, GIS and Remote Sensing
Elenoa Biukoto – Forestry, GIS, Remote Sensing
Maivunijale Waqa – Coastal marine habitat mapping, GIS and remote sensing
Ashweeta Sharma – Project Implementation
Vinaina Raboiliku – Finance and Admin
Kamsin Raju – (Science + Management + GIS)
Samantha Krawczyk – (Geodatabases + GIS and Environment)

Advisors: learning from Ministry of Forestry, Sustainable Forests Team (SPC), J Simpson (UniSyd)

Output 1:

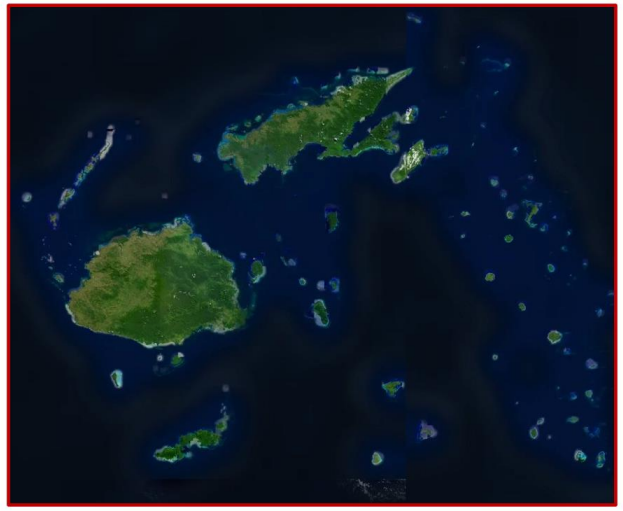
Status and trends of seagrass and mangrove populations mapped at national level and documented regarding changes in coverage

- **I.1** Selection/combination of available remote sensing satellites, sensors, data, and ground-truthing approaches
- **I.2** Mapping of current national SaM coverage
- **I.3** Ground-truthing
- **I.4** Change detection in priority sites

Digital Earth Pacific

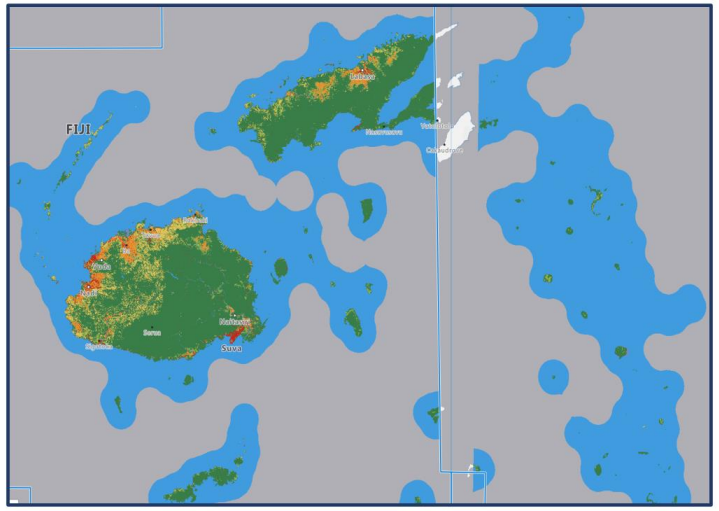
DEP in a (technical) nutshell

Digital Earth Pacific is a **cloud** platform that makes satellite data for the Pacific accessible using open source data science libraries and models.



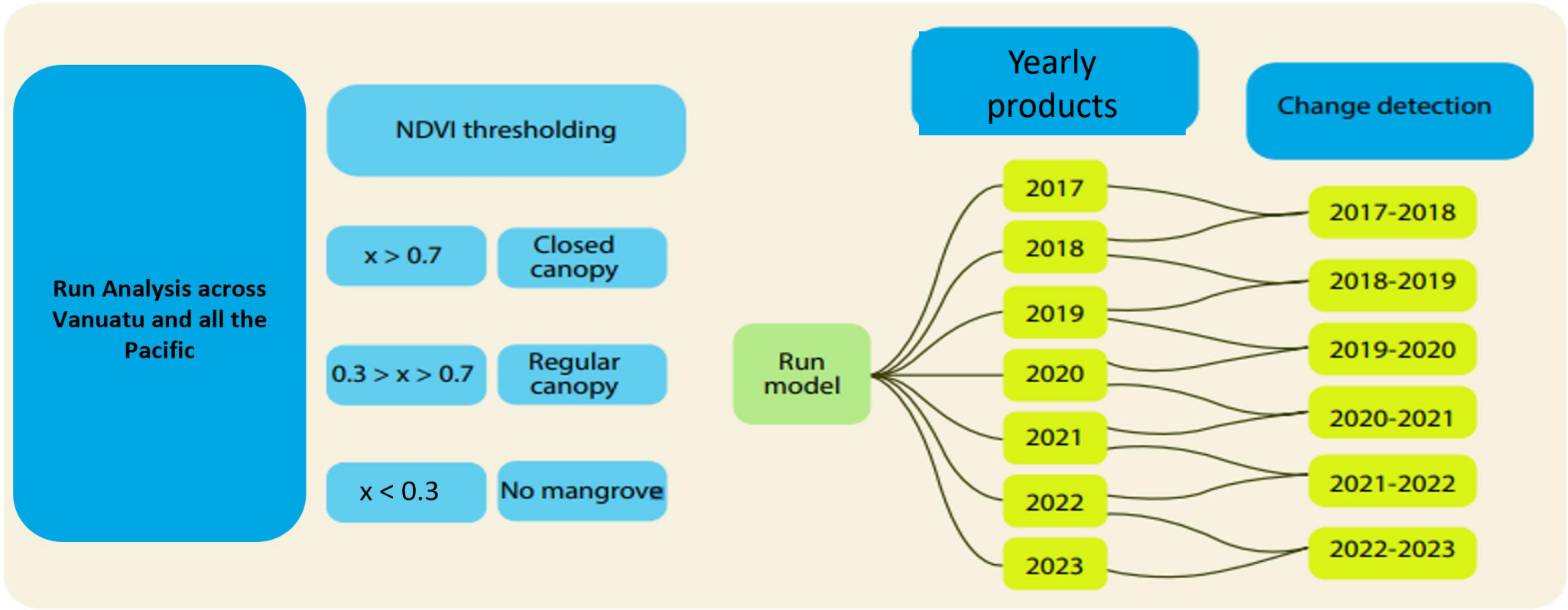
Multi-spectral Satellite Imagery

Notebooks are RESUABLE components that combines live code, visualisations, documentation and configurations to enable EO analysis at scale.



Earth Observation Product

I.2 Mapping of current national SaM coverage



High-level overview of methods used in generating the extent of mangrove areas from earth observation datasets.


Lambase
Lambase
Pacific Ocean
Pacific Ocean

MACBLUE
Management and Conservation of Blue Carbon Ecosystems

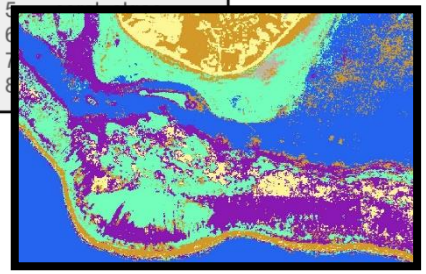
The first version of mangrove extents were made openly accessible online via Digital Earth Pacific www.digitalearthpacific.org

There are interactive webmaps to view these mangrove extents across Fiji and the wider Pacific. https://maps.digitalearthpacific.org

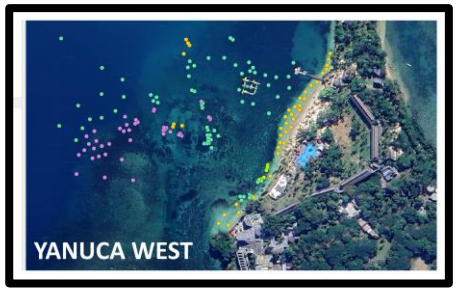
1. SEAGRASS EXTENTS

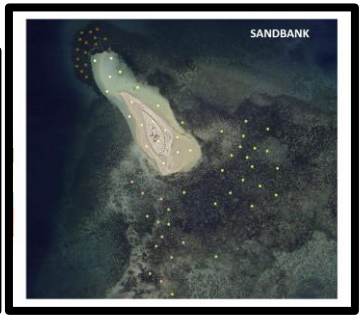
1. Benthic / non-benthic
   - Non benthic = exclude
   - Benthic = include
2. SDB
   - More than 90m depth = exclude
   - Less than 90m depth = include
   - Sachin's - SDB product will highlight < 30m
3. Ecosystem (ce code)
   1. seagrass
   2. mangroves
   3. microalgal_mats
   4. sand
4. Geomorphic

