Satellite data to determine hyper-local risks of coastal erosion & flooding

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Introduction

- Satsense Solutions uses satellite earth observation to address the challenges of climate change and sustainable development.
- Project supported by Ocean Risk and Resilience Action Alliance (ORRAA), a multi-sector collaboration of governments, financial institutions, insurance industry and environmental organizations.
- Targeted towards insurance companies, landowners and local-governments that would like to better understand coastal risks and build resilience measures.

ORRAA
Ocean Risk and Resilience Action Alliance

Sundarbans & Climate Change

Image Credit: NASA, Composite Landsat image over Sundarbans

Coastal Risk Assessment

National or regional level studies of coastal responses to climate change not adequate, as coastal erosion and flooding are strongly determined by site-specific factors.

Climate change and sea-level rise are gradual and long-term processes, while coastal erosion and flooding are sporadic short-term processes.

Mangrove Ecosystems reduce exposure and vulnerability, yet their value is not fully recognized, they continue to be lost and degraded.

Need for hyper-local coastal risk assessment, incorporating latest climate change data, recognizing the protection value of mangroves.

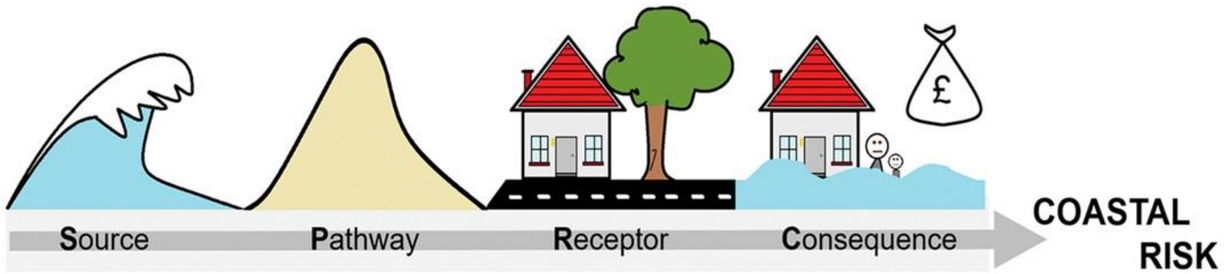


Image Credit: Van der Plank et. al 2021

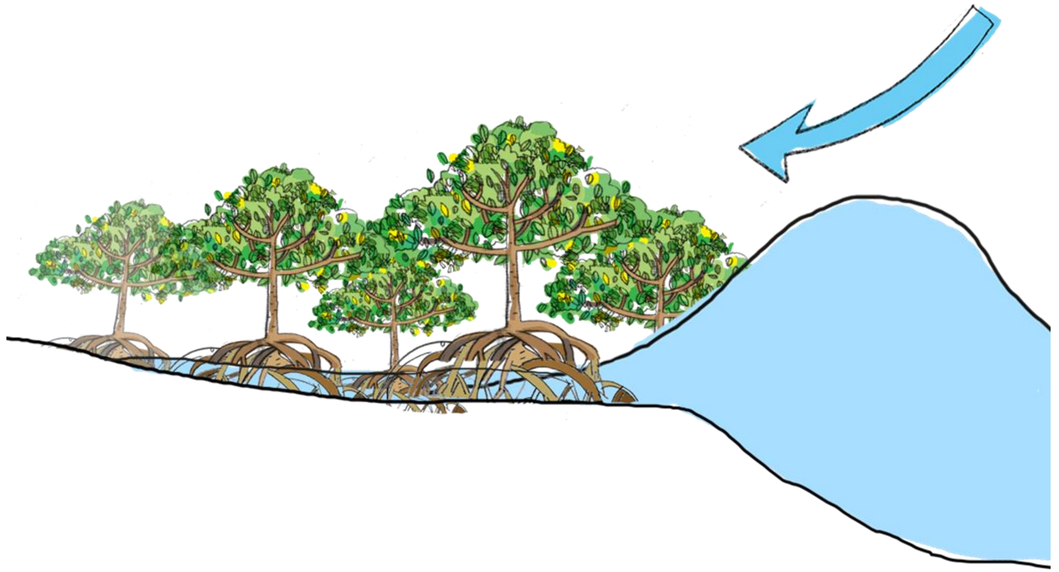


Image: Mangrove ecosystems reduce coastal risks

Methodology: Hazards & Environmental Factors

1. Hazard Inventory

Satellite data going back several decades is used to provide insight on distribution of past phenomena, their intensity, causal factors, frequency of occurrence, and damage caused.

