



# Resilience Analysis of Belize's MPAs



**Nadia Bood**  
**World Wildlife Fund**

ERIC MADEJA | WETPIXEL





# Project Objectives

1. **PRIORITIZED MPAs HAVE A CLIMATE CHANGE RESILIENT ANALYSIS THAT ADDRESSES ECOLOGICAL, WEATHER AND SOCIOECONOMIC VARIABLES AND ANALYZES ADAPTIVE CAPACITY AND RESILIENCE STATUS**
2. **PRIORITIZED MPAs AND THEIR STAKEHOLDERS WILL HAVE A SERIES OF RESILIENCE STRATEGIES AVAILABLE FOR IMPLEMENTATION, BASED ON THE RESULTS OF THE ANALYSIS, TO IMPROVE MPA MANAGEMENT FOR RESILIENCE**



# Process

An underwater photograph of a coral reef. The scene is filled with various types of coral, including branching and table corals. A large school of yellow-striped snappers is swimming in the center. In the background, a diver is visible on the right side. The water is clear and blue.

**1. Create an analytical framework to calculate an Integrated Reef Resilience Index (IRRI) using 9 indicators**

**2. IRRI allows managers to evaluate the level of resilience of MPAs over time**

# Data & Models overview

## Benthic indicators

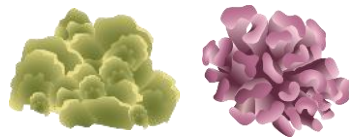
Live coral cover



Fleshy macroalgal index



Coral species richness



Coral disease prevalence

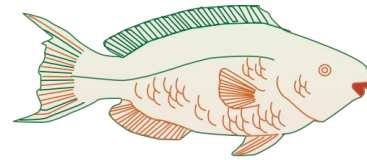


Coral recruitment

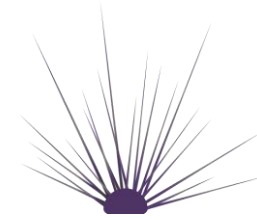


## Herbivore indicators

Herbivorous fish biomass



Urchin density



## Environmental stressors

Sediment



Temperature





# 2/ Belize MPA Resilience Scores



MPA	Coral cover	Coral richness	Coral disease	Coral recruitment	Macroalgae	Herbivores	Urchins	Sediment	DHW	IRRI	<i>IRRI</i>
Caye Caulker Marine Reserve*	2.7		3.0	1.0	2.5	2.3	2.5		5	2.71	0.54
Gladden Spit SPAG*	4.0		4.0	1.0	1.0	1.0	1.0		5	2.43	0.49
Seal Caye SPAG*	3.0			1.0	5.0	4.0	1.0		3	2.83	0.57
Halfmoon Caye Natural Monument*						4.0			5	4.50	0.90
Bacalar Chico Marine Reserve*	2.8		2.8	1.6	1.3	1.3	1.0		3	1.98	0.40
Turneffe Atoll Marine Reserve*	2.7		4.4	1.9	3.5	2.2	1.4		3	2.72	0.54
Sapodilla Cayes Marine Reserve*	2.2		3.0	3.0	3.4	1.8	1.4		3	2.54	0.51
South Point Lighthouse SPAG*	4.0		5.0	2.0	4.0	1.0	1.0			2.83	0.57
Gladden Spit and Silk Cayes Marine Reserve*	2.7			2.0	2.3	3.3	1.0		3	2.38	0.48
South Water Caye Marine Reserve*	2.7		4.3	2.1	2.4	2.2	1.0		3	2.52	0.50
Hol Chan Marine Reserve*	5.0				4.0	3.2	1.0		3	3.24	0.65
Glovers Reef Marine Reserve*	3.0		4.9	1.5	2.5	1.8	1.3		3	2.56	0.51
Ambergris Caye Marine Reserve*	1.8			1.1	4.1	2.6	1.6		3	2.37	0.47
Bird Caye National Park*	2.8		5.0	3.8	1.5	3.0	1.2		3	2.89	0.58

