WATCHING THE GRASS GROW: DELINEATING COASTAL VEGETATION EDGES FROM SATELLITE IMAGERY

Freya M. E. **Muir**[1], Martin D. **Hurst**[1], Luke **Richardson-Foulger**[2], Alistair F. **Rennie**[3], Larissa A. **Naylor**[1]
[1]@fme_muir, School of Geographical and Earth Sciences, University of Glasgow; [2]Leverhulme Centre for Wildfires, King's College London; [3]NatureScot, Inverness

Our coasts are changing

Coastal impacts such as flooding, erosion, and storm events are intensifying with climate change. But our coasts are also home to roughly two fifths of the world's population. We need to know how coasts have been changing in the past and present if we are to make more informed management decisions, and help vulnerable communities become more resilient to the impacts of future coastal change.

VedgeSat: a Python tool for satellite-derived veg edges

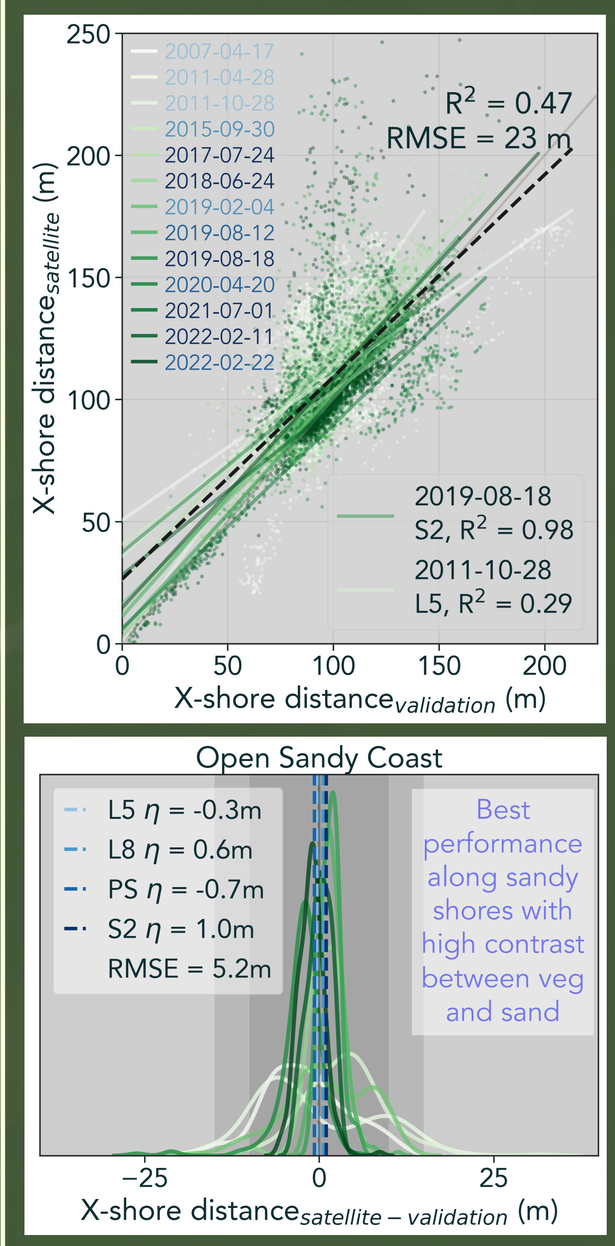
User Requirements
- Date Range
- Area of Interest
- Platform (Landsat 5/7/8/9, Sentinel-2, PlanetScope)