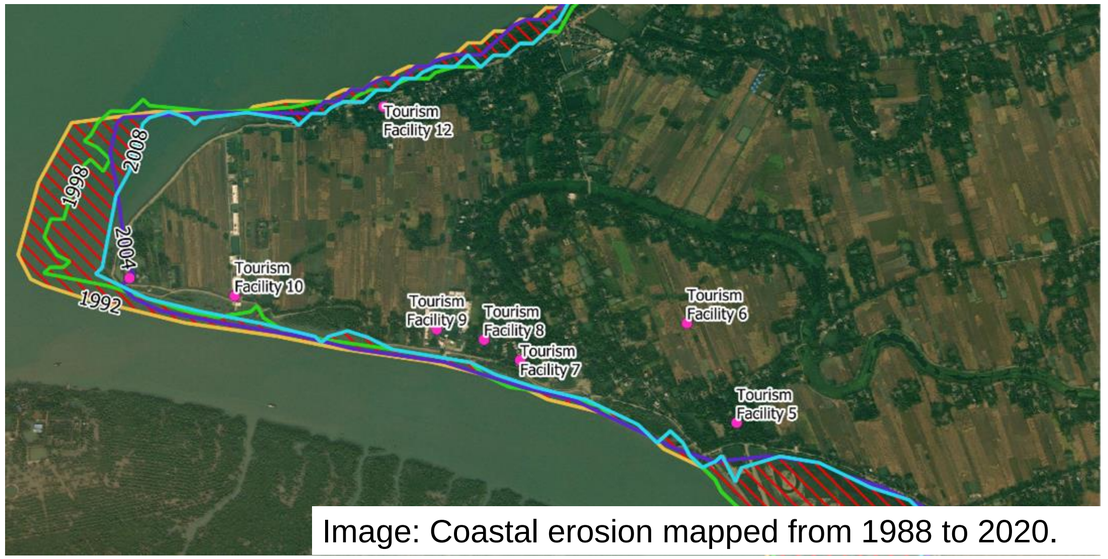


Image: Coastal erosion mapped from 1988 to 2020.

2. Environmental Factors

Evaluated using a mix of satellite, in-situ and modeled data, these are used as indicators in the prediction of future events.

They include geomorphology, elevation, sea-level rise, rate of shoreline change, wave height, presence of natural habitats, surge potential, wind exposure etc.

