



# Mapping Coral Reefs From Space

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AusSeabed Webinar Series  
30<sup>th</sup> July 2020

# Rockets and Sensors

# Satellite Sensors

## 2m WorldView-2/3 (2009/2014)



Blue (2)  
Green  
Red and red edge  
Yellow  
NIR (2)  
1 day revisit

## 10m Sentinel-2A/B (2015/2017)



Blue  
Green  
Red  
NIR  
5 day revisit

## 15m Landsat-8 (2013)



Coastal  
Blue  
Green  
Red  
NIR  
16 day revisit



# Radiative Transfer

Image pixel =  
*f(atmosphere, adjacency, water surface, absorbers and backscatters', seafloor, water depth, sea state, sun and sensor geometry, SNR ratio)*

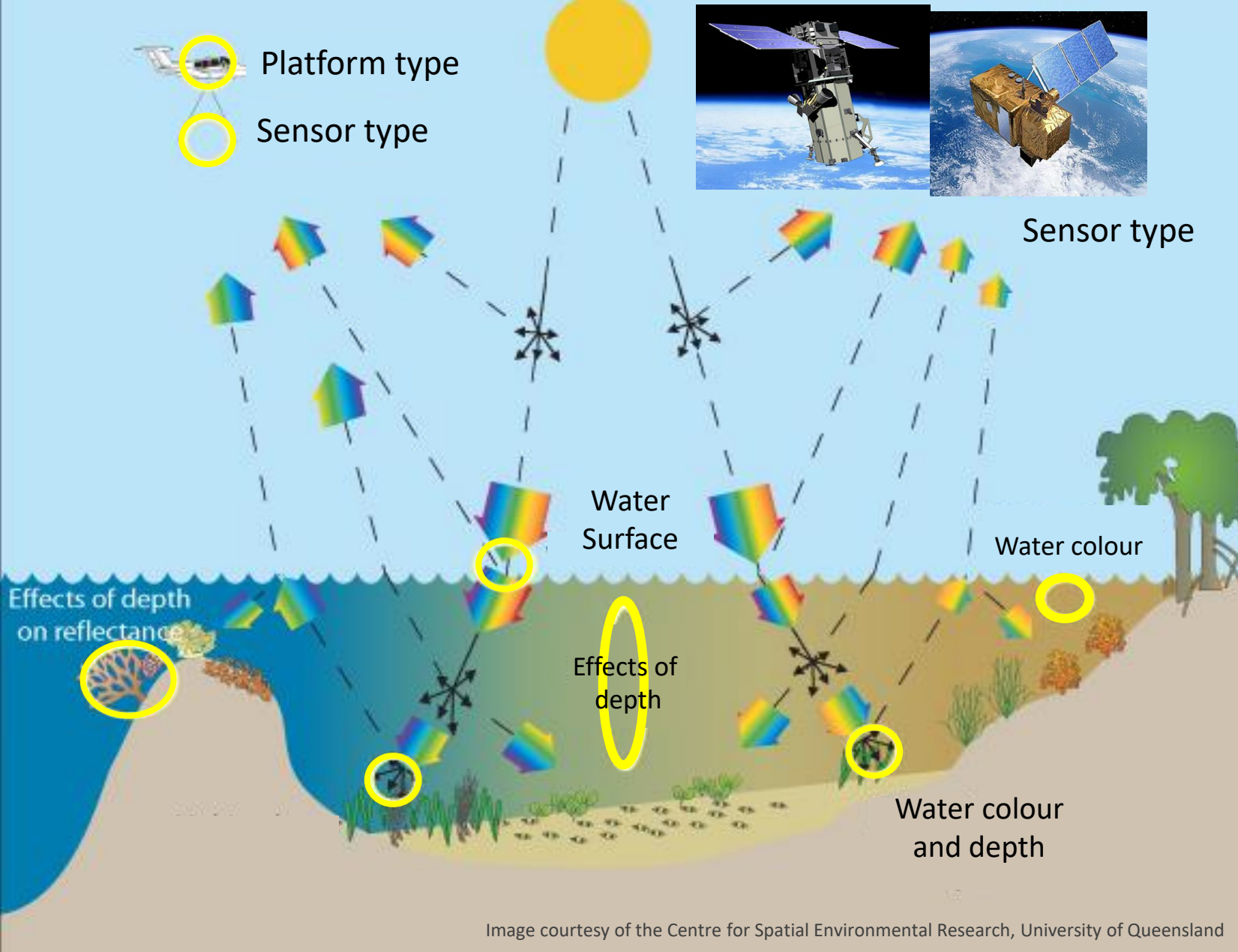
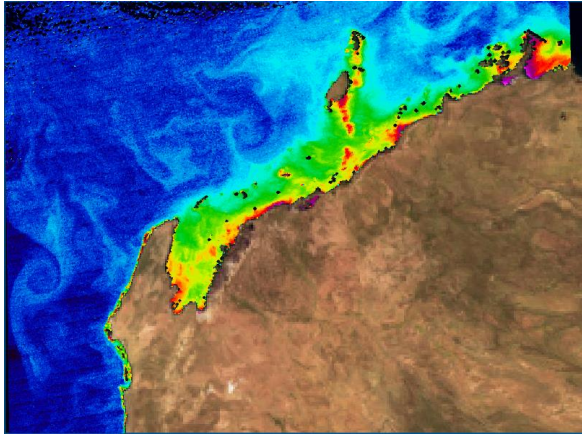


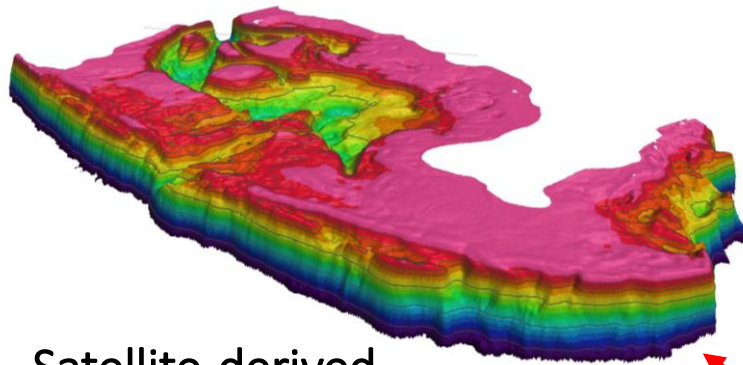
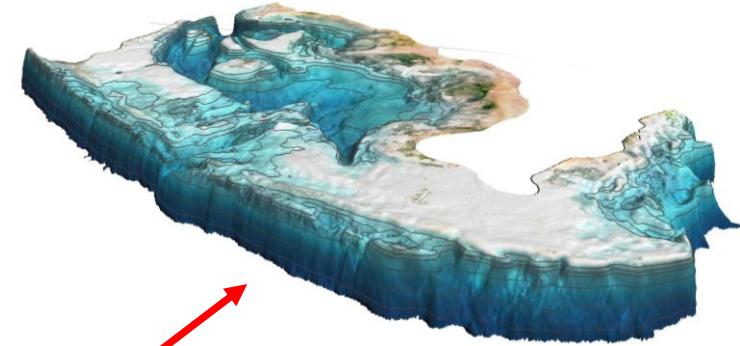
Image courtesy of the Centre for Spatial Environmental Research, University of Queensland

# Modular Inversion Processor (MIP)

Water quality

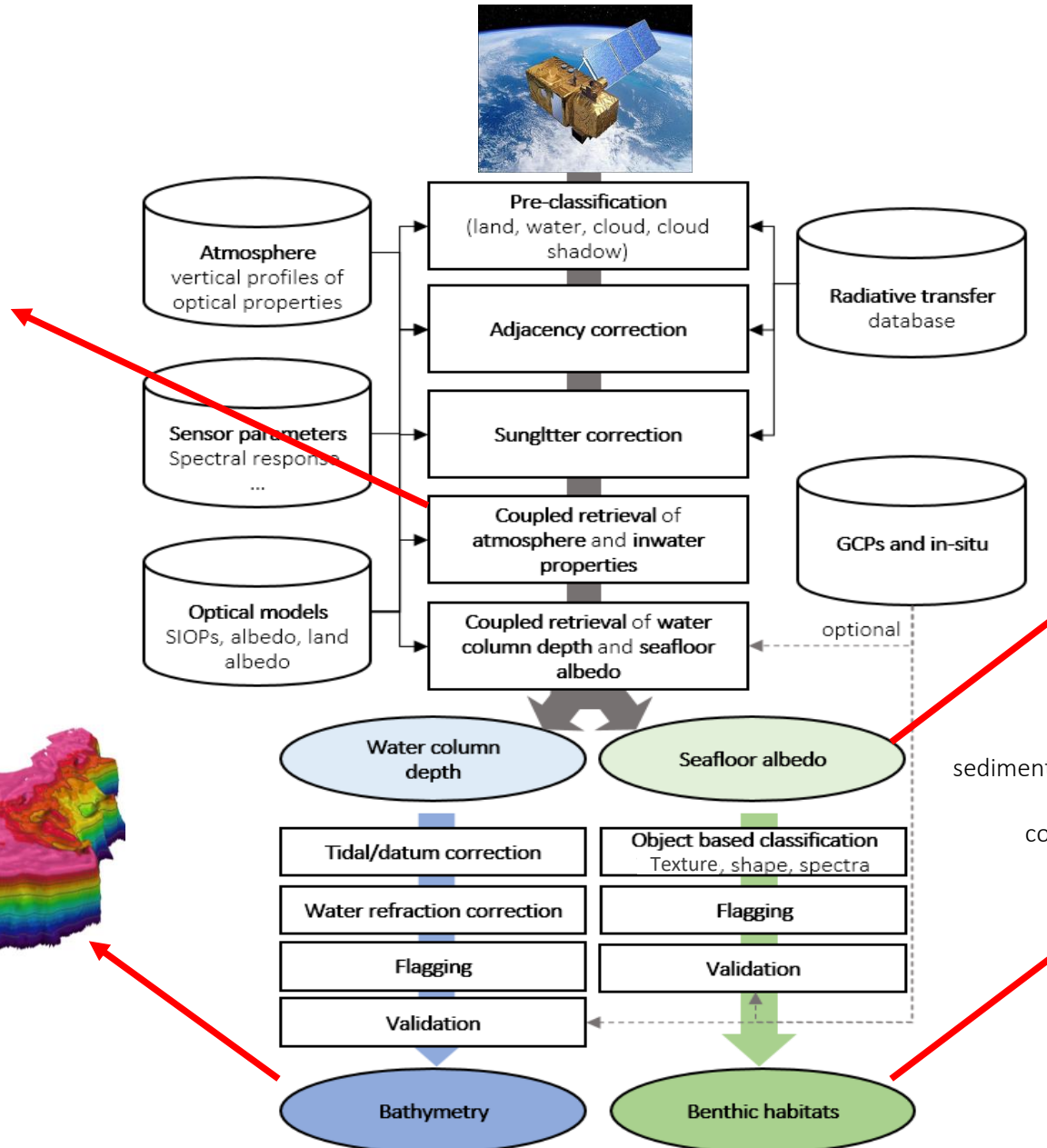
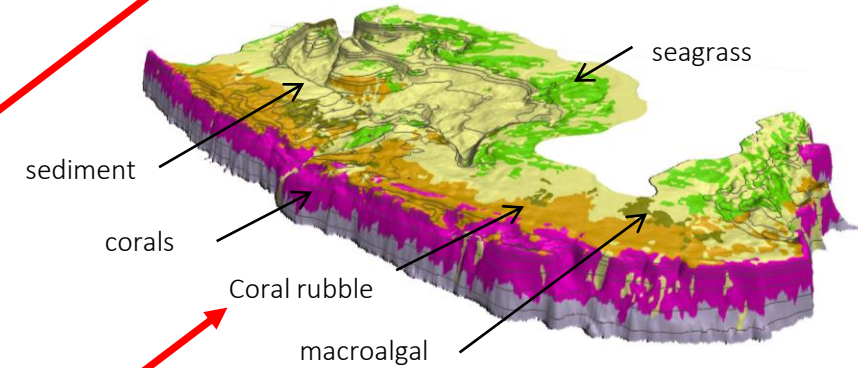


