Pacific partnerships using AI for carbon and habitat mapping



Joey Crosswell
Jiajun Liu
Brano Kusy
and PCBP & iBenthos project teams

Ogea Levu, Lau Group, Fiji

Australian Government
Department of Foreign Affairs and Trade

What these partnerships look like

- Collaborative field research
- Technical workshops



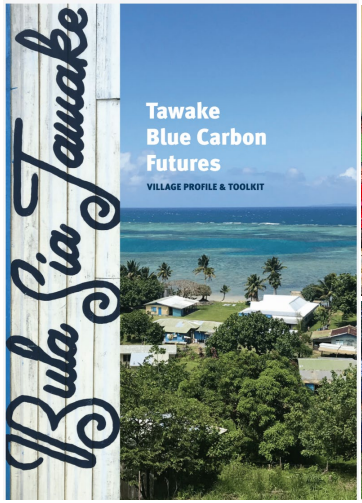


- Exchange/training programs
- Community programs





Wendy Powell, USP
Leo Dutra, CSIRO







USP THE UNIVERSITY OF THE SOUTH PACIFIC

Ministry of Economy Fiji (now Finance)

iTaukei Affairs

Ministry of Fisheries Fiji SUSTAIN • MANAGE • PROTECT

SPC Secretariat of the Pacific Community

CONSERVATION INTERNATIONAL

Transcend OCEANIA

CSIRO

Pacific Blue Carbon Program

COP23 FIJI
UN CLIMATE CHANGE CONFERENCE
BONN 2017

Australian Government
Department of Foreign Affairs and Trade

Motivation: Support national climate action and livelihoods through enhanced measurement, management and investment in coastal blue carbon ecosystems

Goal: Establish blue carbon inventories and understand what controls carbon storage


Fiji


Papua New Guinea

iBenthos: Mapping blue carbon ecosystems across the Indo-Pacific

Goal: Develop cloud-computing and observational tools for mapping seagrass and biodiversity benefits


Fiji


Indonesia


Thailand


Australia

Google

Australian Government
Department of Foreign Affairs and Trade

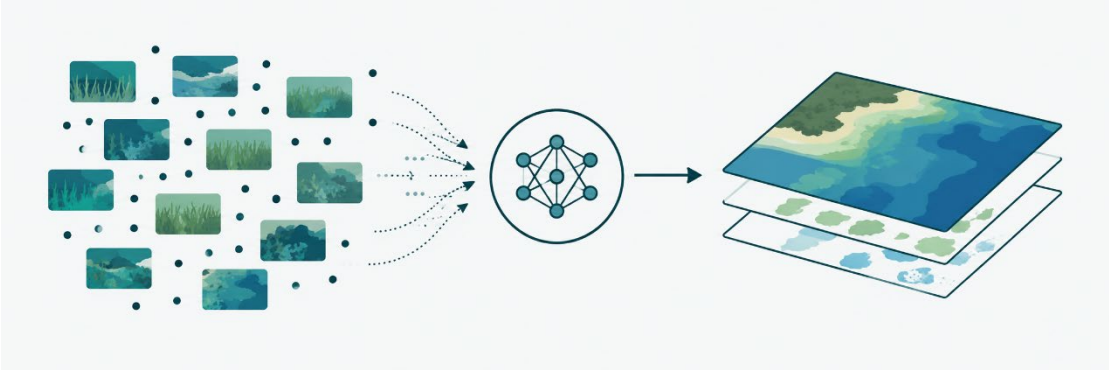
Pacific Blue Carbon Program

Blue carbon inventories
& ecosystem understanding



iBenthos

Scalable coastal habitat mapping



Seagrass Soil Carbon Stocks in Fiji

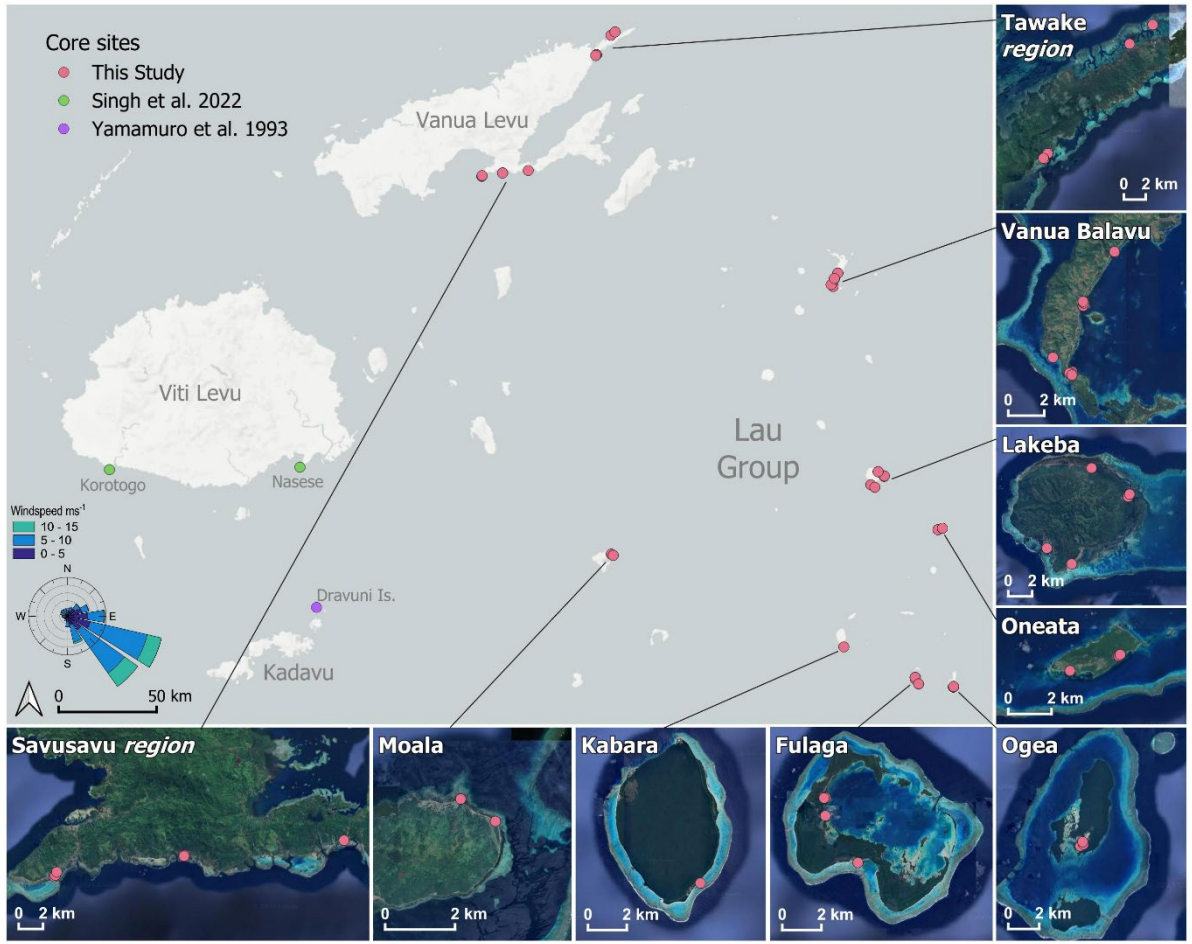
Global Biogeochemical Cycles

RESEARCH ARTICLE
10.1029/2026GB009079

Special Collection:
Exploring Carbon Cycling in Aquatic Ecosystems Using Novel Analytical and Data-Driven Approaches

