From Space to Sea: Mapping the National Seagrass Extent in Seychelles using PlanetScope NICFI Data

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Introduction

Background:

- Seagrass meadows provide many valuable ecosystem services, such as blue carbon sequestration, food source, habitat, and so on. For example, the fisheries support at Gran Canaria was estimated to be worth 600,000 € per year (Tuya *et al.*, 2014, de los Santos *et al.*, 2020).
- Seagrasses are highly threatened, with global habitat losses of 19.1% (Dunic *et al.*, 2021).
- There is a considerable lack of knowledge on the global seagrass distribution, and spatial data for seagrass habitats is unavailable in many places (Waycott *et al.*, 2009; Dunic *et al.*, 2021).
- As this information is essential for the Blue Carbon Accounting, seagrass mapping is needed.

Situation:

- Seagrasses are usually submerged, so employing optical sensors is most practical from space.
- The recent free and high-resolution (4.77 m) Norway's International Climate and Forests Initiative (NICFI) by PlanetScope has a buffer along the shorelines that includes shallow coastal waters. These are where seagrasses can usually be found.
- Our multitemporal approach works with Sentinel-2 to map seagrasses (Traganos *et al.*, 2022a, 2022b, Blume *et al*, 2023).

Challenges:

- The NICFI has only four spectral bands, which is a limiting factor.
- The NICFI dataset is a surface reflectance composite image, normalised using Landsat imagery (Planet Team, 2017).
- Owing to accessibility matters, collecting data from all islands has been challenging.

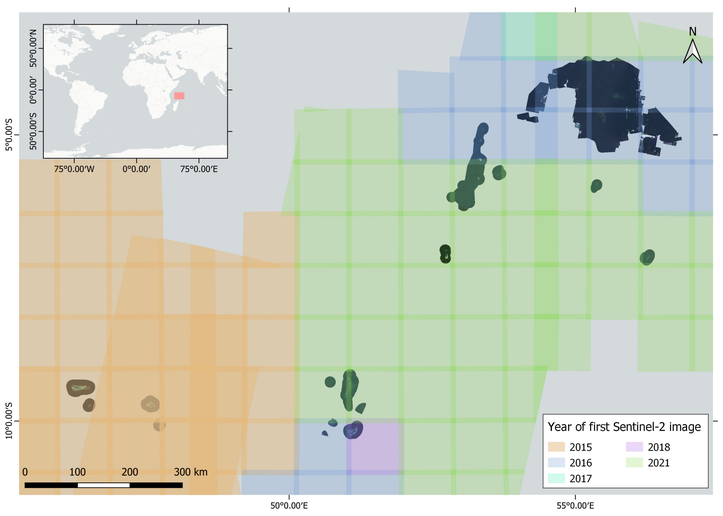

Figure 1. *Map of the Seychelles showing the year of the first Sentinel-2 image available, based on MGRS tiles. Basemap: CartoDB Positron.*

Study aim:

- Map the seagrass extent of Seychelles using Planet NICFI images and our multitemporal approach.

