

Beach Erosion and Shore Protection along Placencia Peninsula, Belize

Ping Wang

Elizabeth Royer

Lara Novalvos-Hernandez

School of Geosciences

University of South Florida

Outline

Introduction

Study Area

Field Data Collection and Shoreline-Change Analysis

Numerical Modeling (not discussed here)

Beach Erosion and Causes

Shore Protection Options

Summary

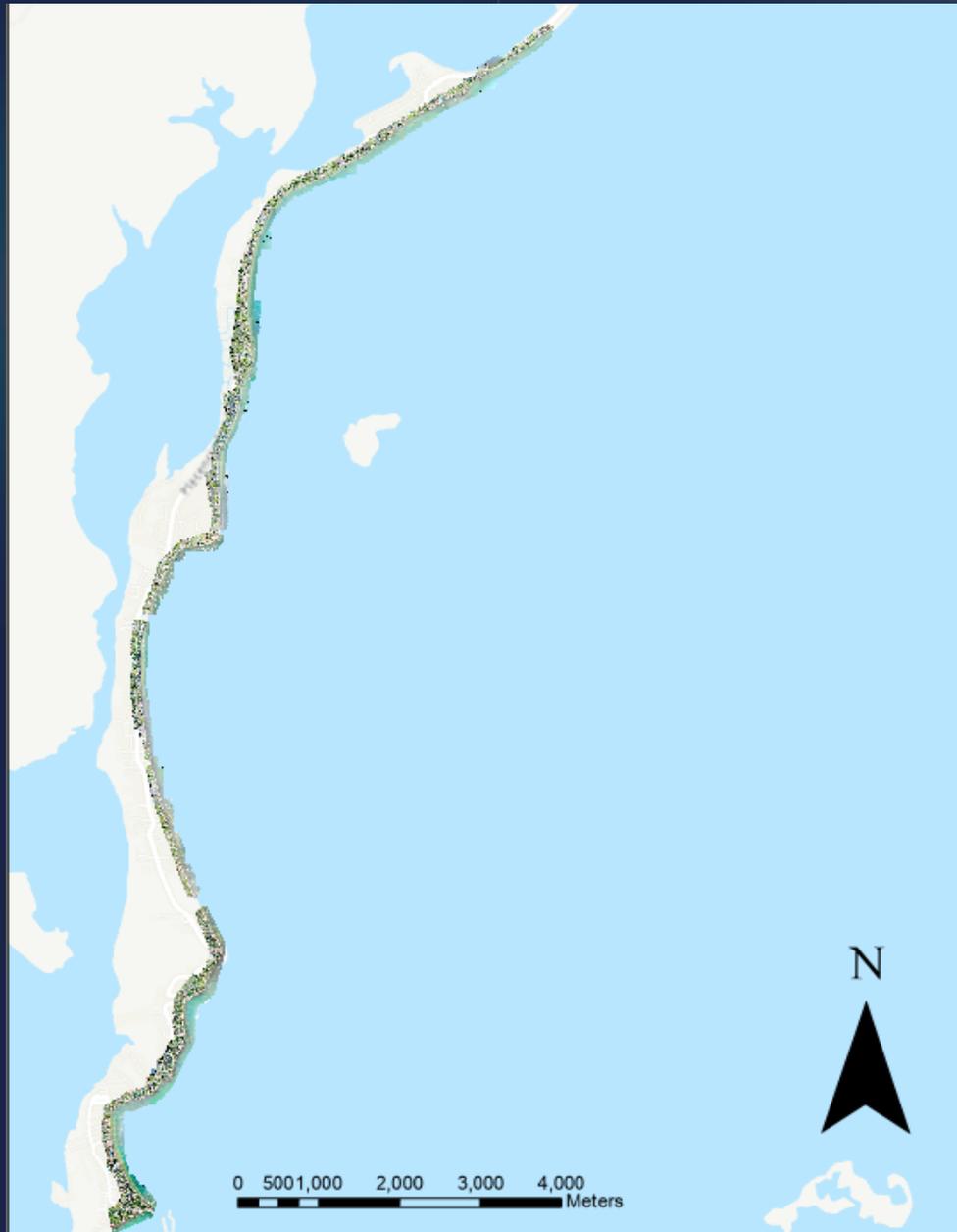
Study Area



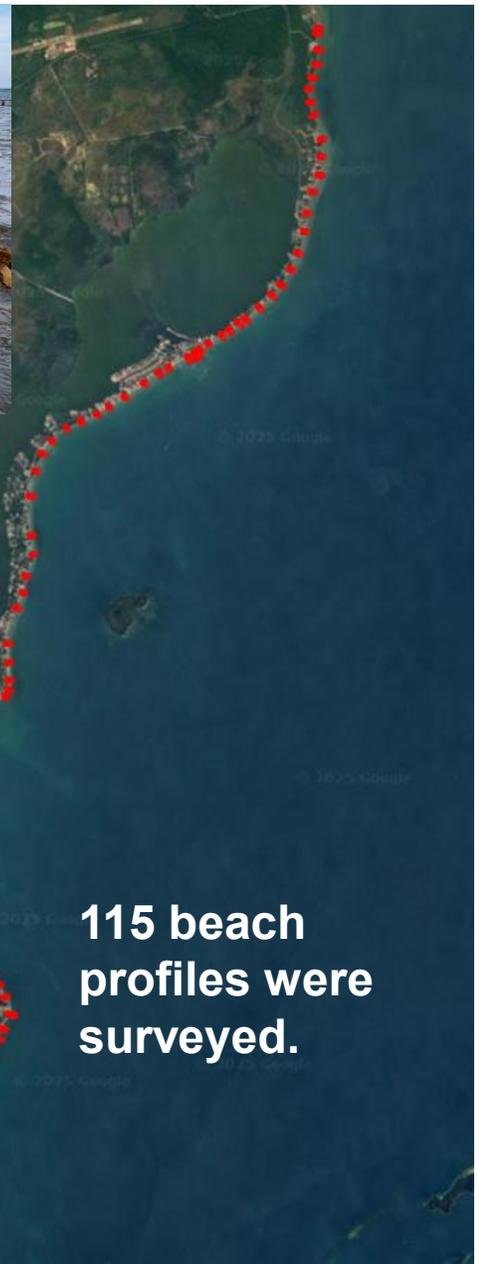
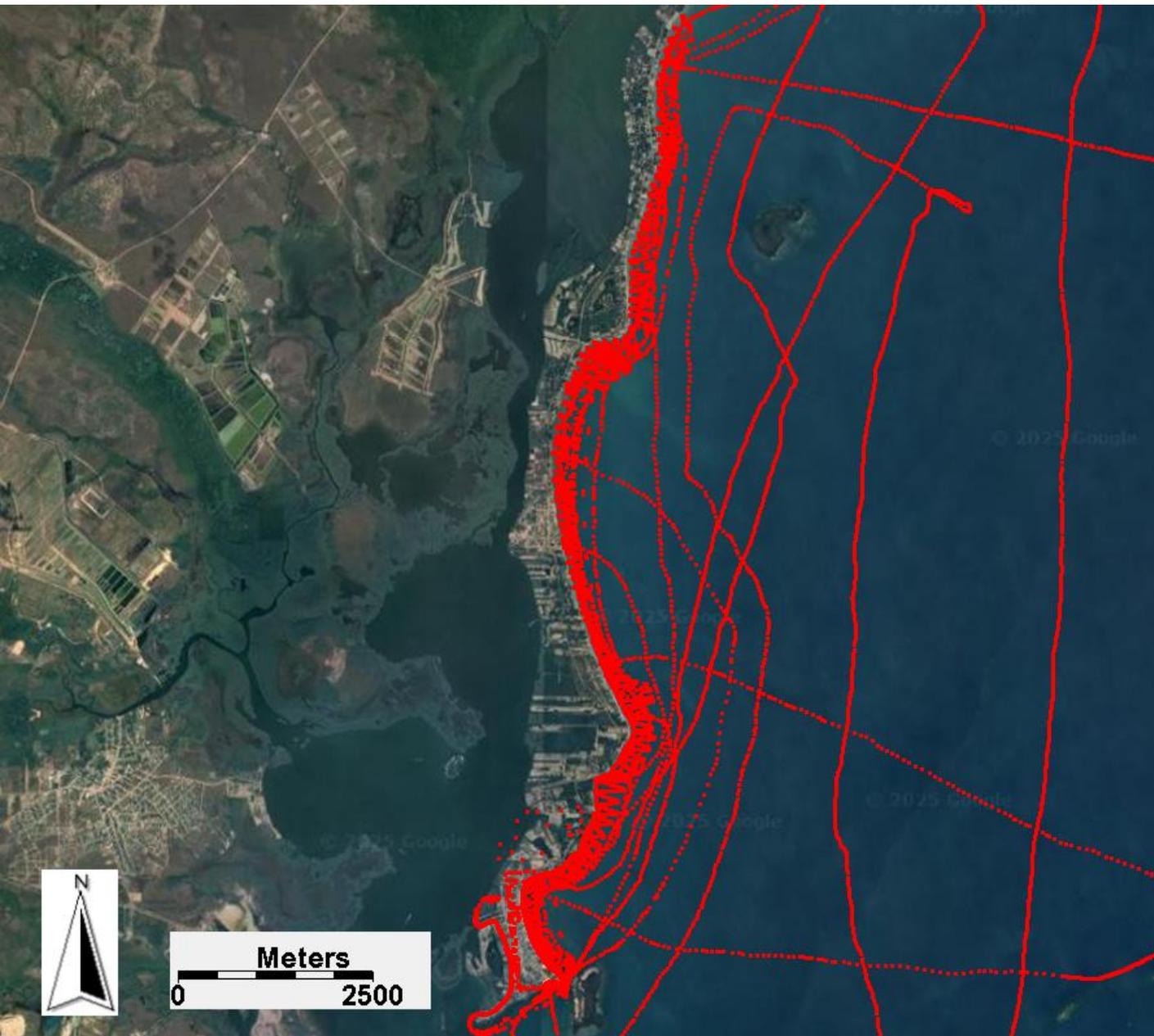
Study Area



