Validating satellite-based seafloor maps for small islands

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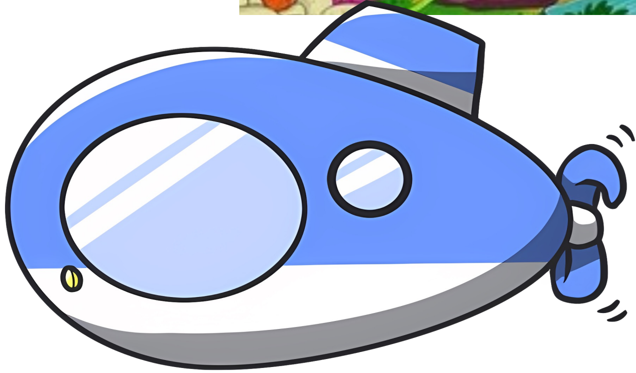
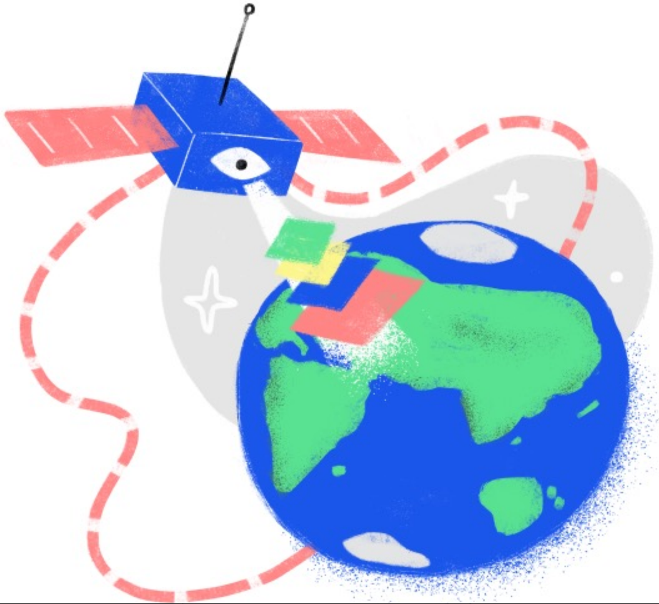
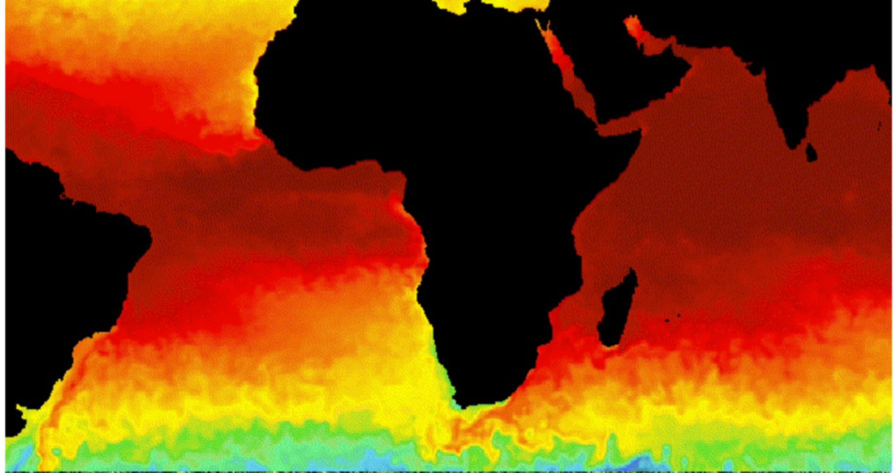
Benthic Habitats

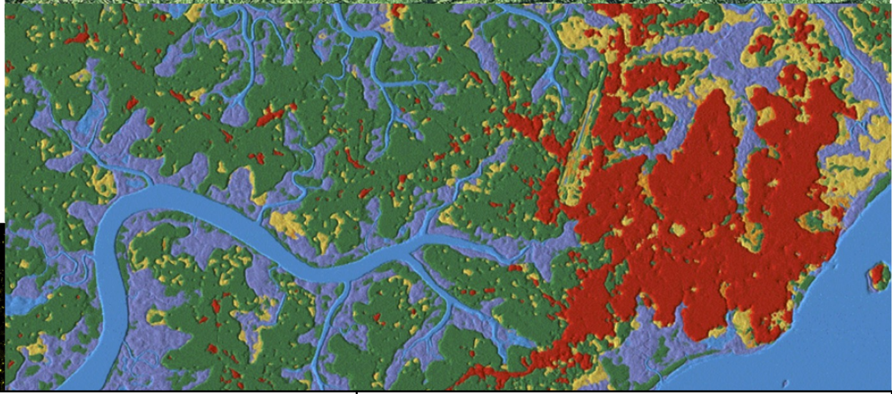




GOOGLE EARTH ENGINE

- Simple GIS mapping using Python code
- Connects to available datasets
  - Satellite data and imagery
  - Derived products (data and analysis)
- Web-based
  - No software needed
- Efficient online cloud processing
- Define your own parameters
- Export resulting images and data
  - QGIS, ArcGIS
- Easily share code and results