Methods and Materials

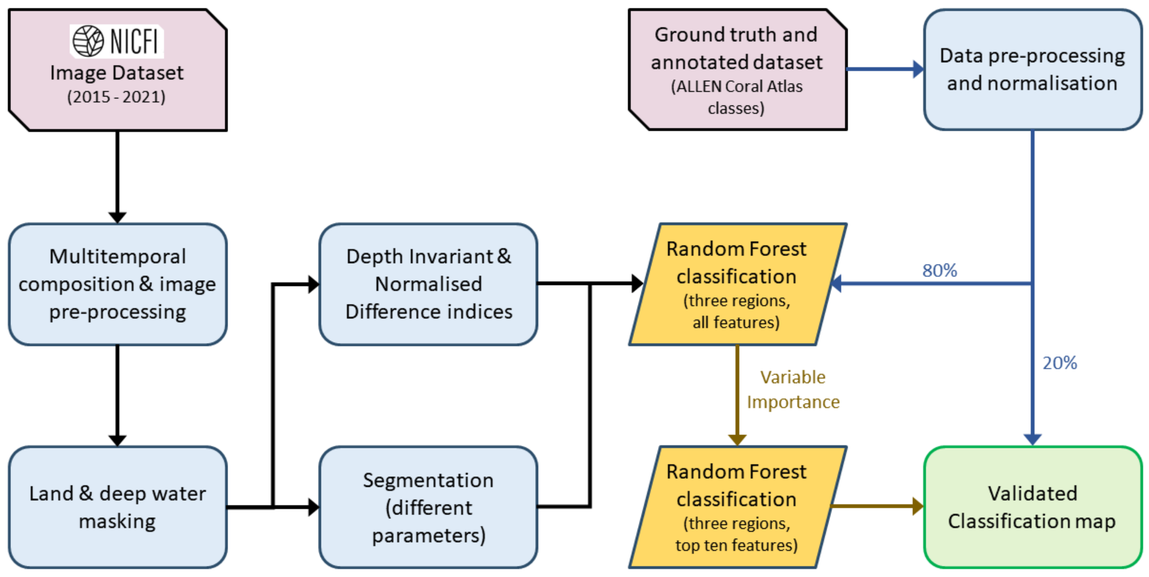

Figure 2. *Study workflow.*

Table 1. *Processing done in this study.*

Process	Steps	Details
Multitemporal Composition	Time range	Biannual Images from 2015 to 2020.
	Composite statistics	Interval Mean of 10th and 50th percentiles.
Masking	Land	Normalised Difference Water Index thresholding
	Deep water	True Colour HSV thresholding, manual clean up
Feature Generation	Spectral Band indices	Pairwise band combinations of Depth Invariant Index and Normalised Difference indices
	Segmentation statistics	Simple Non-Linear Clustering (SNIC, GEE function): *Seed Grid* (5, 10, 15), *Compactness* (0, 0.2, 0.4, 0.6, 0.8, 1), *Reduce Connected Component* (10, 100, 1000)
Reference data	Source	Groundtruth data (points and tracks) Visual Photointerpretation to supplement more
	Normalisation	Retain only points within the 5th and 90th percentiles
Classification	Variable selection	Top ten variables
	Classification	Random Forest (GEE function)