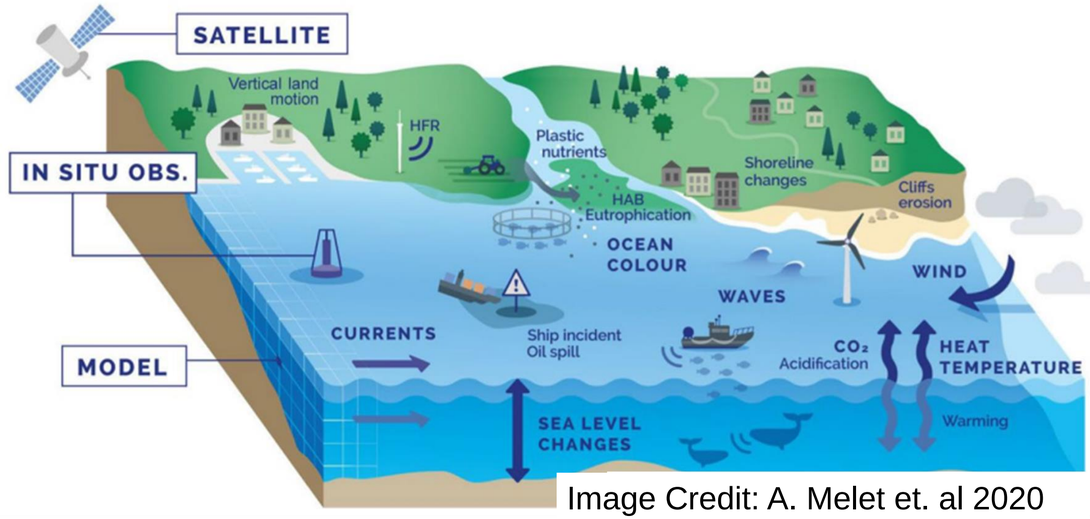


Image Credit: A. Melet et. al 2020

Methodology: Risk Index & Resilience Measures

3. Multi-Criteria Evaluation

Hazard and vulnerability indicators are ranked and combined:

- Ranking is done by standardizing and analyzing each indicator based on its contribution.
