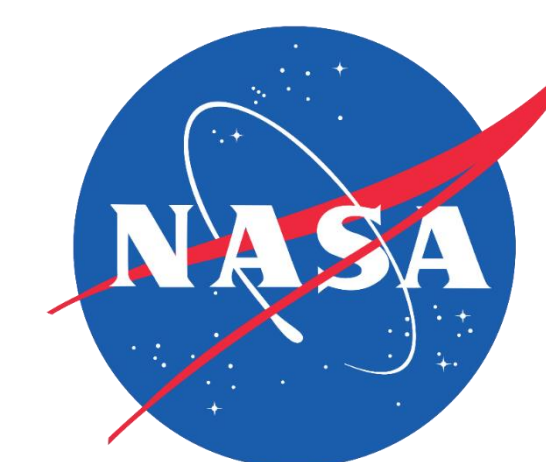




# Monitoring Shoreline Changes and Island Loss in Response to Climate Change



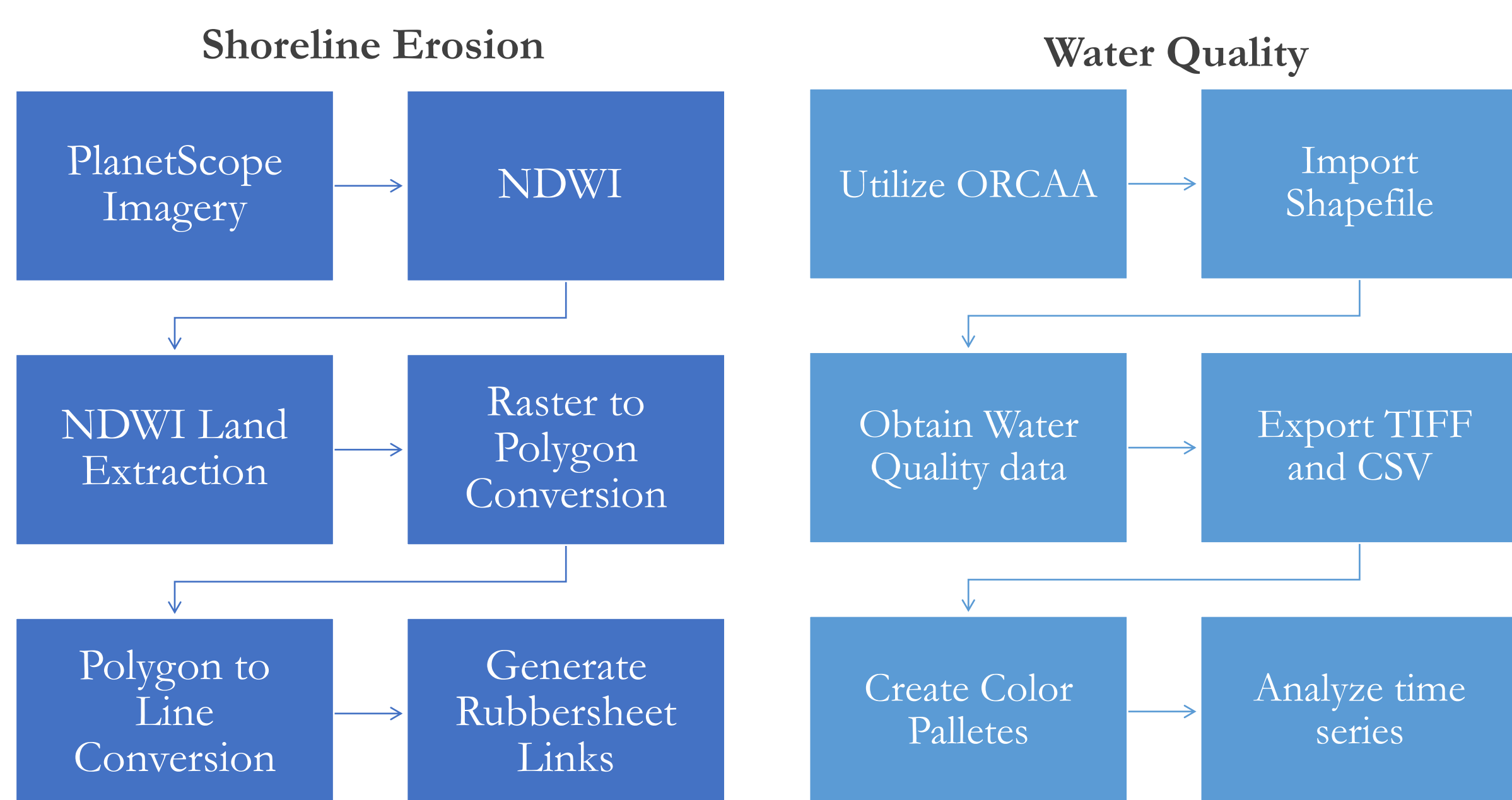
## Abstract

Global sea level rise as a result of climate change continues to pose a critical threat to coastal ecosystems and populations. The archipelagic country of the Maldives is of critical concern due to being one of the lowest lying areas in the world. The development of reclaimed land in the Maldives by sand dredging has been a frequent response to both increasing sea levels and population increase. Such disturbance can lead to increased sedimentation off the coast and negatively impact coastal environments. Remote sensing tools such as satellite imagery have proved to be an effective tool in observing coastal changes in response to climate change and development. We, the NASA DEVELOP team, created a methodology to analyze both water quality and shoreline erosion in the Maldives utilizing satellite imagery. Our methods relied on open-source software such as QGIS and Google Earth Engine (GEE) and Satellite Imagery from PlanetScope, Landsat 8 Operational Land Instrument (OLI), Sentinel-2 Multi Spectral Instrument (MSI), and Aqua & Terra Moderate Resolution Imaging Radiospectrometer (MODIS) to analyze the changes in shorelines and assess water quality of select atolls within the Maldives. We found that there is less shoreline change in developed parts of the island and more shoreline change in natural parts of the island. Additionally, water quality varies throughout the year and our data did not indicate seasonal trends. Our methodology will be replicated to continue to monitor island erosion and water quality with the Maldives and will be applicable to other island and coastal systems.

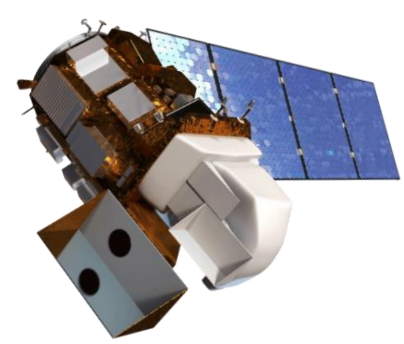
## Objectives

- **Monitor** the extent of shoreline erosion using NDWI analysis
- **Assess** water quality based on turbidity and chlorophyll-a concentration
- **Create** a repeatable methodology to do water quality and shoreline analysis
- **Teach** local stakeholders to employ the methodology to study other islands