Soil Carbon Stocks in Fijian Seagrass: Environmental Drivers, National Inventories, and Implications for Blue Carbon Accounting in Small Island Settings

Joseph R. Crosswell[1], Wendy-Jane Powell[2], Geoffrey Carlin[1], Christina Asanopoulos[3], Carrie Wentzel[4], Mitchell B. Lyons[5], and Andrew D. L. Steven[1]



135 sediment cores

47 sites

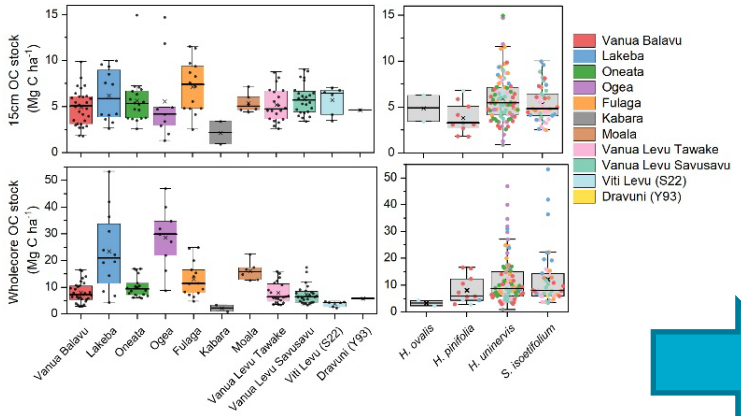
Measured soil carbon across range of coastal settings and asked: what drives the difference?

- **Biology**: species and seagrass density
- **Scale**: island → → → site
- **Coastline shape:** exposure and water flow

Inventory framework: a practical way for Pacific island nations to count their blue carbon *with AI*

Observations

Soil cores: carbon stocks

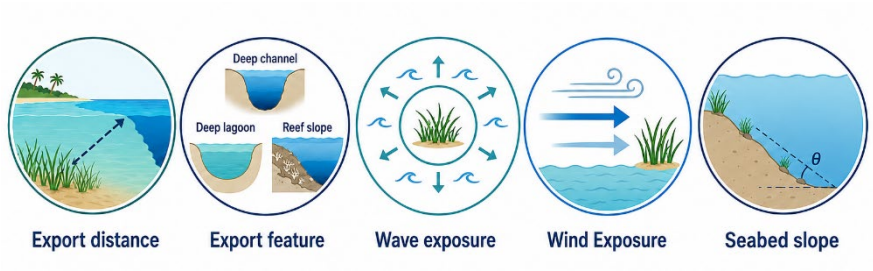


Seagrass coverage/species

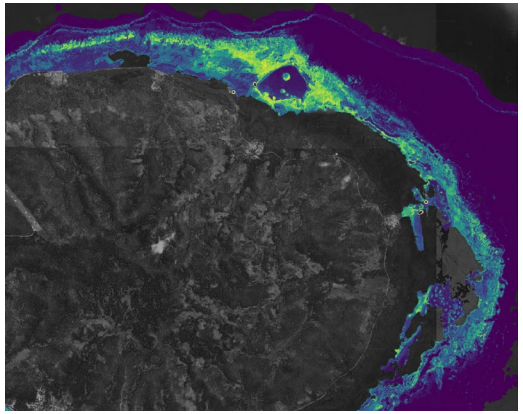


Mapping and modelling

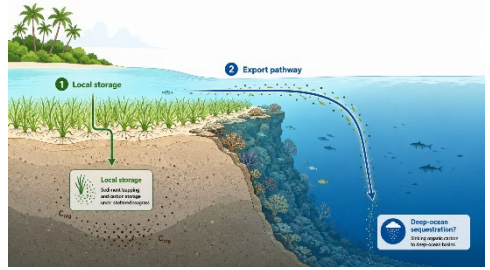
Use free global data to find which coastal features predict carbon

