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Exploiting satellite technology and machine learning to describe and predict hazardous shoreline change

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East Anglia is particularly vulnerable to sea level rise, increases in storminess, coastal erosion, and coastal flooding. Critical national infrastructure (including Sizewell's nuclear power stations and the Bacton gas terminals), population centres close to the coastal zone (> 600,000 in Norfolk and Suffolk) and iconic natural habitats (the Broads, attracting 7 million visitors a year) are under threat. Shoreline change, driven by complex interactions between environmental forcing factors and human shoreline modifications, is a key determinant of coastal vulnerability and exposure; its prediction is imperative for future coastal risk adaptation.

An automated, python-supported, tool has been developed to simultaneously extract the water and vegetation line from satellite imagery. PlanetLab multispectral optical imagery is used to provide multi-year, frequent (up to fortnightly) images with 3-5m spatial resolution. Net shoreline change (NSC) has been calculated along multiple stretches of the East Coast of England, most notably for areas experiencing varying rates of change in front of, and adjacent to, 'hard' coastal defences. The joint use of water and vegetation line proxies enables calculation of inter-tidal width variability alongside NSC. The image resolution used provides new opportunities for data-led approaches to the monitoring of shoreline response to storm events and/or human shoreline modification.

Artificial Neural Networks (ANN) have been trained to predict shoreline evolution until 2040. Early results are presented, alongside considerations surrounding data pre-processing and input parameter selection requirements. Training data comprises decadal-scale shoreline positions recovered using automated shoreline detection. Shoreline position, alongside databases of nearshore bathymetry, sea defences, artificial beach renourishment, nearshore processes (wave and tide gauge data, meteorological fields), combined with land cover, population and infrastructure data act as inputs. Optimal input filtering and ANN configuration is derived using hindcasts.

The research is timely; ANN predictions are compared with the Anglian Shoreline Management Plans (SMPs), which identify locations at greatest risk and assign future risk management funding. The findings of this research will feed into future revisions of the plans.