Examples:
1. Reef_slope
2. Sheltered_reef_slope
3. Reef_crest
4. Outer_reef_flat
5. Inner_reef_flat
6. Terrestrial_reef_flat
7. Plateau
8. Small_reef
9. Patch_reefs
10. Black_reef_slope
11. Shallow_lagoon
12. deep_lagoon

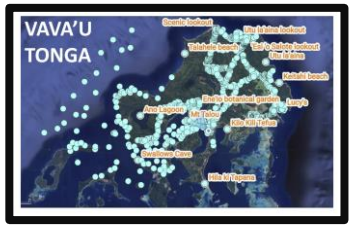


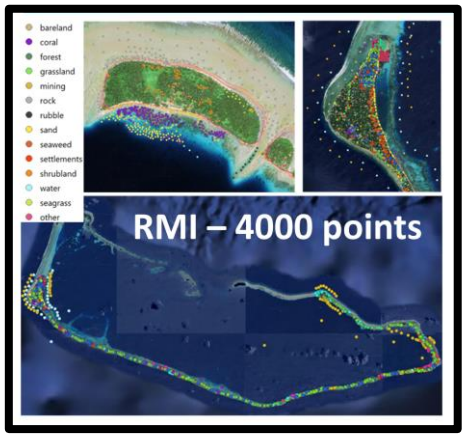
2. TRAIN>PREDICT>VALIDATE>RETRAIN ACROSS FIJI