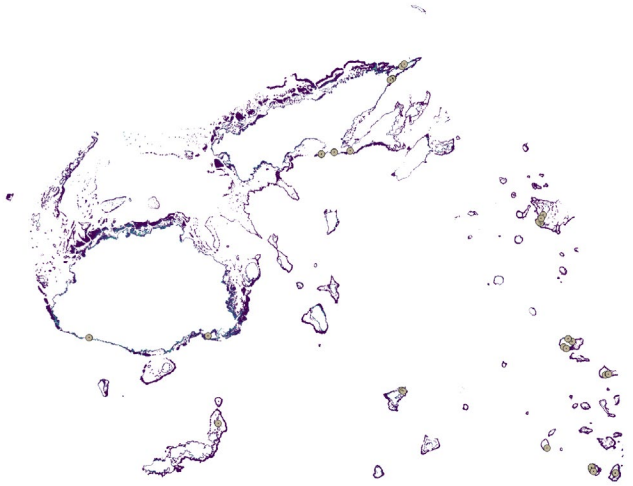


Validate/adjust seagrass maps



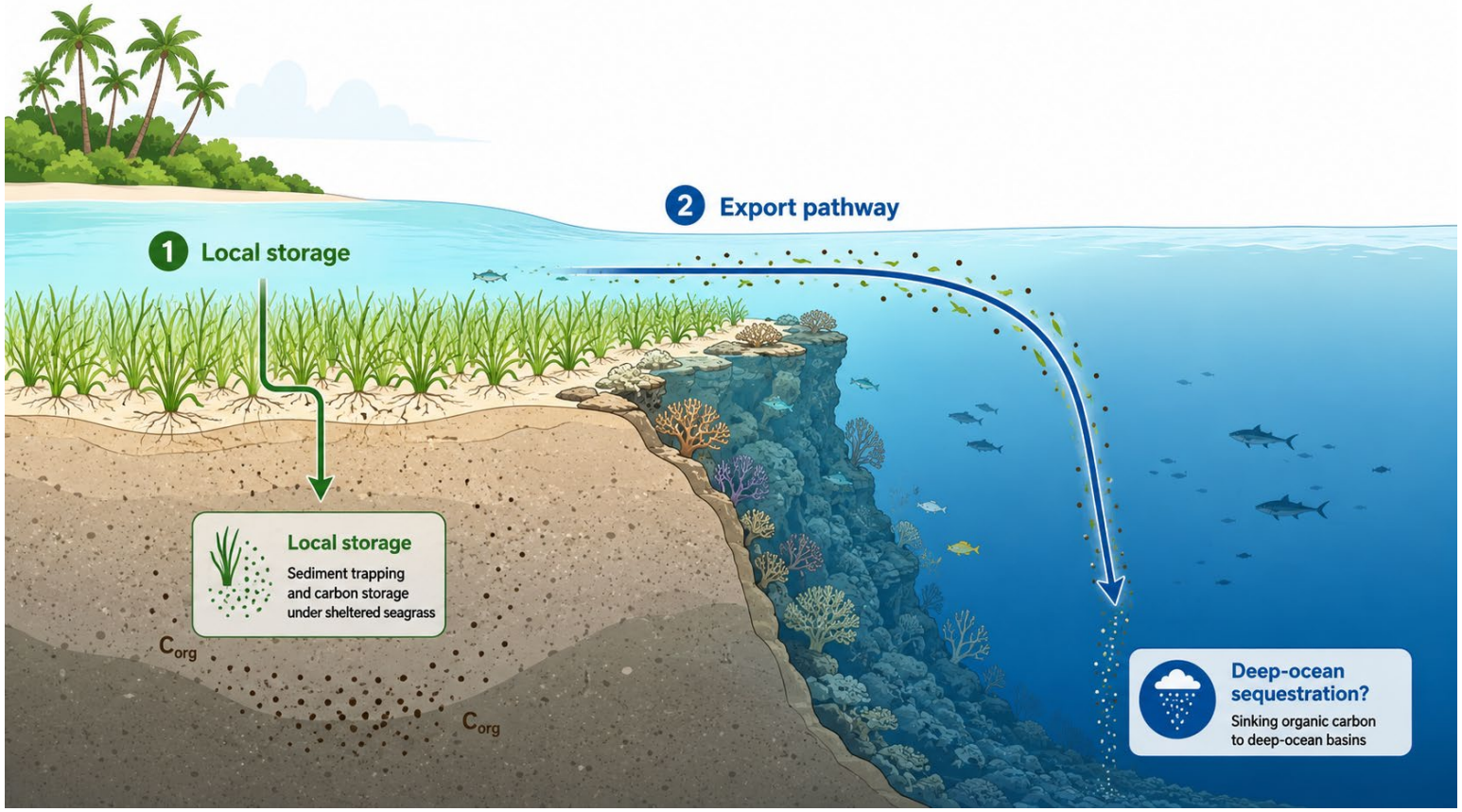
Scalable insight and inventory



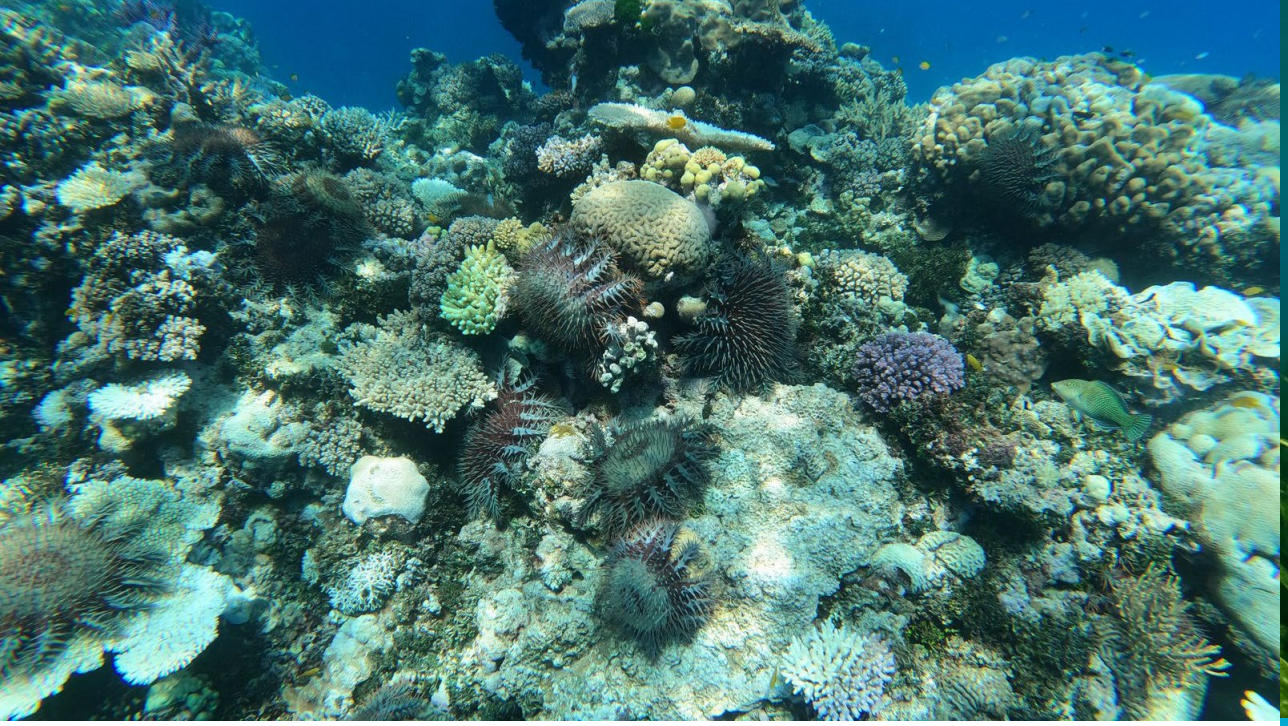


Key insight:

Fijian seagrass export much of their carbon to the ocean rather than storing it in soil beneath the meadows, potentially transferring carbon to long-term storage in deep-ocean basins



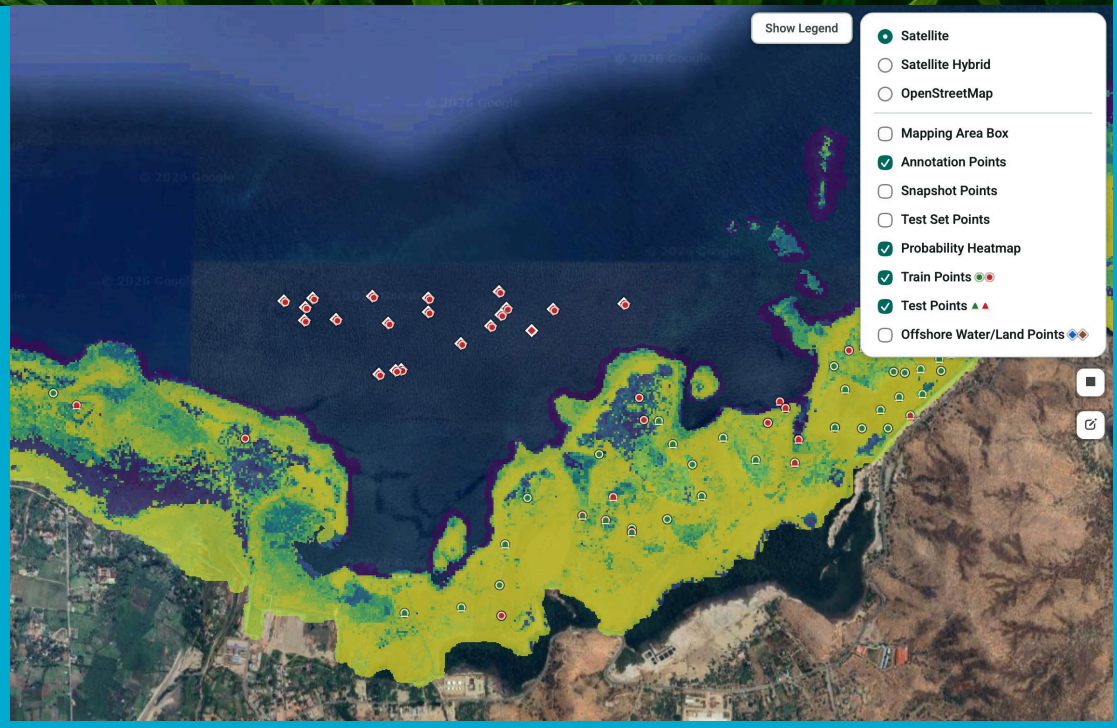
Pacific island settings present unique challenges, but also unique climate solutions