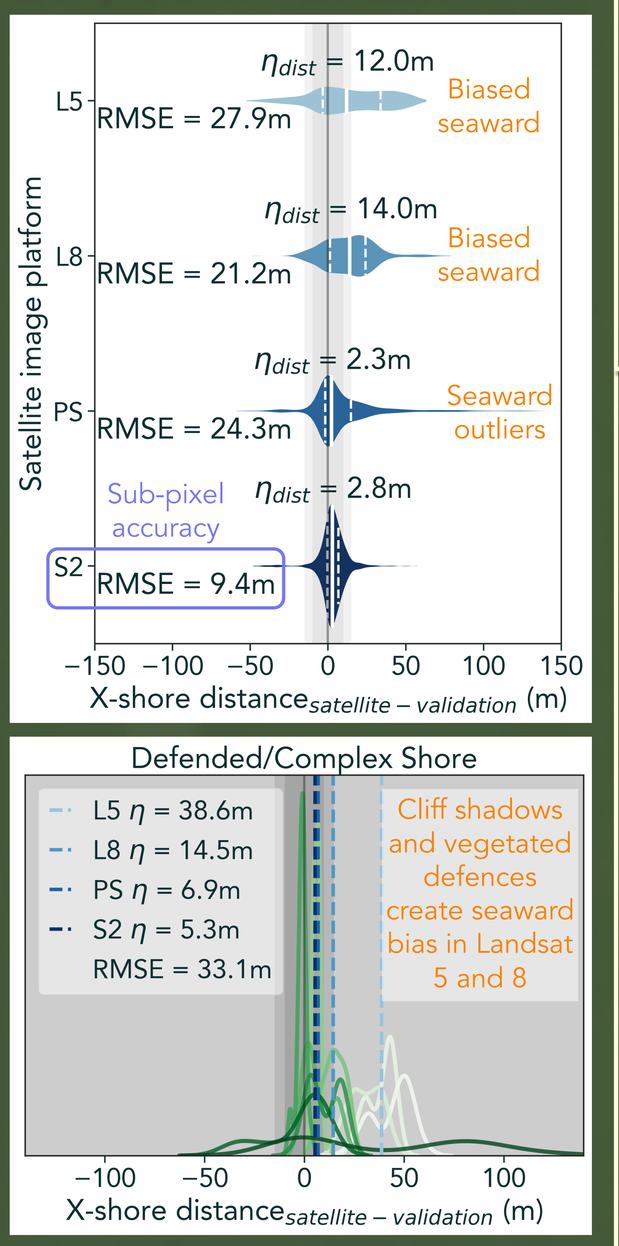
Satellite Image Pre-processing
- Cloud-based image metadata (Google Earth Engine, geemap)
- Clouds masked, image bands downsampled/pansharpened to RGB

Image Classification
- Multispectral band indices generated (NDVI, NDWI, RB-NDVI, NGRI, SAVI)
- Trained neural network classifies 'veg' or 'non-veg' pixels

Thresholding & Contouring
- Weighted Peaks finds optimum NDVI threshold between pixel classes
- Marching Squares extracts sub-pixel contour along veg edge

Results: Sentinel-2 and sandy shores work best

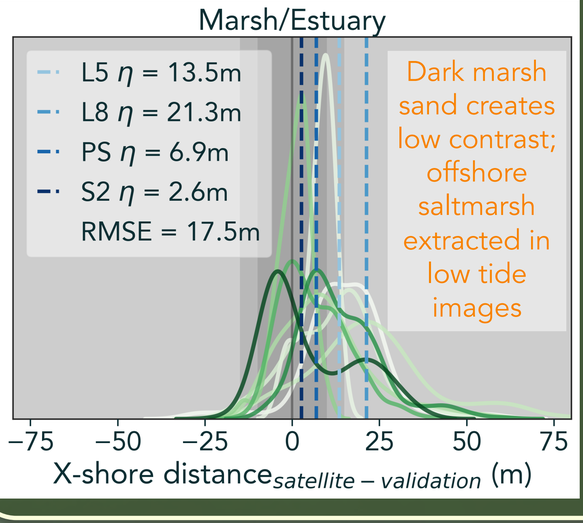




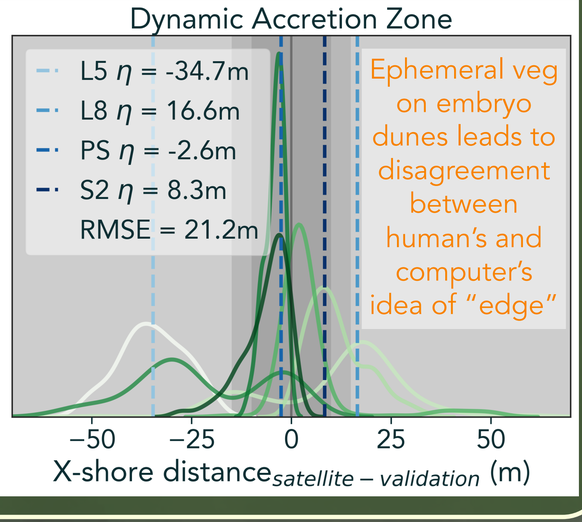
Open Sandy Coast

Defended/Complex Shore

Marsh/Estuary



Dynamic Accretion Zone



What coastal information are we missing?