Seafloor reflectance (colour)



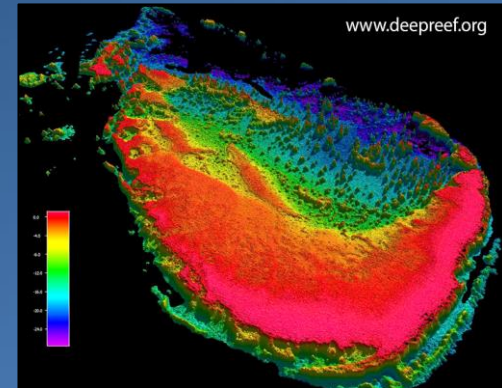
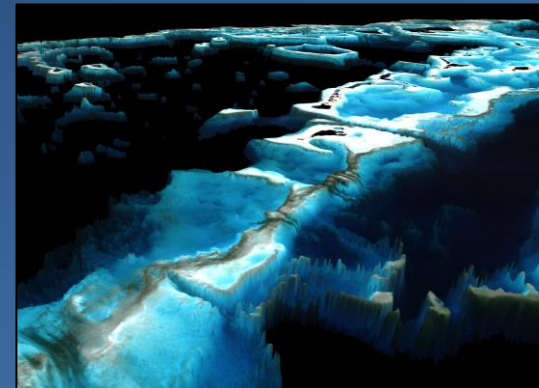
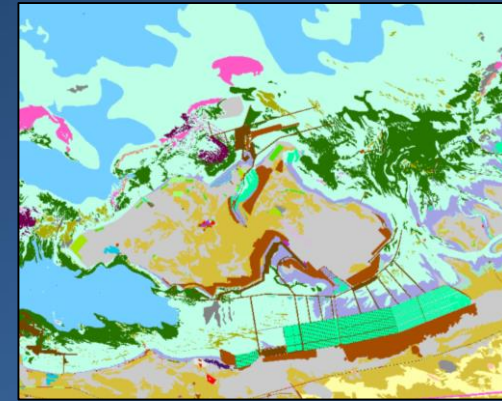
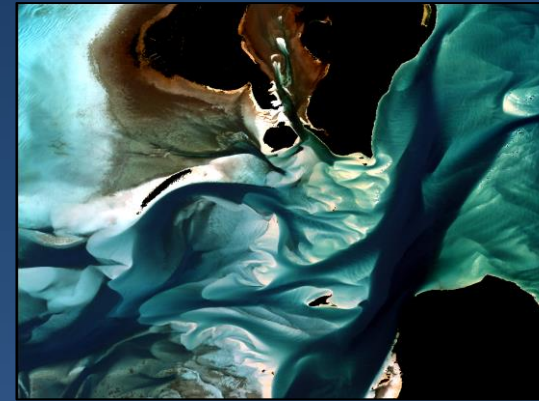
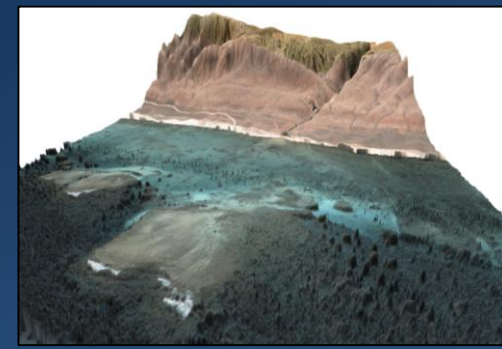
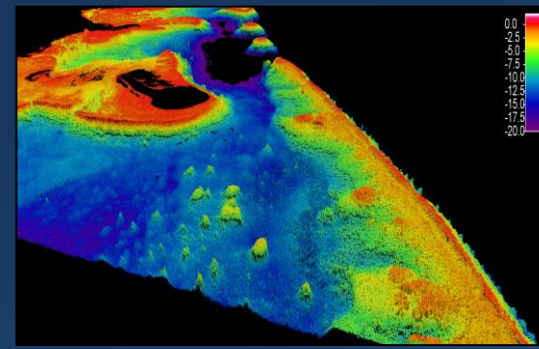
Satellite-derived bathymetry (SDB)

Benthic habitats



# Use cases

- Hydrographic mapping - safety at sea
- Environmental monitoring
- Baseline and ongoing habitat mapping
- Detecting change
- Pipeline crossings for oil & gas
- Coastal development
- Hydrodynamic modelling
- Resolving coastal boundary disputes



# Managing Coral Reefs in the Anthropocene

- 'Earth Observation' addresses some of the challenges
- Many reefs have no comprehensive maps to support research
- What essential layers/maps do we need to monitor change and support management?
- Improved spatial and temporal information on bathymetry, reflectance (colour) and habitats

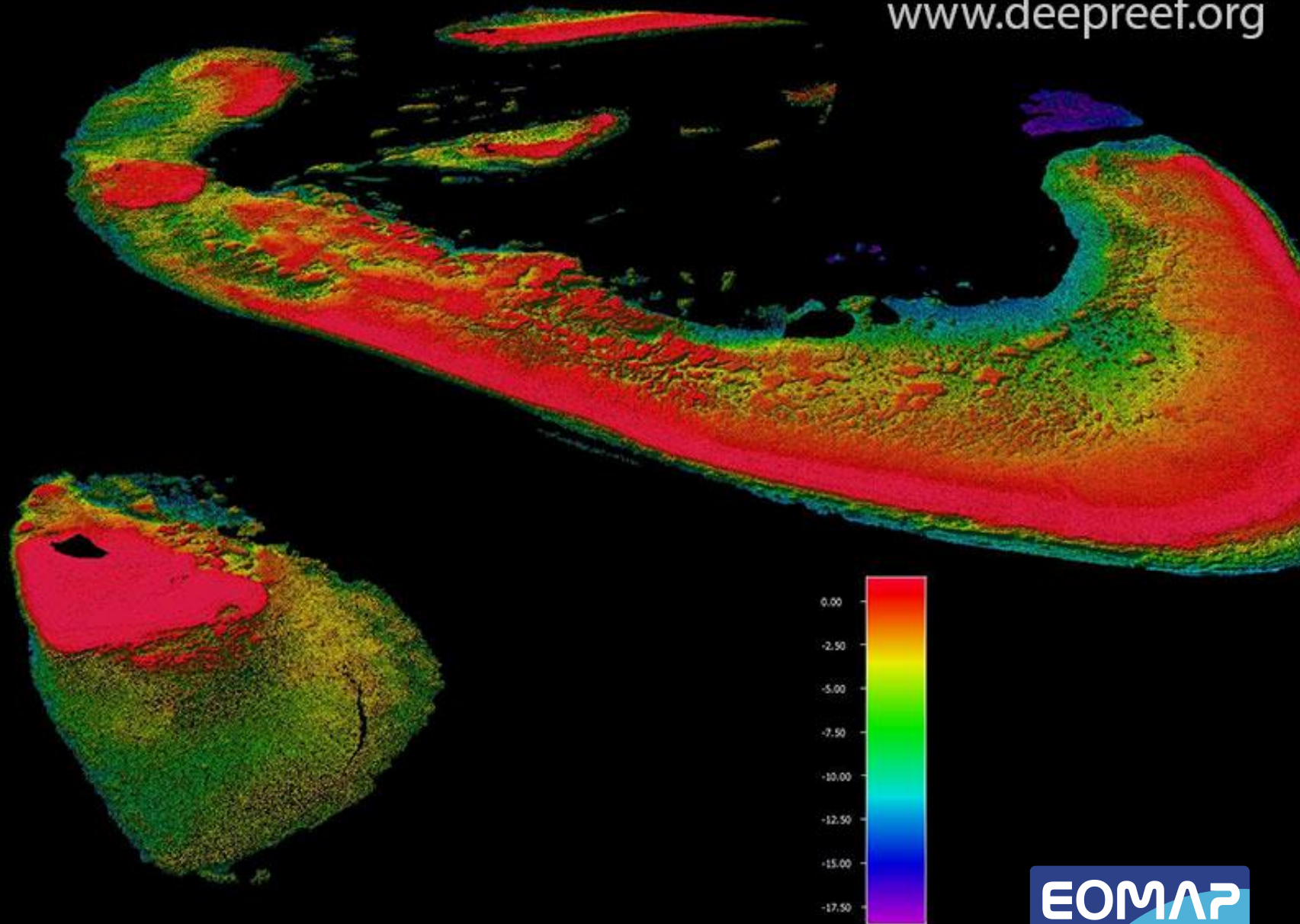


# Great Barrier Reef Mapping

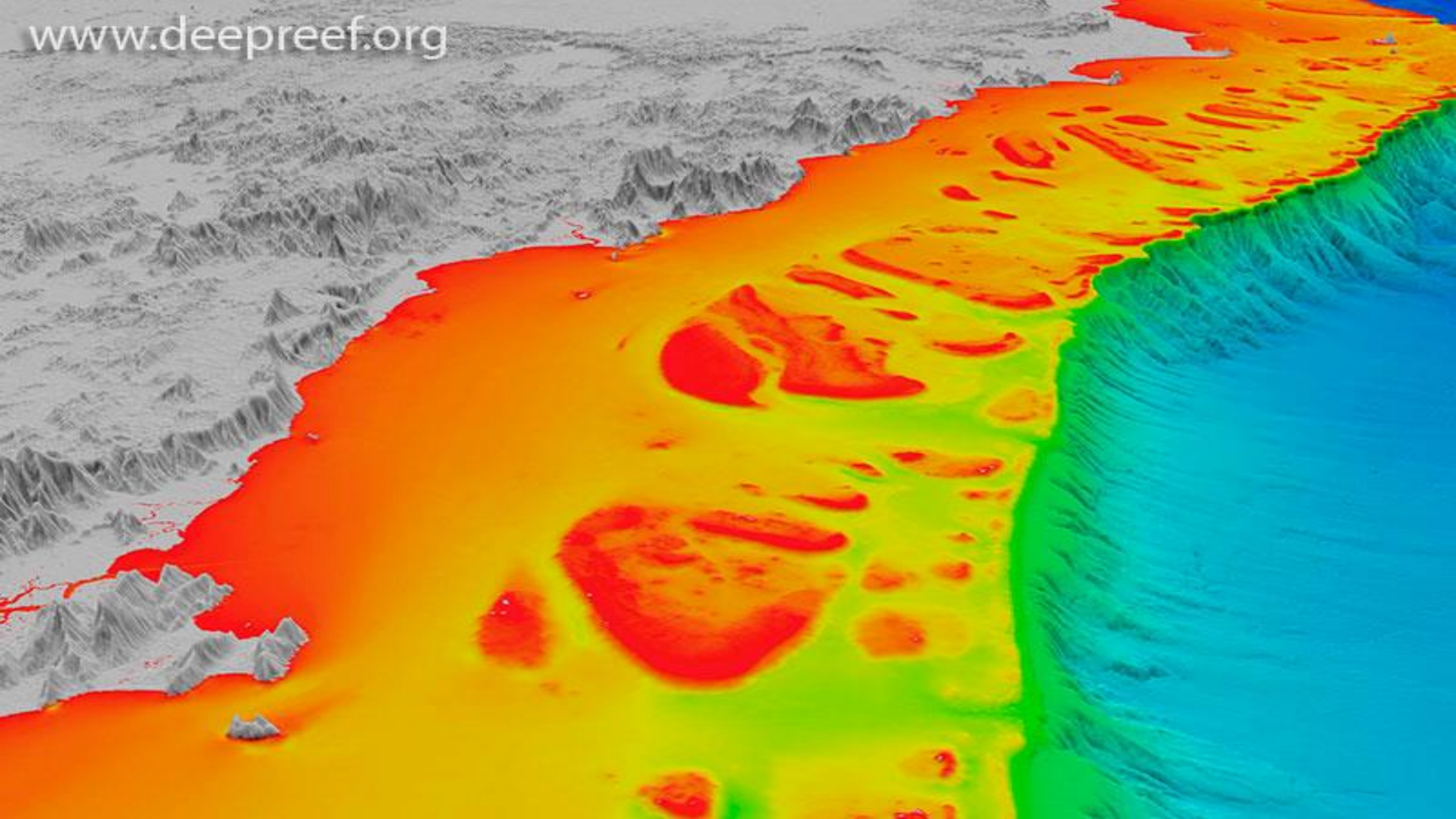
- Entire shallow water GBR at 30m resolution (2013)
- Selected very high resolution surveys
- Integrated in GBR30 and GBR100 grids (Project 3D-GBR, Robin Beaman JCU, GA, AHO)