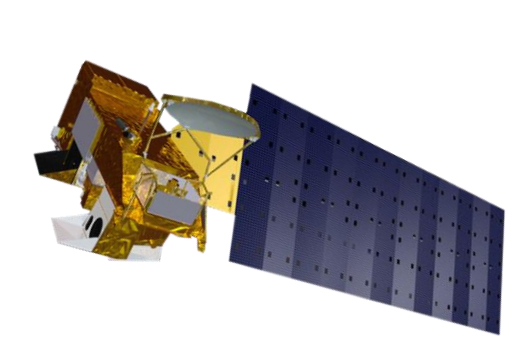
## Methodology



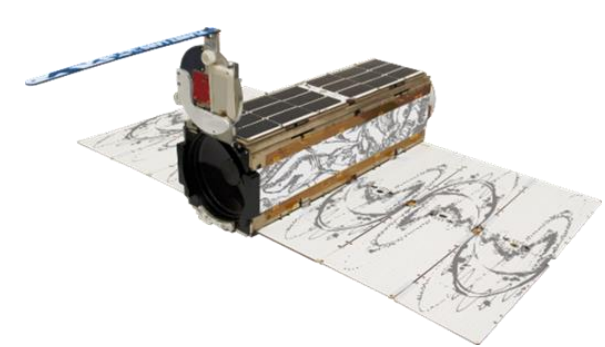
## Earth Observations




**Landsat-8 OLI**  
Parameters: NDWI, MNDWI, NDTI, Turbidity



**Aqua MODIS**  
Parameters: Chlorophyll-a, Sea Surface Temperature (SST)



**PlanetScope Dove**  
Parameters: True Color (R, G, B), NDWI



**Sentinel-2**  
Parameters: Turbidity, Chlorophyll-a

Image Credit: Planet Labs PBC

## Team Members



Aidan Harvey  
Project Lead



Daniel Lopez



Derek Chin



Mitch Porter

## Study Area

Republic of Maldives  
Study Period: 2016-2022

- Haa Alifu, Haa Dhaalu, and Kaafu Atolls
- Climate: Warm, tropical with distinct dry and wet seasons
- Maldives consists of over 1,100 islands