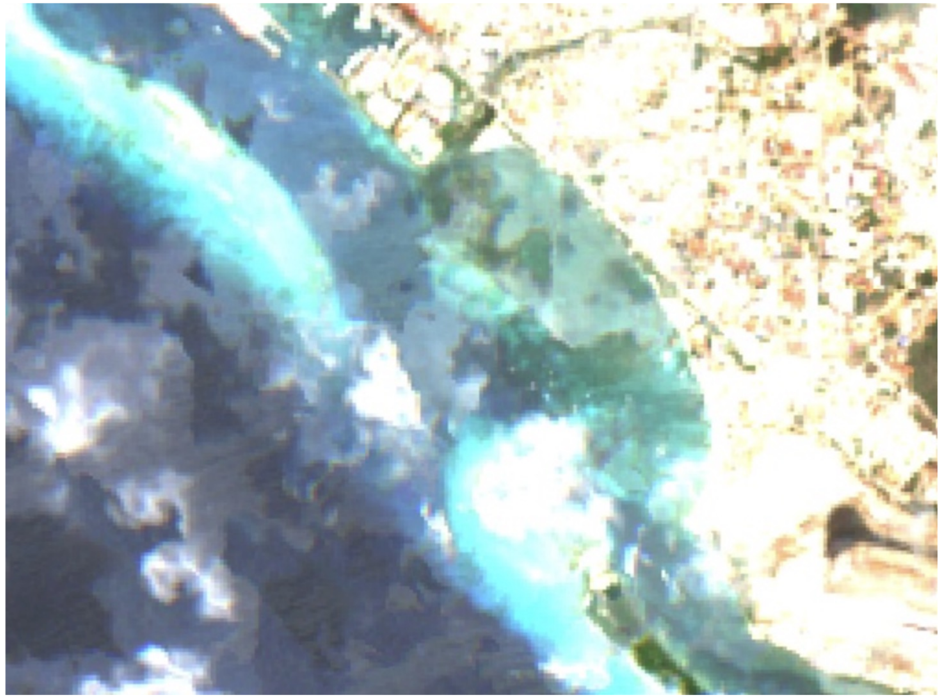

Harmonized Sentinel-2 A MSI

B1	443.9nm (S2A) / 442.3nm	Aerosols
B2	496.6nm (S2A) / 492.1nm	Blue
B3	560nm (S2A) / 559nm	Green
B4	664.5nm (S2A) / 665nm	Red
B5	703.9nm (S2A) / 703.8nm	Red Edge 1
B6	740.2nm (S2A) / 739.1nm	Red Edge 2
B7	782.5nm (S2A) / 779.7nm	Red Edge 3
B8	835.1nm (S2A) / 833nm	NIR
B8A	864.8nm (S2A) / 864nm	Red Edge 4
B9	945nm (S2A) / 943.2nm	Water vapor
B11	1613.7nm (S2A) / 1610.4nm	SWIR 1
B12	2202.4nm (S2A) / 2185.7nm	SWIR 2
AOT	Aerosol Optical Thickness	
WVP	Water Vapor Pressure	
SCL	Scene Classification Map	
TCI_R	True Color Image, Red channel	
TCI_G	True Color Image, Green channel	
TCI_B	True Color Image, Blue channel	
MSK_CLDPRB	Cloud Probability Map	
MSK_SNWPRB	Snow Probability Map	
QA10	Always empty	
QA20	Always empty	
QA60	Cloud mask	

SEAFLOOR MAPPING: Data Processing

Filtering and Cleaning:

- Time
- Location
- Water
- Bands
- Turbidity
- Sun glint
- Clouds
- Boats
- Image selection
- Image quality
- Bands

