

For coastal communities, cliff erosion can be a constant threat so sea-level rise caused by global warming can only make matters worse — or can it? **Steve Pearson** and **John Rees** analyse the impact of future climate change and management scenarios.

Coastal effects of climate change

The threat of increased rates of coastal erosion over the next century is of concern to scientists, policymakers and the general public, especially with the expectation of increased rates of sea-level rise and increased storm activity. As well as assisting with the prediction of social implications of land loss, increasing our understanding of cliff erosion is of great importance in wider coastal science. Hence, tools are needed to help predict future shoreline recession. A Tyndall Centre-funded project, led by the BGS and involving partners from the Universities of Newcastle, Southampton and Cambridge, has recently completed a project to provide a tool to predict future coastal change in response to changes in climate and coastal management options.

Confidence in the performance of the model was provided by validating it against historical maps, with shoreline positions being digitised from a series of maps covering a time period of more than a century. These showed a good match over the majority of the coastline, and enabled future predictions to be made for the period from 2000 to 2100 under combined climate change and management scenarios provided by the University of Southampton and Tyndall Centre. The integrated analysis of coastal system behaviour with potential impacts of different climate change and

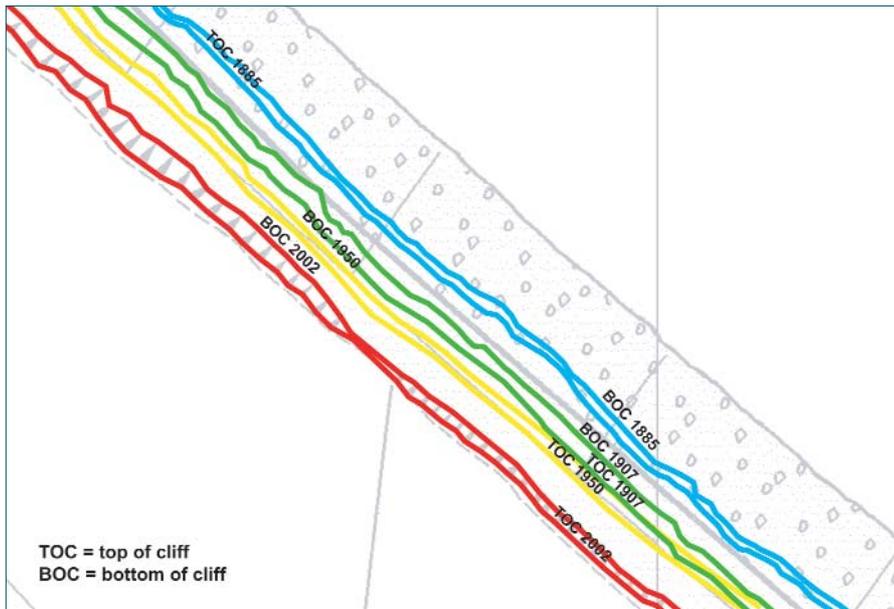
The project developed a regional-scale model of coastal erosion and shore profile evolution along a fifty-kilometre length of soft, erodible, cliffed coast between Weybourne and Happisburgh, north-east Norfolk. It covers the period from 2000 to 2100, when this coast will be subject to increases in sea level and storminess. The model is the first, at a regional scale, to take into account combined scenarios of sea-level rise, changing wave climate and coastal management.

locations along the coastline. It provides predictions of shore profile and cliff plan-shape, which are of use in strategic coastal zone planning.

In order to predict shoreline recession effectively, it is necessary to represent the processes involved, especially where the shoreline responds in a non-linear fashion due to variations in geology or changes in coastal protection strategy. A process-based Soft Cliff and Platform Erosion model (SCAPE) was developed by project partners at the University of Newcastle. The model is based on BGS data describing the volume and character of sediment input from the cliffs, the thickness of the beach sediments and altitude of the shore platform at selected



Rapidly eroding cliffs south of Happisburgh, north-east Norfolk. Erosion has accelerated in this area following the removal of coastal defences.