Field Data Collection: detailed drone photos



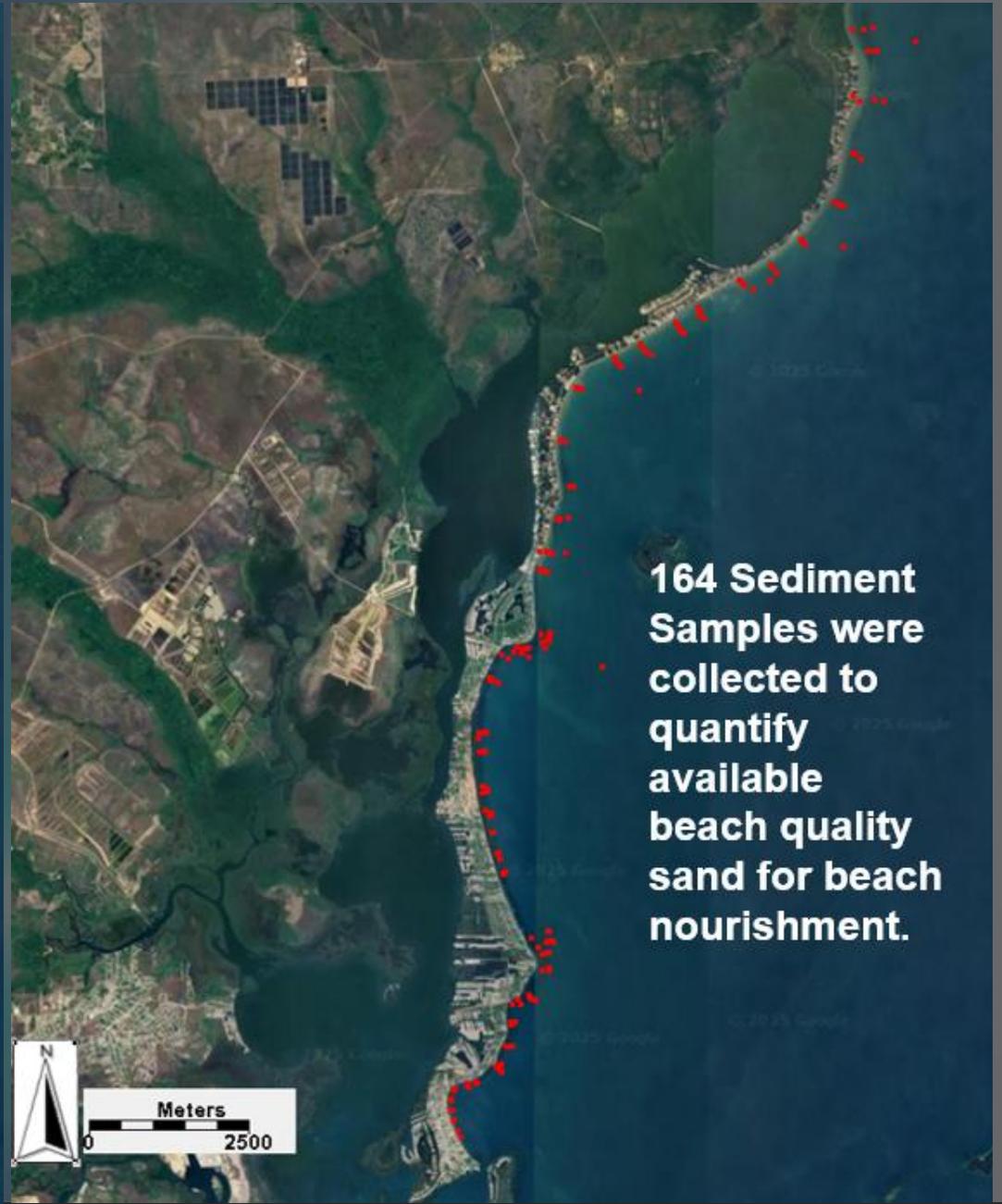
Field Data Collection: bathymetry and beach-profile survey



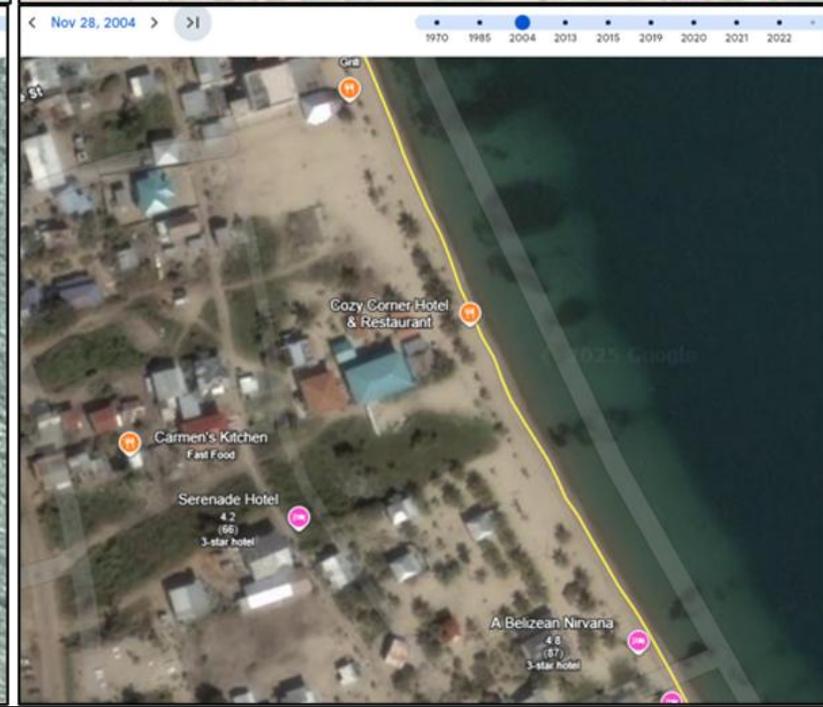
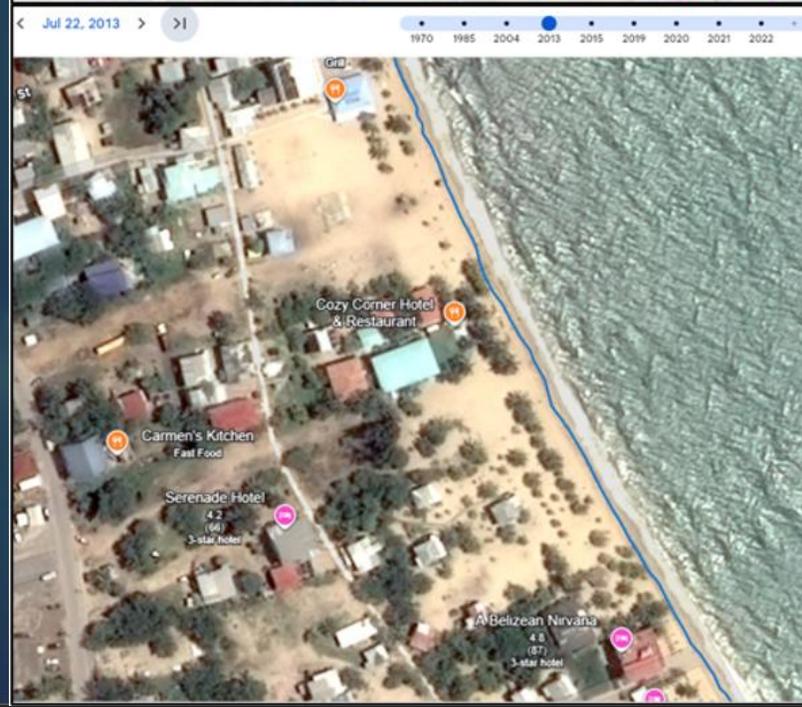
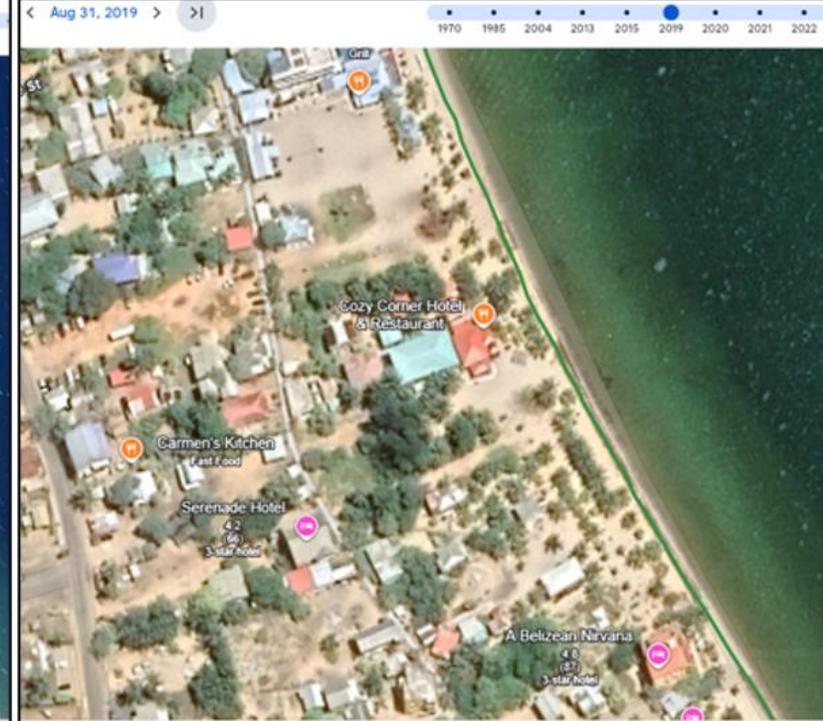
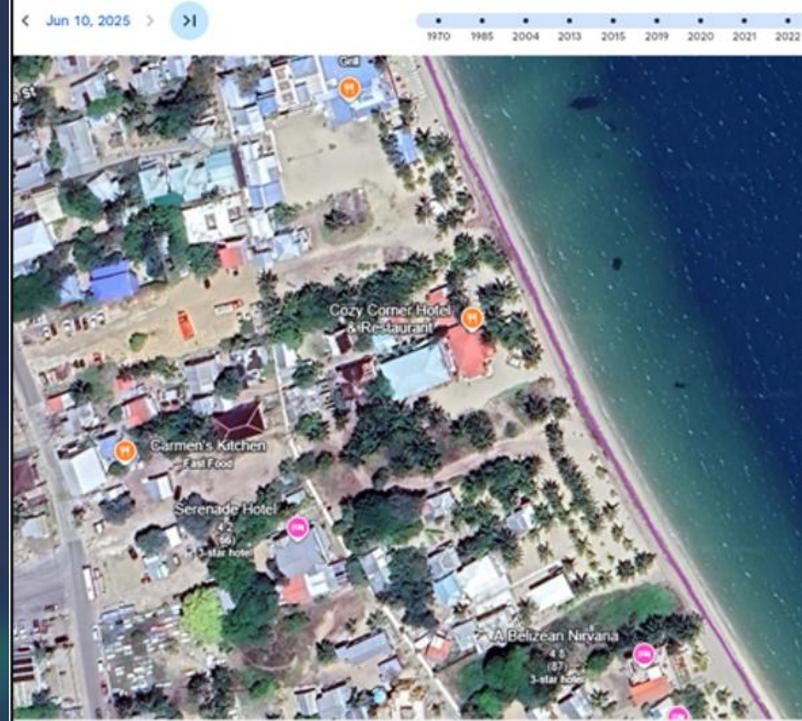
Field Data Collection: surface and sub-surface sediment sampling