Traditionally, mapping coastal change manually on the ground has been costly, laborious and logistically difficult.

The resulting data is sparse in its spatial and temporal coverage, limited to local studies on irregular timelines.

Coastal change monitoring now demands repeatability, scalability and applicability if we are to arm decision-makers with useful data.

Multispectral satellite imagery offers near-global coverage on daily–weekly revisit times, and has been used to automatically delineate the wet-dry shoreline (or sea and land boundary).

While the shoreline position is helpful for mapping topographic and hydrodynamic change, it doesn't represent upper shoreface change and can be noisy due to its dynamism and tidal bias. Vegetation edges can offer a more stable coastal change metric.

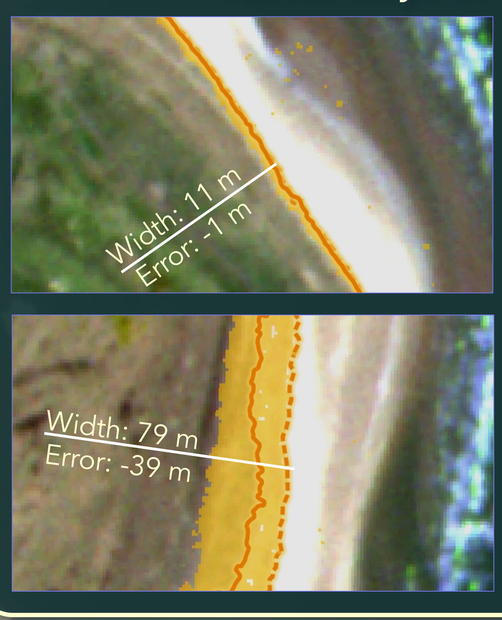
Validating VedgeSat

- The tool is partially inspired by *VEdge_Detector* (*Rogers et al., 2021*) and builds upon *CoastSat* for extracting shorelines from satellite imagery (*Vos et al., 2019*), improving on data management and platforms available.
- *VedgeSat* was tested on the site of St Andrews and the Eden Estuary in Scotland. Satellite image resolutions tested range from 15m down to 3m.

13 ground-truth surveys were collected and matched to the next available satellite images from Landsat 5 & 8, Sentinel-2 and PlanetScope.

The cross-shore distance between each satellite-derived veg edge and its matching ground survey was measured for ~1700 evenly spaced transects.

Novel ways of classifying the coast



- Each classified satellite image shows an overlap in NDVI values representing 'veg' and 'non-veg' classes. This overlap region was also mapped out with the classified pixels to produce a veg transition zone.
- The zone is a way of marking an area of uncertainty around the extracted edge, where both veg and non-veg are classified. But if we compare the width of the transition zone across different transects, we see a pattern where historically eroding dune edges have a narrower transition zone, and accreting areas with new dune grass growth have a wider transition from veg to sand.

The seeds are sown; how do we branch out?

By using freely available satellite imagery with near-global coverage, dense timeseries of coastal vegetation change can be built, even in historically data-poor areas. While some environments are more complex, using a standardised model means less human error in deciding where the veg edge lies. Additional metrics such as the vegetation transition zone allow for a more nuanced understanding of coastal vegetation processes. Combining metrics like the veg edge with shorelines also paints a broader picture of coastal change across the whole shoreface. Extracting these multiple metrics from single satellite-derived datasets can act as the building blocks for regularly updating, data-driven modelling of future coastal change.

Try *VedgeSat* for yourself! Available on Github

References and Acknowledgements

Vos, K., Splinter, K. D., Harley, M. D., Simmons, J. A., & Turner, I. L. (2019). CoastSat: A Google Earth Engine-enabled Python toolkit to extract shorelines from publicly available satellite imagery. Environmental Modelling and Software, 122, 104528. https://doi.org/10.1016/j.envsoft.2019.104528

Rogers, M. S. J., Bithell, M., Brooks, S. M., & Spencer, T. (2021). VEdge_Detector: automated coastal vegetation edge detection using a convolutional neural network. International Journal of Remote Sensing, 42(13), 4809–4839. https://doi.org/10.1080/01431161.2021.1897185

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