BioREaCH: Biodiversity-Remote sensing for Estuarine and Coastal Habitat research

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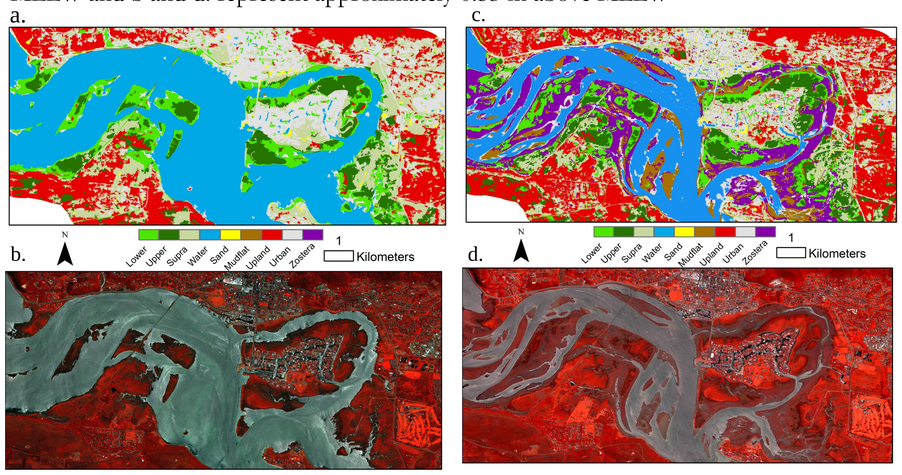
Year One…

We focused on six of our nine tasks during the first year of our project, including **planning field data collection, prediction of plant function types, calculating spectral diversity and dimensionality, expanding to space-borne data, time series analysis, and predicting climate impacts.**

Prediction of Plant function types

We predicted estuarine plant functional type communities across the tidal gradient. We utilized high spatial resolution satellite data from Worldview-2/3. Here we highlight the result for the Knysna estuary (Figure 1). In Knysna, we mapped 366.5 ha of Zostera (Fig. 1c), a very similar amount of Zostera as previous estimates from the 2000s, i.e., 350-390 ha (Barnes and Elwood 2012). When repeating our classification for earlier years, we found that a higher tidal stage and turbidity made mapping Zostera extent impossible (Fig. 1a-b). However, the low marsh plant functional community was still mappable, though darkening was evident (Fig 1. a-b.

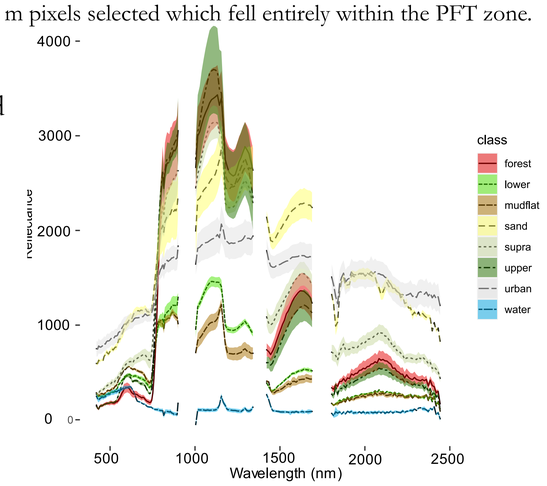
Figure 1. map and underlying data in pseudo color for December 2011 (a and c) and December 2021 (b and d). a and c represent a high tidal stage approximately 1.5 m above MLLW and b and d. represent approximately 0.53 m above MLLW



Spectroscopy

In Knysna, we have explored the spectral separability of our proposed PFTs with EnMap at 30 m spatial resolution (Fig. 1). We further analyzed how these classes relate to elevation and expect LVIS or other elevation data to improve the classification.

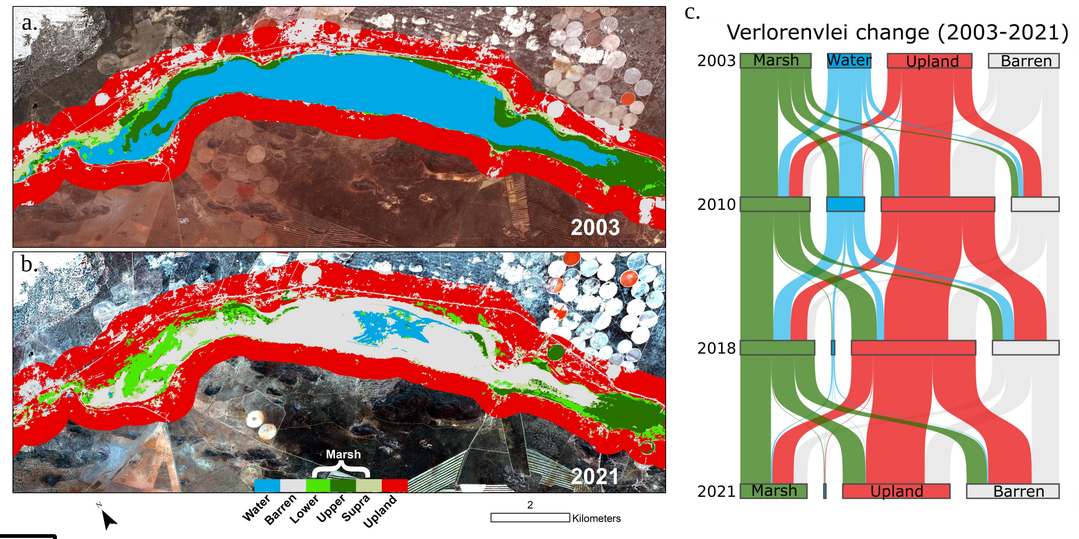
Figure 2. EnMap spectral curves for major PFTs in Knysna estuary, South Africa. Each PFT had a minimum of three 30 m pixels selected which fell entirely within the PFT zone.



