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Pixel-based coastal change detection

Benedict Collings, Murray Ford, and Mark Dickson

School of Environment, University of Auckland, Auckland, New Zealand (ben.collings@auckland.ac.nz)

Satellite earth observation data has been frequently applied to monitor shoreline change at very large geographic scales. Techniques focus on the extraction of the instantaneous waterline boundary, a shoreline proxy that can be extracted from publicly available multispectral satellite data with sub-pixel accuracy. Interpreting coastal change through this proxy can be uncertain as the position of the waterline is dynamic, a function of beach gradient and constantly fluctuating marine processes, and might not capture information of the full spectrum of drivers influencing change for a given section of coast.

Satellite data is acquired in raster format and there is useful information stored in each pixel across the entire coastal zone. Applying per-pixel change detection techniques could offer further insights to the role of drivers of coastal change beyond a vectorised land-water boundary. This paper describes a new method for monitoring coastal change at large geographic scales with public satellite remote sensing data through pixel-based change detection. The first step is the classification of pixels into specific coastal landcover classes. This is challenging at large scales owing to complex and diverse physical environmental characteristics. A methodology was developed and applied to New Zealand's coastline, identifying 9 landcover types including sedimentary coast. A combination of Sentinel multispectral and synthetic-aperture-radar data were used to derive composite imagery for 2019 using Google Earth Engine cloud computing platform. This was classified using a set of hierarchical rules and machine learning in a Python programming environment. This was validated nationally against high-resolution aerial photography and commercial satellite imagery. This produced a coastal specific landcover classification from which per-pixel change detection techniques can be applied. Overall accuracy was 86.38% and exceeded 90% when normalised by class area.

The outputs and code are available, and the framework has been designed to work with a range of earth observation datasets and can be applied to other regions around the world. Ongoing work includes implementing a framework to assess long-term change, at the coast in New Zealand. By investigating how specific coastal landcover types are changing, useful information can be acquired to better interpret drivers of coastal change and the impacts on coastal geomorphology at large geographic scales.

Keywords: Satellite Remote Sensing, Multispectral, Synthetic Aperture Radar, Landcover classification, Change detection, Coastal change.