Field Data Collection: surface and sub-surface sediment sampling

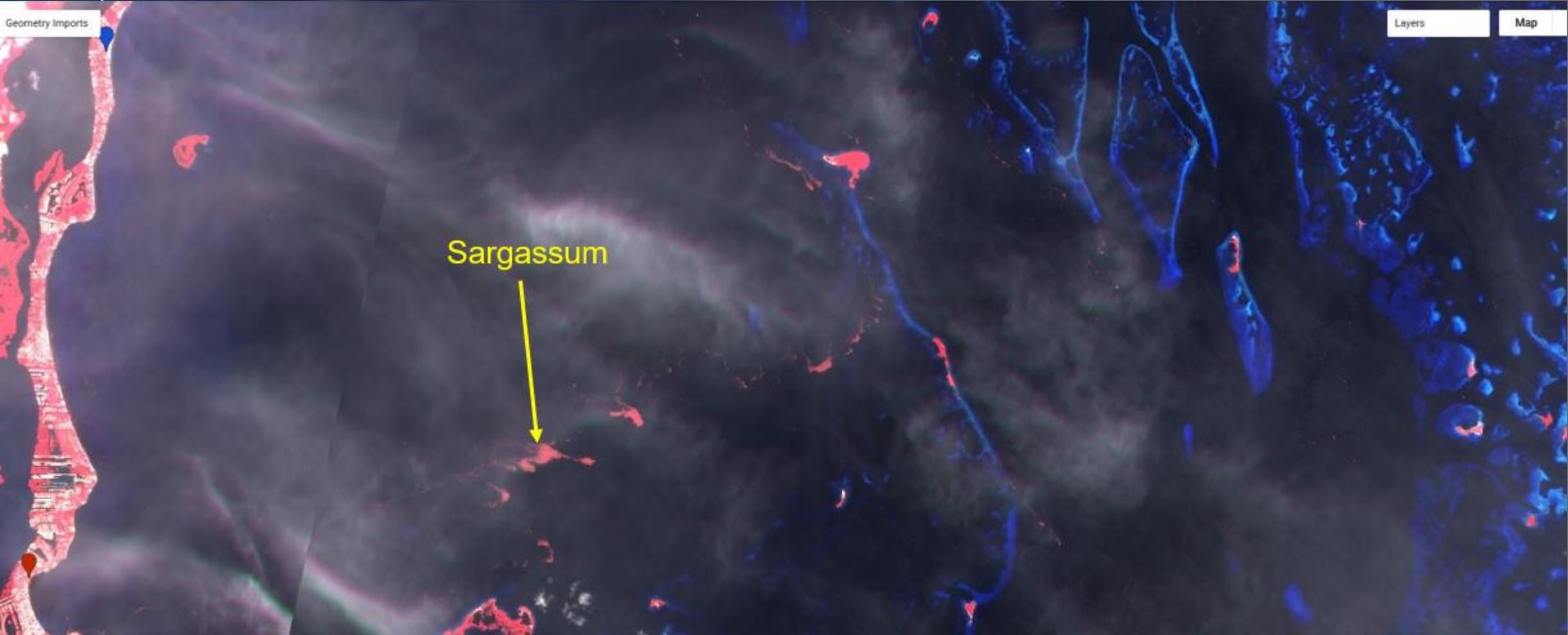


Shoreline Change Analysis



Sargassum Monitoring and Analysis

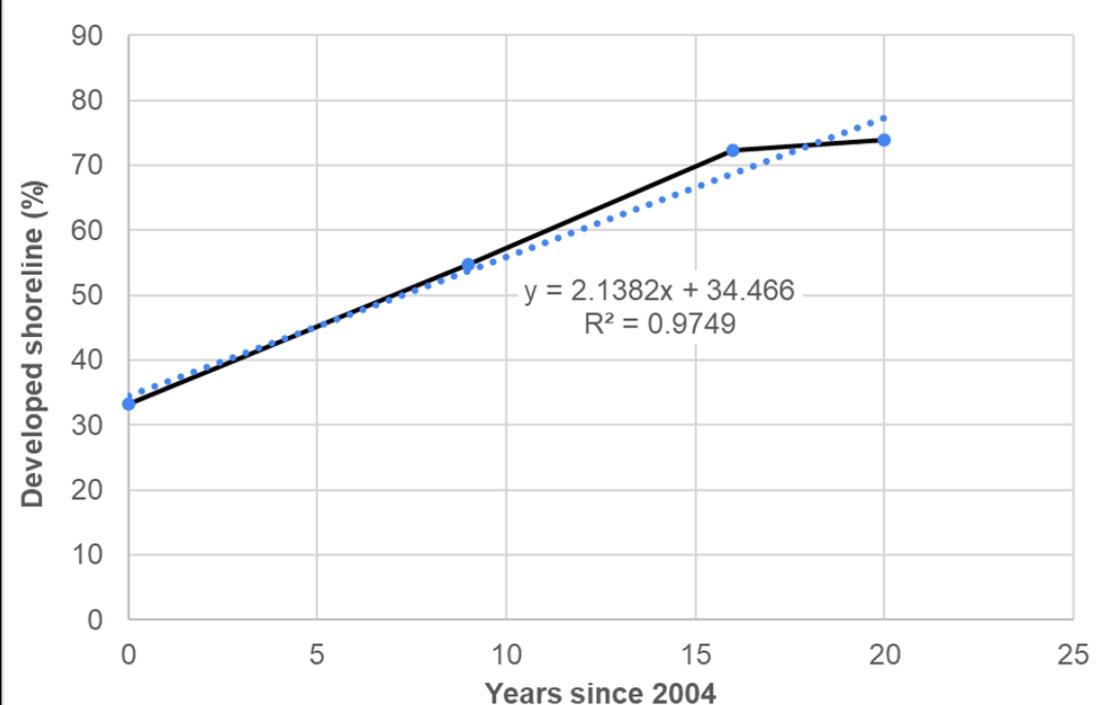
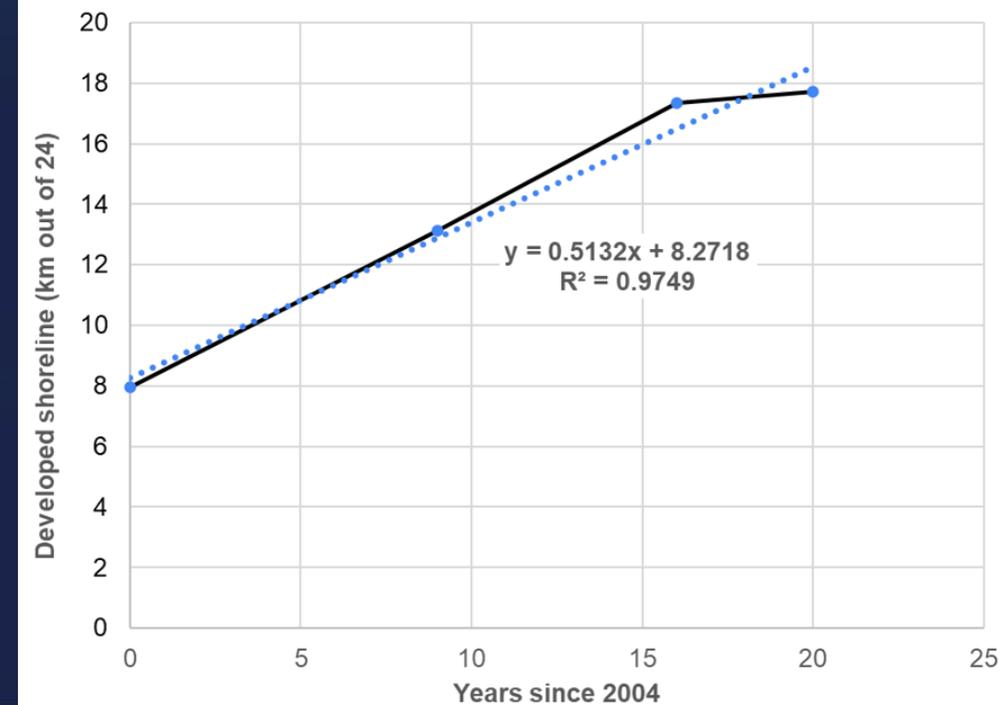
8/08/25



The problem



Following this trend, the coast can become 100% developed in ~31 years since 2004, or ~10 years from now.



Beach erosion



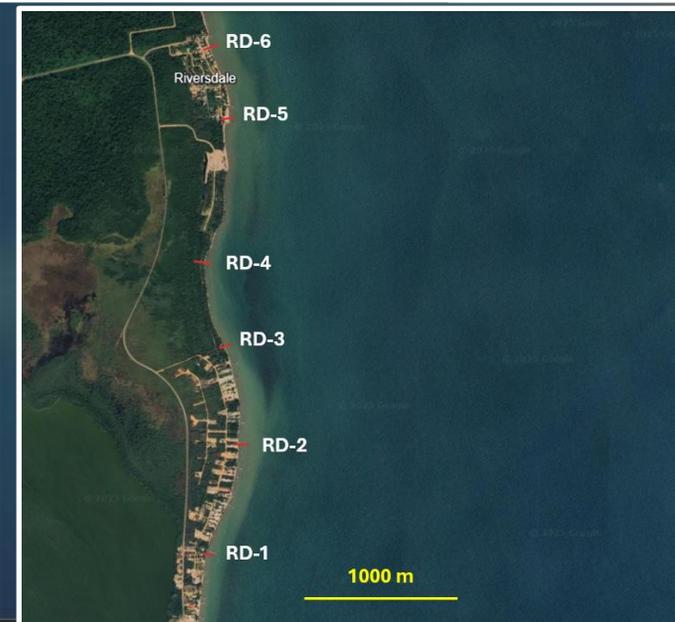
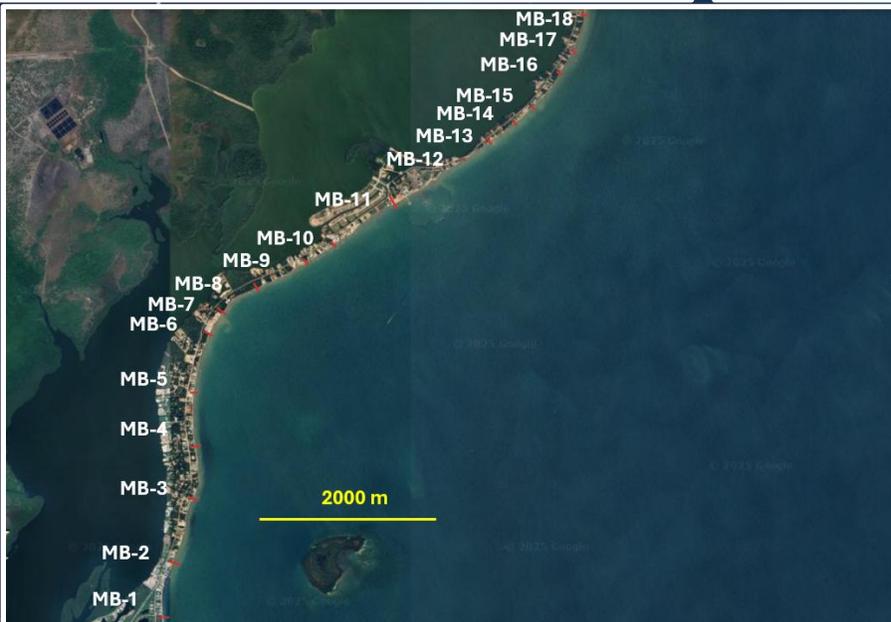
7. Since 2004;
2013- 0.21m loss
2019- .15m loss
2024- 3.14m gain
2025- 4.35m loss