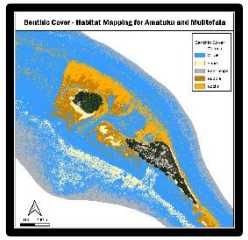




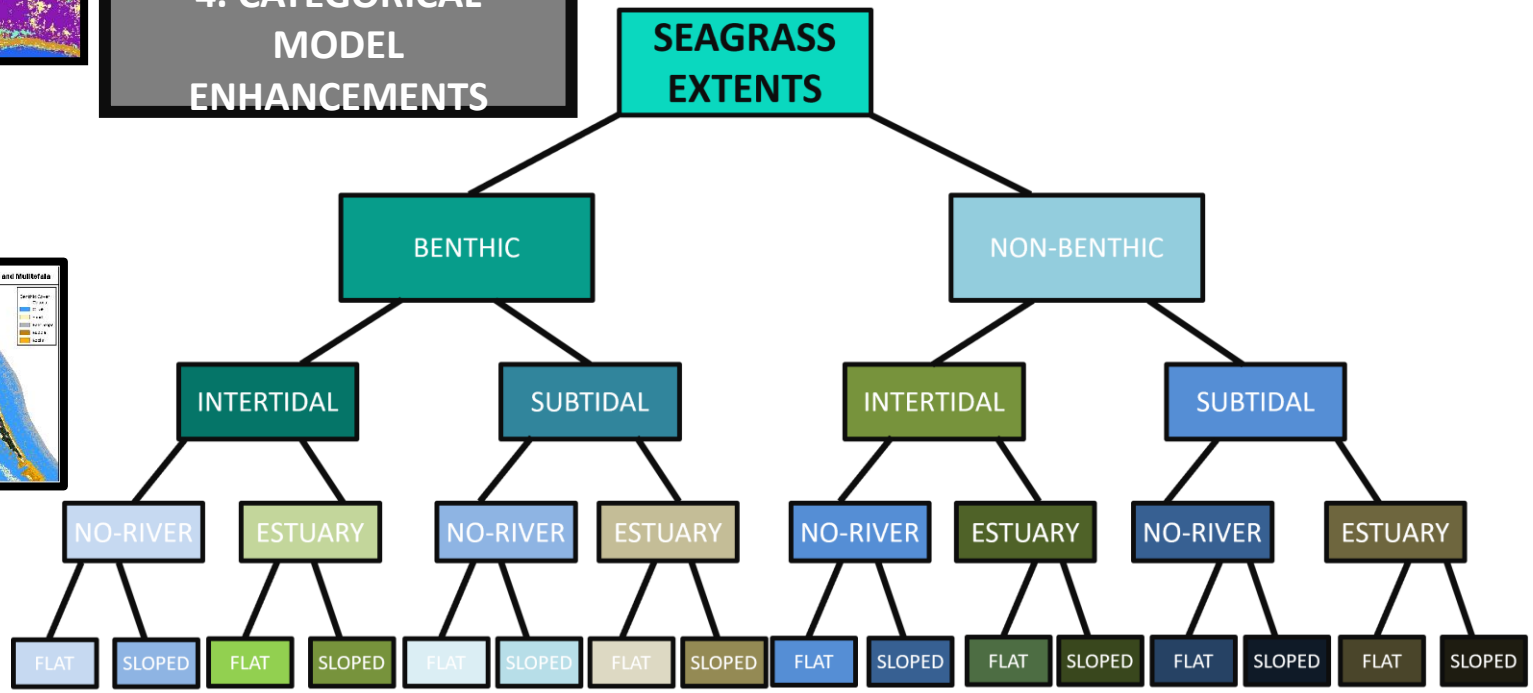
3. TRAIN>PREDICT>VALIDATE>RETRAIN ACROSS OTHER MACBLUE COUNTRIES



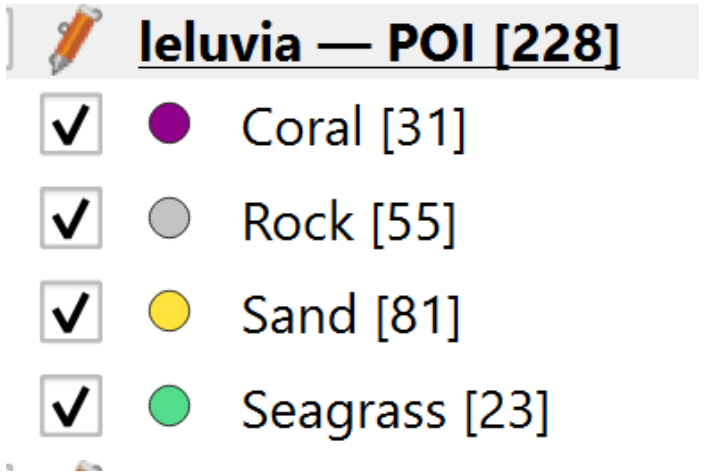




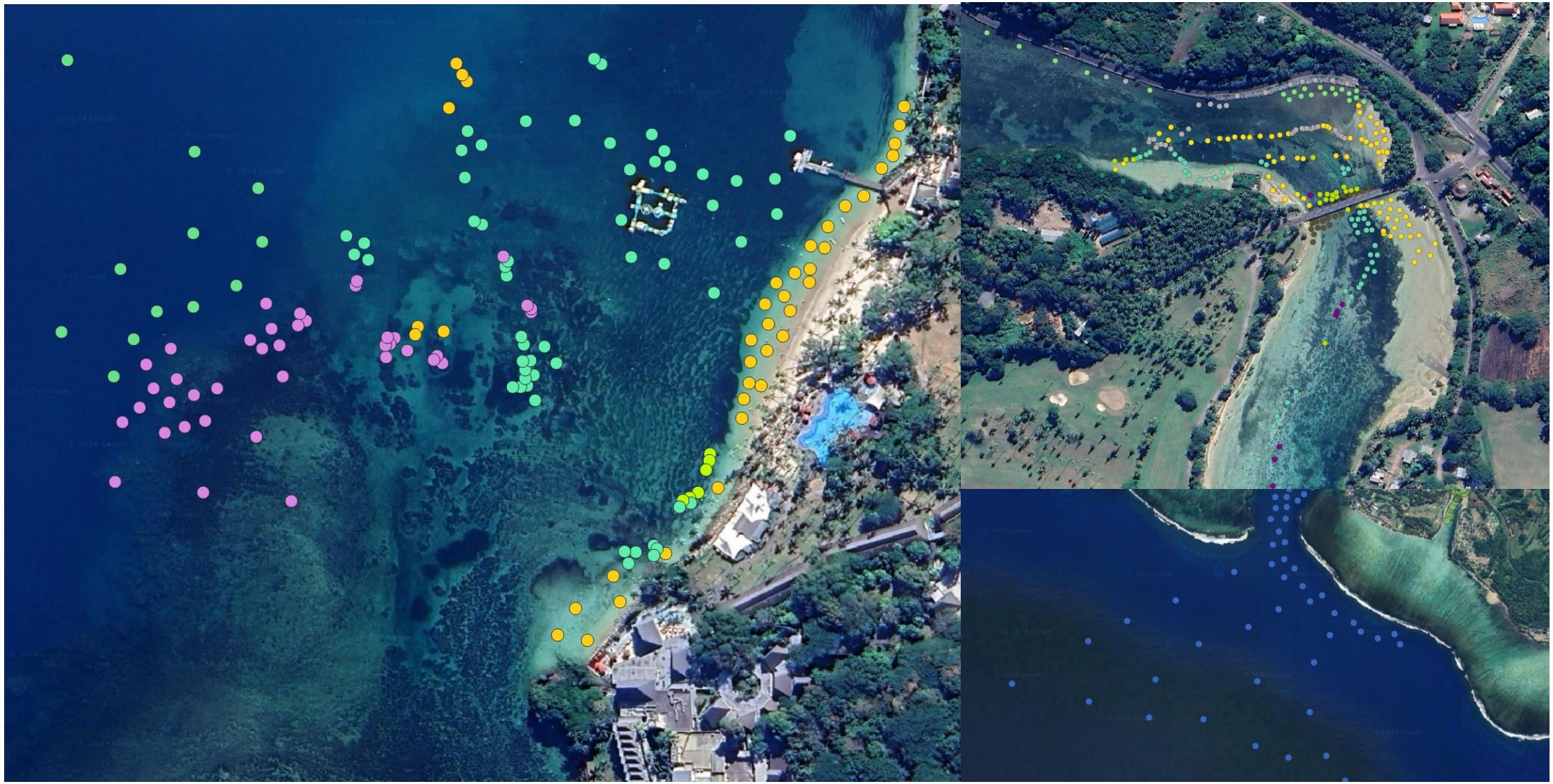
4. CATEGORICAL MODEL ENHANCEMENTS



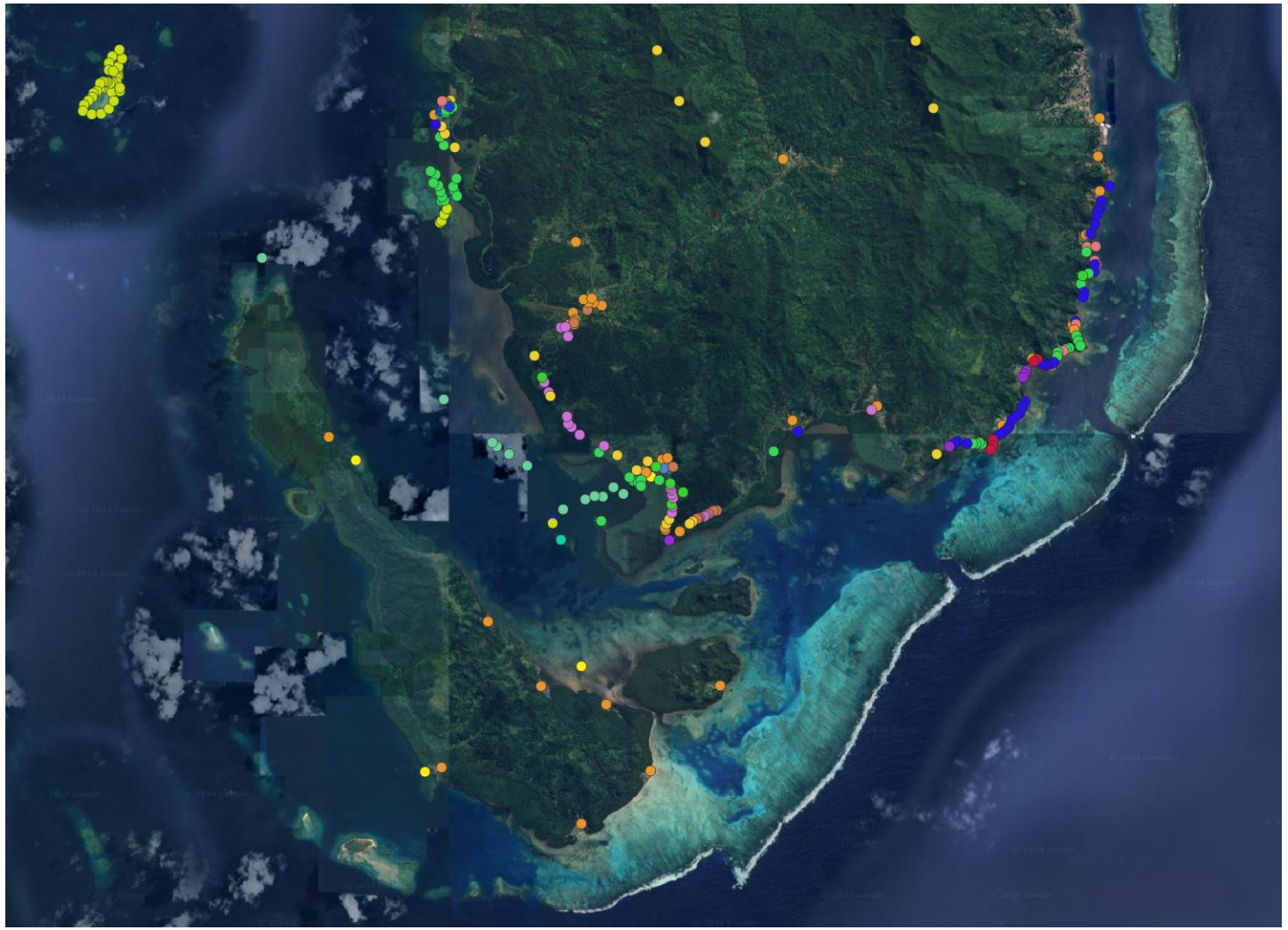
Leluvia Aug



Nadroga – coastal data collection



Ovalau, Lomaiviti, working with SPREP + Alluvium



Dawasamu sites

Jupyter interface

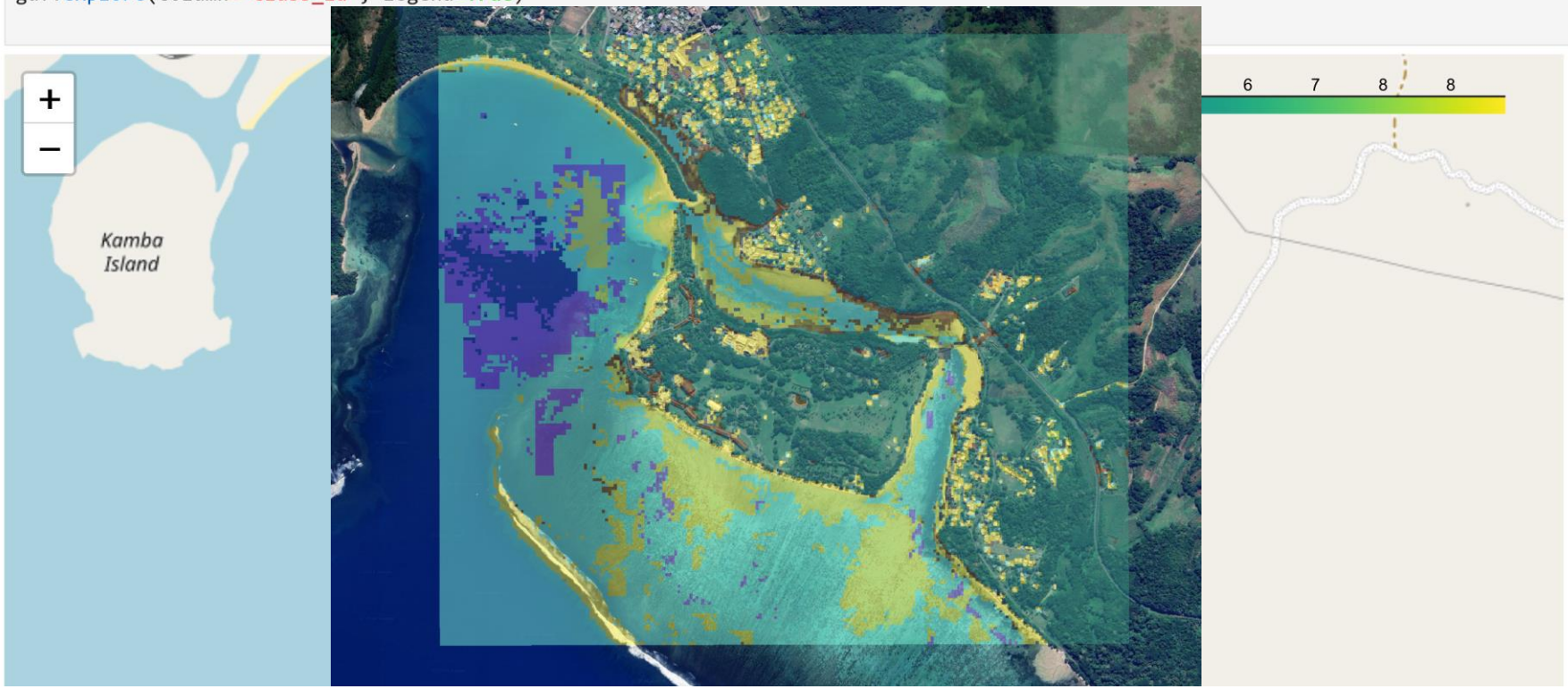
crs 7/8

[5]:
```
dask_client = DaskClient(n_workers=1, threads_per_worker=16, memory_limit='16GB')

configure_s3_access(cloud_defaults=True, requester_pays=True)
```