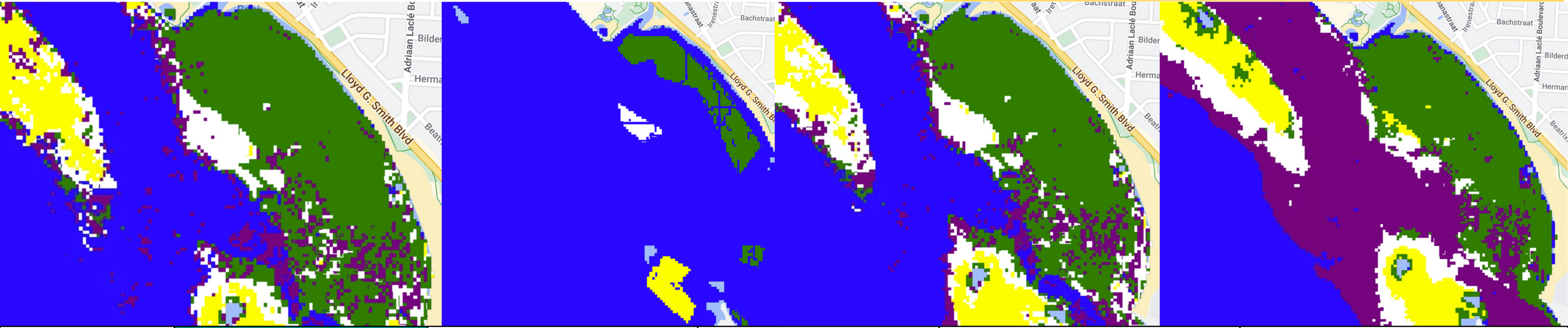


SUPERVISED CLASSIFICATION

1. Image pre-processing (Li et al., 2021)
2. Training data
3. Classify map testing different models (CART, SVM, RF, NB)

Main Mapping Steps:

1. Draw box around beach of interest
2. Sentinel 2 data for region and dates of interest
3. Mask out bad data
4. Median pixel values
5. Create classifier model using relevant bands and training data
6. Classify map
7. Export map data



VALIDATION

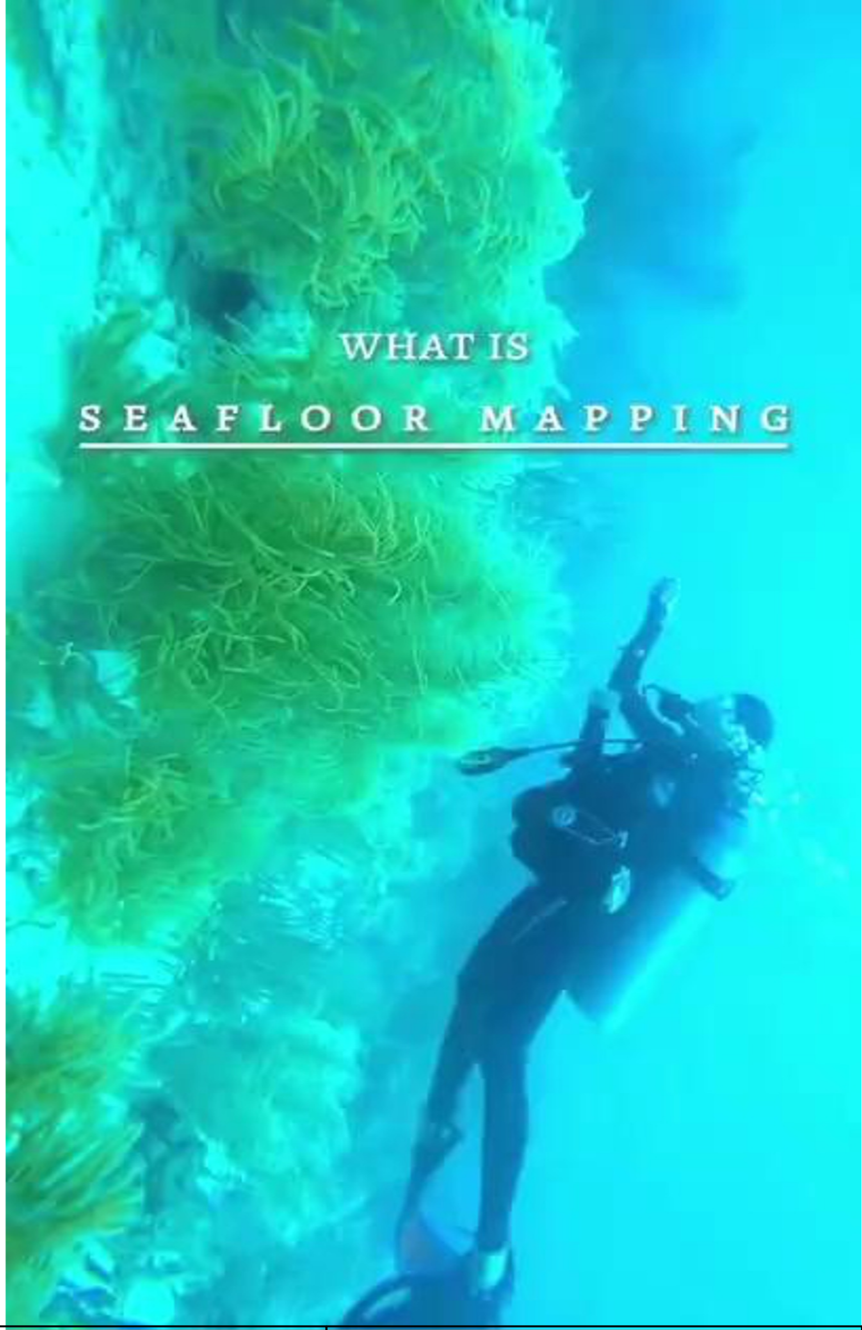
WHY?