[www.deepreef.org](http://www.deepreef.org)

[www.deepreef.org](http://www.deepreef.org)







# Habitat maps to enhance monitoring and management of the Great Barrier Reef (Coral Reefs, 2020)

Chris M. Roelfsema<sup>1</sup> · Eva M. Kovacs<sup>1</sup> · Juan Carlos Ortiz<sup>2,3</sup> · David P. Callaghan<sup>4</sup> · Karlo Hock<sup>3</sup> · Mathieu Mongin<sup>5</sup> · Kasper Johansen<sup>1,9</sup> · Peter J. Mumby<sup>3</sup> · Magnus Wettle<sup>6</sup> · Mike Ronan<sup>7</sup> · Petra Lundgren<sup>8</sup> · Emma V. Kennedy<sup>1</sup> · Stuart R. Phinn<sup>1</sup>

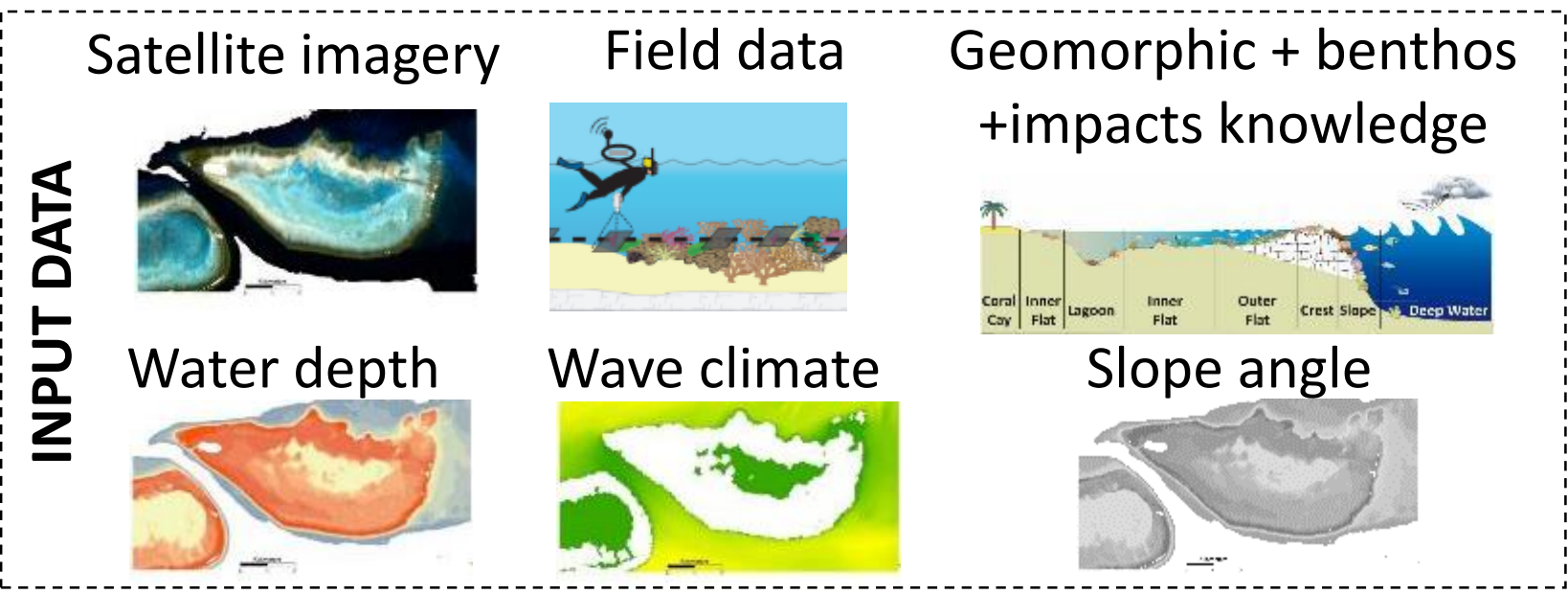
2017: 237 reefs Cairns Management Area

2016: 20 reefs Capricorn-Bunker

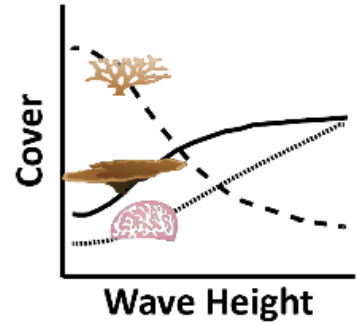
2000-2018: Heron Reef



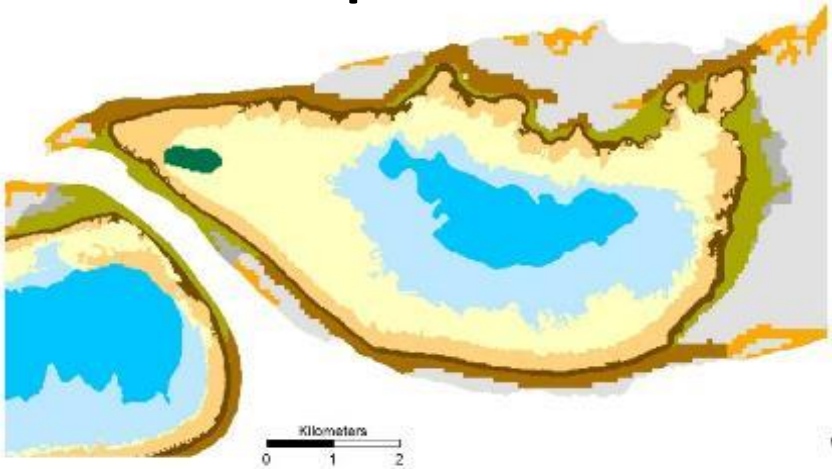
**Object-based analysis:  
Trimble  
eCognition 9.3  
software**