[5]:
```
<botocore.credentials.DeferredRefreshableCredentials at 0x7f3b4832b400>
```

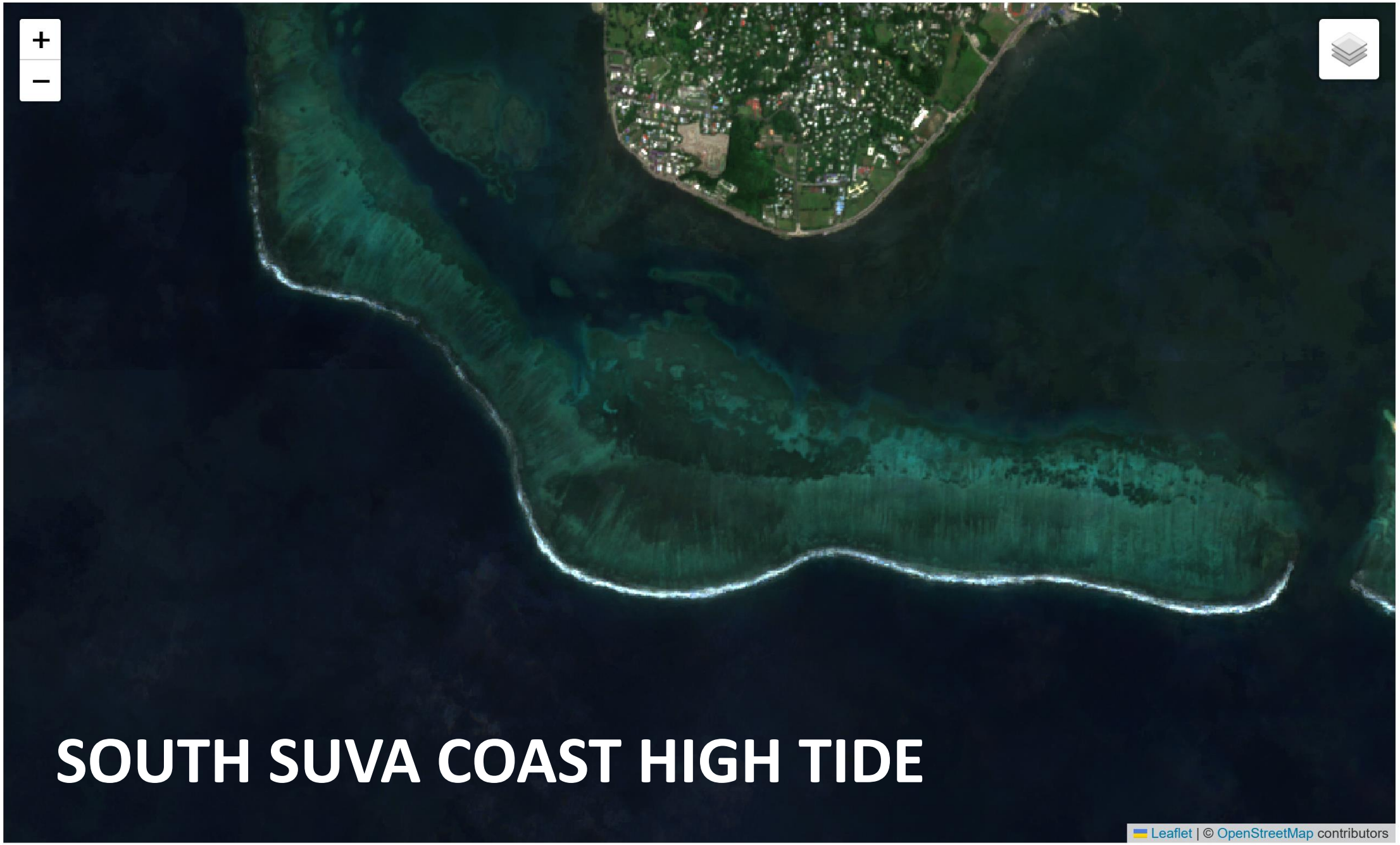
[6]:
```
# Define training data

gdf = gpd.read_file("marine_tdata_rf.geojson")

gdf.explore(column="class_id", legend=True)
```

[6]:

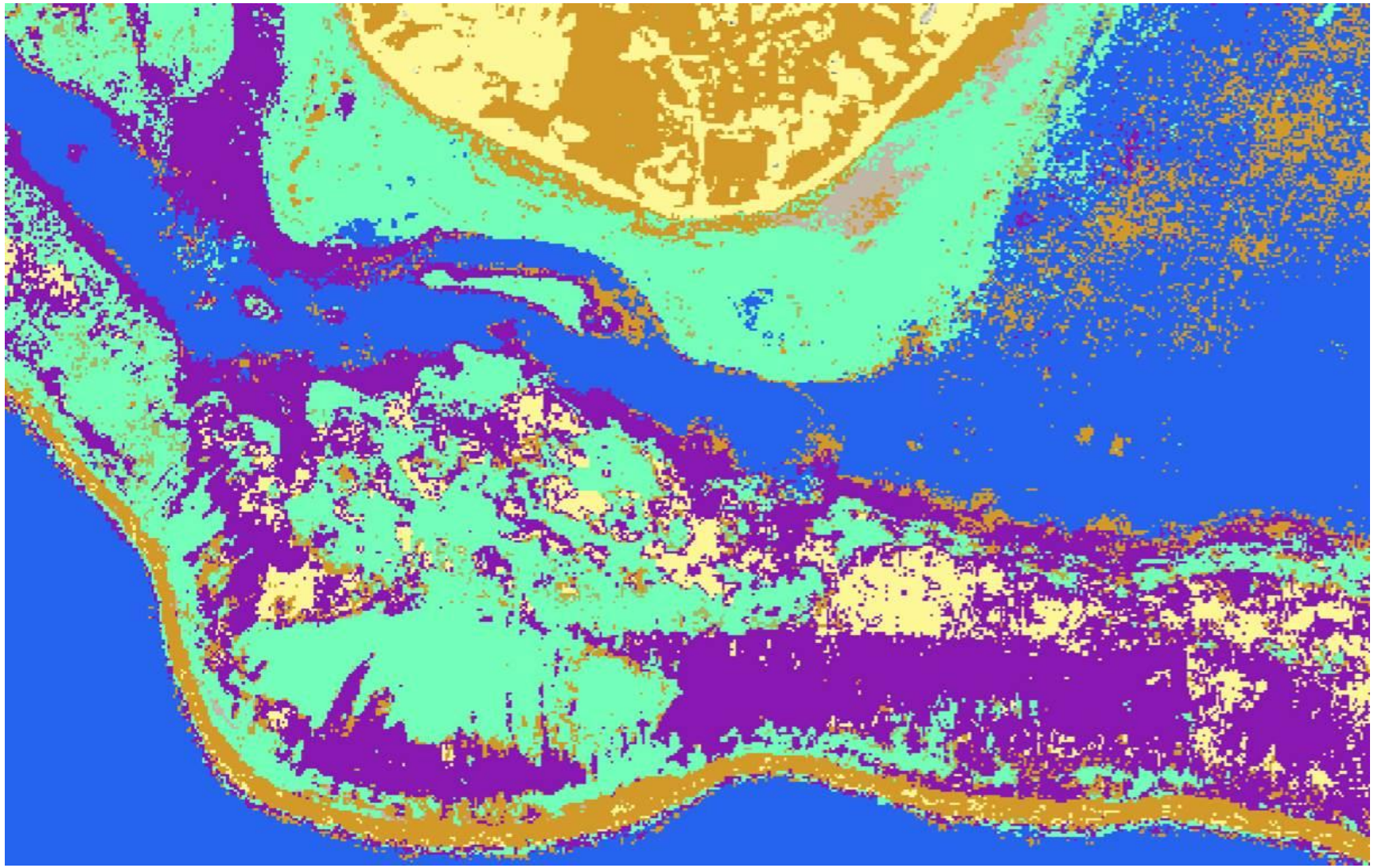


```
median_low.odc.explore(vmin=1000, vmax=4000)
```

```
median_high.odc.explore(vmin=1000, vmax=4000)
```