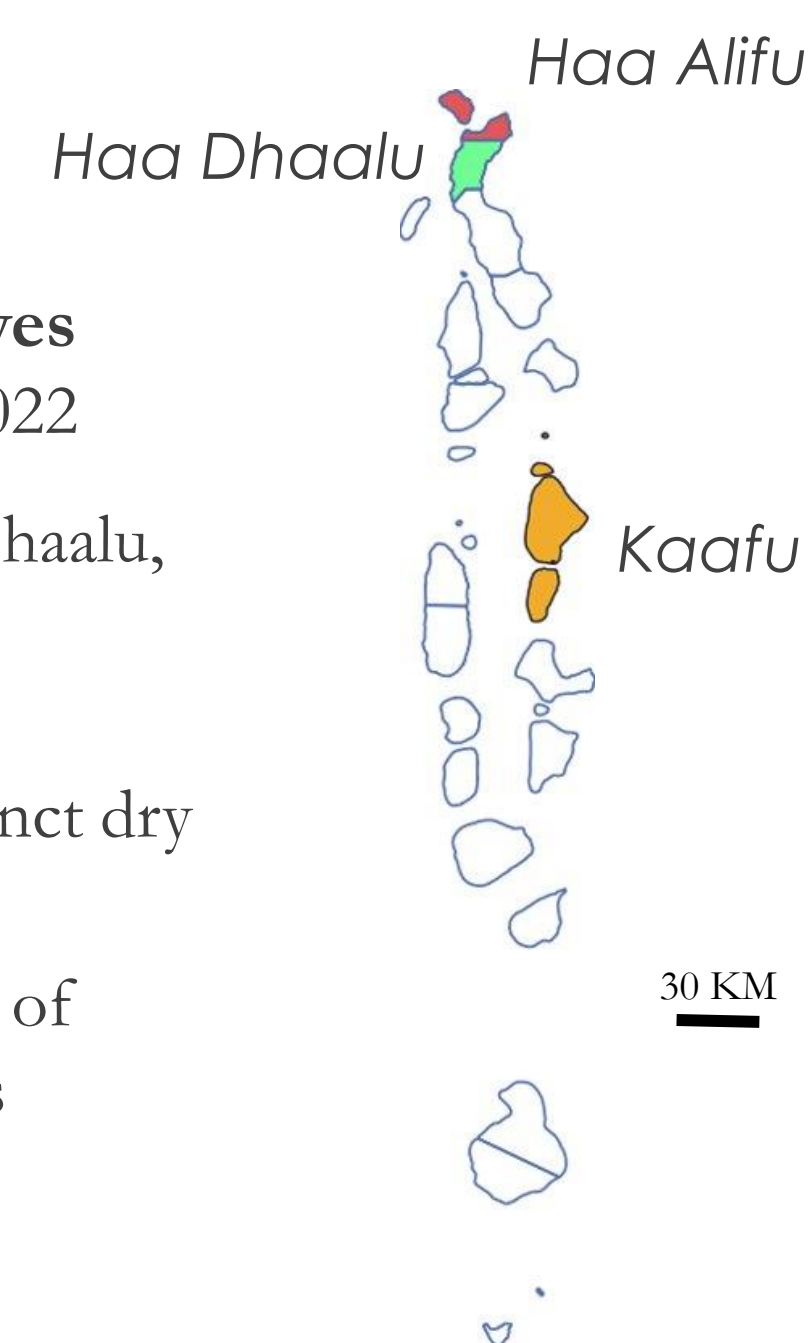


Image Credit: QGIS & Wikimedia commons

## Results

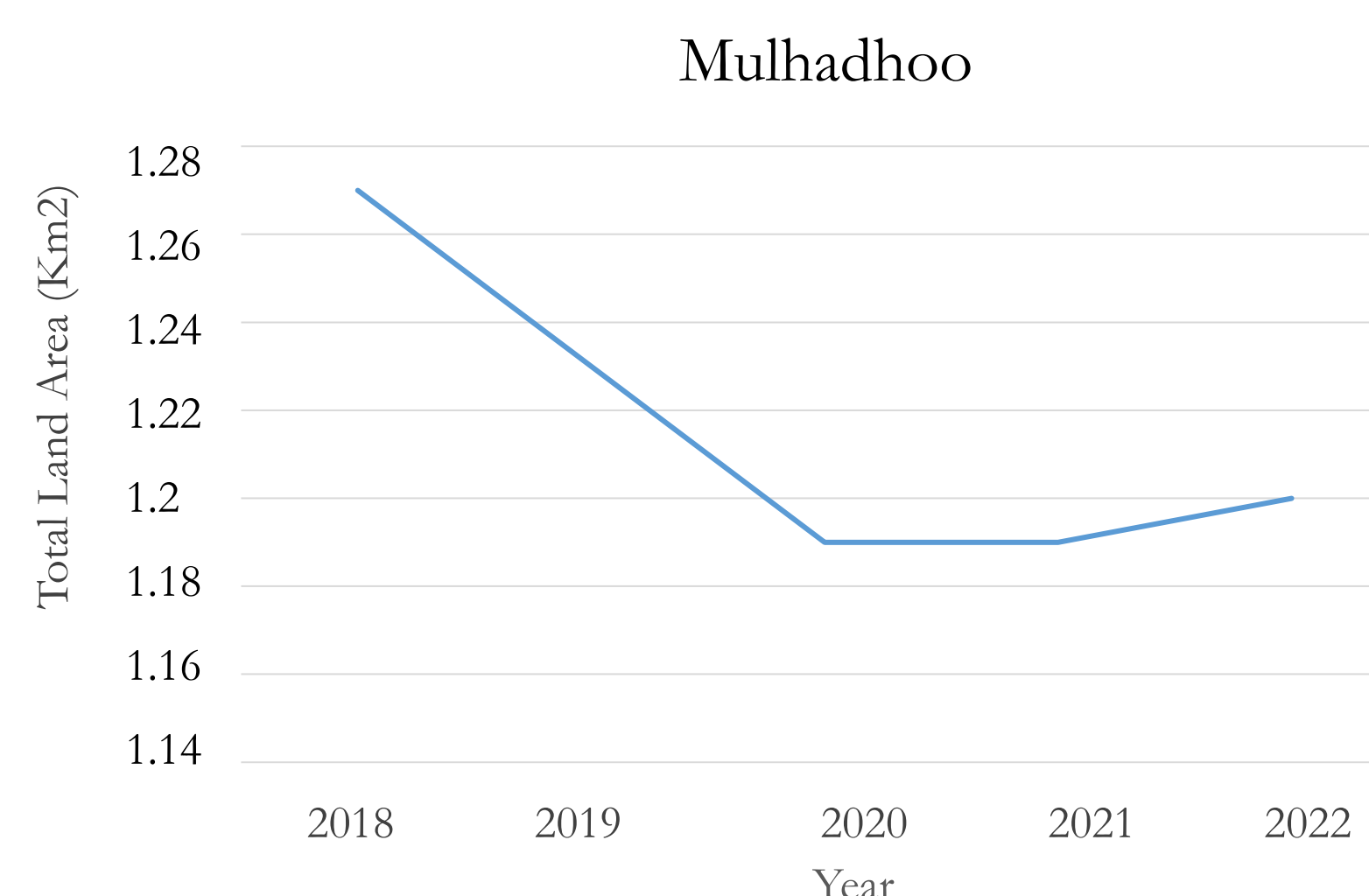


Figure 1. Graph of total Area Change for Mulhadhoo

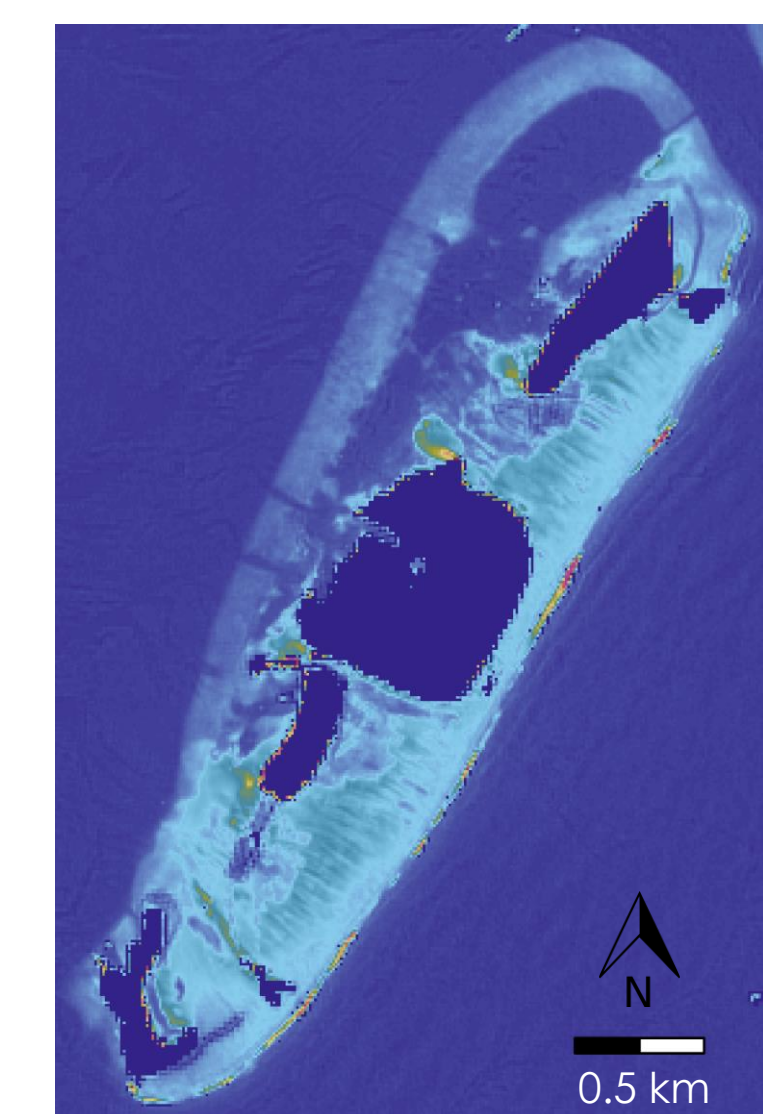


Figure 2. Turbidity imagery of Huraa Island in the Kaafu Atoll