From Field Surveys to Regional Insights

Next-gen cloud & AI-powered systems for benthic habitat mapping & reef resilience

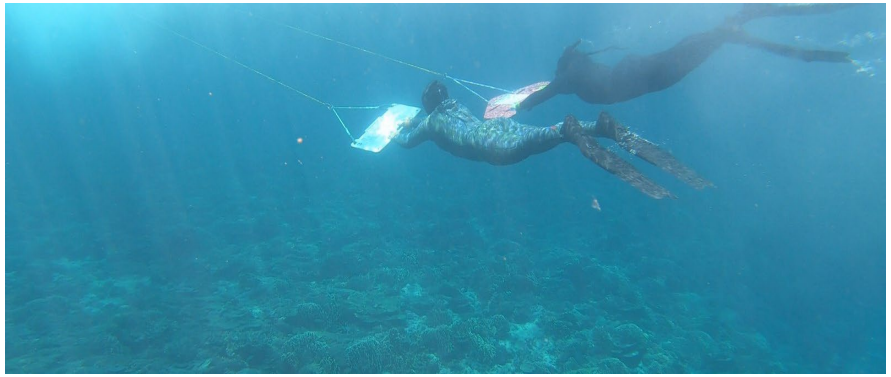


Australia's National Science Agency

The environmental observation challenge

Complex ecosystems need repeated observations
across locations, depths and seasons.

Collection and interpretation still depend heavily on people.



Broadscale ocean surveys



UAV surveys



Detailed visual surveys



Data labelling

Robots and AI extend survey capacity

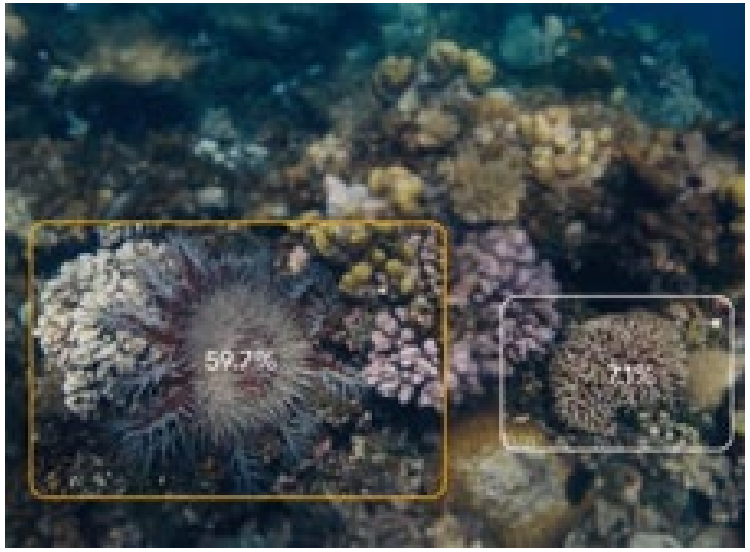
Collect
with better coverage & granularity



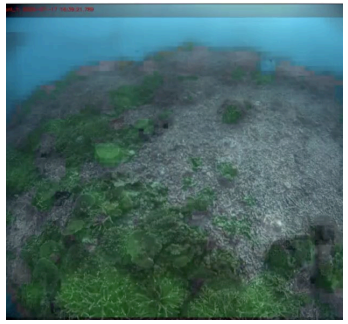


Camera-based platforms cover more ground

Analyse
with AI-based recognition



Detect organisms and map habitats



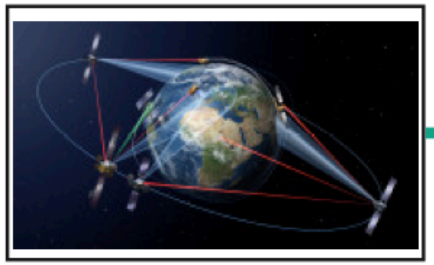
Scale up
with Google Earth Engine



Link local observations to regional mapping

SkySea: Integrating Data Across Scales

Challenge: frequent/coordinated multi-scale mapping → **Solution:** Automate data collection, **integration,** and analysis workflows through ML







Geo-referenced images

GPS Correction

Correction signals

GNSS RTK Base Station

OpenDroneMap

Photogrammetry

Image overlay

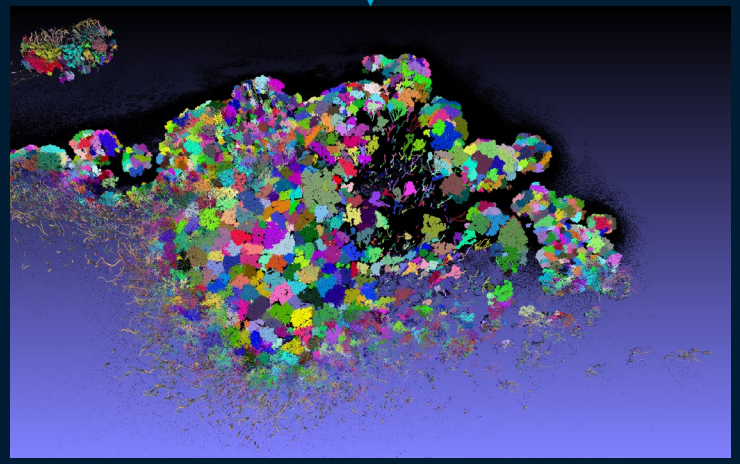
Structure-from-motion

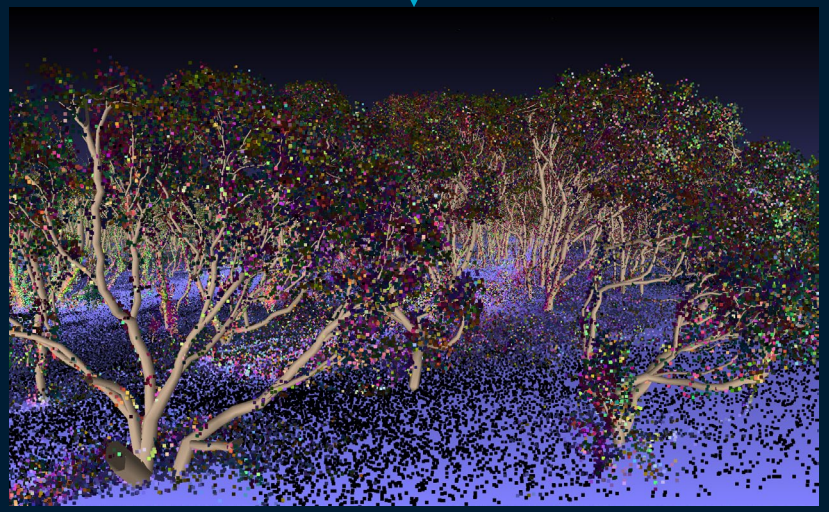
SkySea: Connecting Satellite, UAV and Underwater Imagery for Benthic Habitat Mapping, Brendan Do et al, 2023 Workshop on UAVs in Multimedia: Capturing the World from a New Perspective