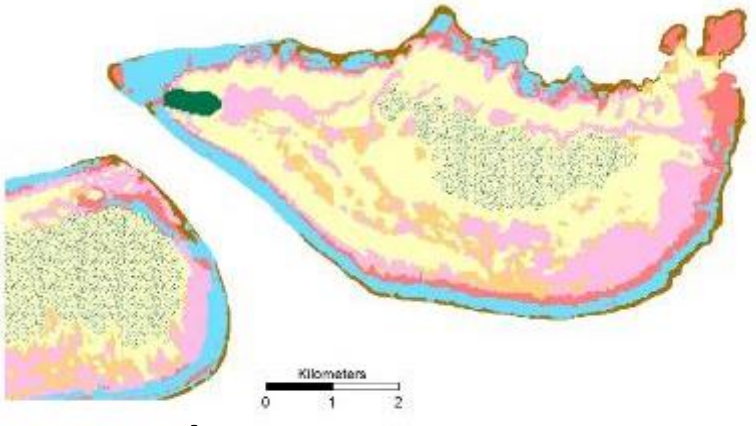
**Mapping and Modelling**



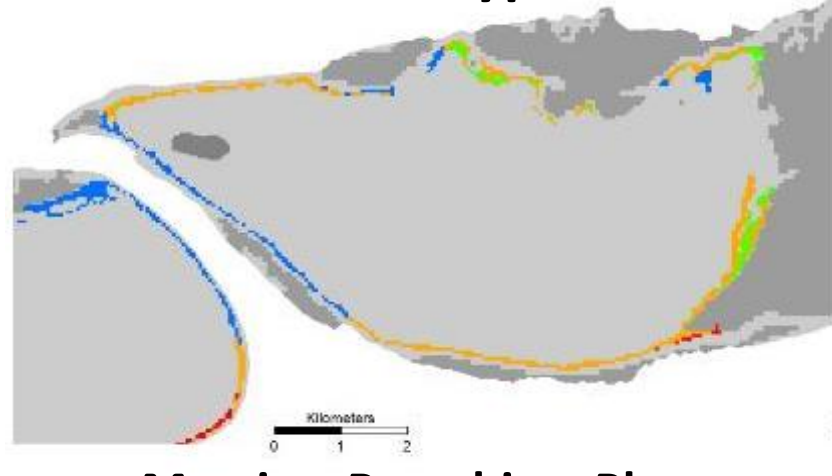
**Geomorphic zonation**



**Benthic Habitat Type**



**Predicted Coral type habitat**

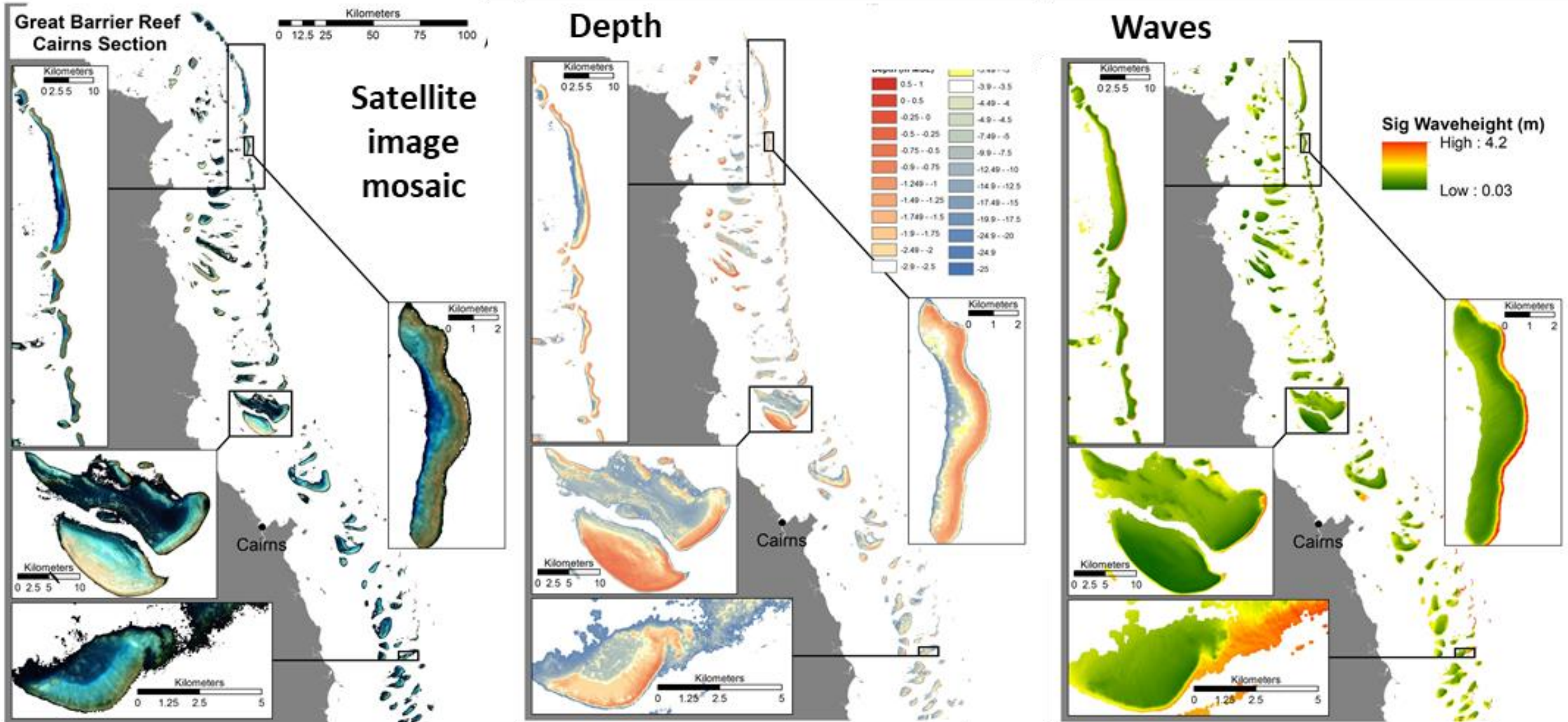


**Reef Slope, Crest, flat, lagoon**

**Coral/Algae, Rock, Rubble, Sand**

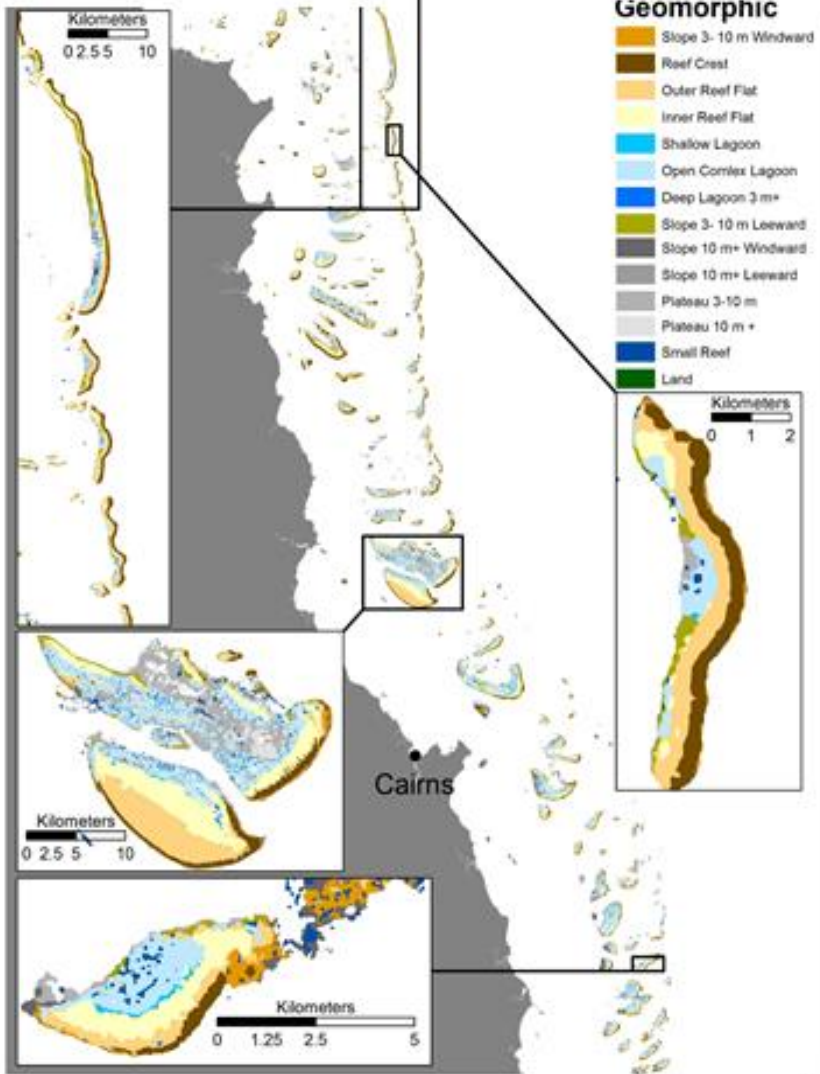
**Massive, Branching, Plate**

# GBR Mapping

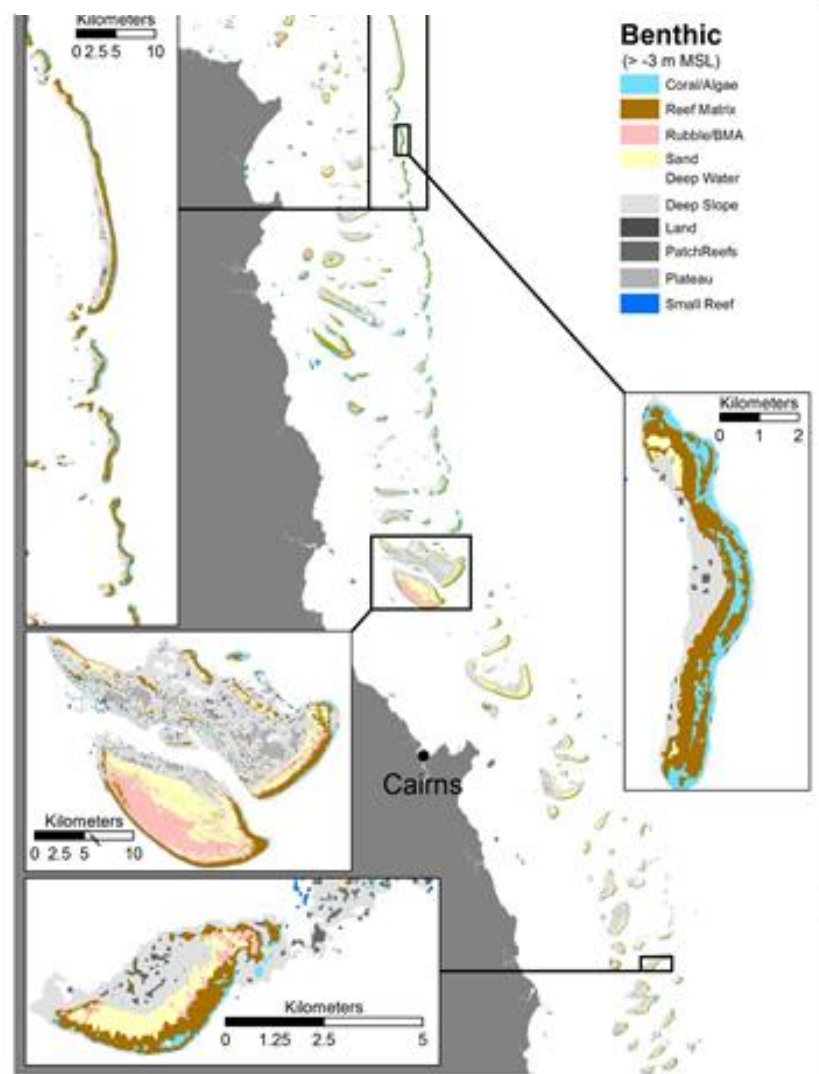


# GBR Mapping

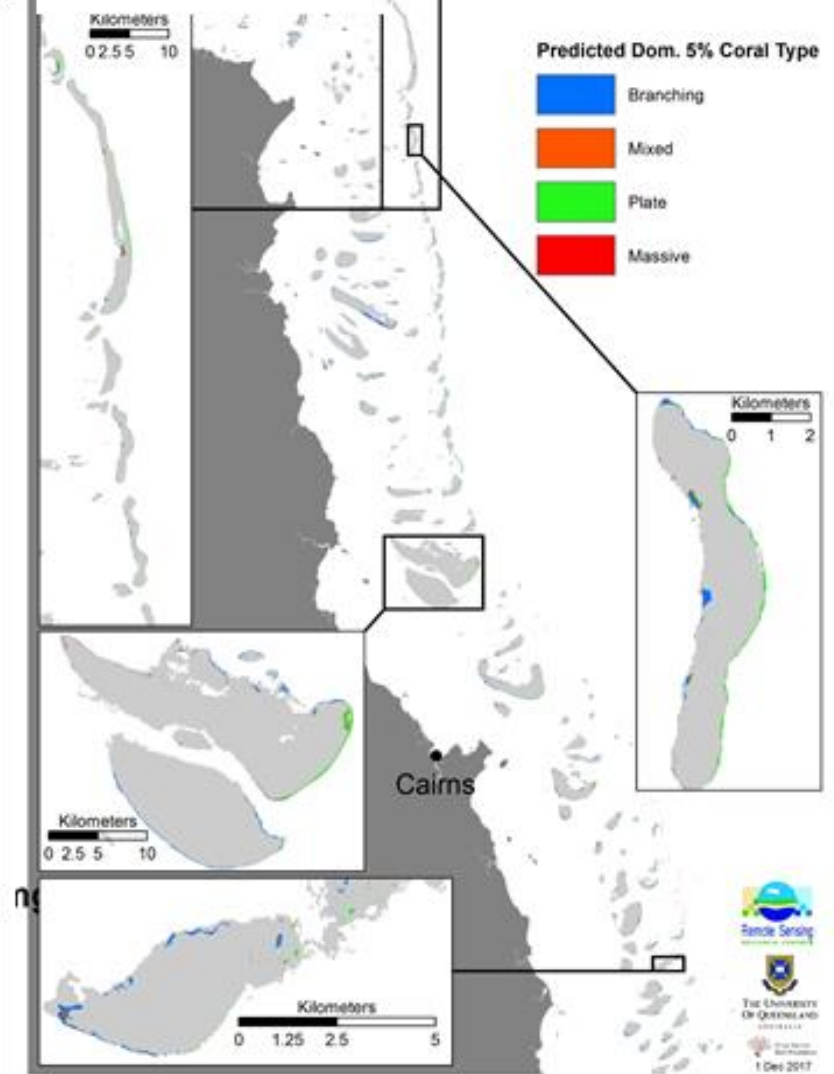