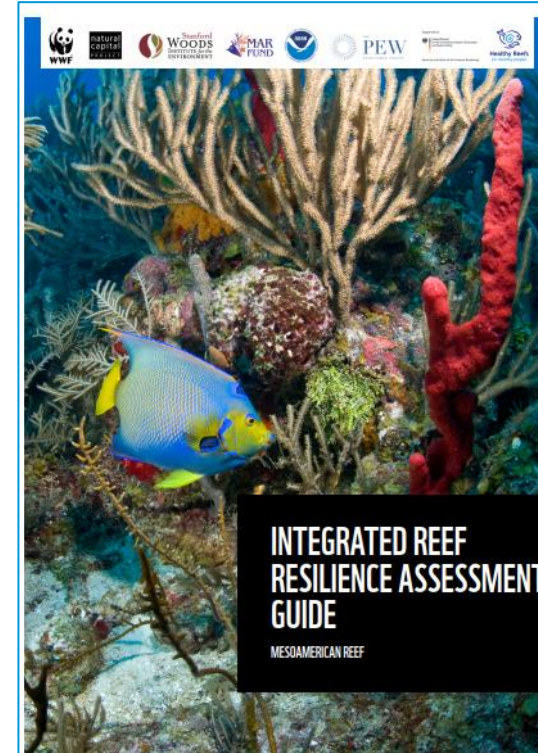


Stanford University



# Take away messages

- PROVIDES A **MAP, TABLE, CASE STUDY AND PROTOCOL** TO MPA MANAGERS THAT CAN HELP IDENTIFY MPAs RESILIENT TO CLIMATE CHANGE
- SOME MPAs REQUIRE MORE SAMPLING
- SEDIMENTATION IS MISSING FROM THE ANALYSIS BECAUSE DATA SUITABLE FOR THE ANALYSIS WERE CHALLENGING TO FIND