8. Since 2004;
2013- 0.92m loss
2019- 1.3m gain
2024- 9.2m loss
2025- 7.5m loss

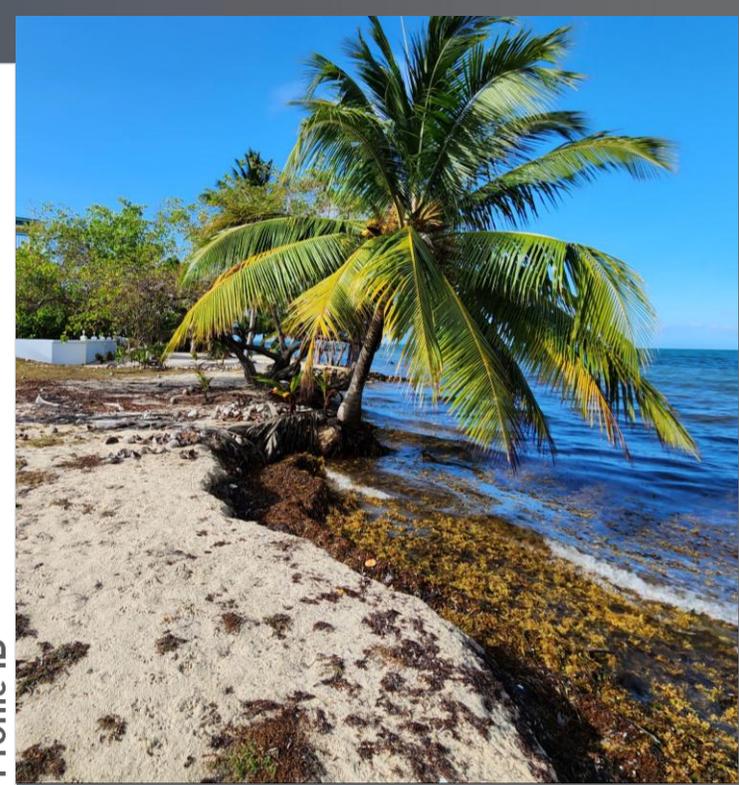
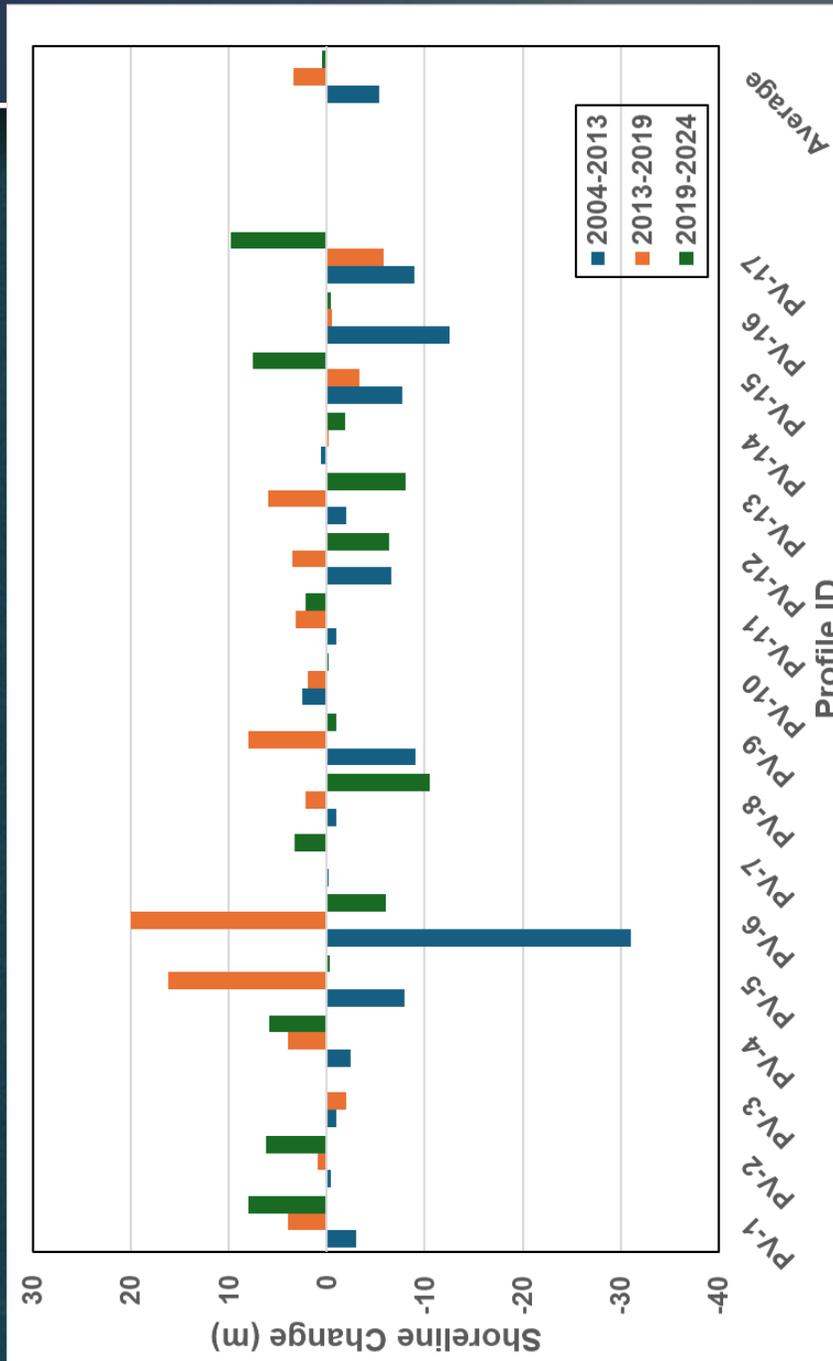
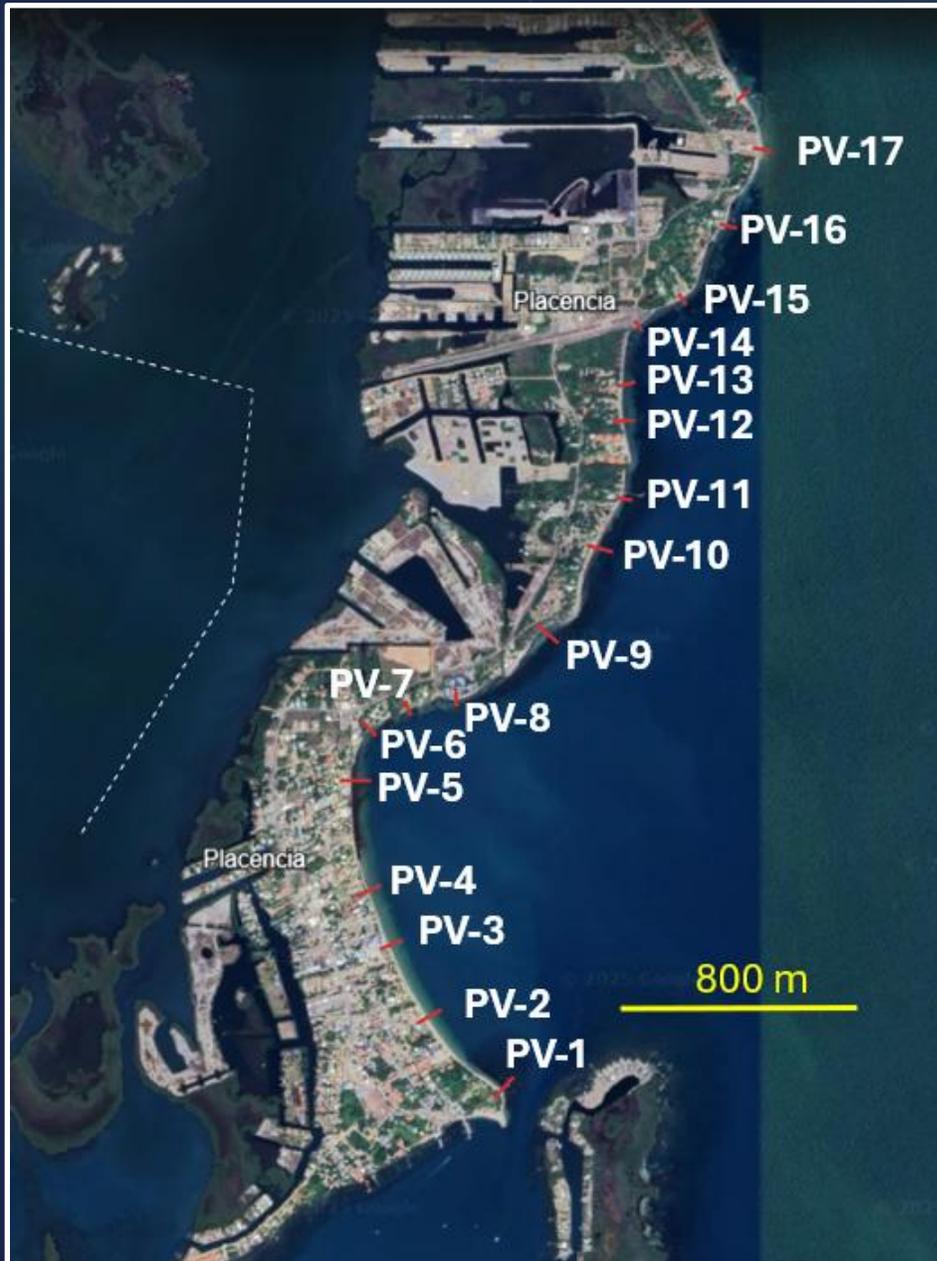
9. Since 1988,
2004- 12m loss
2013- 21m loss
2019- 13m loss
2024- 14m loss
2025- 20m loss