Current iteration of seagrass model



Step 3: Coastal Ecosystem classification

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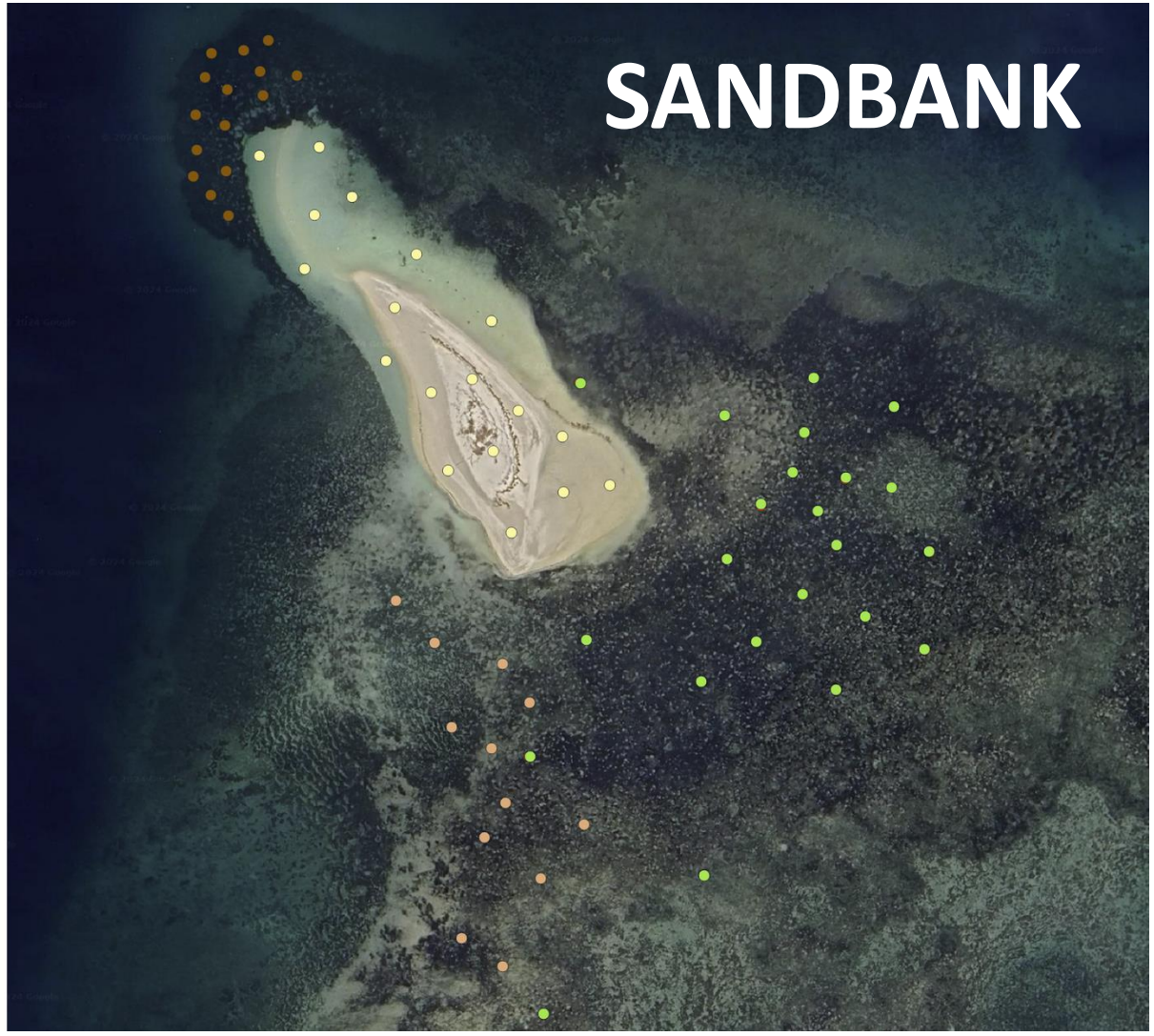
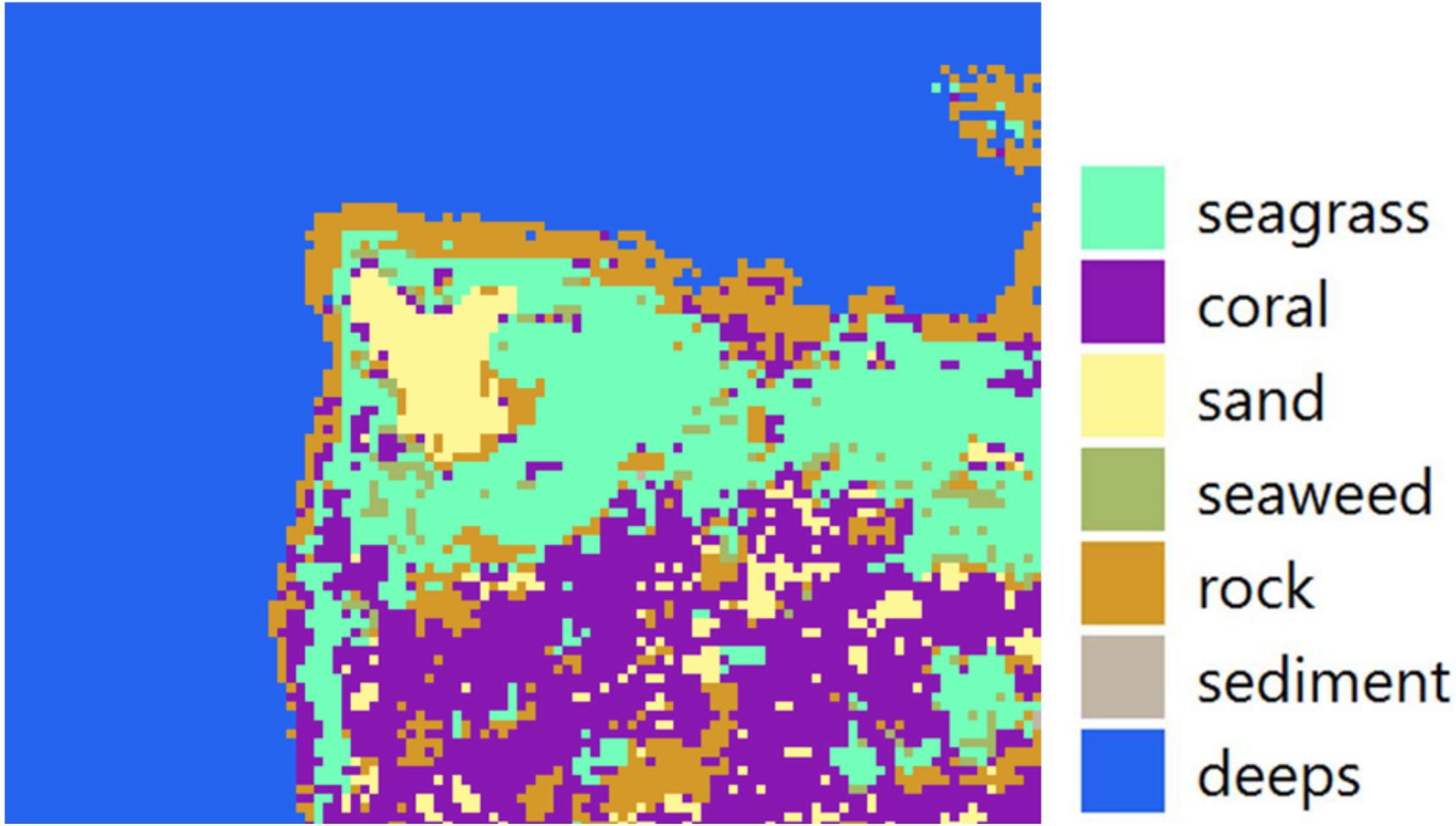
CE classification