Enhanced analytics with data & ML workflows



CSIRO Tools

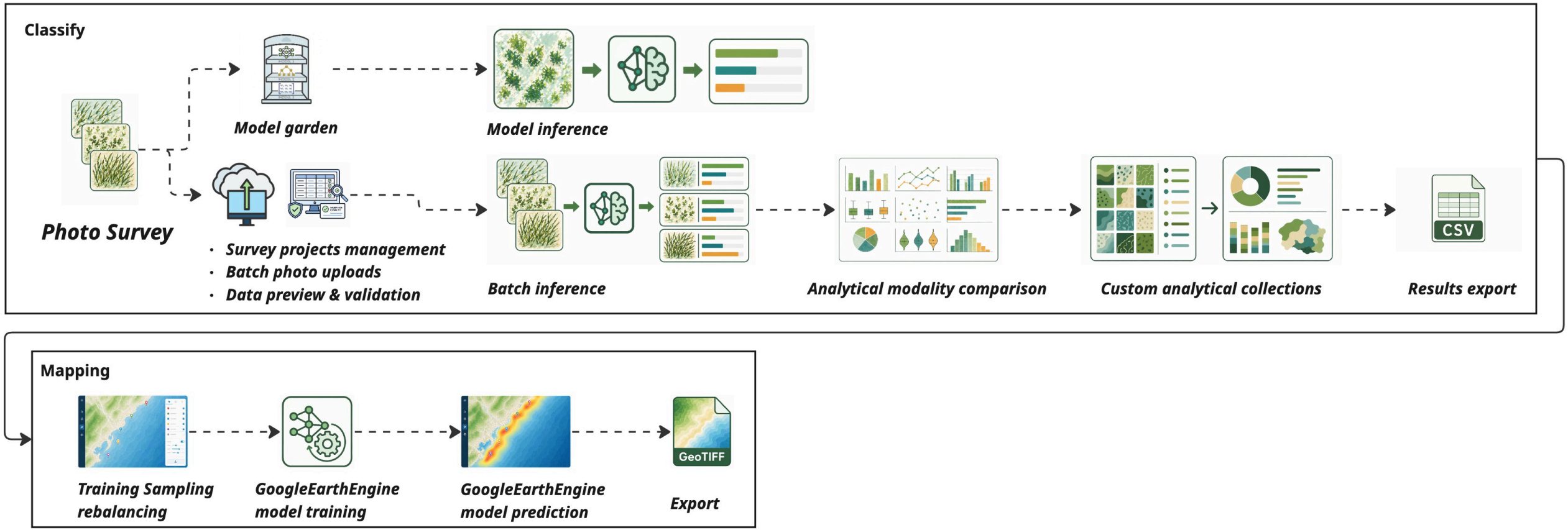




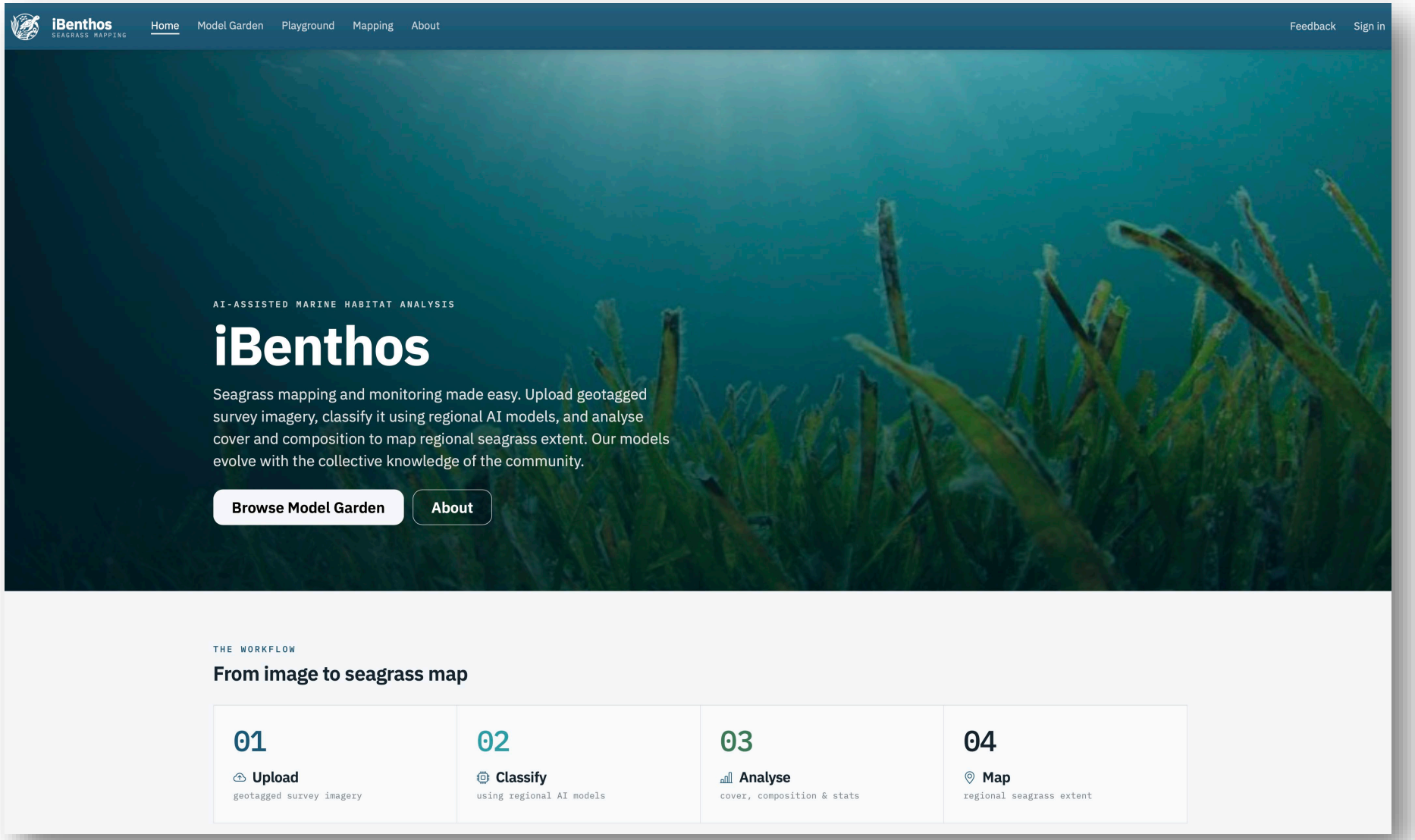
Number of:
trees: 6048
branches: 124811
trunks wider than x: 25.628x^-1.096 with correlation (r2) 0.783
trees longer than l: 28854.612l^-2.235 with correlation (r2) 0.741
branches longer than l: 529254.440l^-3.198 with correlation (r2) 0.861
Total:
volume of wood: 674.790 m^3. Mean,min,max: 0.112, 0.000, 43.951 m^3
mass of wood (at 0.5 T/m^3): 337.395 Tonnes. Mean,min,max: 55.786, 0.000, 21975.589 kg
location: 106.420, -43.495, min: 20.346, -180.952, max: 224.174, 108.709
Per-tree mean, min, max:
trunk diameter (DBH) (m): 0.084, 0.000, 2.283
tree height (m): 3.972, 1.000, 12.390
crown radius (m): 2.208, 1.000, 17.642
trunk strength (diam^0.75/length): 0.049, 0.001, 0.794
branch dominance (0 to 1): 0.236, 0.000, 0.947
branch angle (degrees): 21.903, 0.000, 143.352
trunk bend (ratio): 0.055, 0.000, 0.462
dimension (w.r.t length): 1.653, 0.393, 3.000