10. Since 2004,
2013- 2.5m gain
2019- 4.5m gain
2024- 4.3m gain
2025- 8.8m gain

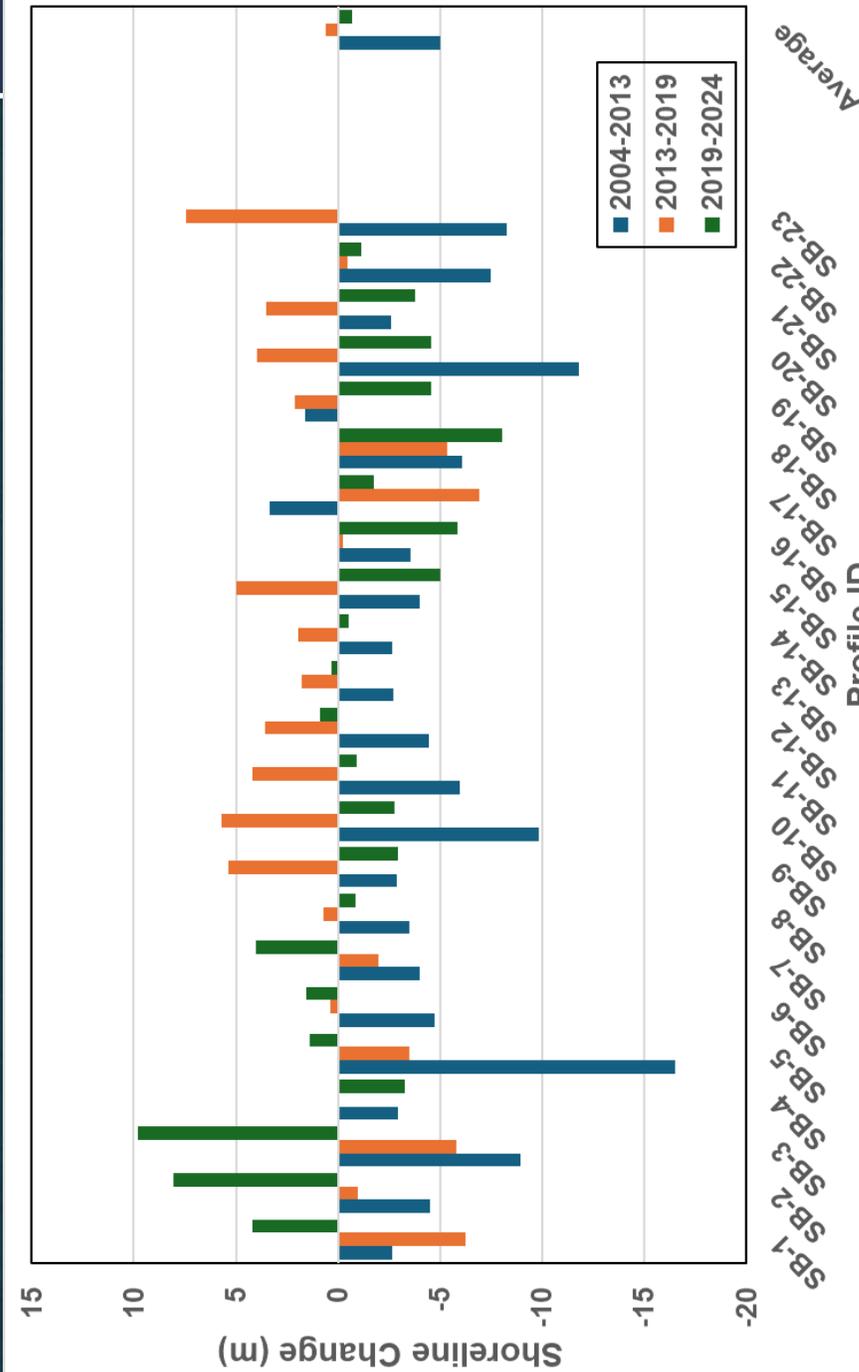
Beach erosion



Beach erosion



Beach erosion



Beach erosion: causes

Long-term: Interruption of sand supplies to the coast from rivers

Short-term: interruption of longshore sand transport by property-scale "shore protection" measures



Beach erosion: causes

Long-term: Interruption of sand supplies to the coast from rivers

Short-term: interruption of longshore sand transport by property-scale "shore protection" measures



Beach erosion: causes

Long-term: Interruption of sand supplies to the coast from rivers

Short-term: interruption of longshore sand transport by property-scale "shore protection" measures



Beach erosion: causes

Long-term: Interruption of sand supplies to the coast from rivers

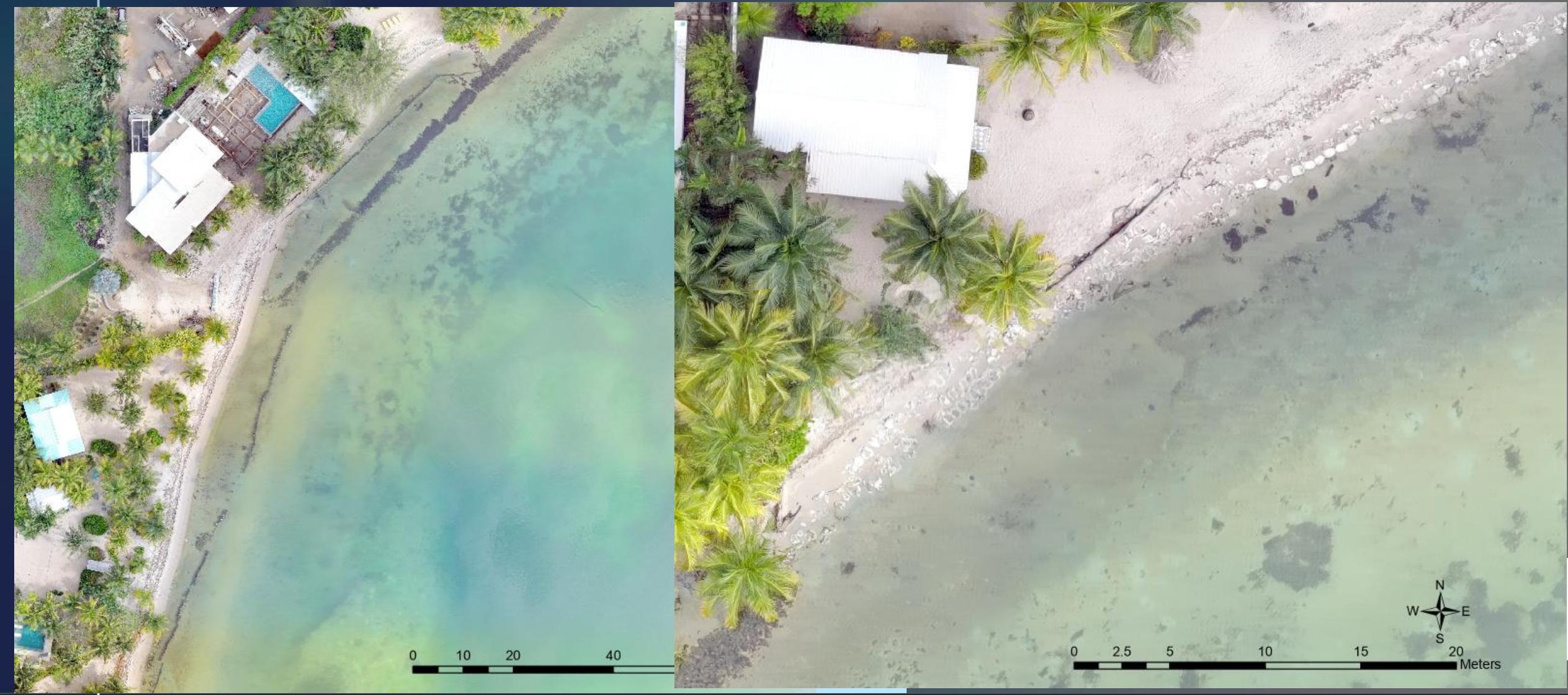
Short-term: interruption of longshore sand transport by property-scale "shore protection" measures



Beach erosion: causes

Long-term: Interruption of sand supplies to the coast from rivers

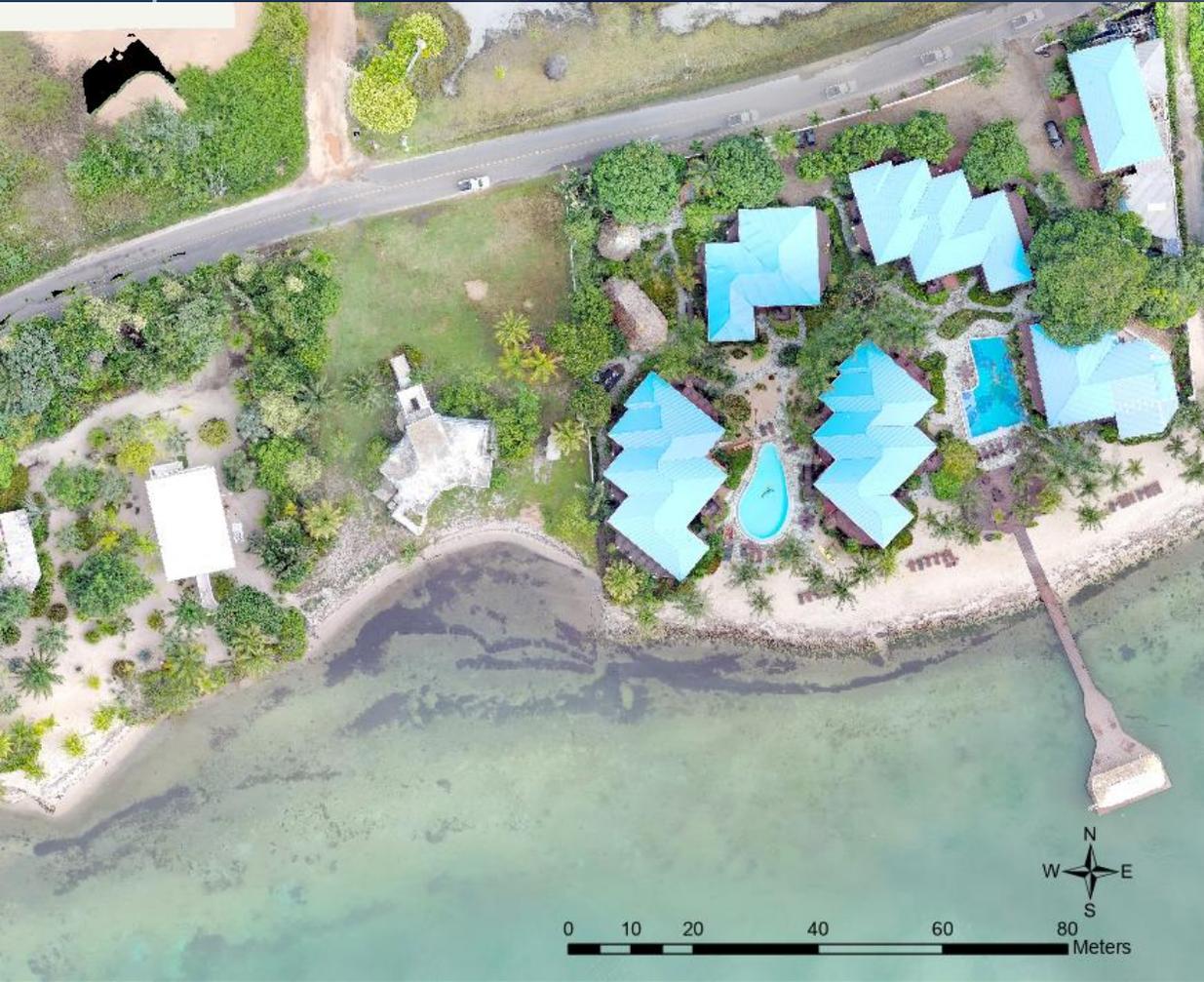
Short-term: interruption of longshore sand transport by property-scale "shore protection" measures