Ecosystem types:

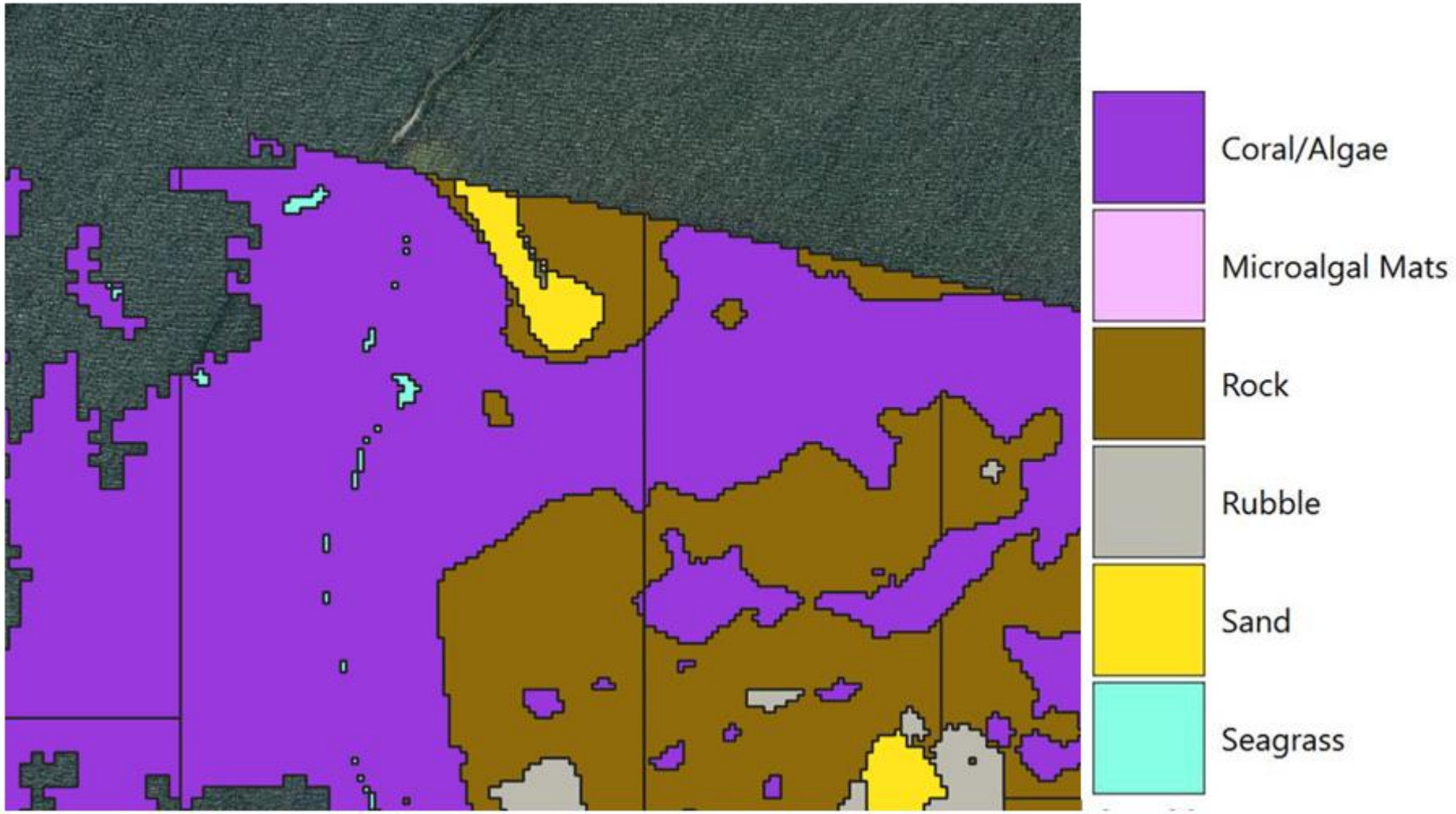
benthic_code	benthic_class
1	seagrass
2	mangrove
3	microalgal_mats
4	sand
5	coral_algae
6	rubble
7	rock
8	other



