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Investigating the resilience of coastal ecosystems to changes in climate and land management

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Abstract

Liverpool Bay, in the eastern Irish Sea, receives inputs from numerous rivers draining agricultural land and large population centres. Inorganic nutrient concentrations are elevated in the region with respect to thresholds set under the Water Framework Directive and OSPAR assessment frameworks, and nitrogen to phosphorous ratios have steadily increased over the last 25 years. Changes in the phytoplankton community structure have been observed, with potential negative impacts on the marine food web.

In this study we used a combination of remote sensing, catchment and coastal modelling and in situ water quality monitoring data to determine the impact of river plumes on the coastal ecosystem under current day conditions and altered climate and land use scenarios. The current spatial extent of the river plumes was determined by deriving and mapping the Forel Ule colour scale, as determined from Sentinel-3 satellite imagery, and application of a high-resolution FVCOM coastal model. Seasonal variability in the river plume extent and associated water quality was observed, corresponding to changes in the river discharge.

A SWAT catchment model was used to simulate the impact of changing land use (as currently being considered under the Environmental Land Management Scheme in the UK) on nutrient and sediment loads from river catchments into the coastal zone of Liverpool Bay. Modelled conversion of agricultural grasslands to transitional woodland and the expansion of existing wetlands through conversion of agricultural grasslands both showed potential for reducing the impact of agricultural activities on riverine water quality.

The tools developed in this study facilitate an integrated assessment of catchment to coastal ecosystem changes from anthropogenic pressures. The framework presented will allow us to better understand, measure and advise on the cumulative impacts of changes in climate and land use on coastal and marine ecosystems.

Keywords

coastal, river, nutrients, plume