Beach erosion: causes

Long-term: Interruption of sand supplies to the coast from rivers

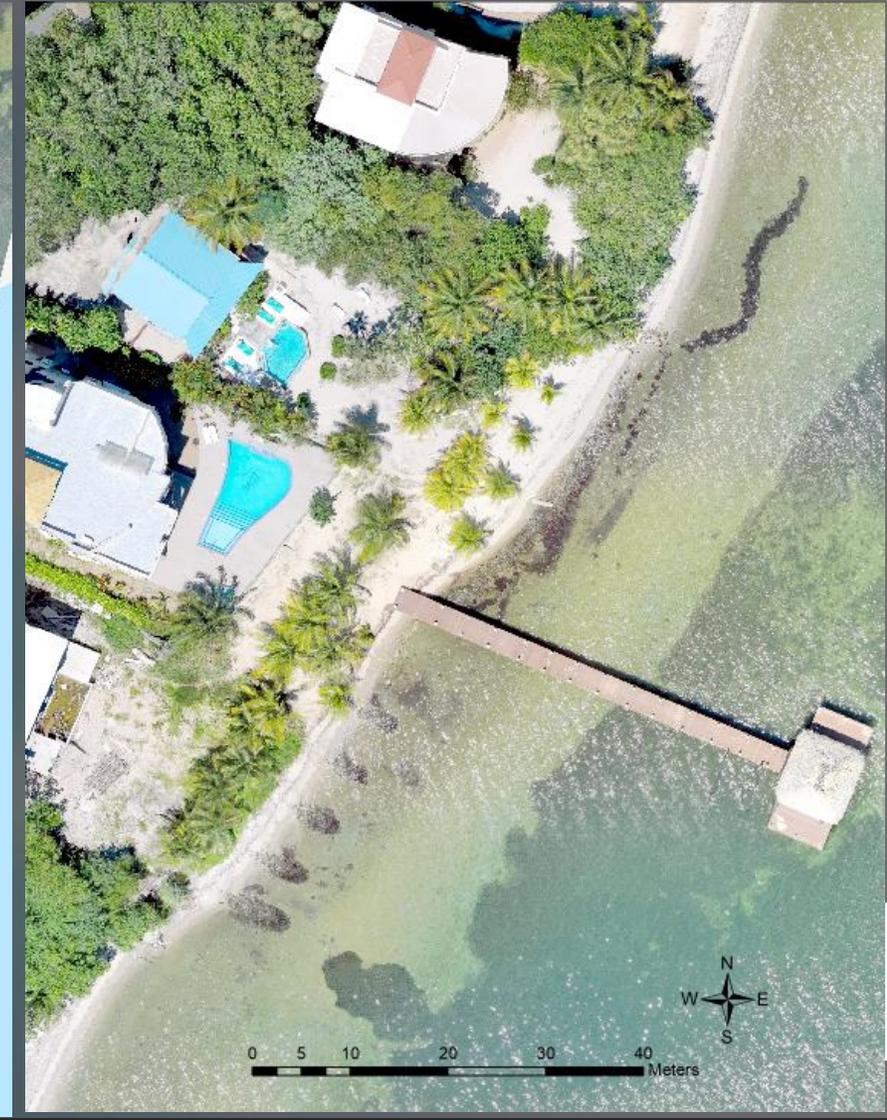
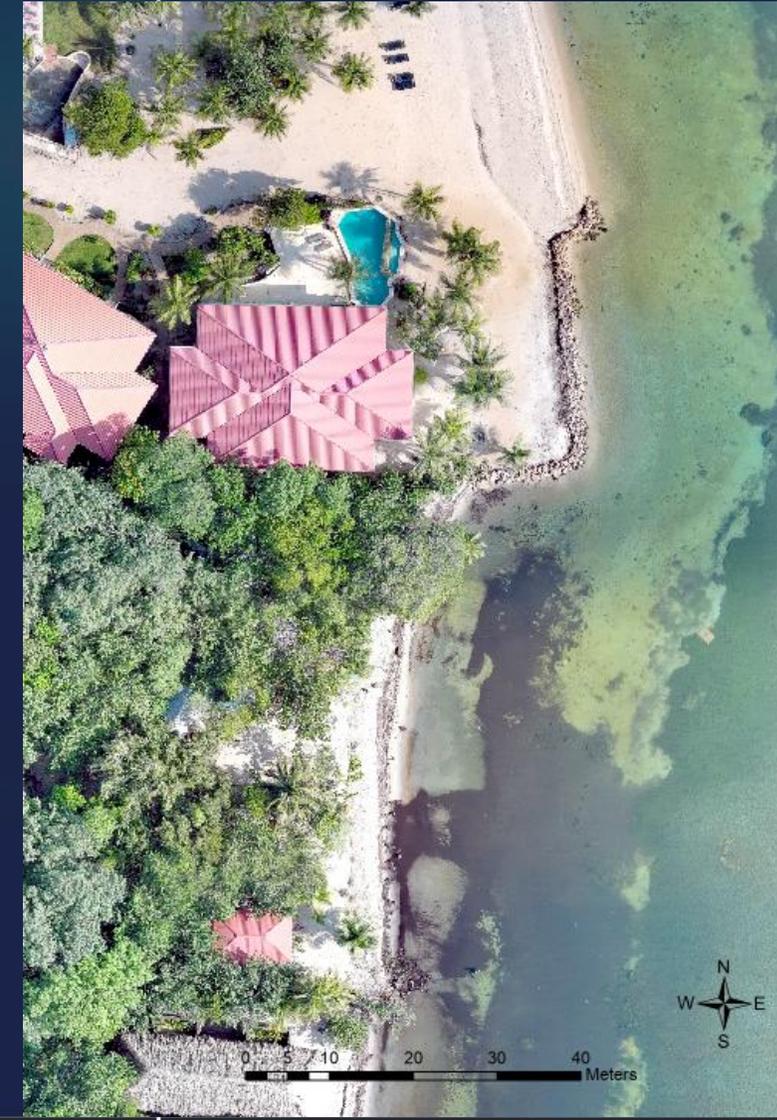
Short-term: interruption of longshore sand transport by property-scale "shore protection" measures



Beach erosion: causes

Long-term: Interruption of sand supplies to the coast from rivers

Short-term: interruption of longshore sand transport by property-scale "shore protection" measures



Beach erosion: causes

Long-term: Interruption of sand supplies to the coast from rivers

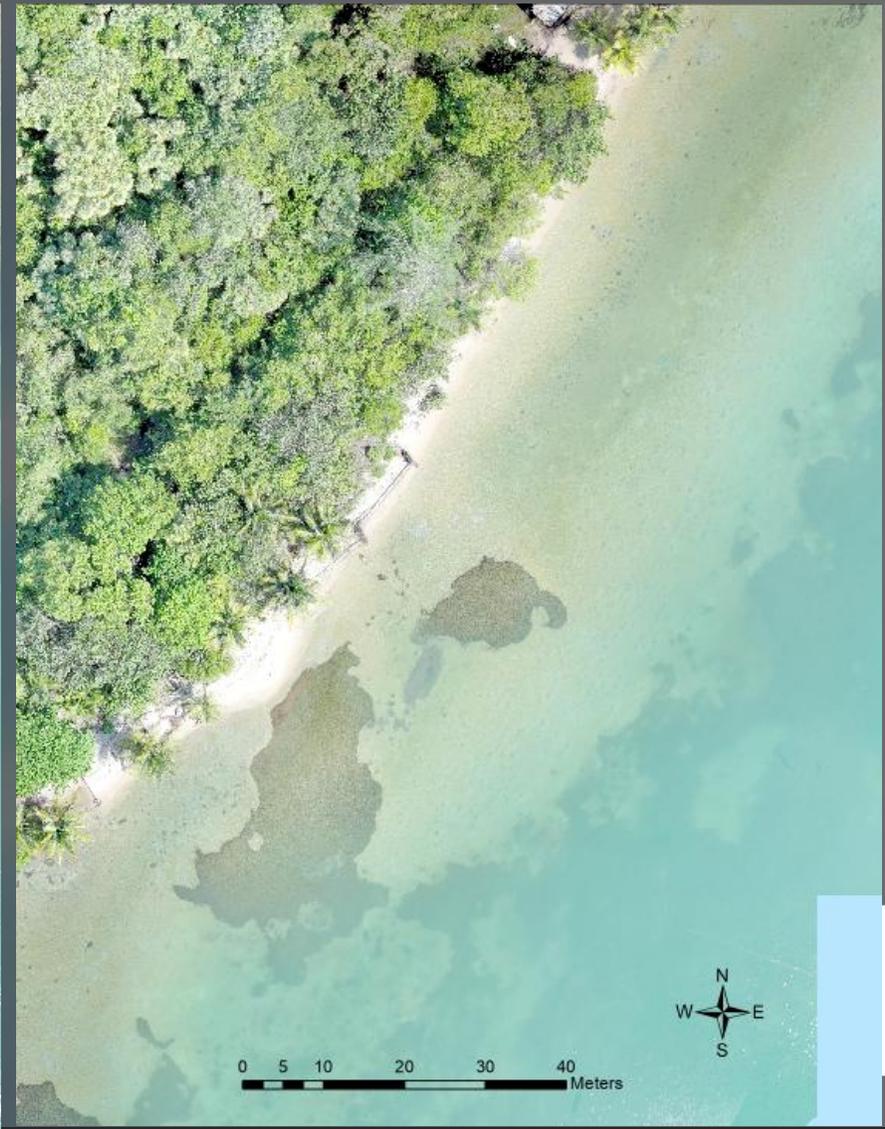
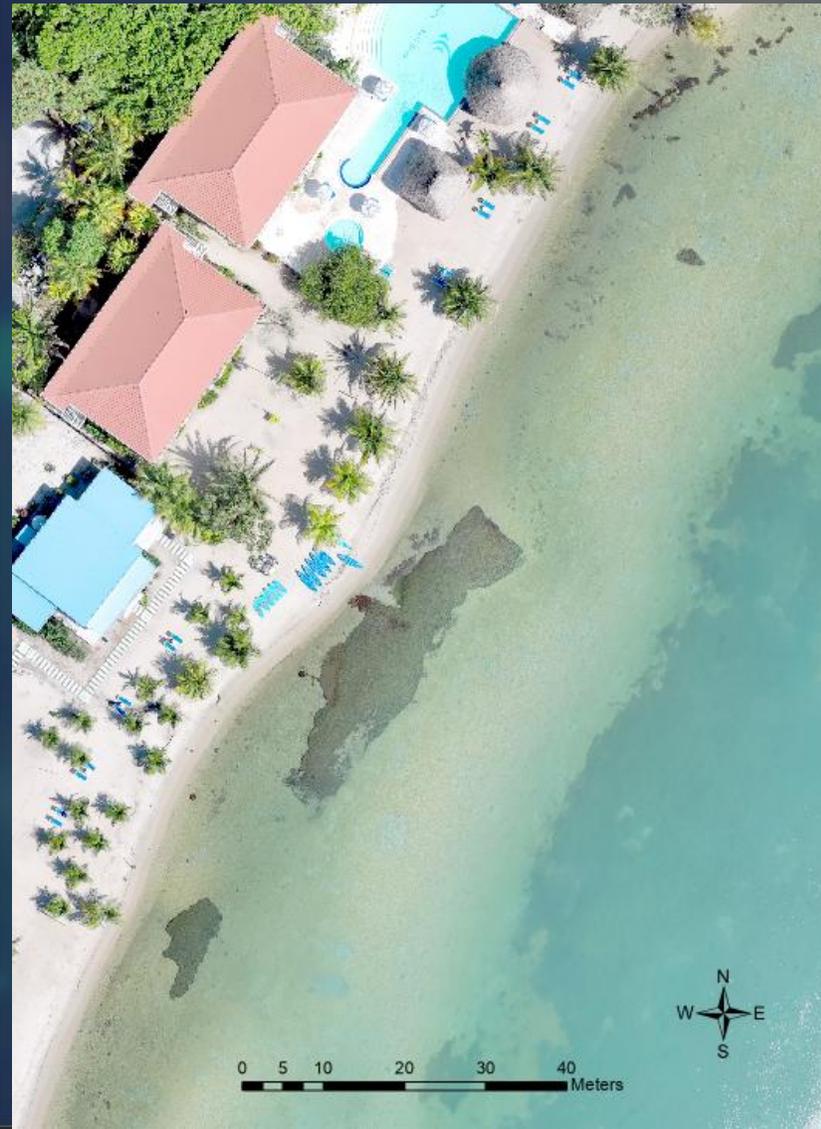
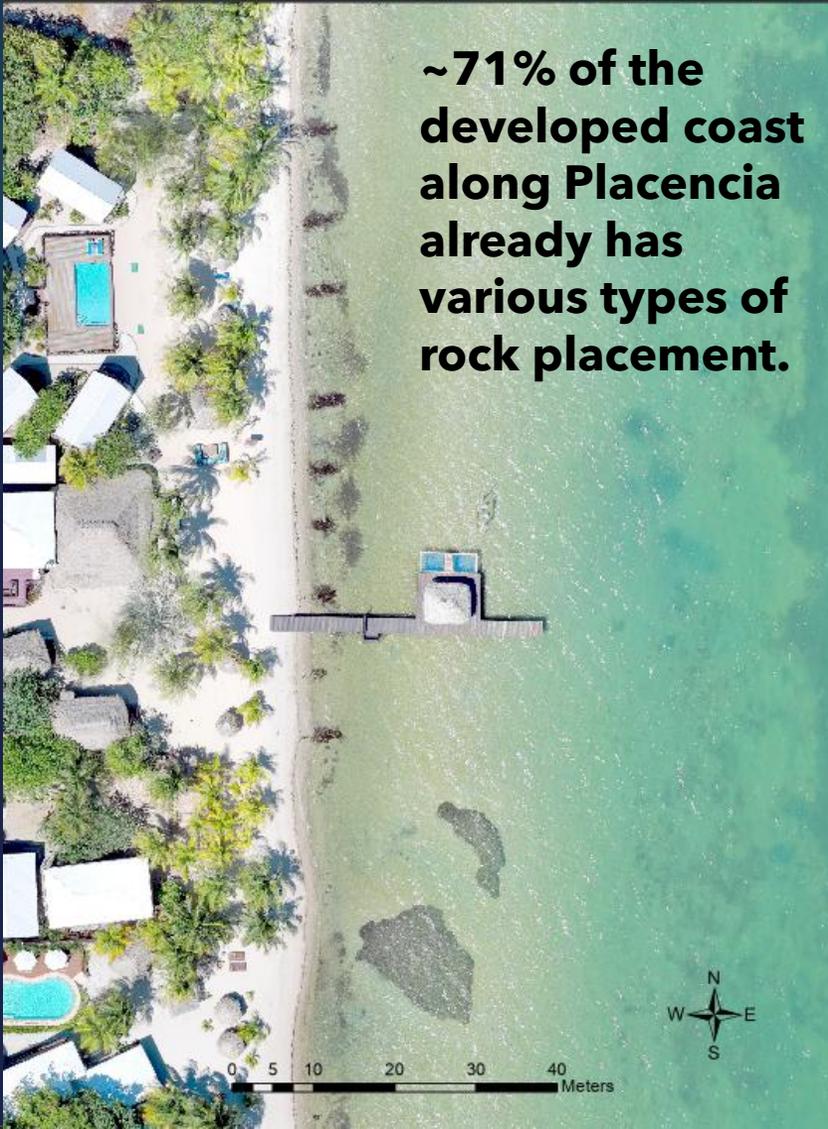
Short-term: interruption of longshore sand transport by property-scale "shore protection" measures