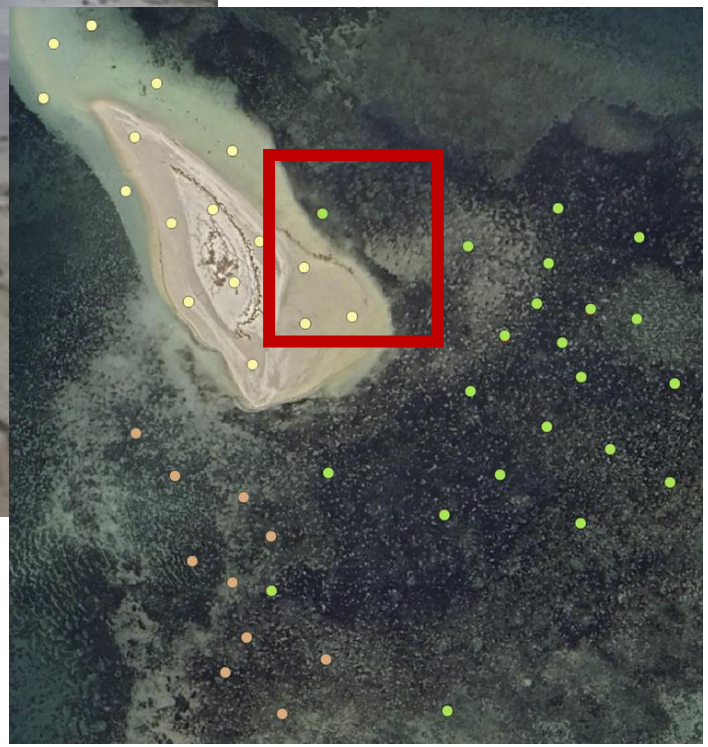
Sandbank Suva – first pass prediction



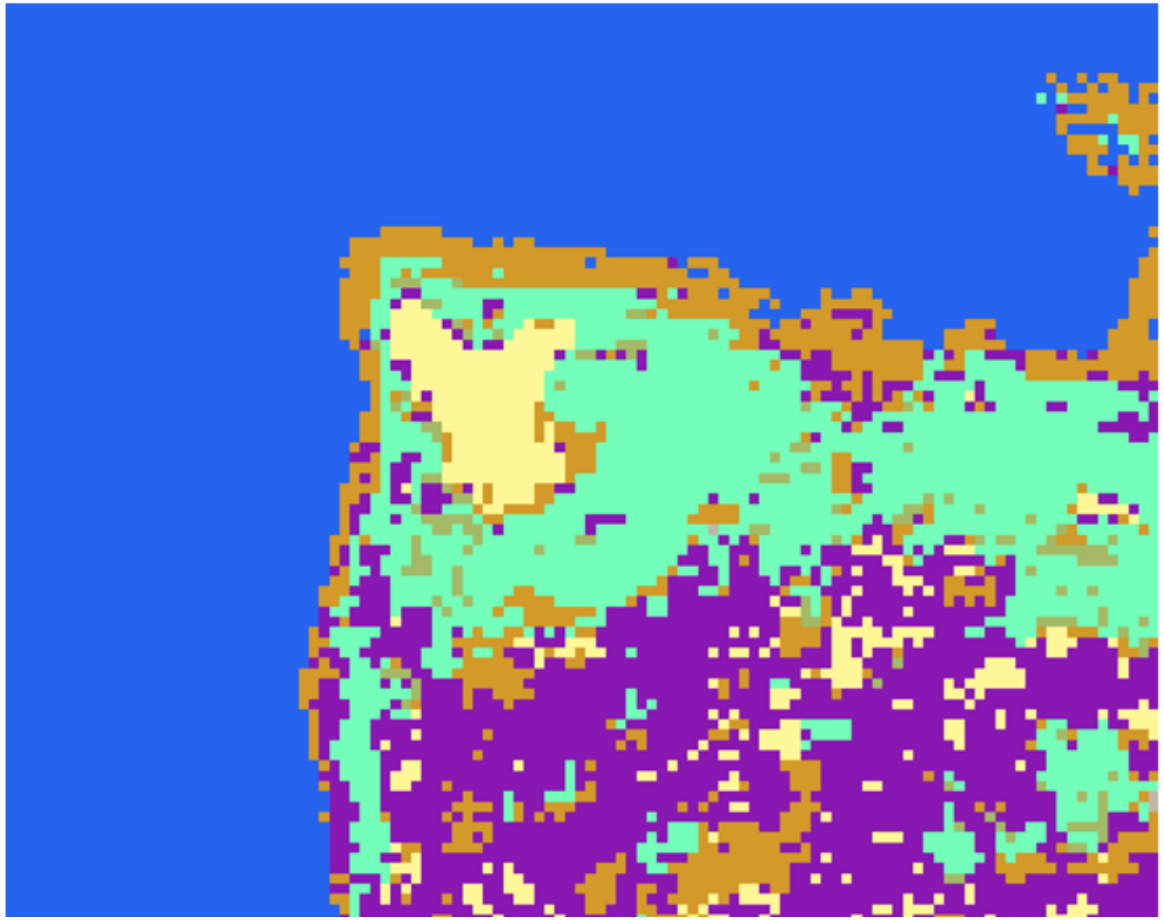
Allen Coral Atlas



Sandbank – seagrass observations



Sandbank – seagrass observations



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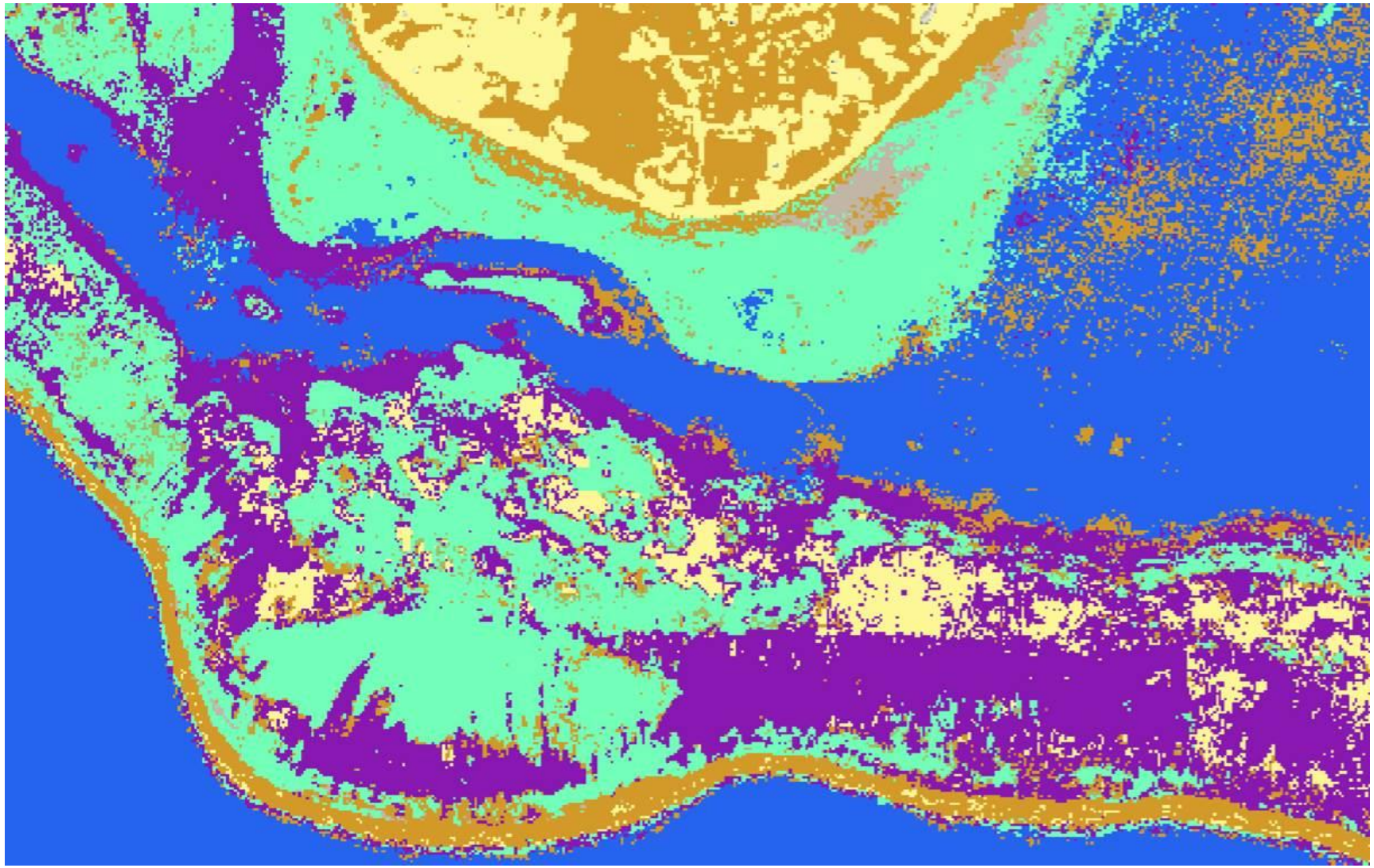


Additional corrections

- Unlike the invasive species work we did that was presented by Elenoa earlier today, we have had to plan for some additional corrections to our coastal marine work:
  - Glint
  - Tidal dynamics
  - Subtidal vs intertidal
  - Depth
  - Water quality
  - Dynamic estuaries etc…

Published results of first version of MACBLUE DEP Mangroves

[Digital Earth Pacific – Approaches to monitoring fishery ecosystems (spccfpstore1.blob.core.windows.net)]

Digital Earth Pacific – Approaches to monitoring fishery ecosystems

Nicholas Metherall,[1,2,3] Joeli Bili,[4] Milika Sobey,[4] Shyam Lodhia,[4] Vanessa Dirking,[4] Raphael Linzatti,[4] Jesse Anderson[5] and Sachindra Singh[3]

Also adds to output 5

Digital Earth Pacific

- Validation processes
- Port Moreseby Inception Workshop 10/2023

to build the infrastructure, and a further USD 300,000 annually to operate. Through cloud computing, DEP can deliver this infrastructure at USD 30,000 per year; equivalent to a 1000% cost saving.

How earth observations can be used to support monitoring and decision-makers

Analysis of the large datasets accessed through DEP can produce a range of different data products. Evidence leads to insights, and these insights support policy-makers and land and ocean planners to make decisions. For example, as part of its coastline change data product, DEP has already mapped 22 years of seashore change along the 34,000 km of coastline within the Pacific Islands region. Similarly, the Water Observations from Space product has provided insights into surface water dynamics over the past 11 years. These decision-ready DEP products can help bridge the science–policy gap to support policy-makers.

Digital Earth PACIFIC

MACBLUE supports DEP product for mangrove and seagrass extents

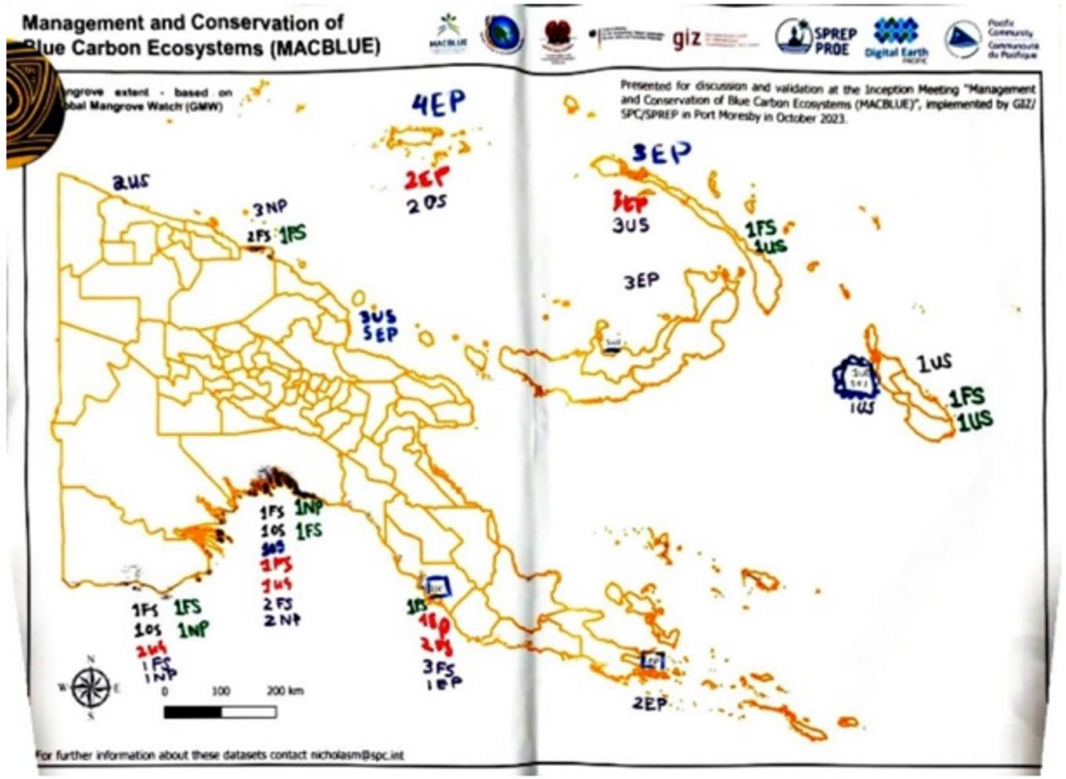
The Management and Conservation of Blue Carbon Ecosystems (MACBLUE) project is coordinated by the German Agency for International Cooperation (GIZ), in collaboration with the Secretariat of the Pacific Regional Environment Programme and SPC. MACBLUE seeks to support Fiji, Papua New Guinea, Solomon Islands and Vanuatu in mapping and monitoring seagrass and mangrove ecosystems. Mapping and remote sensing is a crucial part of blue carbon stock assessments, as the MACBLUE project intends to follow the Intergovernmental Panel on Climate Change guidelines (IPCC 2003). The mapped mangrove and seagrass habitats, in conjunction with verified ground truthing data, can be used to accurately quantify the carbon stocks within these ecosystems. The value of stored carbon, and the ecosystem services they provide, can be used as a basis for creating or improving policies to protect and conserve these ecosystems.