iBenthos.ai - the next-gen AI-powered mapping tool

Data management | Automated recognition | GEE Mapping

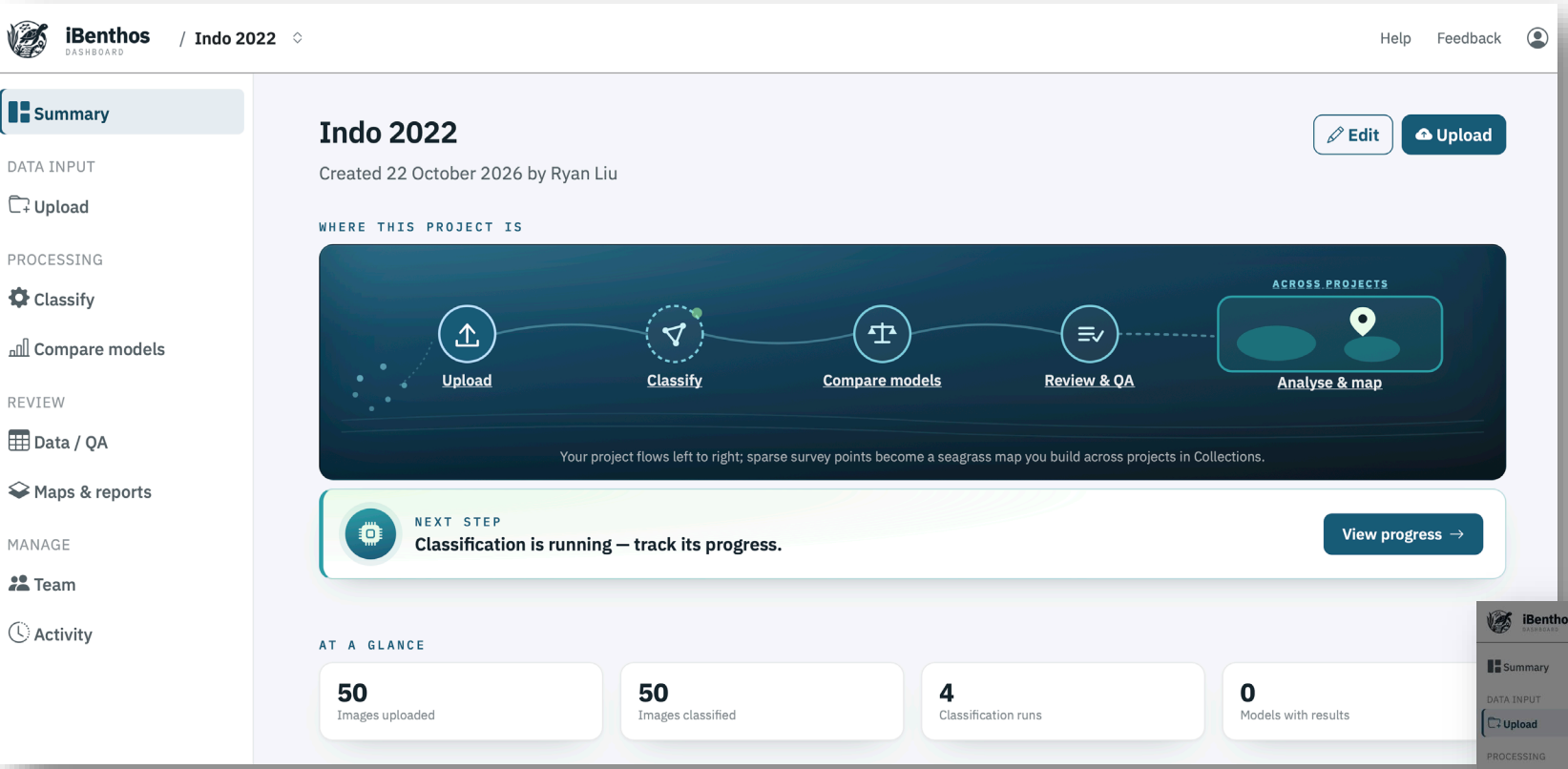


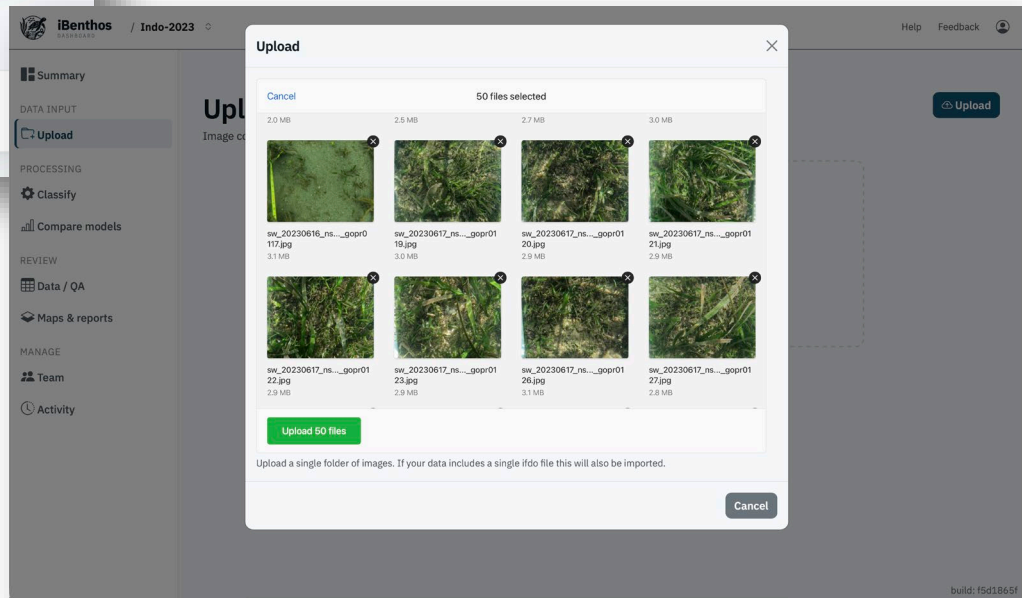
Same workflow applies for other environmental applications



- **103** Research groups/researchers around the globe
- **15,283+** seagrass survey images

Upload/manage survey projects/datasets





Classify images

CLASSIFY

View Results

Classification Job

JCU Seagrass PA (Presence/Absence) Model

JOB

Status	Finished
Created	21 Jul 2026
Started by	Yang Li
Samples	193

MODEL

JCU Seagrass PA (Presence/Absence) Model

A computer vision model designed identify the presence of seagrass from subtidal images. The percent coverage used as reference is from Seagrass-Watch percent cover standards on a...