Beach erosion: causes

Long-term: Interruption of sand supplies to the coast from rivers

Short-term: interruption of longshore sand transport by property-scale "shore protection" measures



Shore-Protection Options

1) Individual property scale: “improved” design of rock armors. **Performance criteria** must be established.

- a) Already happening, just need to provide “technical” improvement.
- b) Property-scale problems can be solved.
- c) Downdrift erosion cannot be eliminated.
- d) Would Permanently change the beach environment into something else.
- e) Would make entry to ocean dangerous.

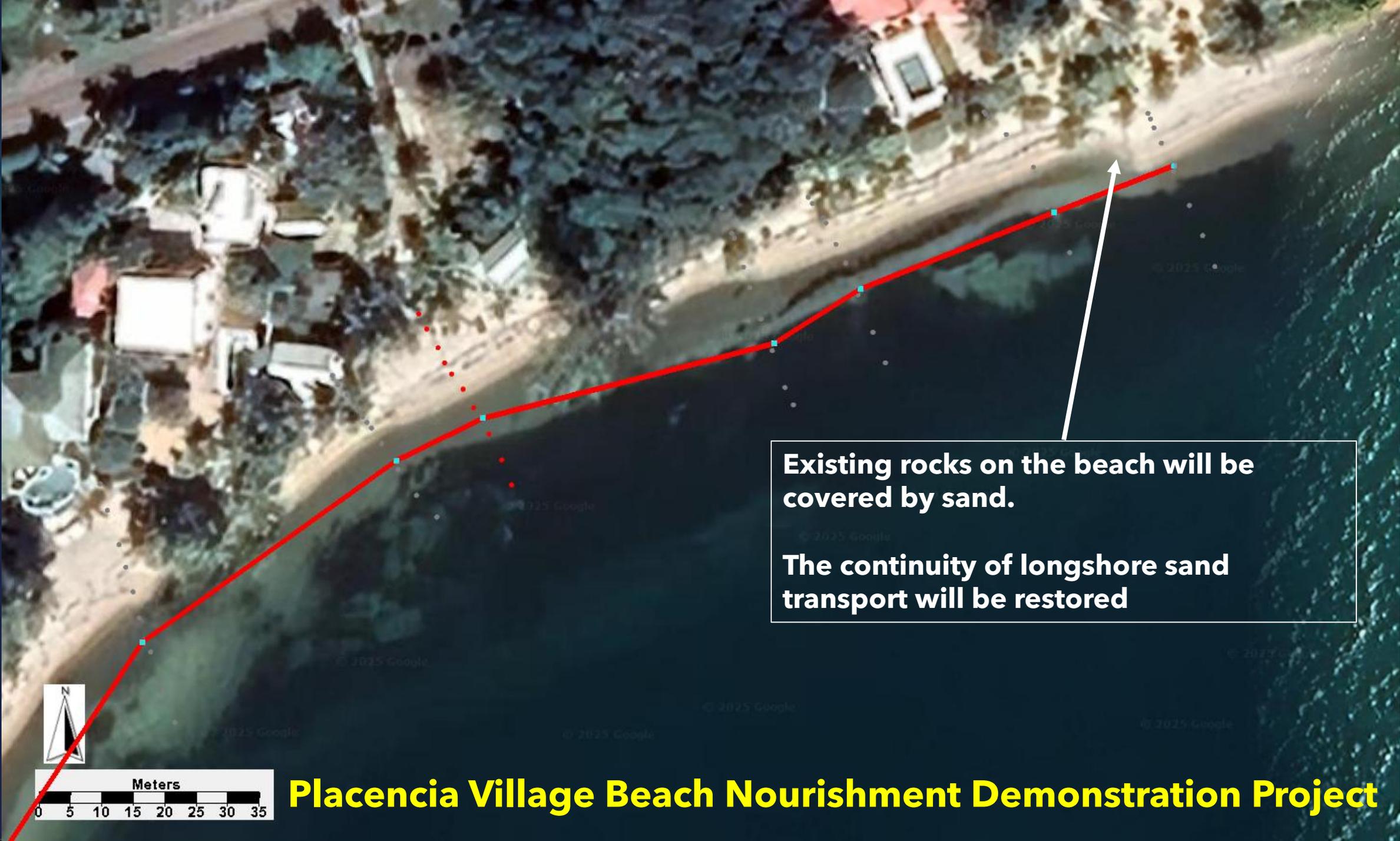
2) Regional scale solution: Beach nourishment.

- a) Have not been done.
- b) Need buy-in of a large enough community, no such mechanism exists.
- c) “If rock cannot stop the erosion, how can sand?”
- d) Cost: much higher than that at individual property scale, but NOT higher than the sum, or per unit length.
- e) Would restore and maintain the sandy beach.
- f) Technical details: sand source, design, construction, performance, re-nourishment interval, etc.

Design of beach nourishment demonstration projects

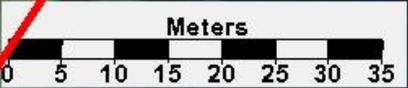
Placencia Village Beach (publicly funded?)

Naia Beach Resort (Privately funded?)



Existing rocks on the beach will be covered by sand.

The continuity of longshore sand transport will be restored



Placencia Village Beach Nourishment Demonstration Project

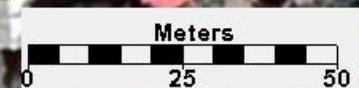
An aerial photograph of a coastal area. On the left, there is a residential area with several houses, some with red roofs, surrounded by lush green vegetation. A sandy beach runs along the coast. To the right of the beach is a body of water. A thick red line is drawn along the coastline, starting from the bottom left and curving towards the top right, indicating the project area. Small blue squares are placed along this red line. The text 'Placencia Village Beach Nourishment Demonstration Project' is overlaid in yellow on the right side of the image.

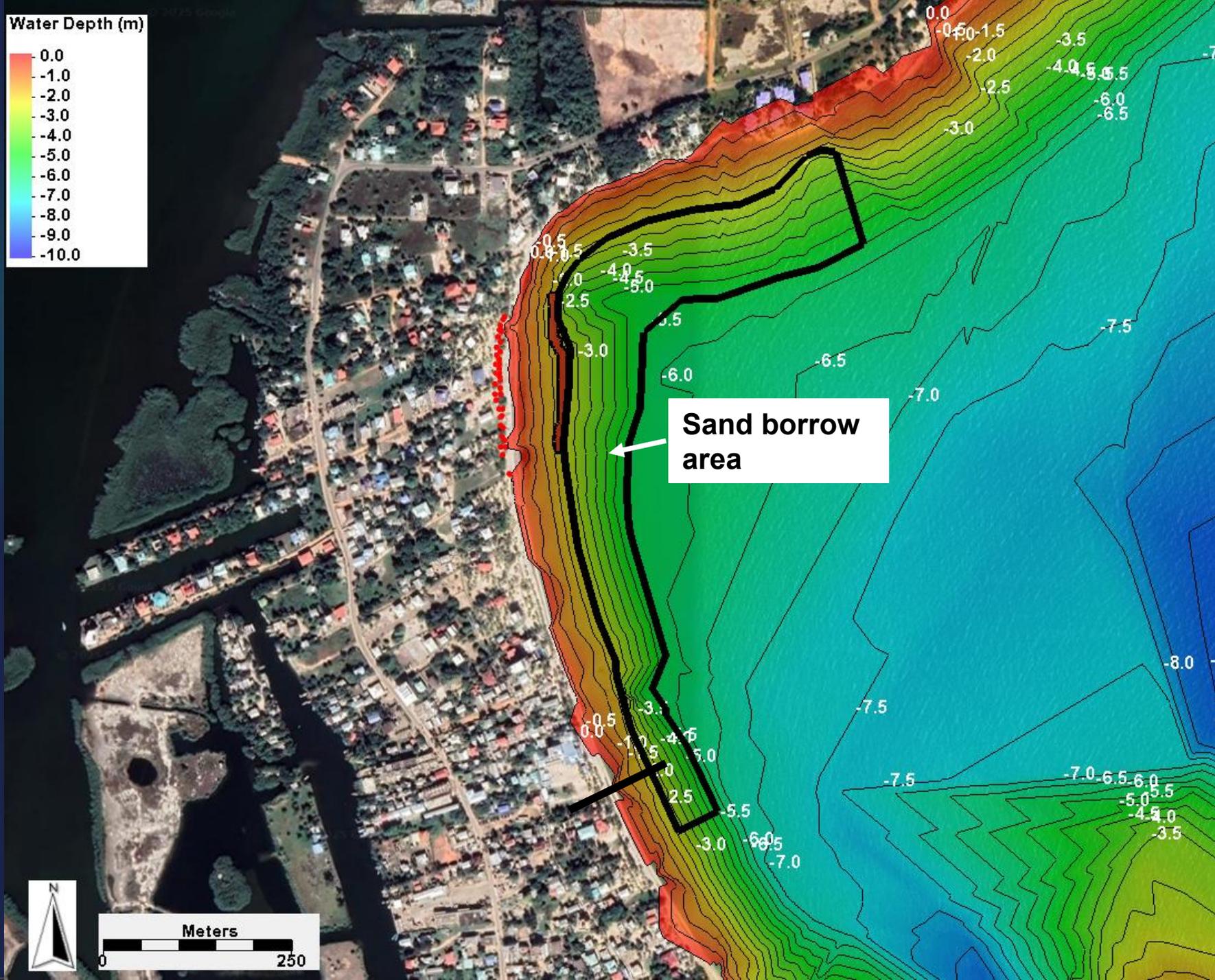
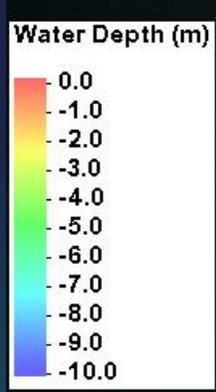
Placencia Village Beach Nourishment Demonstration Project