Change analysis

We have conducted preliminary change estimates for Knysna, Langbaan and a denser time series for Verlorenvlei. Our change analysis of Verlorenvlei demonstrates loss in water over the years from 1086 ha to 119 ha (Figure 3). A major drop in water extent was observed between 2010 and 2018 (Figure 3 c.). We have also conducted time series trends for climate variables which will be used to model the future of these systems along with regional sea level rise rates. These changes are resulting in shifts to the marsh PFTs and risk biodiversity loss.

Figure 3. a. PFT map of Verlorenvlei for 2003 mapped with Quickbird data. b. A map of Verlorenvlei in 2021 mapped with Worldview-2. c. A Sankey diagram of change from 2003-2021 simplified to four classes marsh, water, upland, and barren. Panel c. demonstrates the change in an area of 2804 hectares.



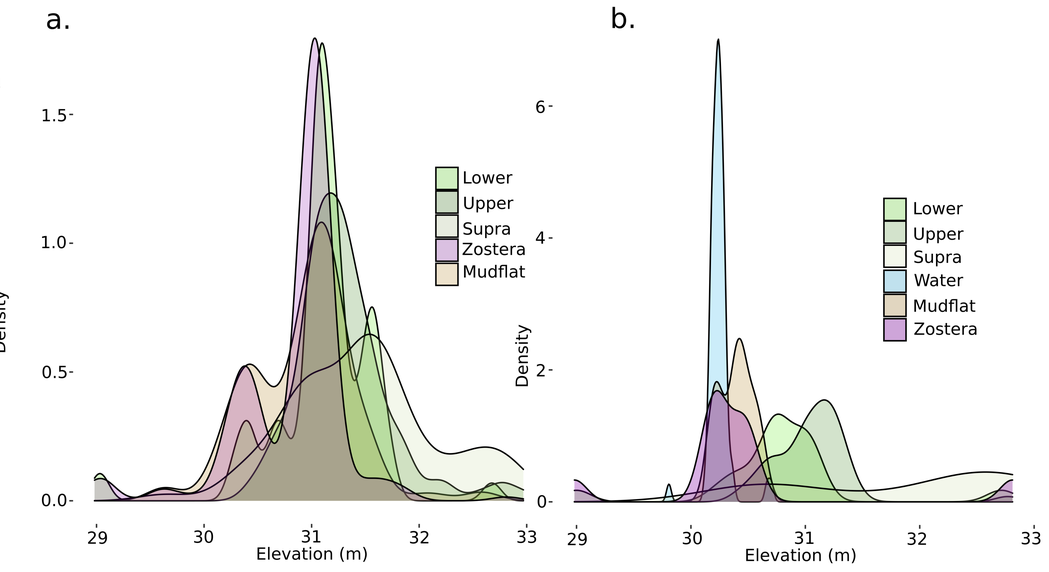
Planning - Field data collection

Our exploration of the existing spaceborne data streams and data fusion between lidar and space-borne spectroscopy demonstrates that the BioSCapes aerial campaign will offer unique data to improve classification and answer our overarching hypotheses surrounding biodiversity across the estuarine gradient. We plan to use these maps to inform field data collection. Tidal stage exploration demonstrates the potential impacts on extent mapping but can be quantified and controlled for with repeat high-resolution data mapping.

Estuarine gradients

We examine how our classifications relate to elevation and tides using the ICESat-2. We estimated the elevation of our estuarine PFTs (Fig 4). In Knysna, we see little separability between classes (Fig. 4a). However, when considering lidar data collected at a low tidal stage (~0.30 m above MLLW), in this case, we can differentiate between the ground elevation of our PFTs (Fig 4b). The elevation analysis also demonstrates that near MLLW tidal stage is necessary to map the exposed seagrass extent.

Figure 4.a An example of a high tidal stage in the Knysna estuary resulting in a similar elevation corresponding with the tidal stage across all the plant functional communities. b. A lower tidal stage but similar to figure 2. a-c where Zostera is inundated but other tidal communities are exposed.



Barnes, R.S.K. and Ellwood, M.D.F., 2012. Spatial variation in the macrobenthic assemblages of intertidal seagrass along the long axis of an estuary. *Estuarine, Coastal and Shelf Science*, *112*, pp.173-182.