## Geomorphic



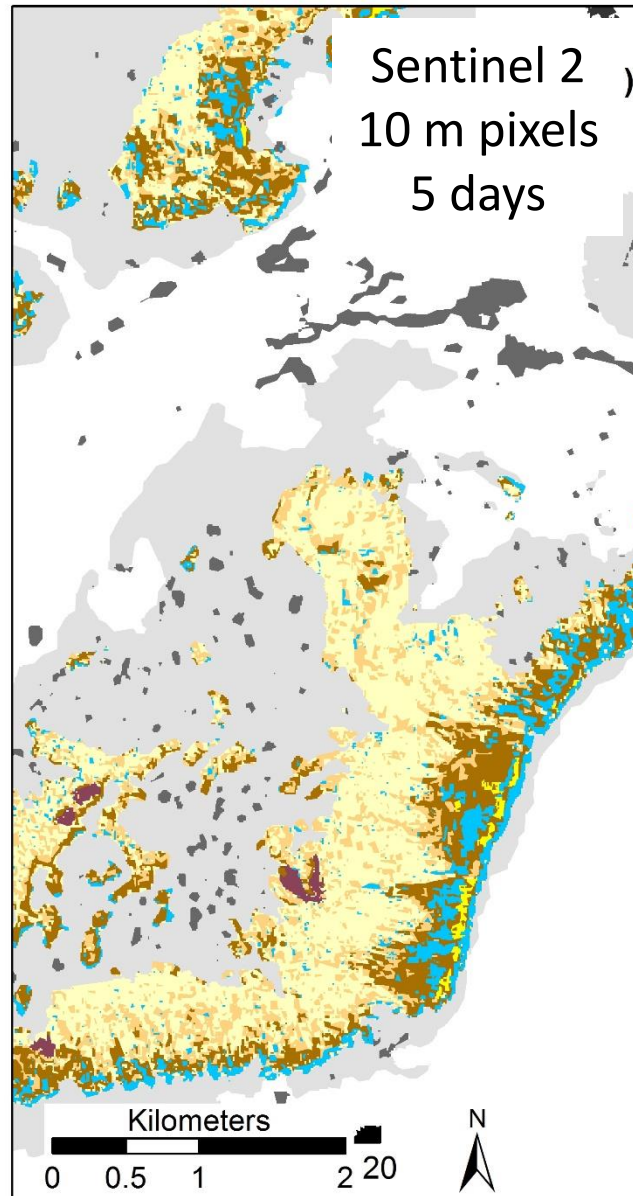
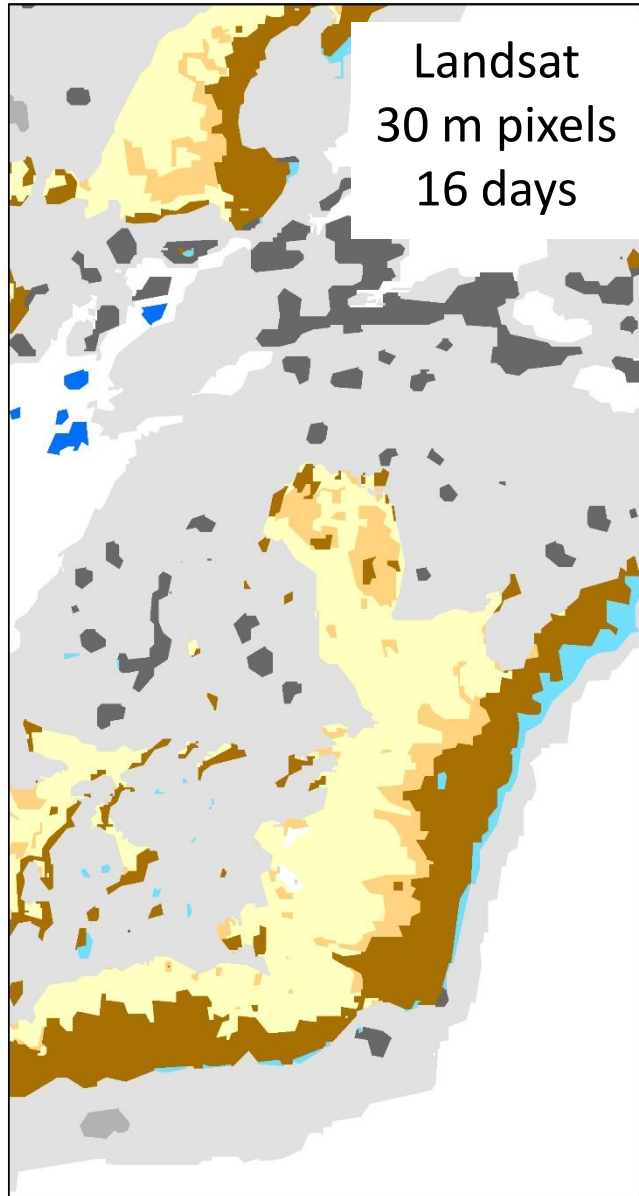
## Benthic Habitat Type



## Coral Type



# '3D live habitats for the full extent of the GBR'



## Benthic (Reef Top) Draft



## Sentinel 2:

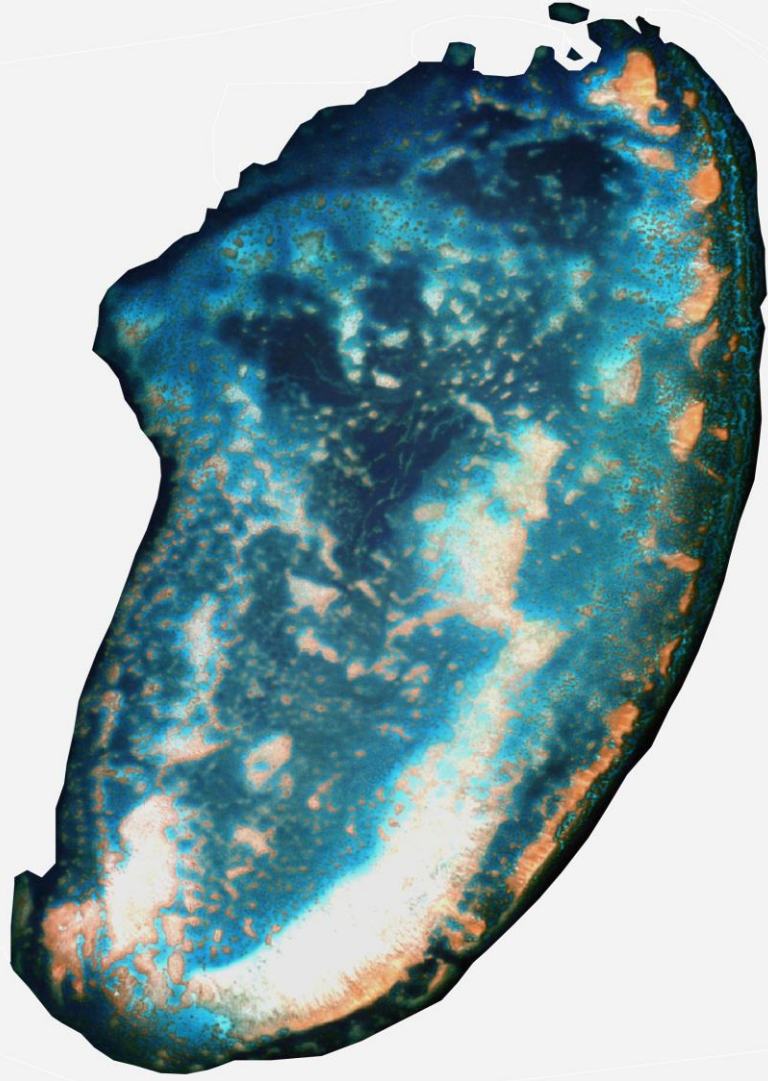
- 10m pixels
- 5 days revisit
- Scenes 2018- 2019

## To derive:

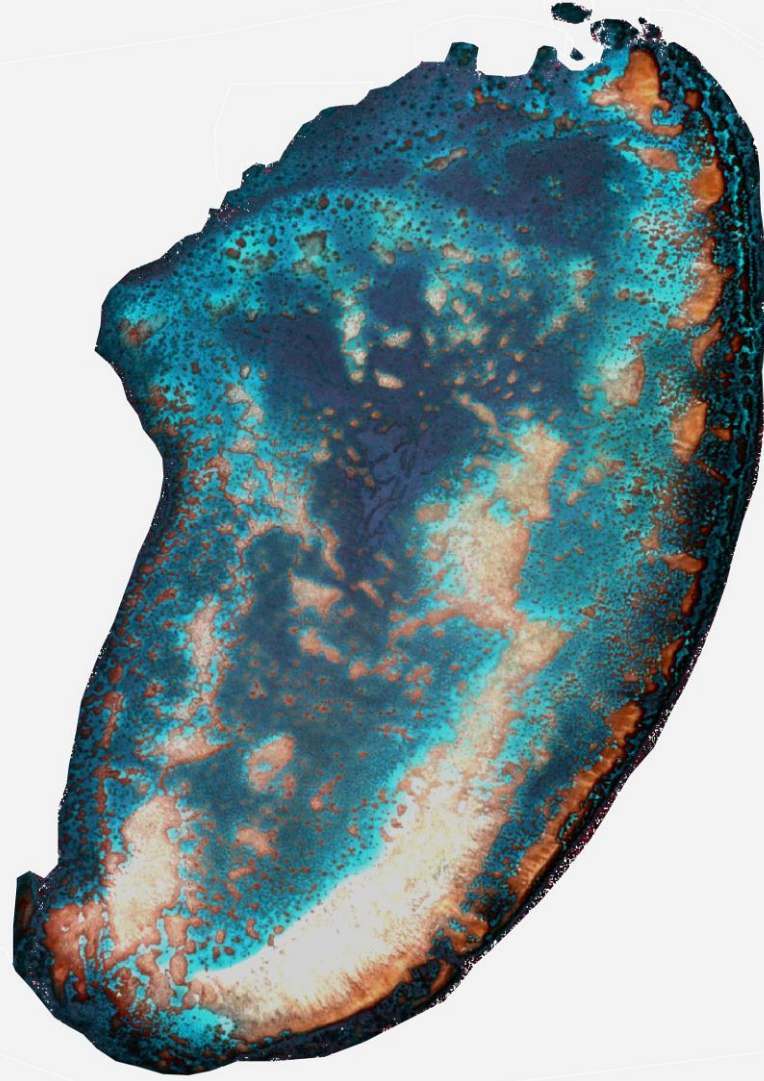
- Surface reflectance (2019)
- Water depth (2019)
- Geomorphology (2020)
- Bottom type (2021)
- Coral type (2021)