- Individual ranks are combined mathematically, assigning weights if required, to arrive at a score called - Coastal Risk Index

4. Coastal Risk Index

Represented spatially on a map, with causal factors

5. Resilience Measures

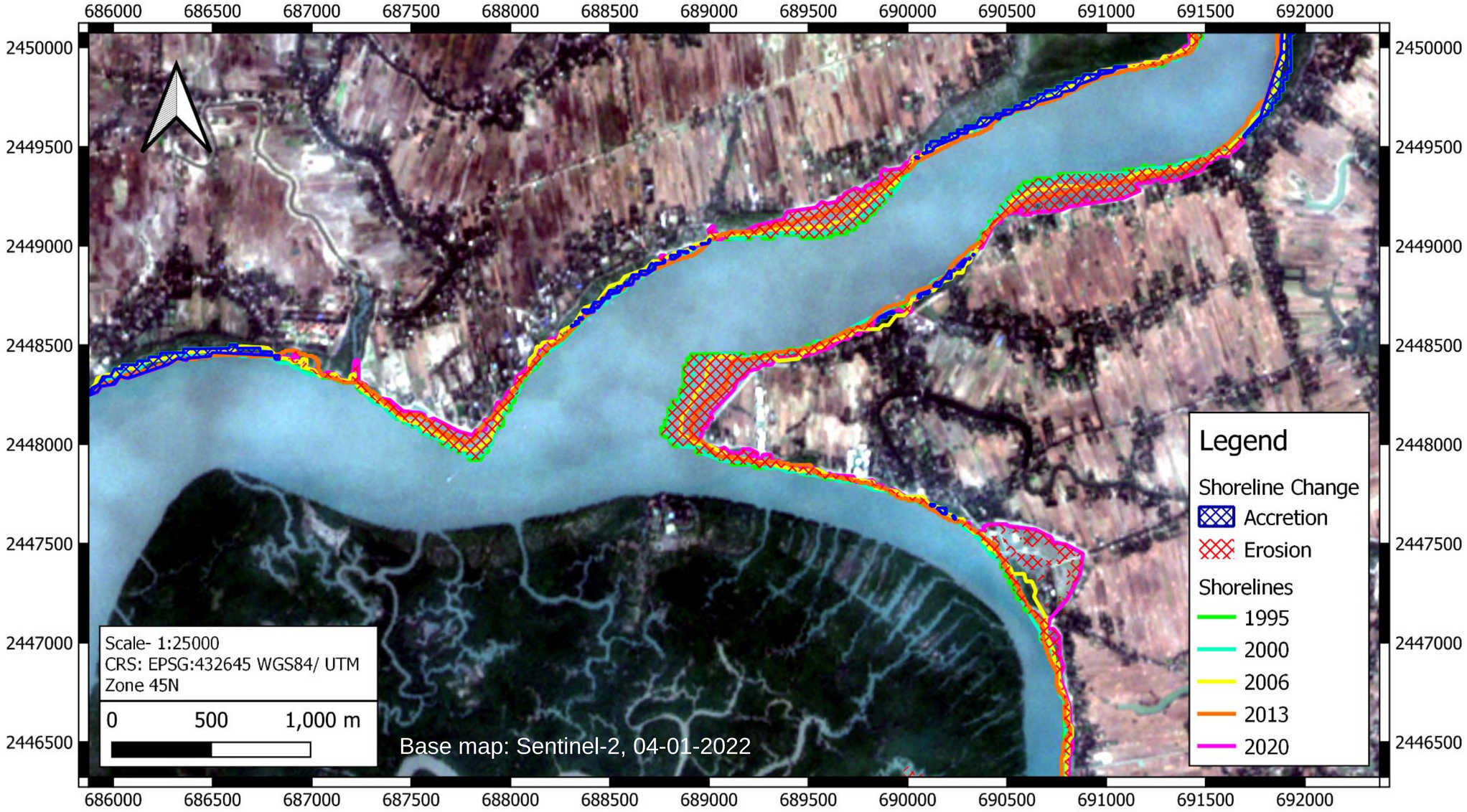
Sustainable, nature-based resilience measures provided for high and very high ranked locations.