Learn more →

MODALITIES

M1 Default — Seagrass binary presence

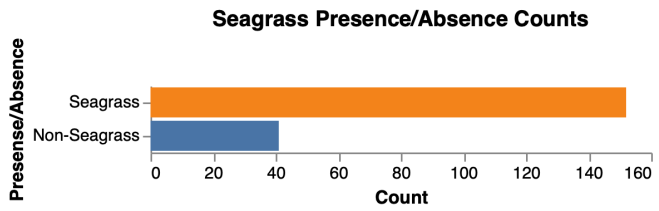
Classification results

Seagrass

152 present / 41 absent

— M1 seagrass presence aggregate

Chart | Table



Model Garden – a global platform with local models

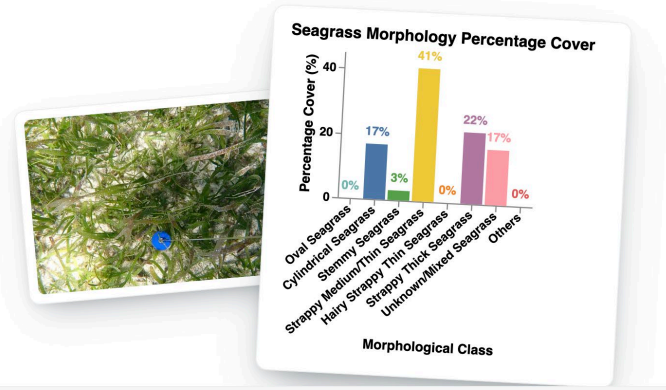
iBenthos SEAGRASS MAPPING

Home | Model Garden | Playground | Mapping | About | Feedback | Dashboard

MODEL GARDEN

Turn an underwater image into seagrass data

Each model classifies a single image and tells you about the seagrass in it — whether it's present, how much cover, or its morphology. Pick the model that matches what you want to know, then try it on your own imagery.



All models | Presence | Cover | Morphology

CSIRO Patch-based 8-class Morphology Model (Indo-Pacific)

This model is a patch-based coarse image segmentation framework designed for seagrass morphological identification and marine habitat mapping across eight...

Try this model | Learn more

CSIRO Patch-based 9-class Morphology Model (Australia)

This model is a patch-based coarse image segmentation framework designed for seagrass morphological identification and marine habitat mapping across 9...

Try this model | Learn more

JCU Seagrass Coverage Model

A computer vision model designed to classify seagrass coverage from subtidal images into 3 cover categories : low seagrass cover (≥3 <10%), medium seagrass cove...

Try this model | Learn more

JCU Seagrass Morphology Model

A computer vision model designed to identify the presence of specific seagrass species morphologies from subtidal images. The morphologies identified are ...

Try this model | Learn more

JCU Seagrass PA (Presence/Absence) Model

A computer vision model designed identify the presence of seagrass from subtidal images. The percent coverage used as reference is from Seagrass-Watch percent cov...

Try this model | Learn more

On-demand Analysis & Comparison

iBenthos DASHBOARD / Indo-23 Collection

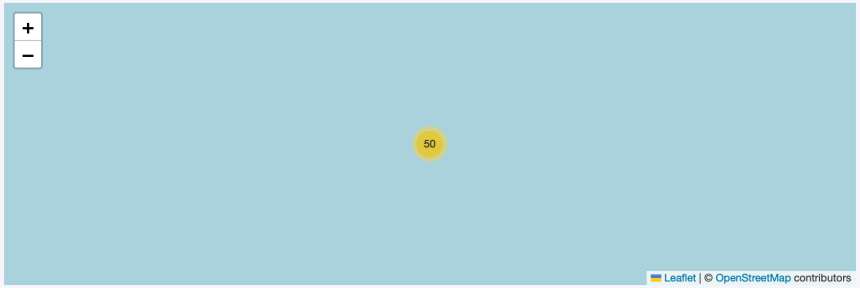
Help

- Dashboard
- Projects
- Collections
- Maps & Reports
- Public website

Indo-23 Collection

Export | Edit | Make a seagrass map

Data as of 22/10/2026, 1:18:24 pm



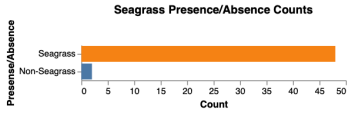
Classification results

Seagrass

48 present / 2 absent

Chart | Table | By collection | By collection table

— M1 seagrass presence aggregate

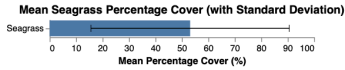


Mean seagrass coverage

53.1%

Chart | Table | By collection | By collection table

— M2 seagrass coverage aggregate

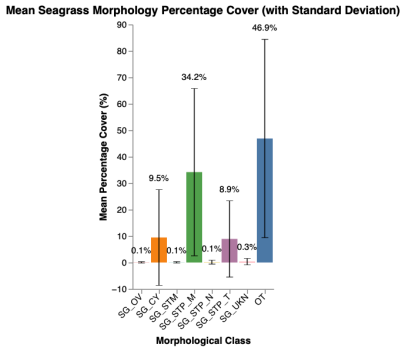


Mean seagrass cover

100%

Chart | Table | By collection | By collection table

— M4 morphology cover aggregate



Inclusion criteria

Model filter

CSIRO Patch-based 8-class Morphology Model (Indo-Pacific)

This model is a patch-based coarse image segmentation framework designed for seagrass morphological identification and marine habitat mapping across eight distinct classes: seven seagrass morphology classes and one background class. Compared with the Australian model, it excludes the ferny morphology class because this type, specifically Halophila spinulosa, is rare or absent in the target Indo-Pacific regions. The framework processes high-resolution benthic imagery by dividing each image into fixed-size patches (e.g., 280×280 pixels), and classifying each patch into a foreground seagrass morphology class, such as strappy or stemmy, or into a single background category, labelled as others. By aggregating patch-level predictions, the model estimates morphology-level seagrass coverage as a percentage of the total image area, providing a scalable and automated tool for seagrass distribution and density assessment.

Projects included

- Indo-2023

Upload tags

No upload tag filter.

Snapshots

0

No snapshots prepared yet.