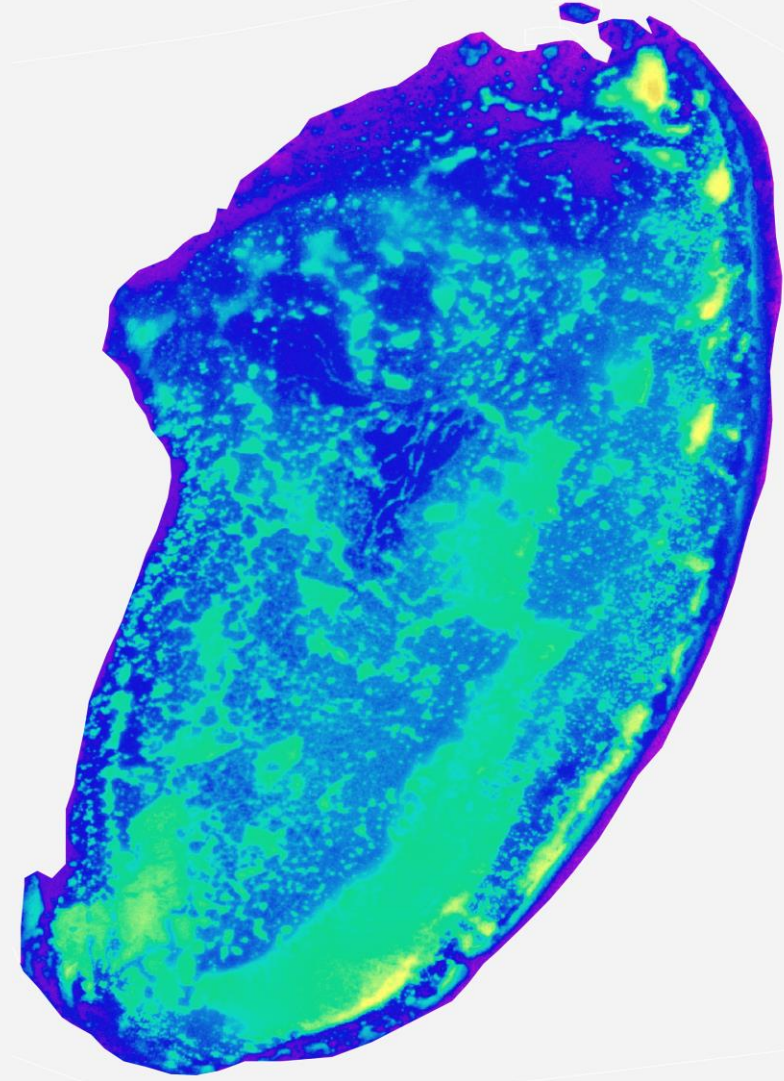
# Sub-surface Reflectance

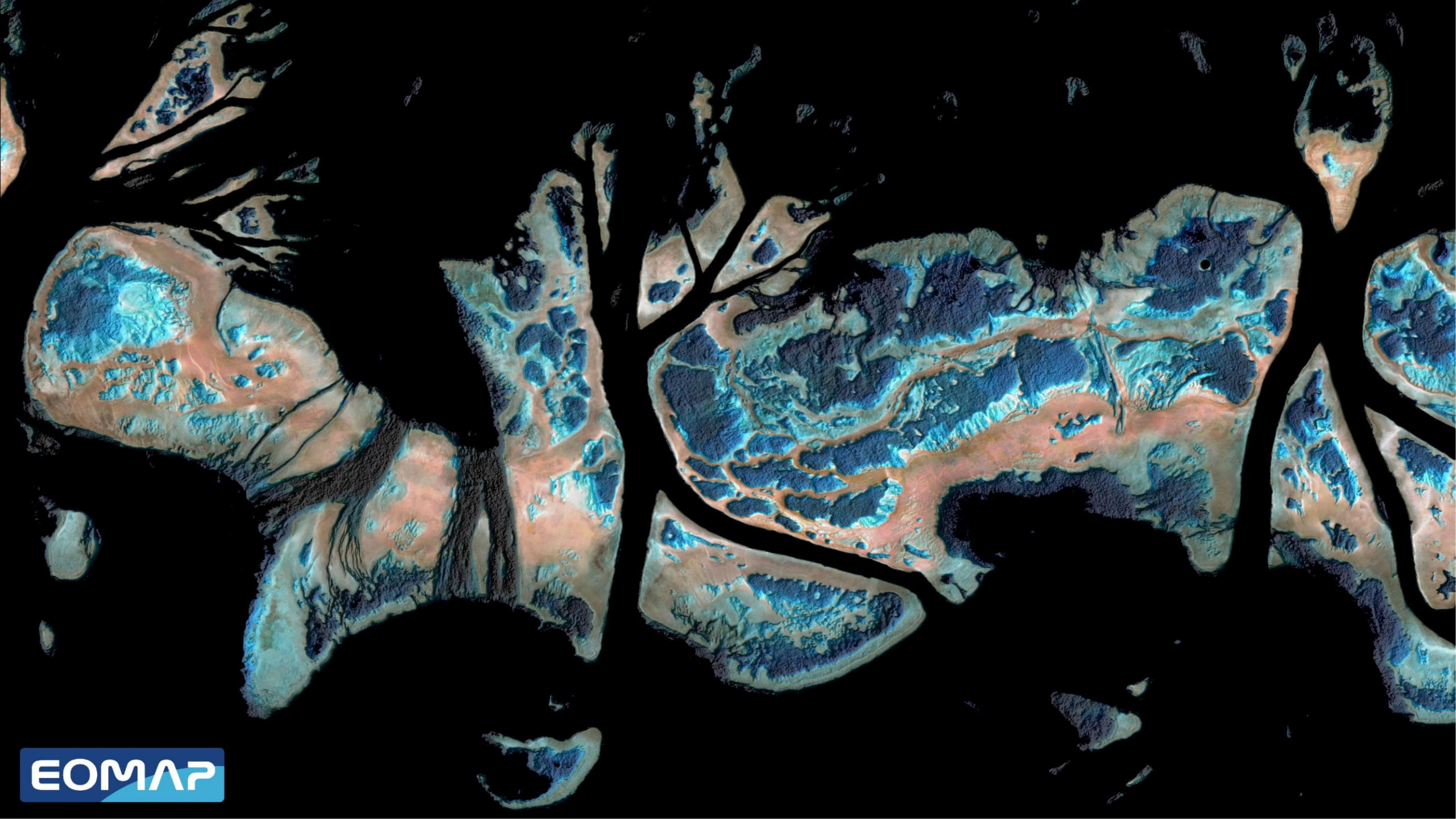


# Seafloor Reflectance



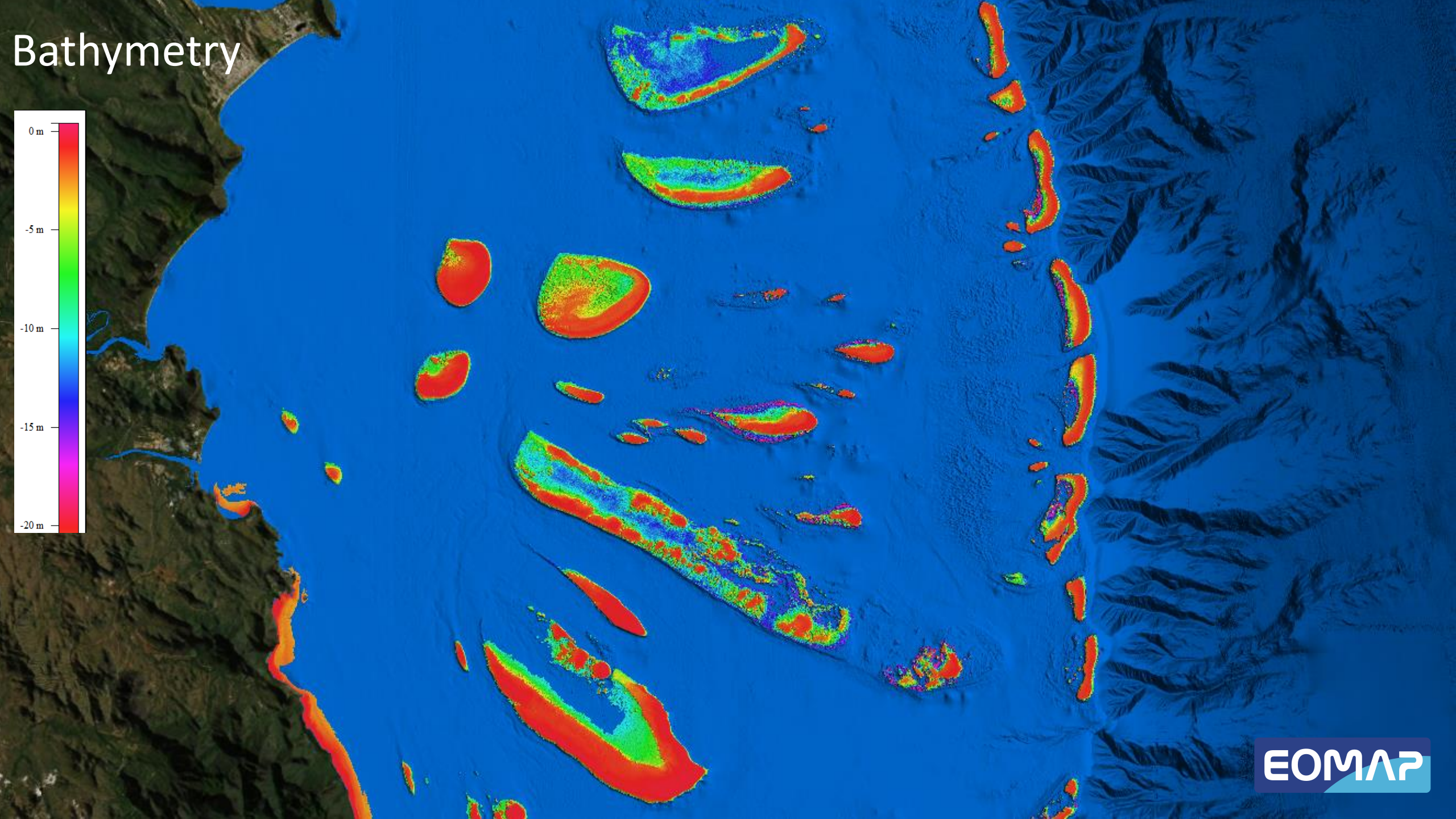
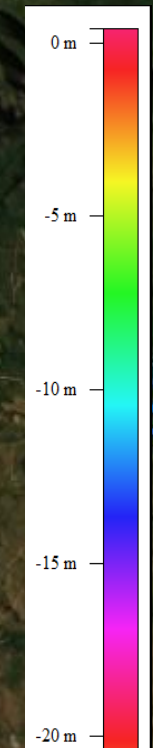
# Bathymetry