- To test the accuracy against real-world conditions
- To quantify the uncertainty for end-users
- To determine the needs for improvements or refinements

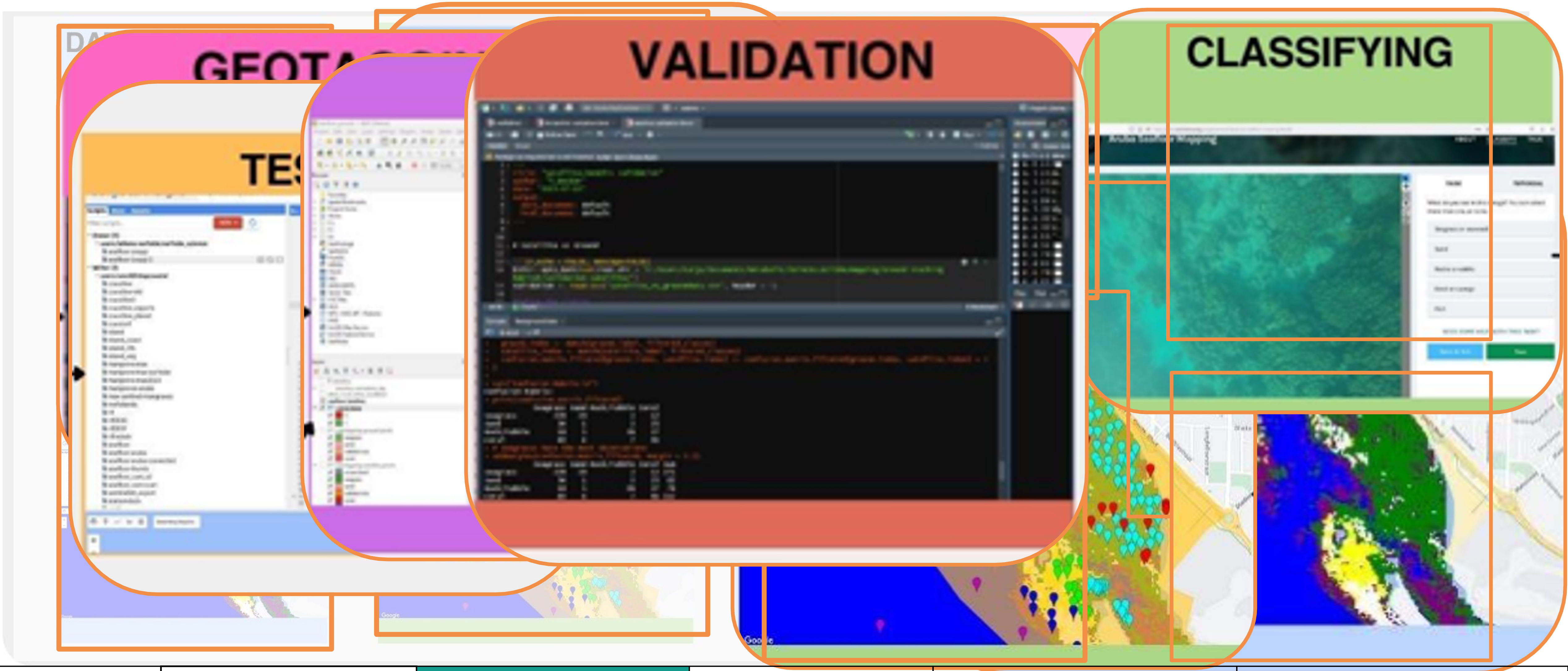
METHOD:

- Sea-truthing according to Roelfsema et al (2019)'s protocol and Stehman & Czaplewski (1998)'s accuracy assessment guidelines

- Transects parallel and perpendicular to shore captures variability along the shore and different depths (max 15 m)
- Assisted by Scubble Bubbles diverss