	Hazard Indicator Ranking				
Variable	Very Low	Low	Moderate	High	Very High
	1	2	3	4	5
Geomorphology	Rocky, Cliffed coasts Fjords	Medium cliffs Indented coasts	Low cliffs Glacial drift Alluvial plains	Cobble beaches Estuary Lagoon	Barrier beaches Sand Beaches Mud flats Deltas
Coastal Slope (%)	>.2	.2-0.7	0.7-0.04	0.04-0.025	<.025
Relative Sea-level change (mm/yr)	<1.8	1.8-2.5	2.5-2.95	2.95-3.16	>3.16
Shoreline erosion/ accretion (m/yr)	>2.0 Accretion	1.0-2.0	-1.0- +1.0	-1.1- -2.0	<-2.0
	Accretion		Stable	Erosion	
Mean tide range (m)	>6.0	4.1-6.0	2.0-4.0	1.0-1.9	<1.0
Mean wave height (m)	<0.55	0.55-0.85	0.85-1.05	1.05-1.25	>1.25

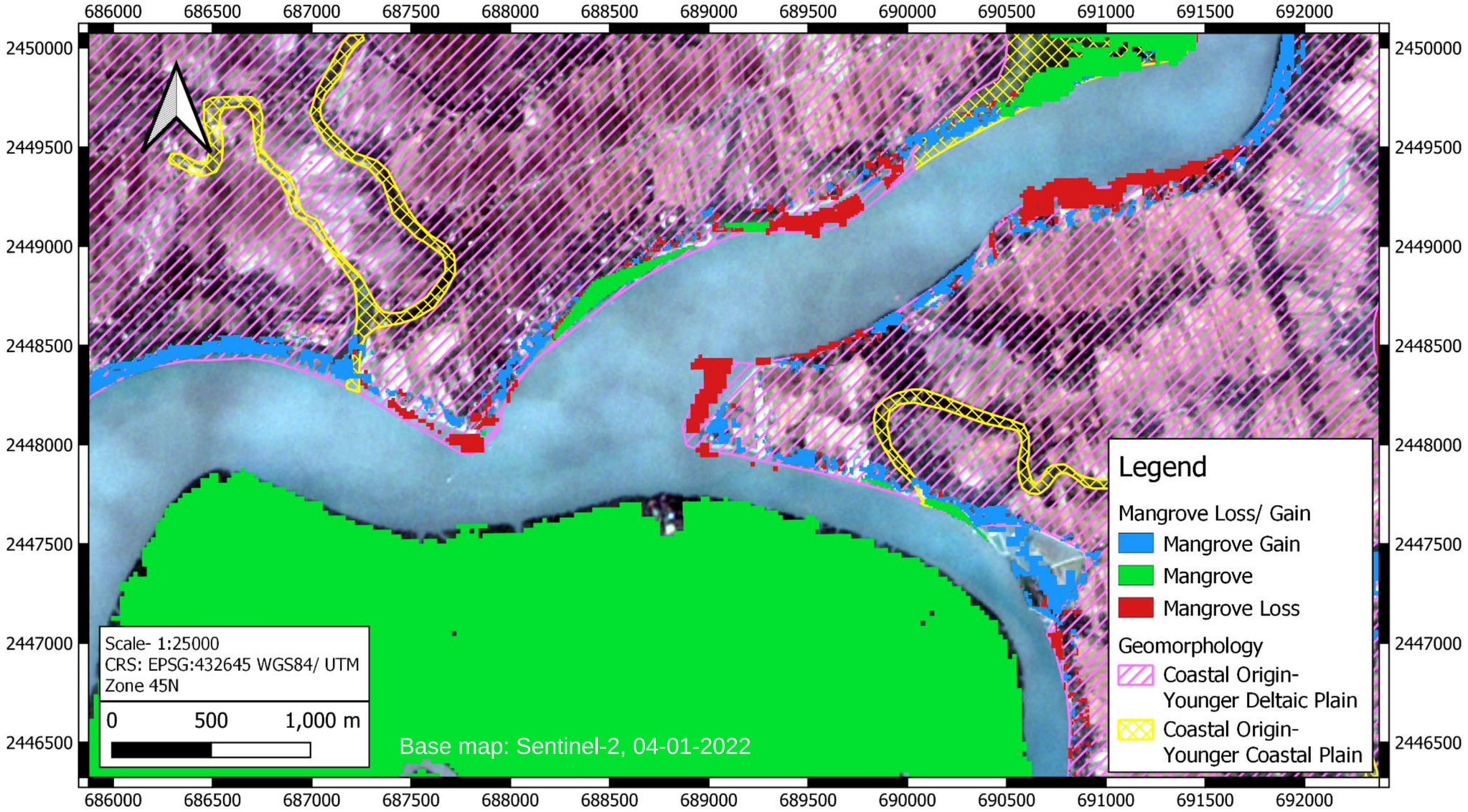
	Vulnerability Indicator Ranking				
Variable	Very Low	Low	Moderate	High	Very High
	1	2	3	4	5
Land Use	Wetlands, Salt marshes, Open lands, River and Inlets mouths (low capital)	Mangroves, Dune vegetations, Vegetations (moderate capital)	Scattered villages, Agricultural lands, Saltpans (high capital)	Hotels, Jetties, Fisheries (very high capital)	Residential Clusters, Refineries, ports, etc.
Road Network	>1km	1km	500m	250m	100 m
Population (along 100 km coastline)	0 to 20 Percentile	21 to 40 Percentile	41 to 60 Percentile	61 to 80 Percentile	81 to 100 Percentile

Credit: United States Geological Survey; Modified Coastal Vulnerability Index, Emad F. Abdelaty