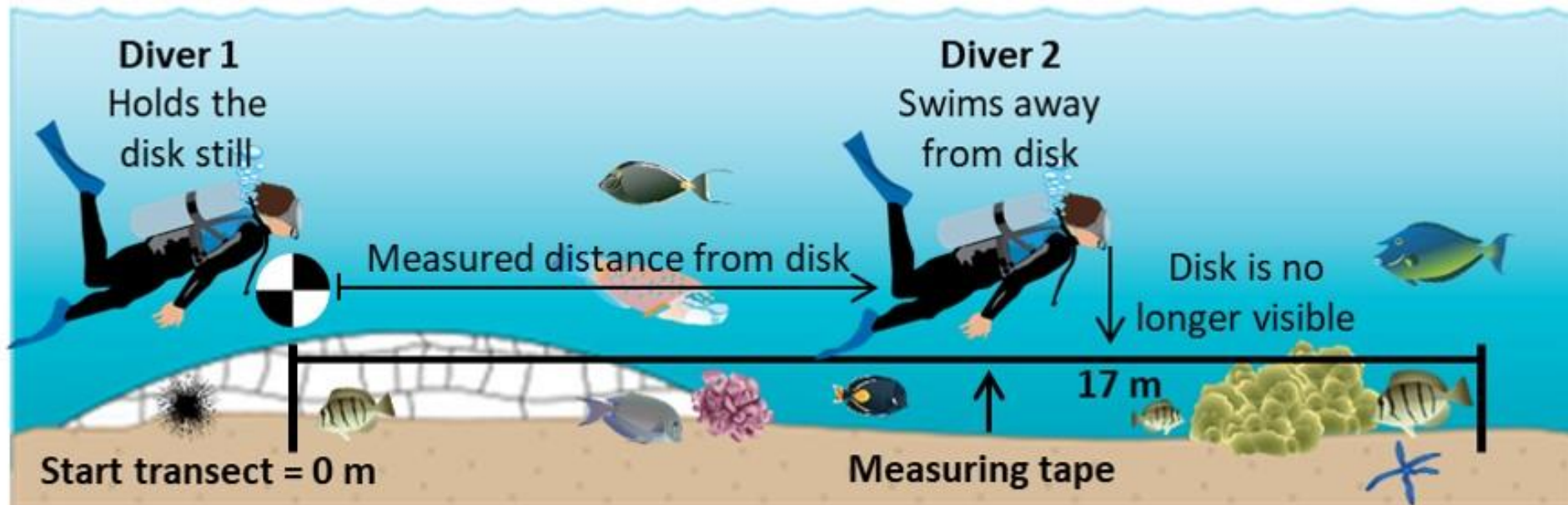


# Proposed method to assess sedimentation

## SECCHI DISK APPROACH:

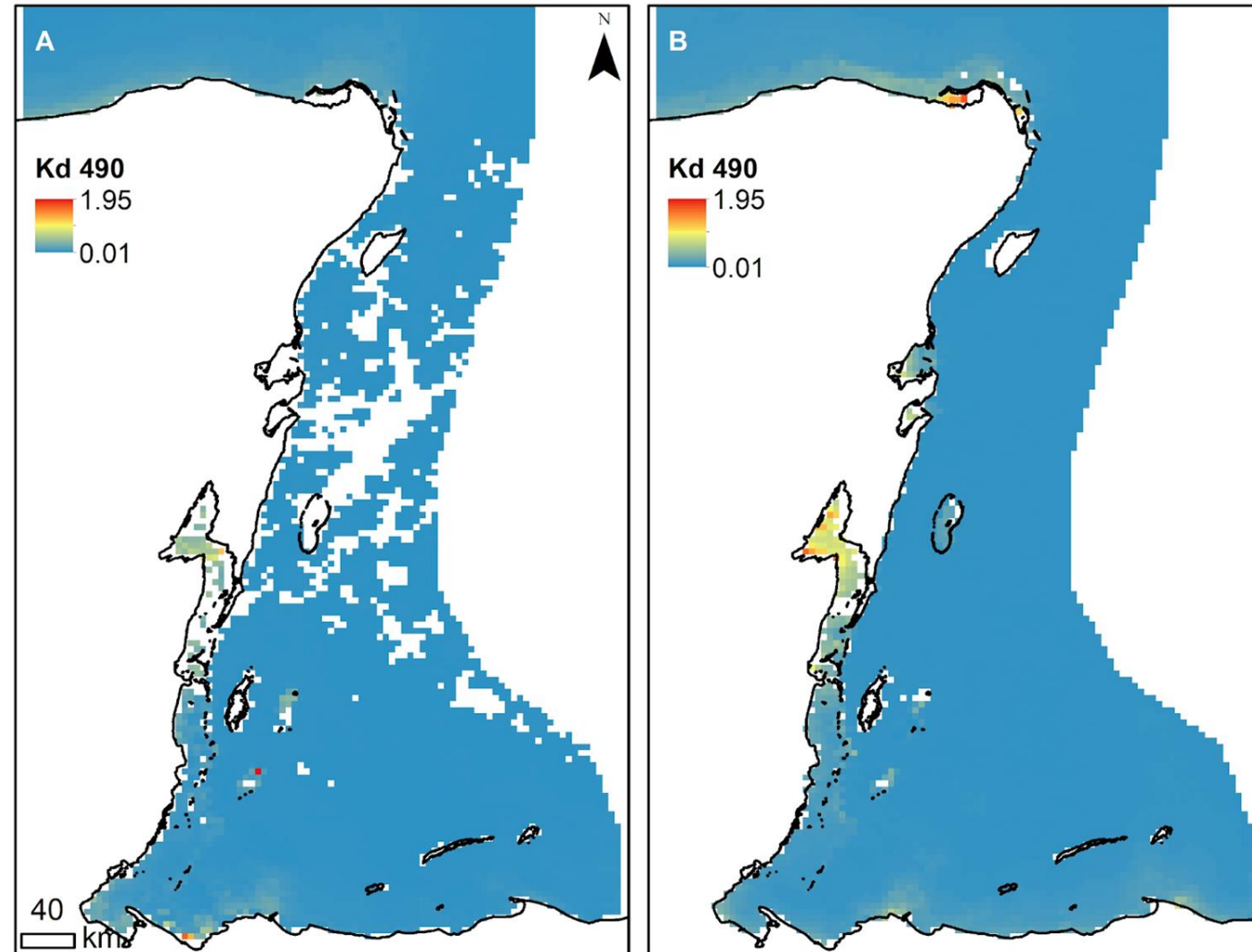
- IDENTIFY **REEF AREAS** WHERE MARINE ECOSYSTEM SERVICES CHANGE
- IDENTIFY THE **WATERSHEDS** DRIVING CHANGES IN MARINE ECOSYSTEM SERVICES THROUGH SEDIMENT EXPORT