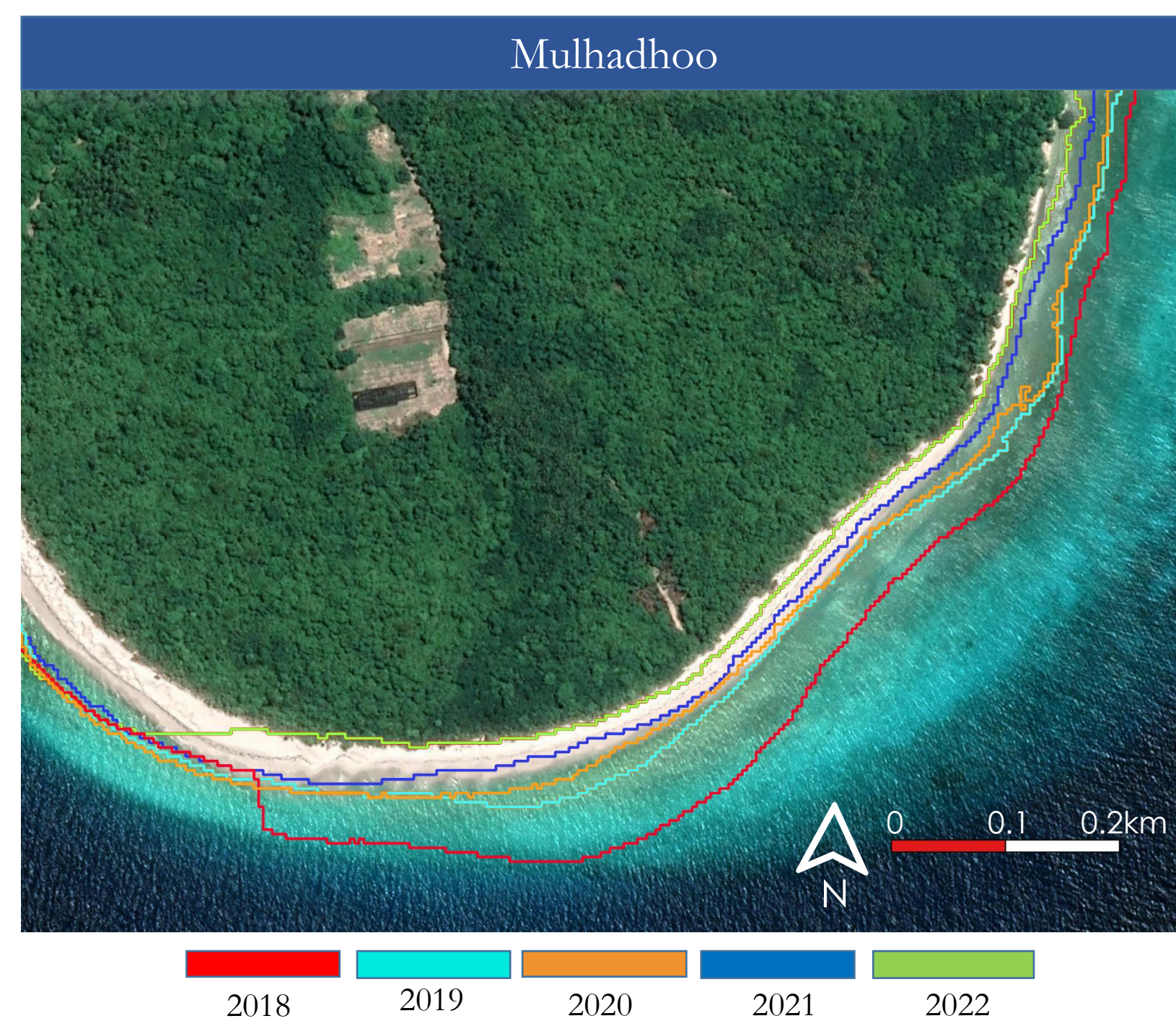


Figure 3. Imagery of the shoreline change in Mulhadhoo in the Haa Dhaalu Atoll

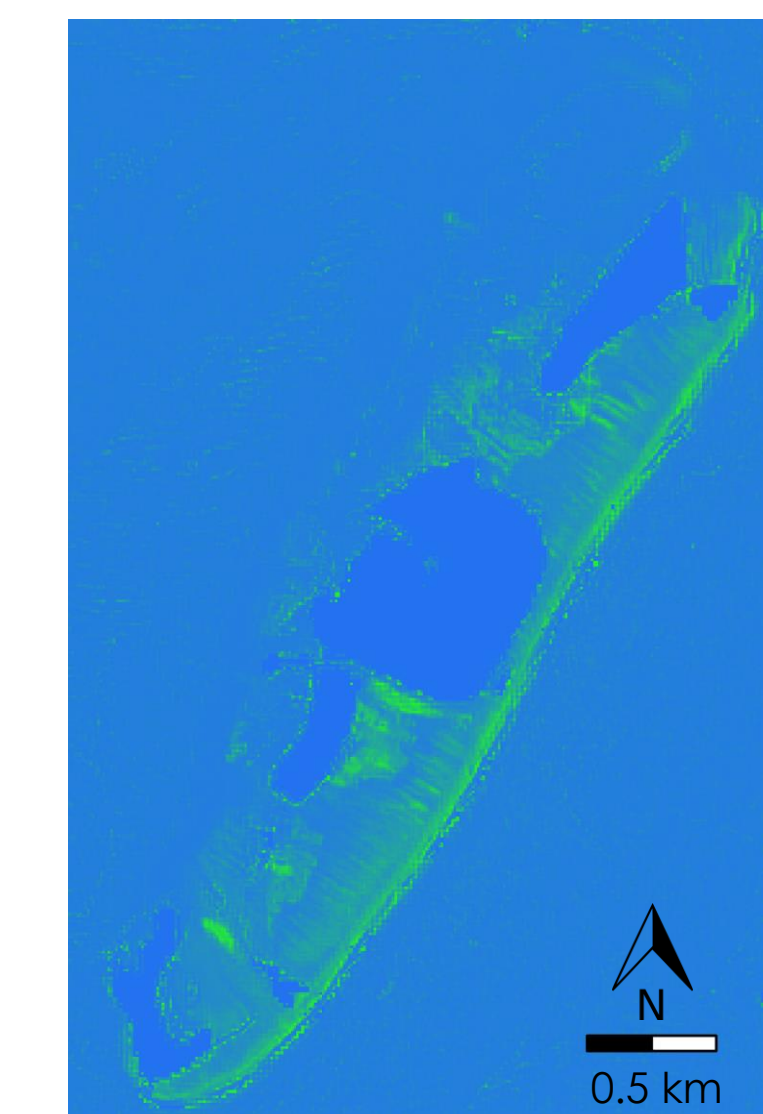


Figure 4. Ch-a imagery of Huraa Island in the Kaafu Atoll

## Conclusions

- **High resolution imagery** provided detailed analysis of shoreline change.
- Shorelines experience dynamic **interannual variability**, indicating shoreline extent is highly dependent on environmental conditions.
- ORCAA assessments for water quality were inconclusive for accurately detecting seasonal or annual trends for both chlorophyll concentrations and turbidity

## Acknowledgements

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## Project Partners

The Ministry of Environment, Climate Change, and Technology; U.S. Department of State, Bureau of South-Central Asian Affairs, Office of Bangladesh, Nepal, Sri Lanka, Maldives, and Bhutan; USAID, Maldives Office