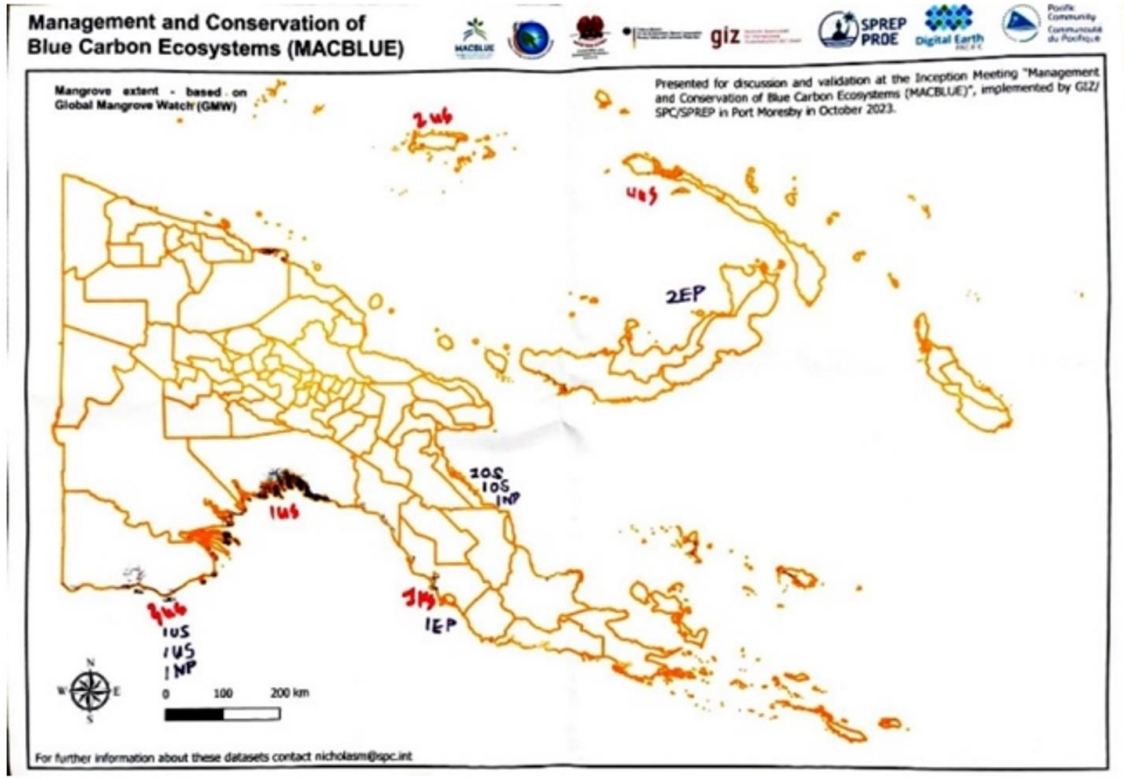
Through this MACBLUE project, participants from each of the participating countries will support in the co-design, data collection, calibration and validation of the DEP products, which will aim to map the extent of mangrove and seagrass ecosystems. Currently, DEP has generated datasets for the past seven years of mangrove forests throughout all PICTs. The next stages will include the further assessment, re-calibration and validation of these data products. Seagrass meadows will be a longer-term product, given the additional complexities associated with these commonly submerged intertidal ecosystems.

Local Papua New Guinea government representatives provide input into calibration and validation of Digital Earth Pacific mangrove and seagrass products. Image: ©GIZ Pacific

Mapping of current national SaM coverage

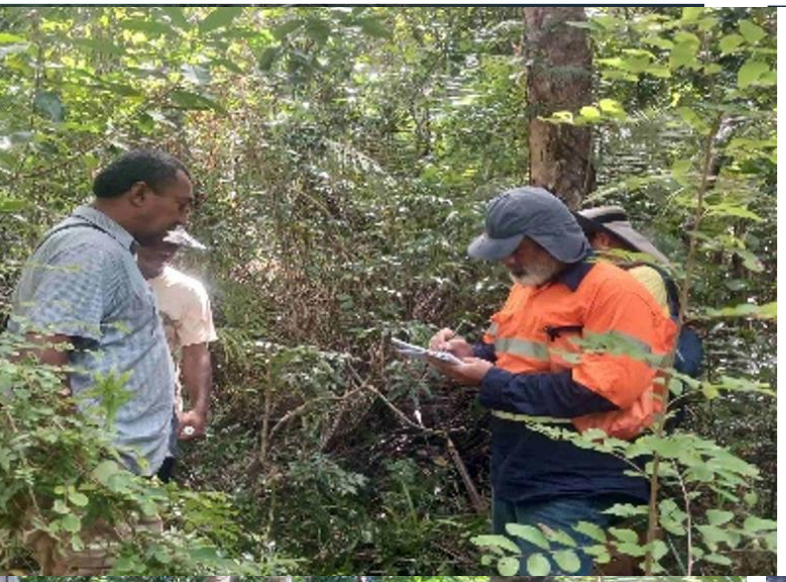
ANNEX B: VALIDATION EXERCISE

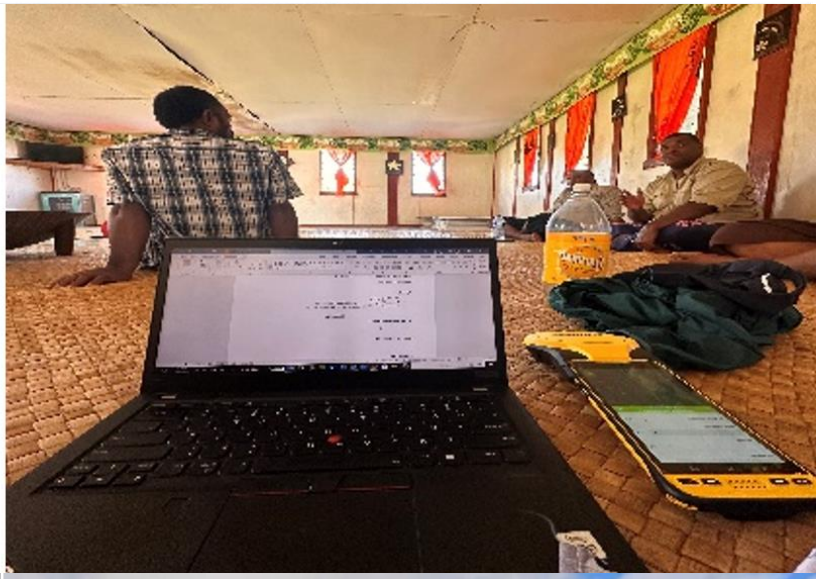




KEY	
FS	Further Study
US	Underestimation
OS	Overestimation
NP	New Project
EP	Existing Project

Ground truthing






VINAKA