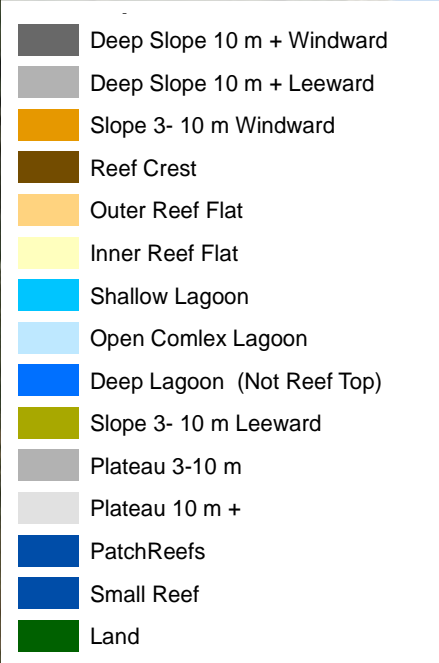




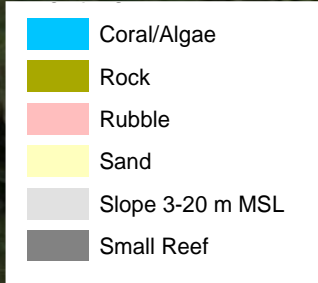
# Bathymetry



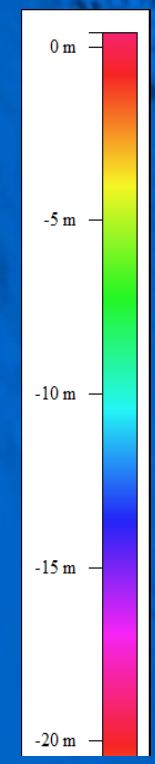
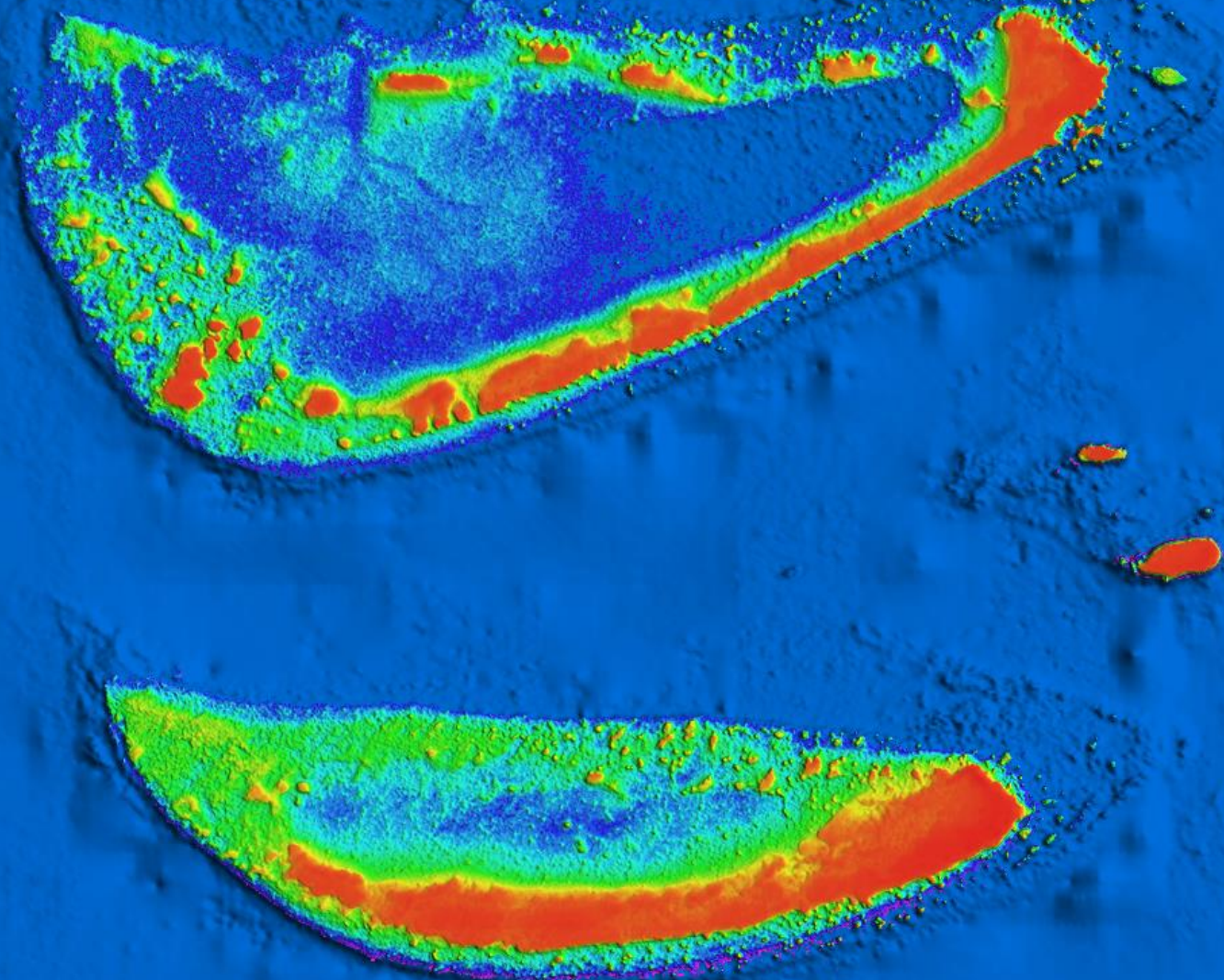
# Geomorphology



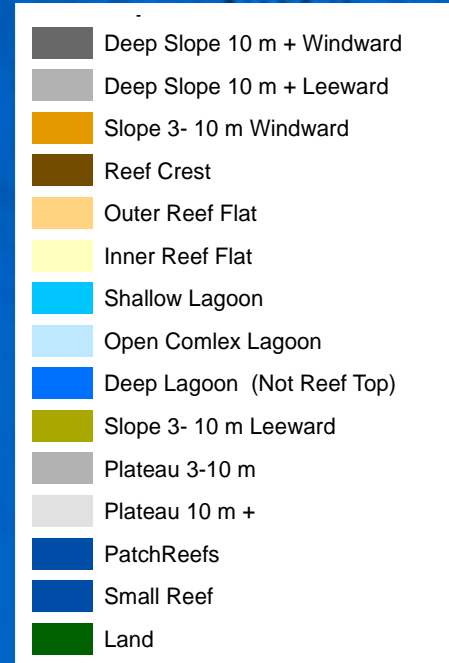
# Benthic Habitat



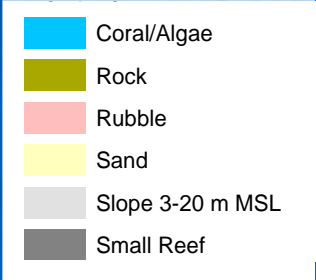
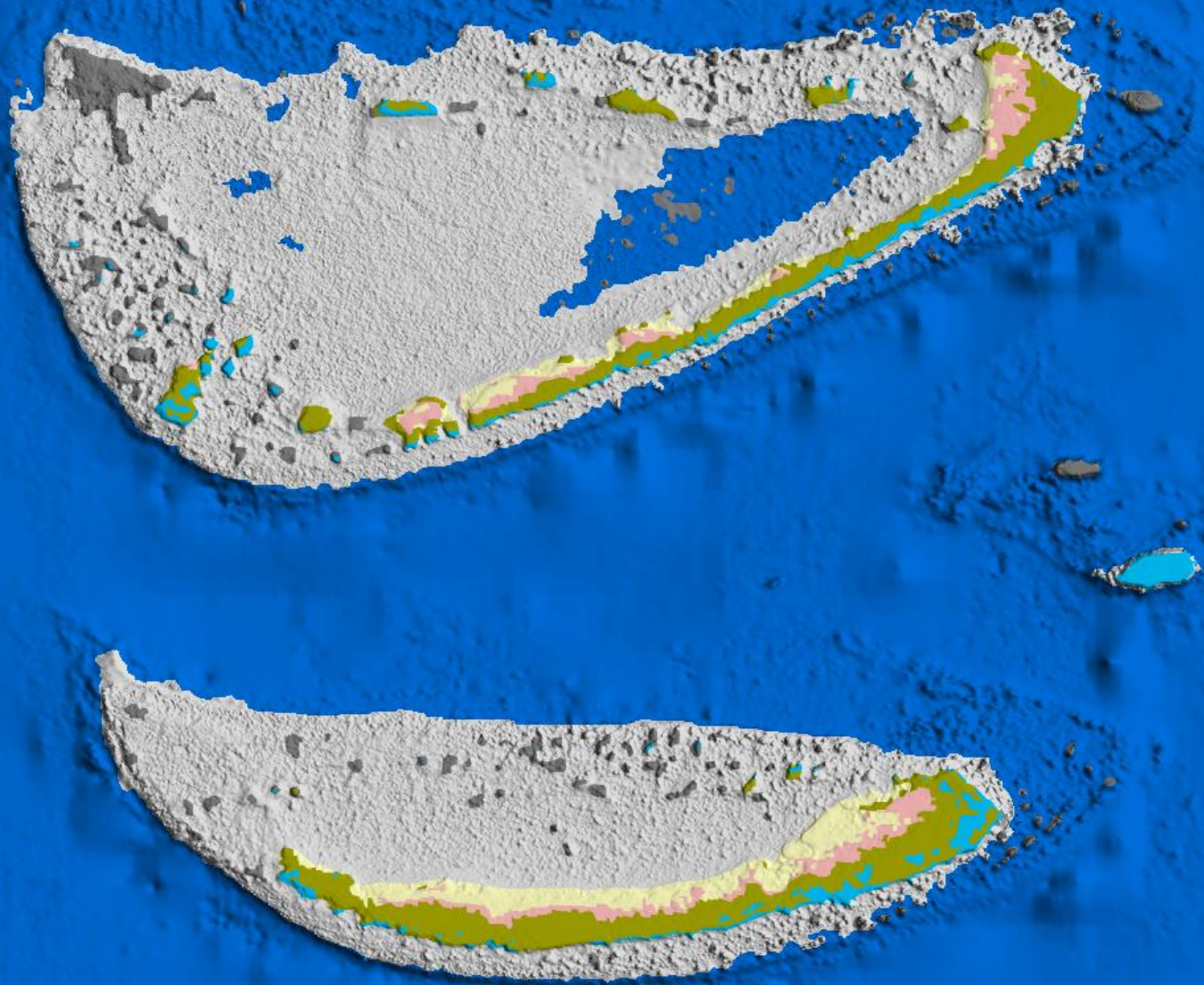
# Bathymetry