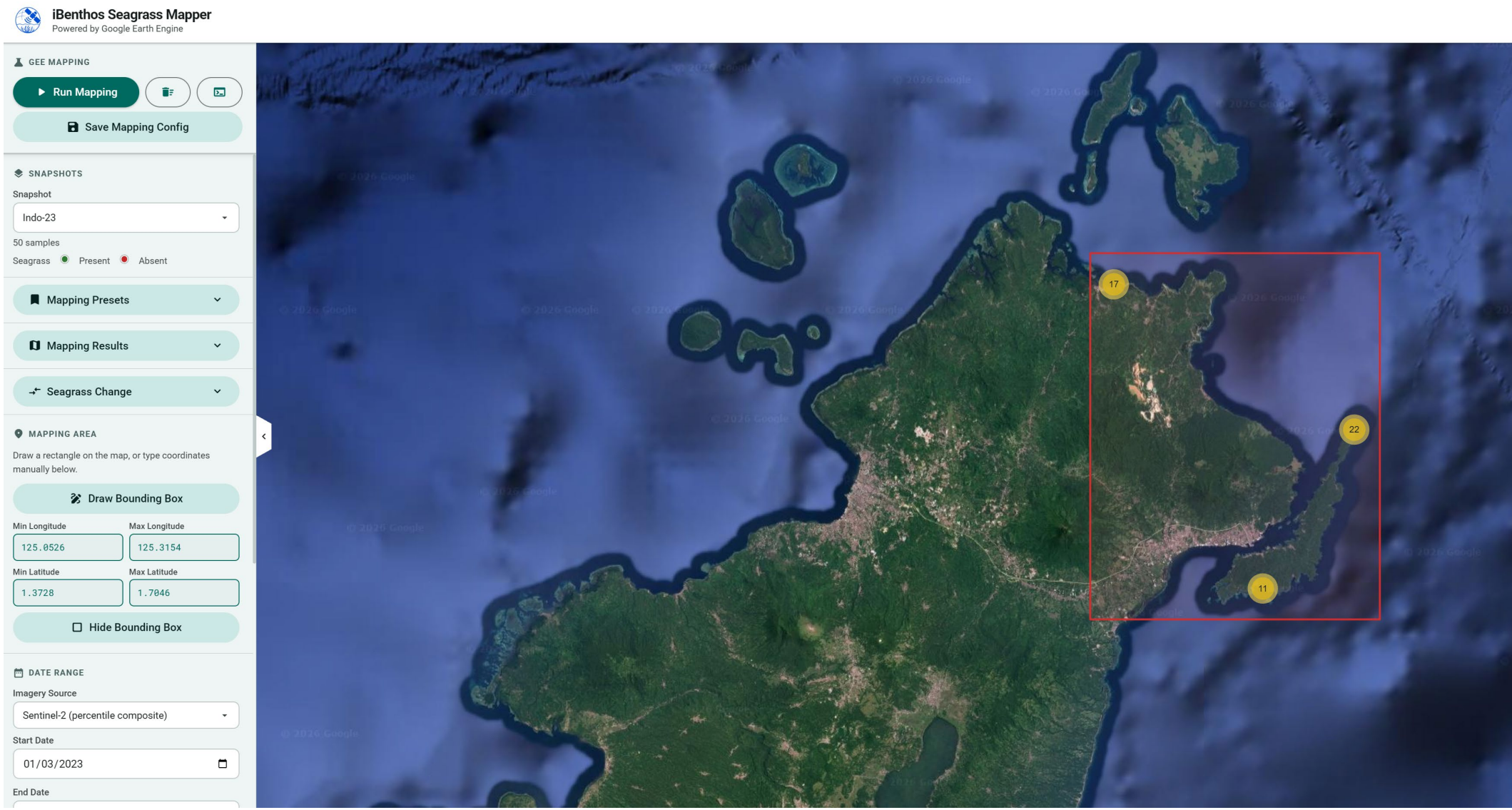
Define Snapshot

Modalities included:

- **M1** : Seagrass binary presence - Model decides if there's seagrass in the image Class will be either Seagrass or Non-Seagrass
- **M2** : Seagrass binary percentage - Model estimates how much of the image is covered in seagrass Value is a percentage. No models actually do this but the csiro models estimate morphology coverage which can be added up.
- **M4** Default : 8-class seagrass morphology percent cover - Model estimates how much of the image is covered by each modality Each modality gets a number between 0 and 1

Mapping: from sparse samples to regional coverage in a few clicks

- View
- Label
- Train



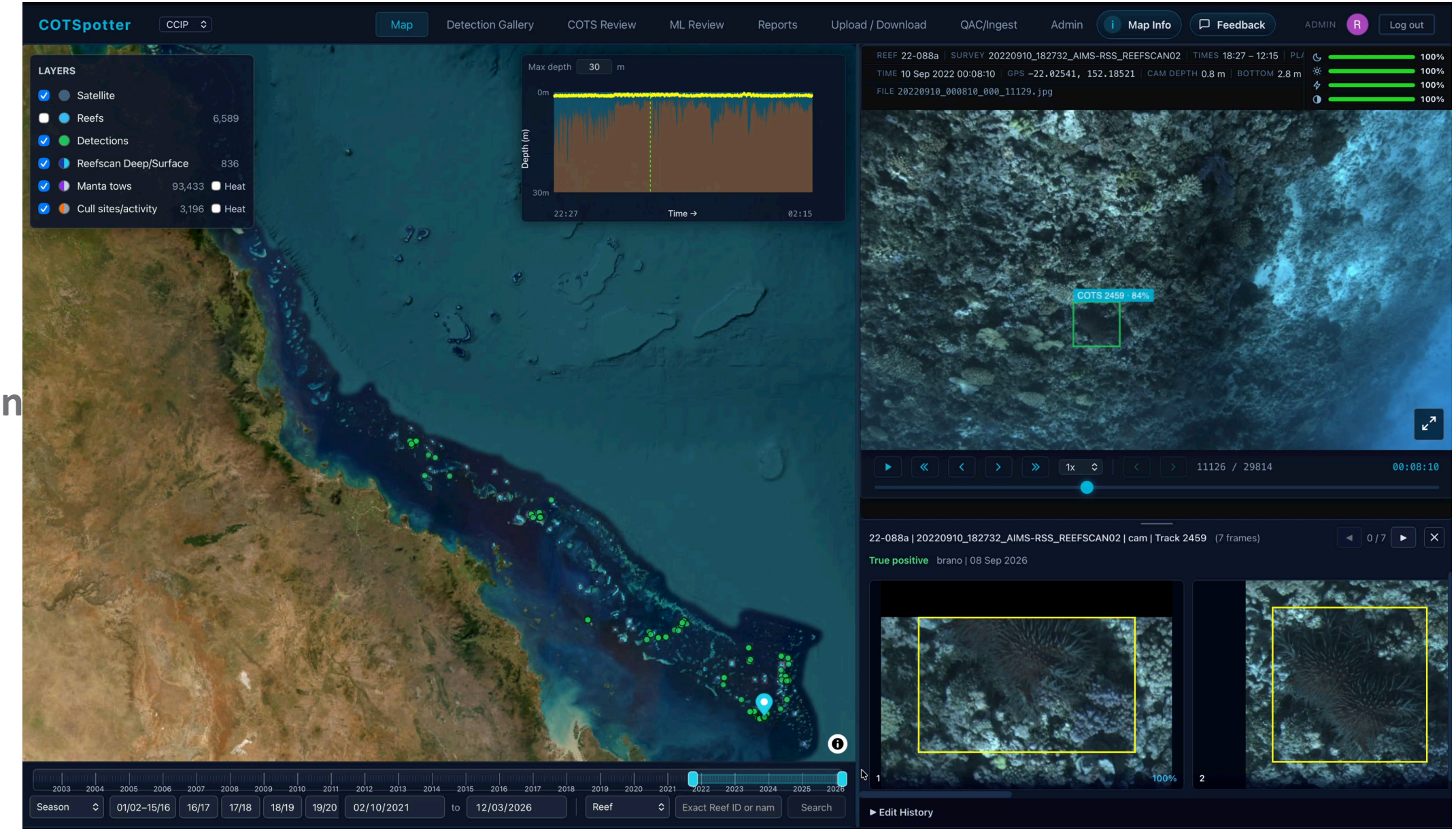
Mapping: from sparse samples to regional coverage in a few clicks



- **Predict**
- **Validate**
- **Export**

COTSpotter – from AI predictions to usable insights

- Validation
- Integration
- Visualisation



COTSpotter – currently supporting partner operations

Current scale of data



Camera-equipped manta board



ReefScan surface and deep platforms

2.99M
indexed images

767
image surveys

2,224
COTS observations

124 reefs · 20 field trips

COTSpotter turns large reef image datasets into validated COTS detections, integrated visualisations, and decision-ready data products.

Thank you