VALIDATION: WORKFLOW



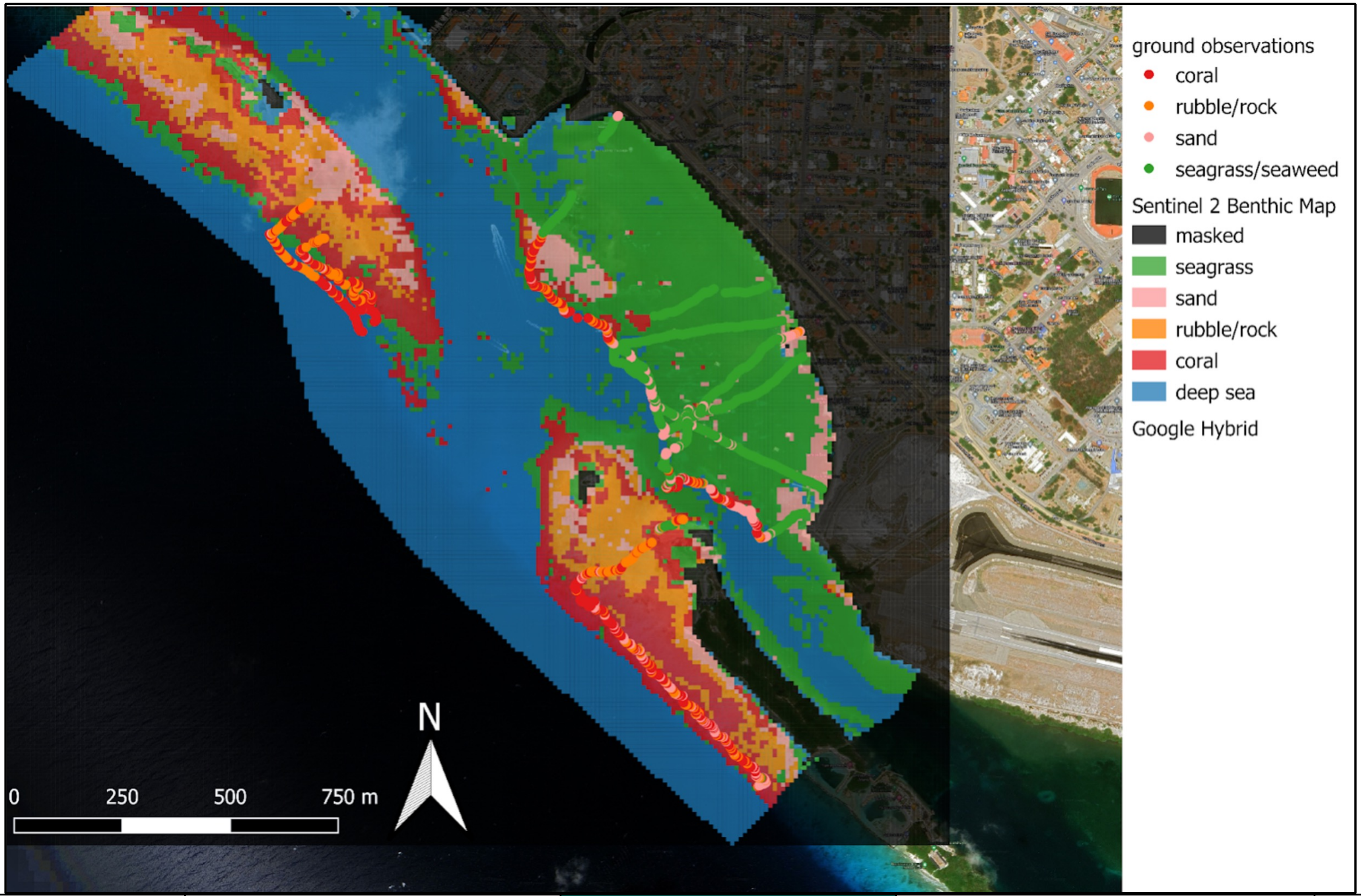
FINDINGS: SENTINEL (SSS) vs Sea-truthing

Testing Accuracy:

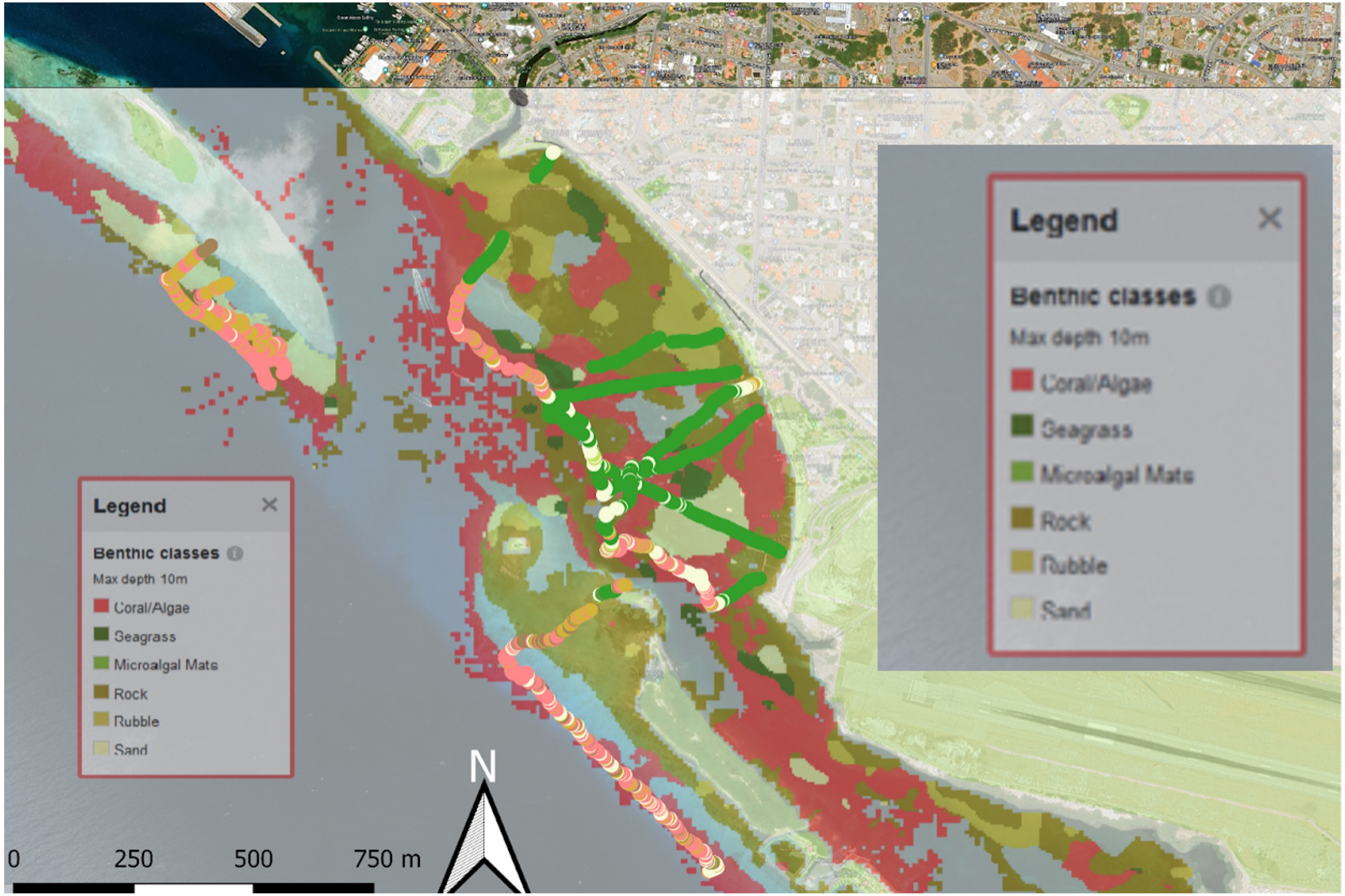
46.3%

Validation Accuracy:
60.7%

FINDINGS: SENTINEL (SSS) benthic habitat map



FINDINGS: vs Allen Coral Atlas

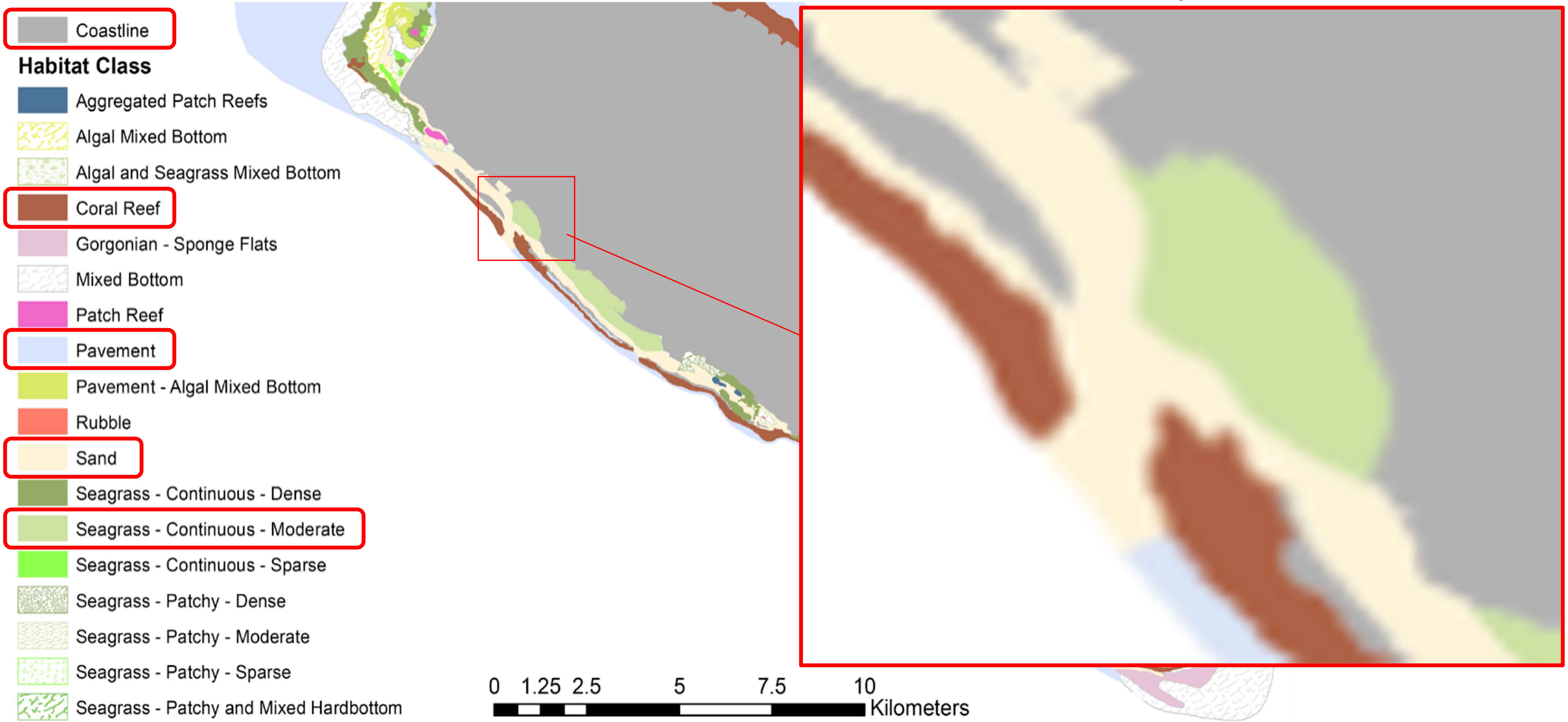


ground observations
- Coral
- Not applicable
- Rock
- Rubble
- Sand
- Seagrass
- Seaweed
- Unclear
- Water

Allen coral atlas map Image

Google Hybrid

FINDINGS: vs Carmabi Benthic Habitat Map



Discussion

- Balance sea-truthing effort:
  - Emphasis on habitat vs cover
  - increasing sampling in macroalgal habitat
- Limited accuracy of used GPS devices
- Timeframe correspondence of Field and Sentinel imagery
- Sea-truthing classification labels: Redefining?

Conclusions

- Moderate accuracy
    - Similar or even better compared to other literature (e.g. Fauzan et al., 2017, Wicaksono et al., 2021)
    - Better accuracy indicated for local-scale mapping, compared to existing seafloor maps for Aruba
    - Depth limit of 10 m
- More accurate in shallow depths
    - Fast changes (bleaching, disease, rapid invasions)
    - Slow notable changes, considering the availability of long-term data