### WATER QUALITY MEASUREMENT



## Challenges - Sediment

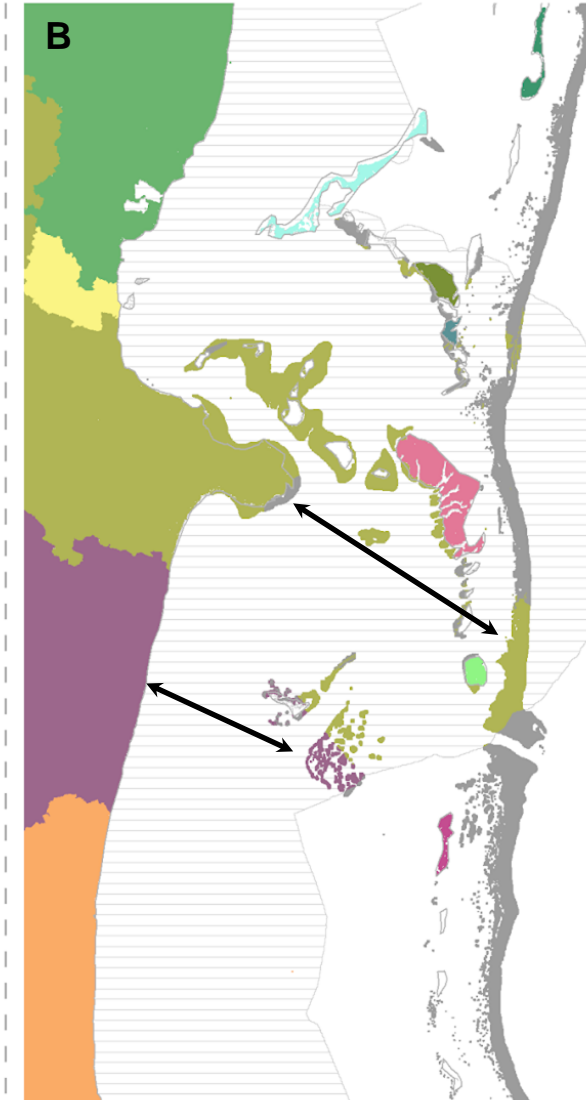
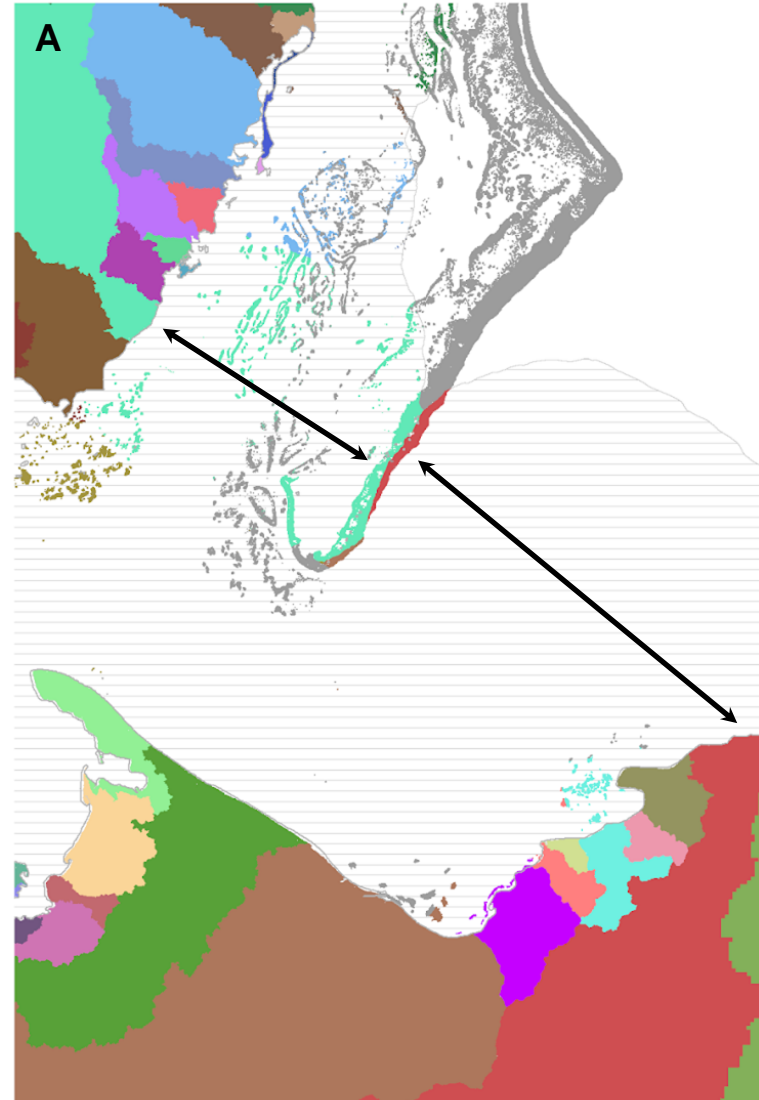
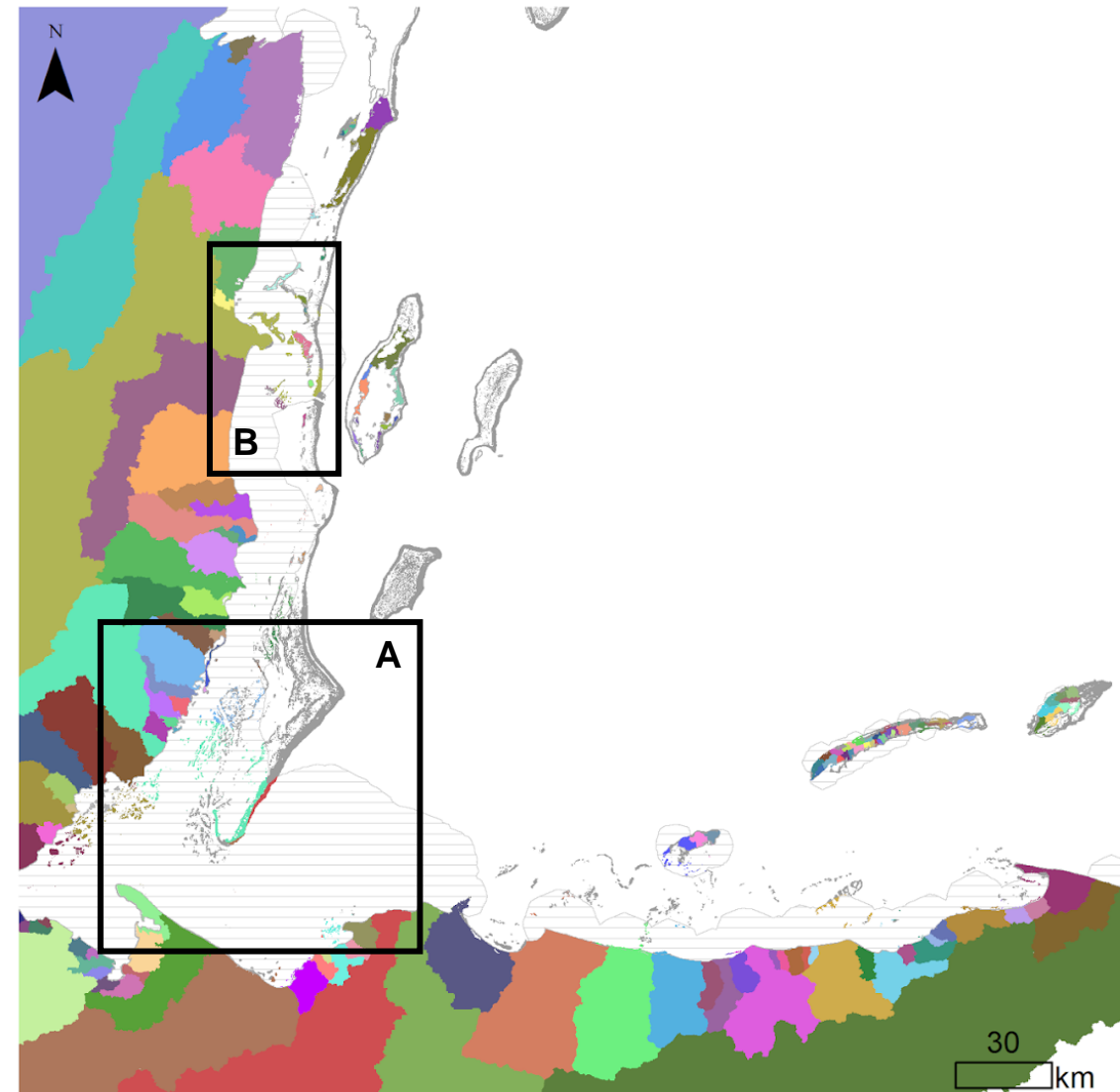
- WE ASSESSED THE POTENTIAL OF USING  $K_d490$  FROM OCEAN COLOR REMOTE SENSING DATA TO ASSESS THE IMPACT OF SEDIMENT AND TURBIDITY ON CORAL REEFS
- BUT THESE DATASETS ARE COARSER SCALE (4KM X 4 KM) & RESEARCH LACKS TO ESTABLISH RANGES OF  $K_d490$  VALUES THAT WOULD DESIGNATE POTENTIAL STRESS ON CORAL REEFS.





# IKI SMART COAST MAR Project

Ex: Watersheds driving changes in coral reef resilience through sediment export





# THANK YOU!

QUESTIONS?

[nbood@wwfca.org](mailto:nbood@wwfca.org)