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VEdge_Detector: Automated coastal vegetation edge detection using a convolutional neural network

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Coastal communities, land covers and intertidal habitats are vulnerable receptors of erosion, flooding or both in combination. This vulnerability is likely to increase with sea level rise and greater storminess over future decadal-scale time periods. The accurate, rapid and wide-scale determination of shoreline position, and its migration, is therefore imperative for future coastal risk adaptation and management. Developments in the spectral and temporal resolution and availability of multispectral satellite imagery opens new opportunities to rapidly and repeatedly monitor change in shoreline position to inform coastal risk management decisions. This presentation discusses the development and application of an automated tool, VEdge_Detector, to extract the coastal vegetation line from high spatial resolution (Planet's 3 – 5 m) remote sensing imagery, training a very deep convolutional neural network (Holistically-Nested Edge Detection) to predict sequential vegetation line locations on annual/decadal timescales. The VEdge_Detector outputs were compared with vegetation lines derived from ground-referenced positional measurements and manually digitised aerial photographs, revealing a mean distance error of <6 m (two image pixels) and > 84% producer accuracy at six out of the seven sites. Extracting vegetation lines from Planet imagery of the rapidly retreating cliffed coastline at Covehithe, Suffolk, UK identified a mean landward retreat rate >3 m a^{-1} (2010 - 2020). Plausible vegetation lines were successfully retrieved from images of other global locations, which were not used to train the neural network; although significant areas of exposed rocky coastline proved to be less well recovered by VEdge_Detector. The method therefore promises the possibility of generalising to estimate retreat of sandy coastlines in otherwise data-poor areas, which lack ground-referenced measurements. Vegetation line outputs derived from VEdge_Detector are produced rapidly and efficiently compared to more traditional non-automated methods. These outputs also have the potential to inform upon a range of future coastal risk management decisions, including hazard and risk mapping considering future shoreline change.