Existing rocks on the beach will be covered by sand.

The continuity of longshore sand transport will be restored.

Eroded beach will be recovered.





Placencia Village Beach Nourishment Demonstration Project

Beach quality sand was identified in the nearshore area for cost-effect sand dredging and pumping.

Total volume needed: 25000 m³ over 1136 m beach, or ~22 m³/m; extending shoreline seaward up to 25 m.

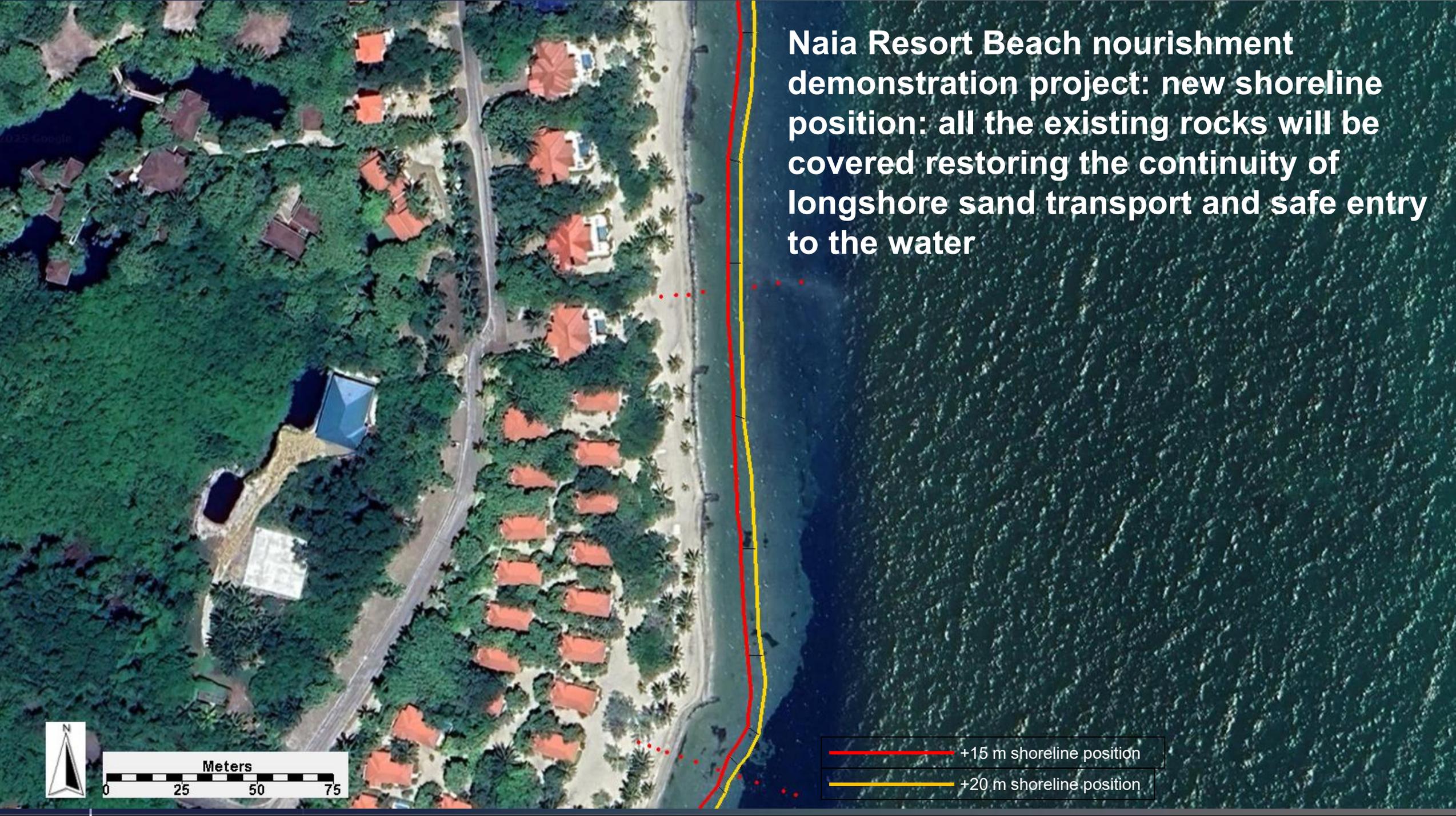


Naia Resort Beach nourishment demonstration project: new shoreline position: all the existing rocks will be covered restoring the continuity of longshore sand transport and safe entry to the water

- +15m shoreline position
- +20m shoreline position

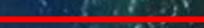


Naia Resort Beach nourishment demonstration project: new shoreline position: all the existing rocks will be covered restoring the continuity of longshore sand transport and safe entry to the water

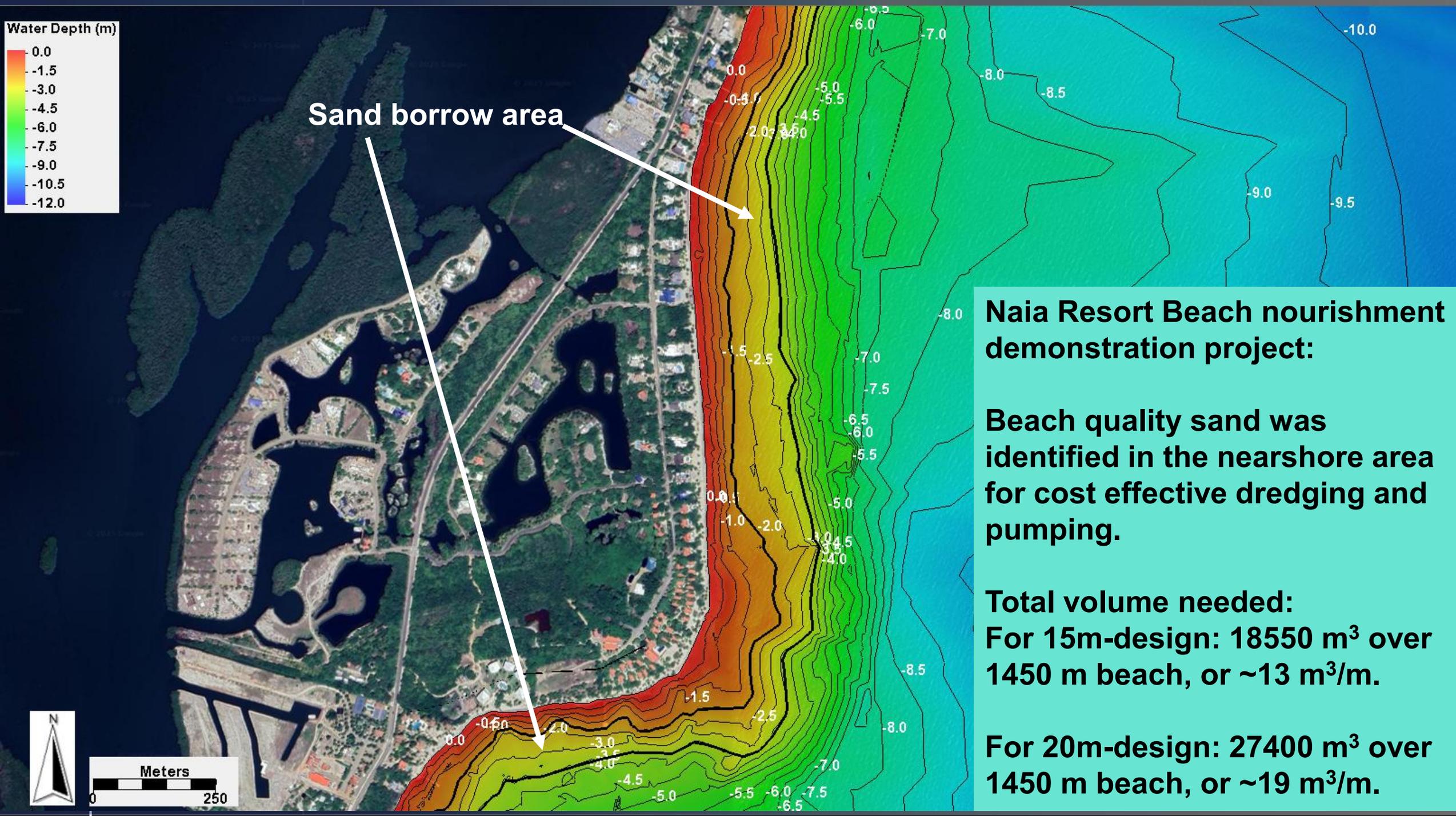


Naia Resort Beach nourishment demonstration project: new shoreline position: all the existing rocks will be covered restoring the continuity of longshore sand transport and safe entry to the water



-  +15m shoreline position
-  +20m shoreline position





Summary

- 1) Existing beach along Placencia Peninsula is mostly narrow, therefore, small shoreline changes, e.g., 4-8 m, represent a large percentage change.
- 2) Depleted sand supply from rivers contributes to long-term trend of landward shoreline retreat.
- 3) Disorganized and poorly designed property-scale shore-protection measures (throw rocks on the beach) are causing large spatial variations of shoreline-change. This needs to be stopped.
- 4) Regional scale, e.g., embayment-scale, beach nourishments are technically feasible and economically achievable.
- 5) Overcoming “roadblocks” for beach nourishment is a very challenging task.