Defra / Environment Agency Flood and Coastal Defence R&D Programme

Technical Summary FD2303

Coastal Defence Vulnerability 2075

Background to R&D project

Our climate is changing and these changes may produce considerable impacts on the coast. This report assesses the possible changes in coastal defence vulnerability (to overtopping or erosion) caused by global climate change over the next 75 years. The effects of climate change on waves and water levels were estimated using two thirty-year time slice simulations of a global climate model. The first simulation represented present day conditions and the second represented a future scenario, centred on 2075. The climate model produced meteorological forcing that was used to drive a wave hindcasting model and a tide-surge model. Hence wave and water level time series were derived for the present-day and future scenarios.

Three methods of estimating the changes in coastal defence vulnerability between now and 2075 were used. The methods use present and future simulations to calculate:
1. Coastal defence response to combined waves and water levels, using numerical models.
2. Longshore drift rates, to compare annual mean drift rates and their variance.
3. Statistical analysis of coastal defence response functions, derived from empirical equations.

Results of R&D project

The results were used to estimate changes in coastal defence vulnerability due to climate change at five test regions around the English and Welsh coastline. The results produced are not site specific but rather generic. Simplified bathymetries and typical structure types were used in an effort to provide results that are broadly representative of stretches of coastline, rather than specific locations. The results have also been driven by a single realisation of a single climate change scenario, run on a single climate model. Due to the variability between models and the range of scenarios considered possible by the IPCC, the modelled predictions do not give a definitive view of the changes that will occur and the results should be interpreted with caution.

Changes in wave climate around the UK are predicted to be small (generally less than 5% for wave height) and the increase in future extreme water levels will generally be within 20% of the increase in mean sea level. Sea level rise of 0.35m will cause average increases in overtopping volume of between 50% and 150%, depending on structure type, location and modelling approach and if present day defences are unchanged in 2075. If the observed coastal steepening continues it will increase overtopping rates by a further 15%, approximately. The inclusion of sea level rise predictions in design calculations should account for the majority of the predicted change in wave impact on coastal structures.

A formula was presented for the increase in crest elevation necessary to maintain present day overtopping rates when sea levels rise. It is based on well-established empirical overtopping formulae and shows that crest levels need to be raised by more than sea level rise to achieve this. Scour and damage potentials may increase or decrease as a result of climate change, depending on how the partial standing wave velocities at the coastal structure change. The average changes

in scour potential were 16% for the seawall and less than 2% for the embankment and shingle beach.

In most cases the simulated future mean annual longshore drift rates were slightly greater than the present day rates (by an average of around 15%) but the standard deviations were all lower (also by around 15%). The greater volumes of material that may need to be re-nourished, but reduced inter-annual variability, would impact on the economic viability of beach nourishment and may necessitate a review of management options. However, as there is great uncertainty in the prediction of longshore transport, the work tends to show that future changes are unlikely to be greater than current levels of uncertainty and these should be considered in the normal course of sensitivity testing.

Qualitative and quantitative differences in future changes in vulnerability were found between the five sites examined around the coastline of England and Wales. This is because the sites have different tidal ranges, wave climates and surge levels. Moreover, the parameters have different joint probabilities at different sites. Thus results from one site cannot be transferred directly to other sites and individual assessments must be made for specific sites. Nonetheless, the modelled scenarios give an indication of the general extent of changes in coastal defence vulnerability that can be expected in the next 75 years.

R&D Outputs and their Use

The principal output is the R&D Technical Report, which details the above results. The project has assessed the effects of climate change on the vulnerability of coastal defences between the present day and 2075. The results have been derived using a single realisation of a single climate change scenario, run on a single climate model. Due to the variability between climate models and the range of scenarios considered possible by the IPCC, the modelled predictions do not give a definitive view of the changes that will occur and the results should be interpreted with caution.

This R&D Technical Summary relates to R&D Project FD2303 and the following R&D output:

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The above outputs are available on the Defra website:
http://www2.defra.gov.uk/research/project_data/default.asp