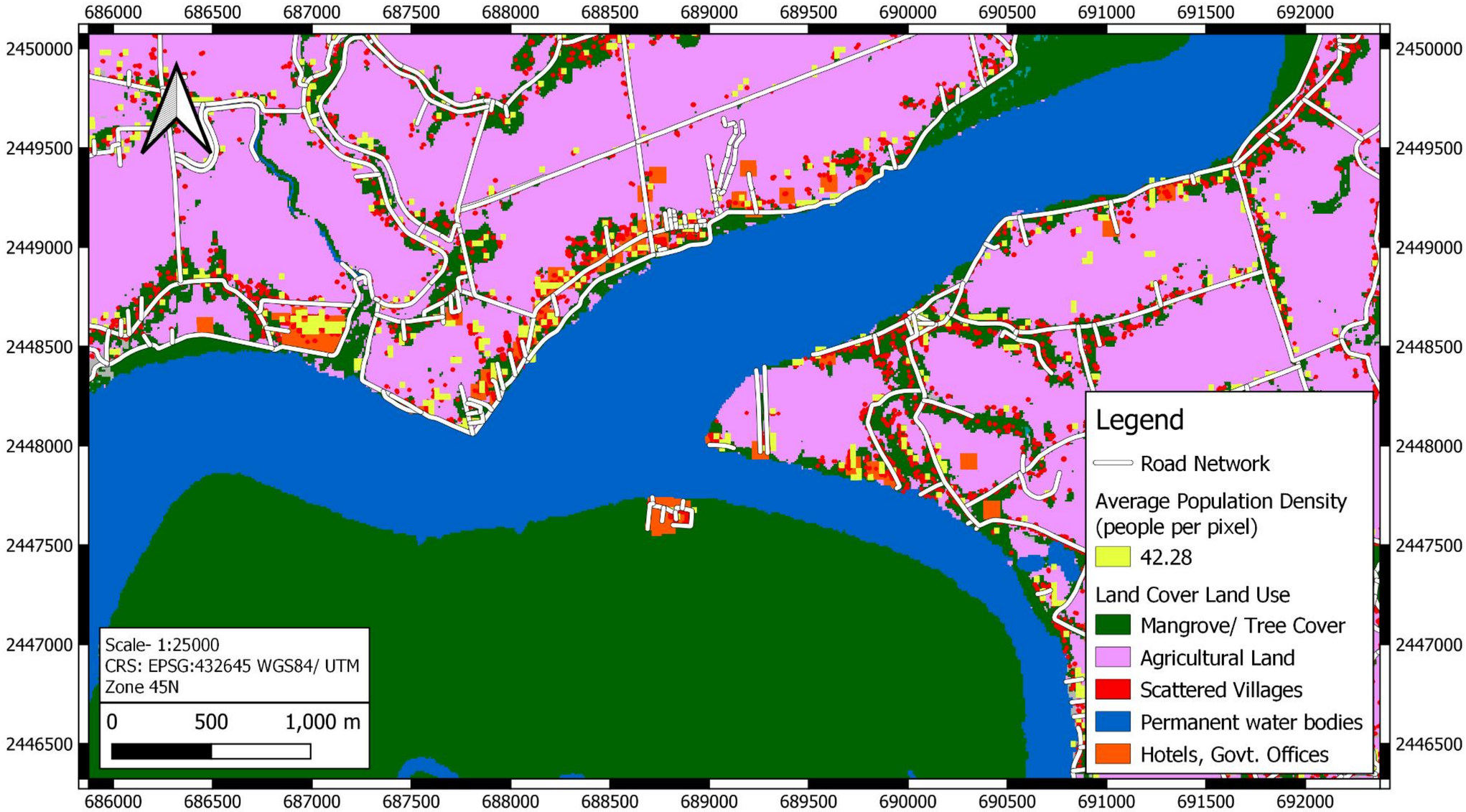
Results: Hazard Inventory



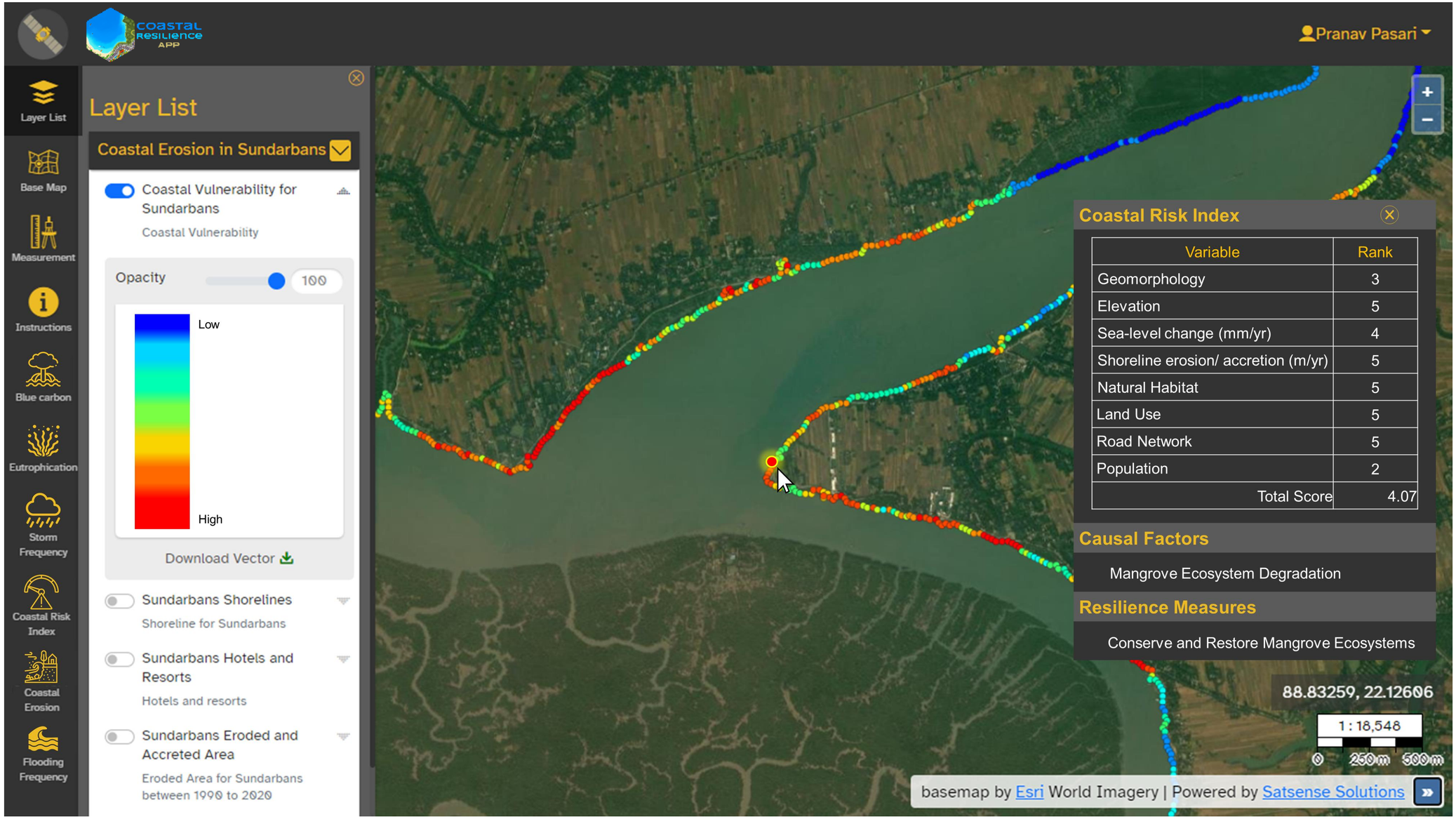
Results: Environmental Factors



Results: Vulnerability Indicators



Results: Coastal Risk Index & Resilience Measures



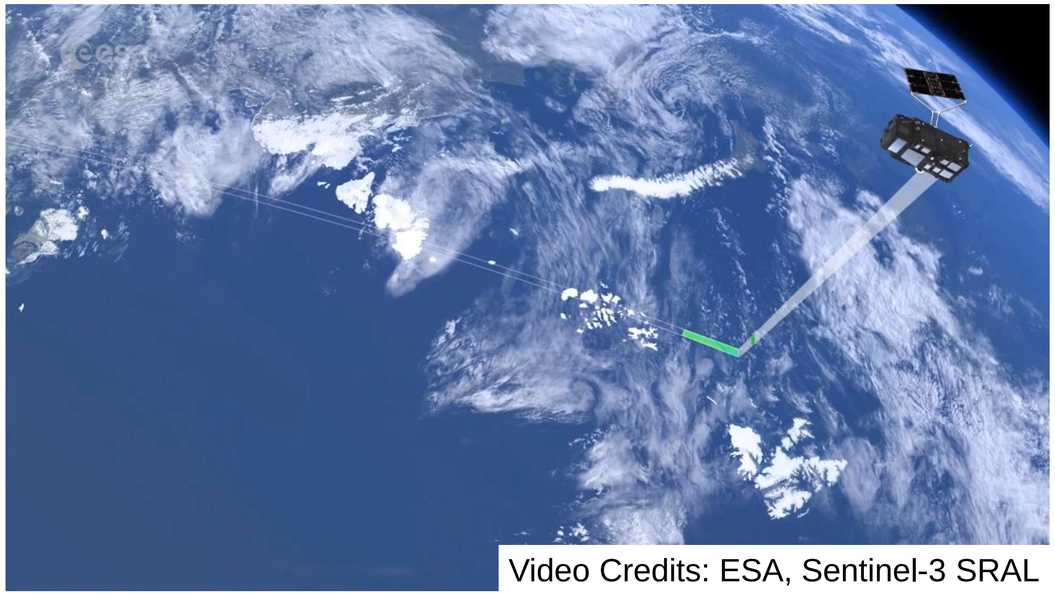
Satellite Data Used

Copernicus Marine Service

Sentinel-3 SRAL data used to measure sea-level and significant wave height, which along with wind speeds are obtained through the Copernicus Marine Service.

Sentinel-2 MSI and Landsat data is used to measure coastline changes and map natural habitats.