Acknowledgements

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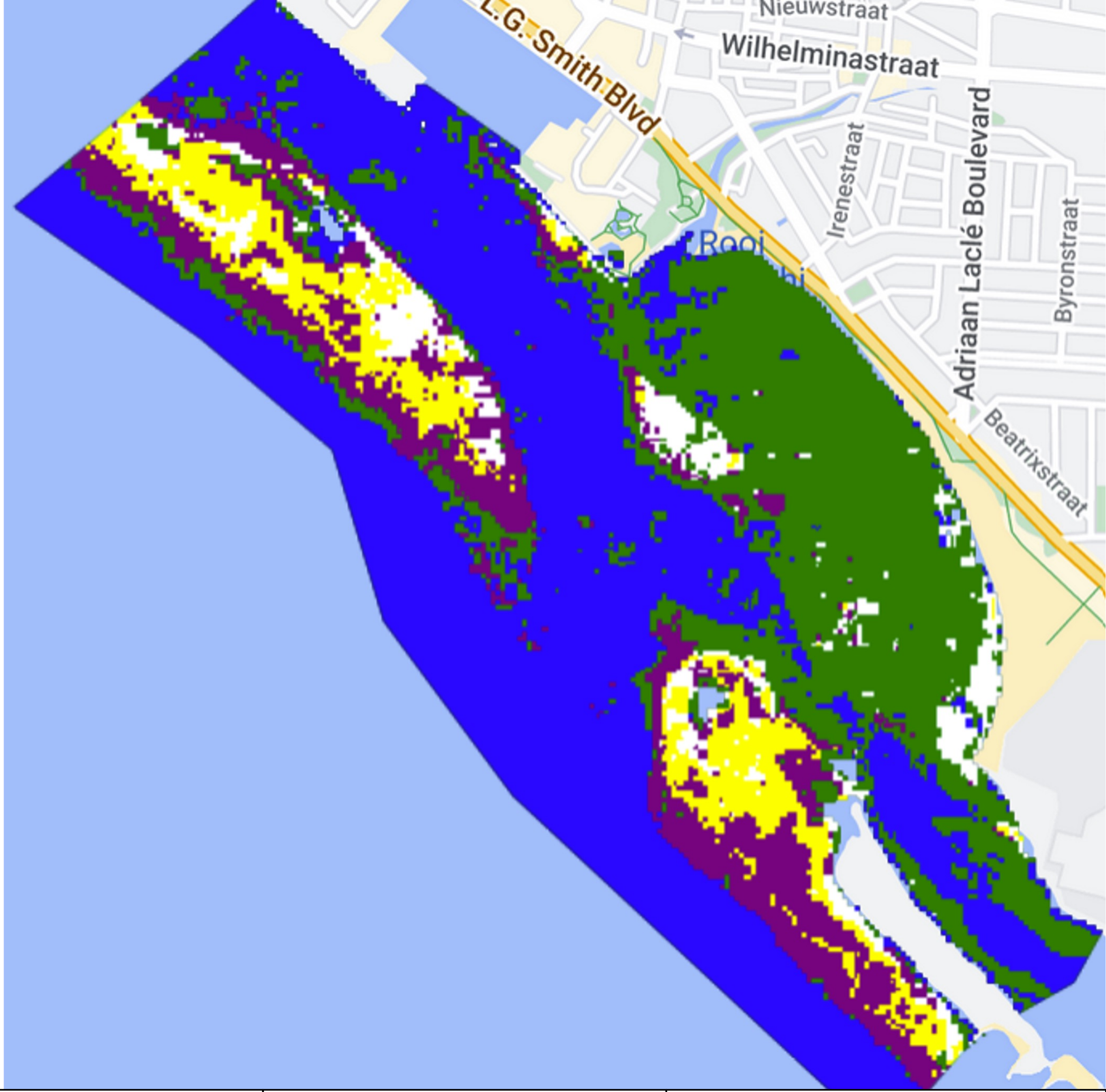
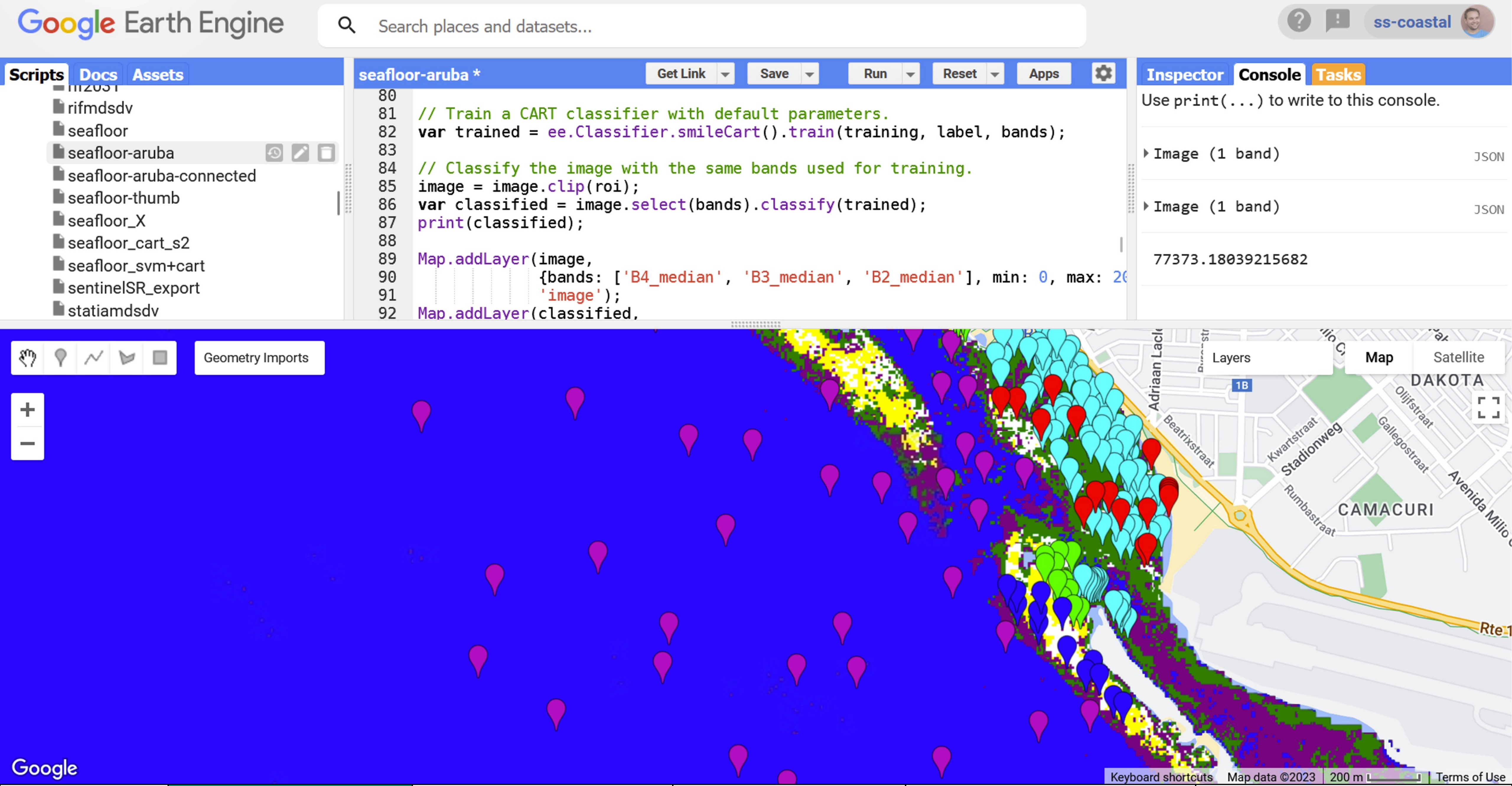
MAPS

To do

- Review training data
  - Groundtruthing
  - Kayak images, zooniverse, AI
- Mask deeper water
- Add indices for training
- Calculate areas
- Repeat for Aruba
- Test on other islands





Intro | **Mapping** | Validation | Findings | Discussion | Conclusion