Results

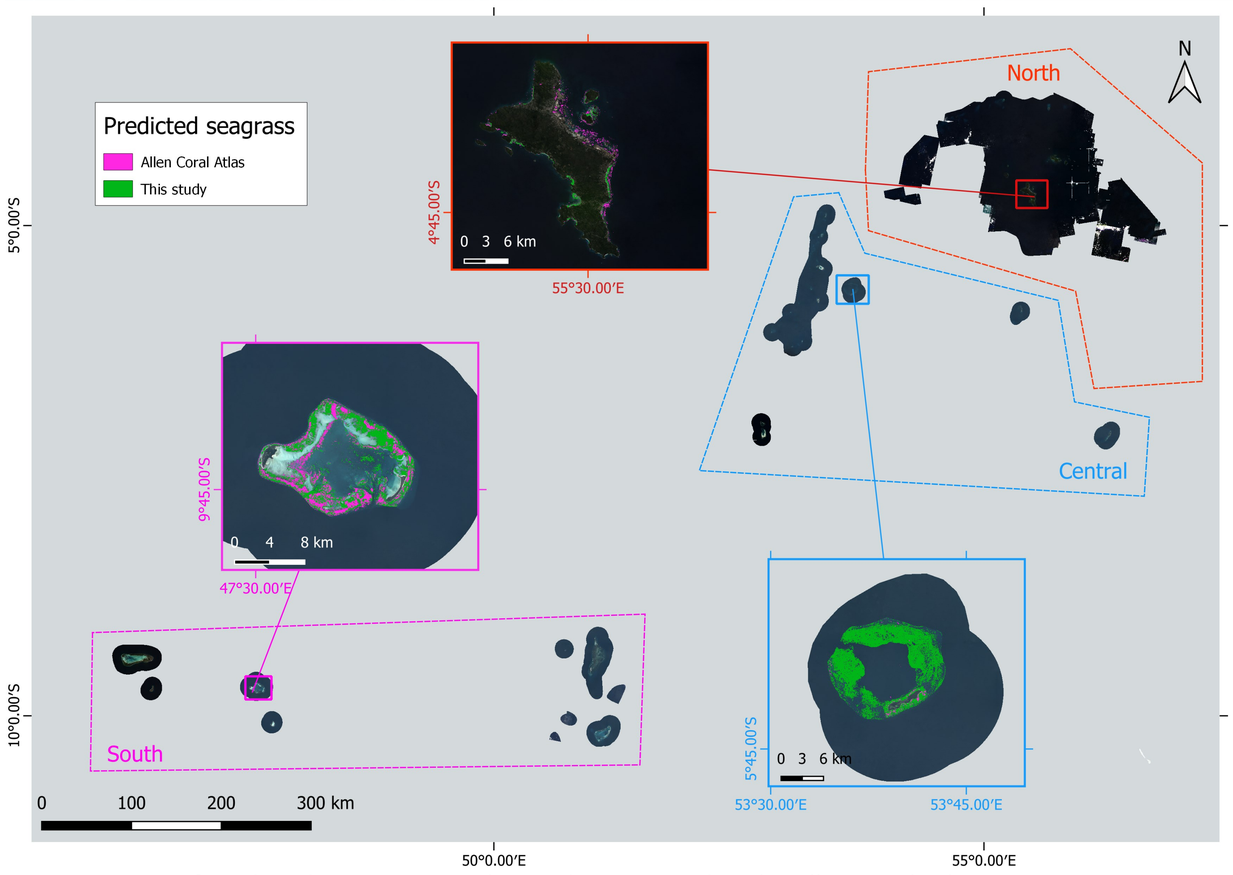

Figure 3. *Map of predicted seagrasses in this study, compared to the Allen Coral Atlas (Lyons* et al.*, 2020).*

Table 2. *Best classification accuracy for the Seychelles with the corresponding segmentation parameters.*

Region	North	Central	South
Best Overall Accuracy	69.7%	73.4%	75.7%
Best Producer's Accuracy for seagrass class	62.6%	89.2%	86.9%
Best User's Accuracy for seagrass class	63.9%	77.7%	81.5%
Seed Grid	10	15	15
Compactness	0.6	0.6	0.8
Reduce Connected Component	1000	100	1000

Table 3. *Estimated seagrass extent in Seychelles by region based on this study which uses only Planet NICFI data, Allen Coral Atlas, and a combined product using the results of this study, Sentinel-2, expert knowledge, legacy data, and other datasets to produce a best available map (Rowlands* et al.*, in preparation).*

Region	Total Predicted Seagrass Area (km^2)		
	Planet NICFI (this study)	Allen Coral Atlas	Combined Approach
North	39.41	7.48	356.90
Central	428.18	24.72	725.82
South	331.38	174.63	337.93
Total	798.97	206.83	1420.65

Discussion

Spatial resolution and temporal coverage versus limited spectral bands:

- The increased spatial resolution provides the potential for a finer-scaled map.
- With the extra coverage, the central region of the Seychelles was mapped to a substantial accuracy for the seagrass class (Figures 1 & 3).
- Owing to the reduced spectral resolution, spectral confusion still occurred with some classes, such as the macroalgae, which were partly mitigated by the added features.

Transferability:

- NICFI basemaps are terrestrially focused, harmonised with Landsat data, and not a product of a radiative transfer model (Planet Team 2017), with limited buffer of 10 km into water.
- Future research will look into uncertainty estimation and using it to improve on the classification.

Beyond mapping:

- The extent data will be combined with in-situ soil carbon measurements to estimate the national blue carbon (Rowlands *et al.*, in preparation).
- This project informed the Seychellois's government's commitment to protect 100% of their seagrass meadows by 2030 in their Nationally Determined Contribution to the Paris Agreement.

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