Other satellite data products used includes SRTM, ASTER DEMs, ESA WorldCover, VHR satellite data etc.



Video Credits: ESA, Sentinel-3 SRAL

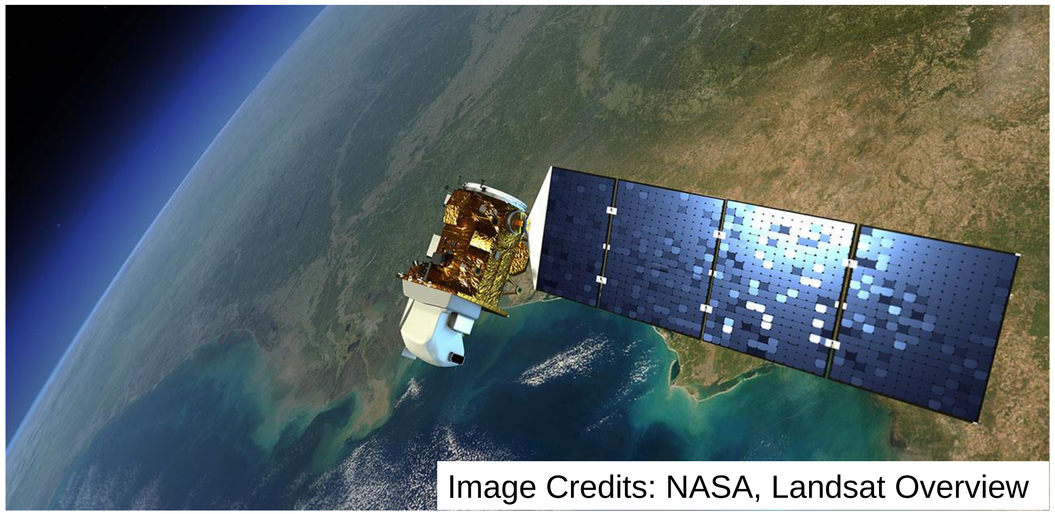


Image Credits: NASA, Landsat Overview

Key Benefits & Conclusion

- Provides coastal planners & managers the information and key decision pathways required to move from planning to action.

- Allows natural ecosystems to be seen as valuable assets for the coastal protection provided to buildings, infrastructure and communities.

- Better measures the need for coastal protection required to attract innovative and sustainable financing through mechanisms such as climate bonds, blue infrastructure bonds, green adaptation funds, and insurance instruments

- Increases understanding of complex coastal systems and prepares communities for climate change adaption. Answers questions about existing assets, spatial extent of impacts, exposure and climate change stressors.

- Replicable across different geographical locations and ecosystems as different indicator rankings are available to incorporate these differences.

- As insurers, communities and governments face increasing losses due to climate change, the demand for such solutions is expected to grow.

Thank you!

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