Digitised former shoreline positions 1885–2002, taken from historical maps. This section of coast is undergoing typical linear recession.

management scenarios has been a major innovation of the project.

“ the threat of enhanced rates of coastal erosion over the next century is of concern to scientists, policymakers and the general public, especially with the expectation of increased rates of sea-level rise and increased storm activity ”

It is generally expected that future climatic changes will increase rates of soft-cliff erosion through accelerated rates of sea-level rise and changes in wave conditions. However, this was shown not to be the case for all sectors of the modelled coastline. Instead there was considerable complexity in the plan-shape response under both natural and engineered coastal management scenarios. The impacts of changing climate and sea-level rise on sediment transport patterns were crucially important. Increased rates of erosion in up-drift areas provided down-drift areas with additional sediment, bulking beaches and decreasing rates of shore-platform lowering and hence cliff recession. The project has been able to model the historical development

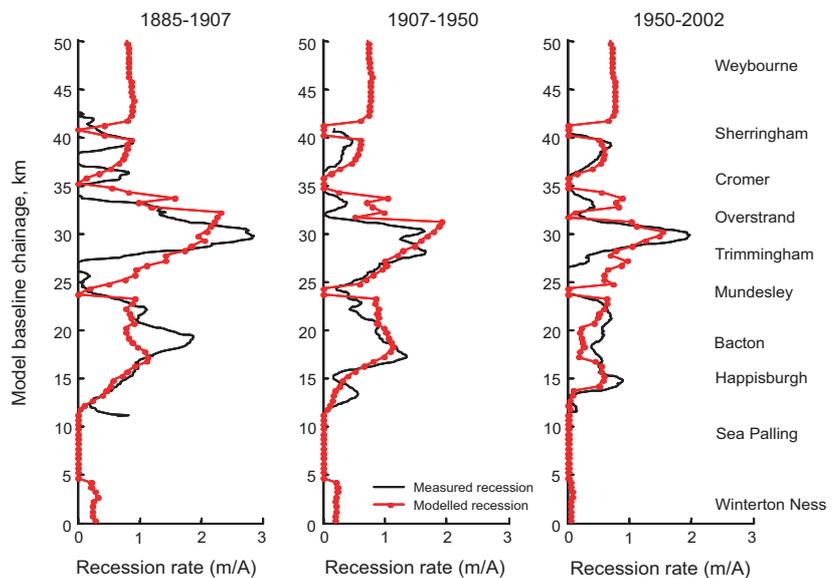
of the north Norfolk coast, and to predict future changes under a range of management scenarios.

It was not the intention of the modelling to deal with all the processes within the interacting system at a local, or site level of detail. Nevertheless, by representing the main regional interactions that determine the long-term behaviour of the system, the response to changes, whether due to climate change or to coastal management, was able to be simulated

with some degree of confidence. The models have developed an understanding of the cliff system as one that is strongly influenced by sediment transport rate, with recession rates in particular areas strongly dependent on both current and historical coastal management decisions.

The modelling approach offers considerable scope for addressing questions such as the extent to which relative sea-level rise is controlling soft shoreline recession; and for determining the relative importance of shore-platform lowering under sea-level rise and changing wave climates. Its application at a regional scale has provided an opportunity to assess coastal response over the spatial and temporal scales that are of particular concern to coastal managers. Outputs from the modelling were linked with a flexible geographic information system tool (SCAPEGIS), developed by partners at the University of Southampton, to provide visualisation and help with the interpretation of the model results. The GIS also allows analysis with other datasets such as land use and building location for impact evaluation, and hence could be used in shoreline management and cliff-top land-use planning.

For further information, contact:
Steve Pearson, BGS Keyworth,
 Tel: +44(0)115 936 3377
 e-mail: spearson@bgs.ac.uk



Modelled versus measured cliff-plan shape recession for the period 1885–2002.