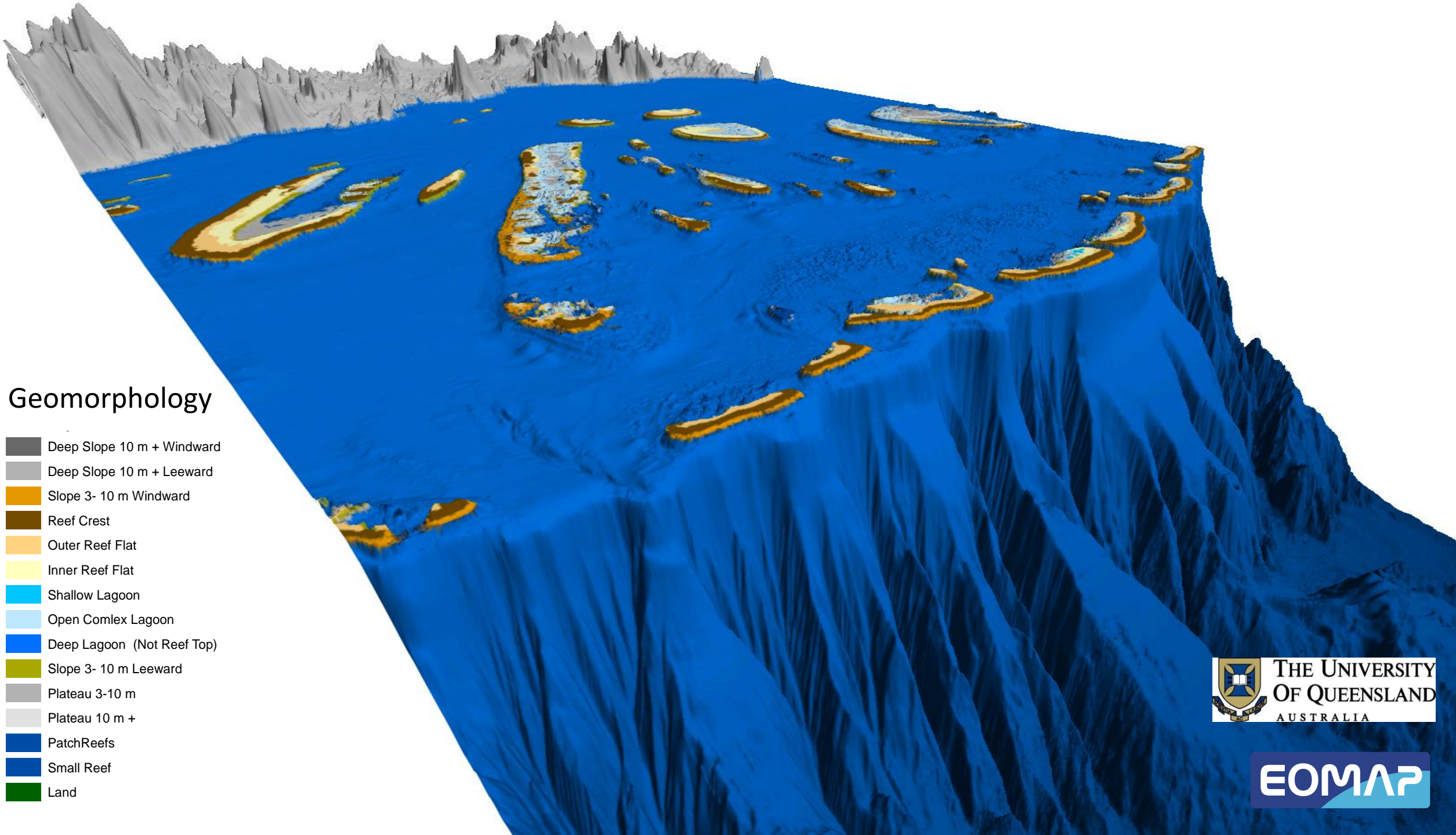


# Geomorphology



# Benthic Habitat



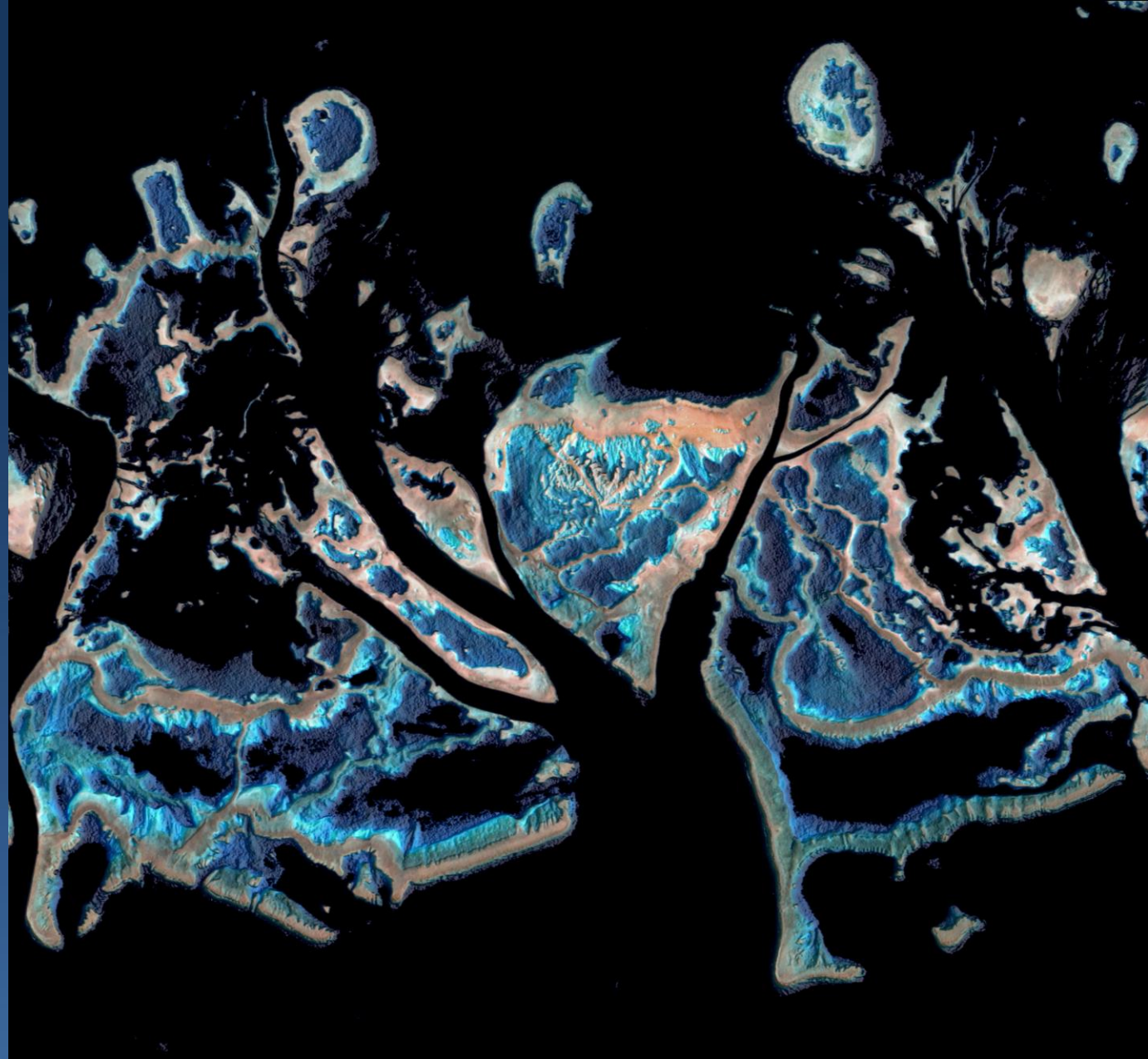


## Geomorphology

- Deep Slope 10 m + Windward
- Deep Slope 10 m + Leeward
- Slope 3- 10 m Windward
- Reef Crest
- Outer Reef Flat
- Inner Reef Flat
- Shallow Lagoon
- Open Complex Lagoon
- Deep Lagoon (Not Reef Top)
- Slope 3- 10 m Leeward
- Plateau 3-10 m
- Plateau 10 m +
- PatchReefs
- Small Reef
- Land

# Mapping from Space

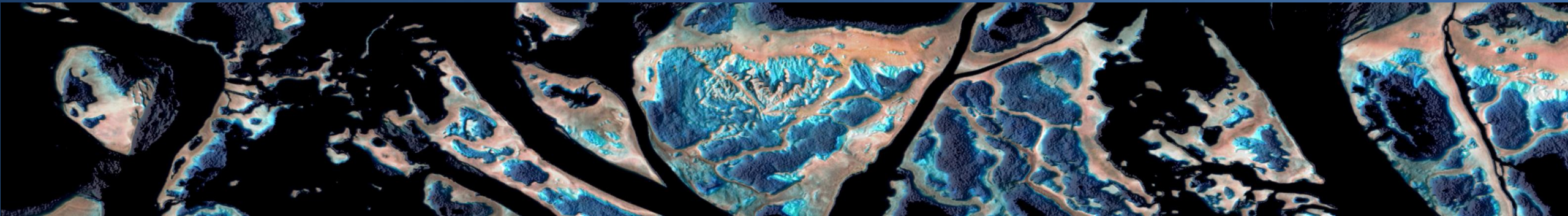
- Map shallow, clear waters globally
- Reliable and cost-effective information:
  - Bathymetry
  - Reflectance
  - Benthic habitats
- Remote, often inaccessible
- Large areas frequently and quickly
- Very high-resolution and accurate
- Complimentary





# Closing Remarks

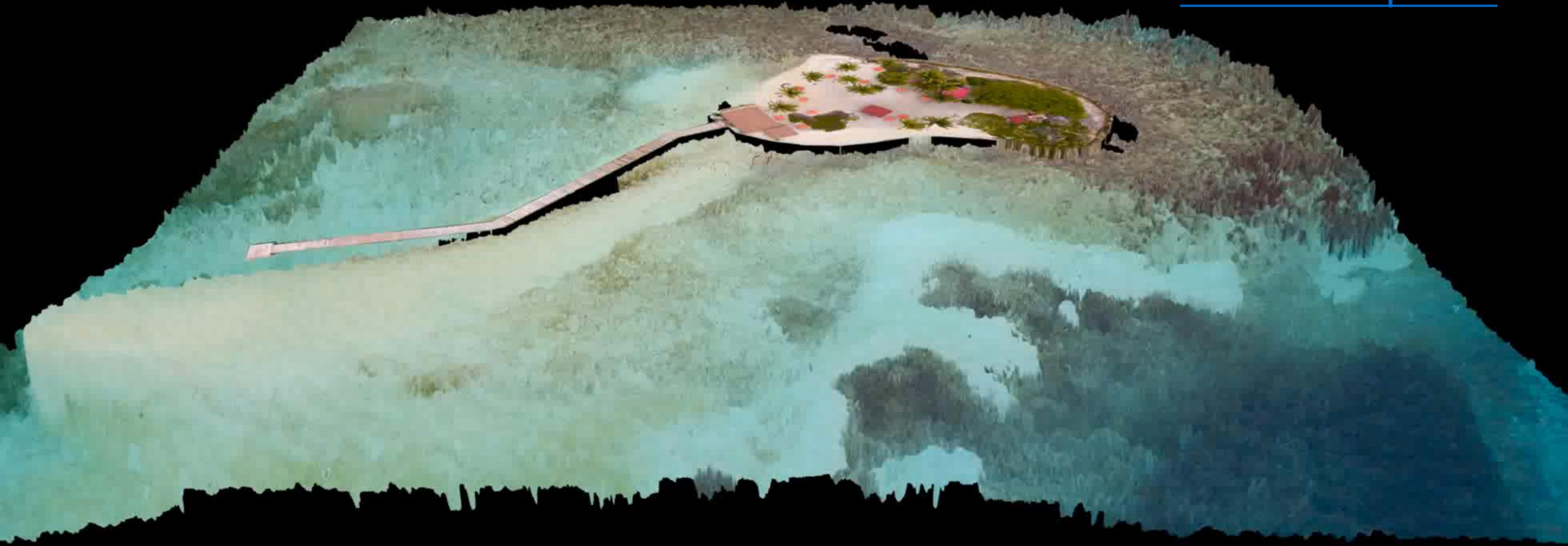
- Impressive increase in the use of satellite-derived mapping for coral reefs - hydrographic mapping and environmental monitoring
- Advances in sensor technology, processing algorithms and machine learning will continue to drive forward capabilities for coral reef mapping
- Ultimately supporting management and conservation!



# Thanks for listening!


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[www.eomap.com](http://www.eomap.com)




A map showing water quality monitoring data with a color scale from green to brown. The text 'EO Mapping Services' is visible in the top left corner of the map.

Water Quality Monitoring (WQ)

A map showing digital elevation and surface models with a grayscale color scale. The text 'EO Mapping Services' is visible in the top left corner of the map.

Digital Elevation and Surface Models

A map showing shoreline mapping data with a color scale from light blue to dark blue. The text 'EO Mapping Services' is visible in the top left corner of the map.

Shoreline Mapping

A map showing benthic cover and habitat mapping data with a color scale from green to brown. The text 'EO Mapping Services' is visible in the top left corner of the map.

Benthic Cover and Habitat Mapping

A map showing satellite-derived bathymetry (SDB) data with a color scale from light blue to dark blue. The text 'EO Mapping Services' is visible in the top left corner of the map.

Satellite-Derived Bathymetry (SDB)

A map showing a multi-source bathymetry grid with a color scale from purple to green. The text 'EO Mapping Services' is visible in the top left corner of the map.

Multi-Source Bathymetry Grid

