IMPACTS OF CLIMATE CHANGE ON COASTAL FLOODING

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Executive Summary

Storm surges are short-lived increases in local water level, above that of the tide. They are driven by low atmospheric pressure and winds, typically in shallow seas. When they occur at or near a high tide large surges are liable to cause flooding. Previous extreme surge events, such as that during Winter 1953, have led to a considerable loss of life and damage to property around the coastline of the southern North Sea.

Future extreme flood events may become more common as a result of increases in local relative time average sea level or altered atmospheric storminess, which could change the storm surge characteristics. The predictions presented in the UKCIP02 analysis show the increase in the height of a flood event with a 50-year return period might be more than 1m during the 21st century at some locations. Most locations were predicted to experience a smaller increase. Comparison of the UKCIP02 results with other studies suggests that the pattern of increases in storm surge height is currently very uncertain and our confidence in being able to accurately predict the changes in extreme water level events is low. Research is underway to improve this situation by using ensembles of model simulations to better quantify the range of uncertainty.

Level of Confidence

Low

Key sources of Information

See Supporting Evidence

Supporting Evidence

Extreme sea level

Storm surges are short lived increases in local water level, relative to the tide, typically occurring in shallow seas. Positive surges are of most concern, representing an increase in water level and an increased likelihood of flooding. They are driven by low atmospheric pressure and strong winds, and water levels can be enhanced locally by the coastal topography, which sometimes leads to a funnelling effect (Wells, 1997).

The damage resulting from storm surges is greatest when they occur at or near a high tide. Previous extreme surge events, such as that during the night of 31st January/1st February 1953, have led to a considerable loss of life and damage to property around the coastline of the Southern North Sea. In the United Kingdom the 1953 surge event killed an estimated 307 people in the counties of Lincolnshire, Norfolk, Suffolk and Essex. In Holland the death toll reached 1835.

There is evidence from tide gauges around the United Kingdom coastline of the long term rise in time mean sea level. However, extreme sea levels appear to change in a similar way and there is no clear evidence of a long term trend in the storm surge height (Araujo *et al*., 2002). Our ability to detect such a trend is made difficult by the limited number of very long tide gauge records with a high enough sampling frequency, and the existence of sizeable long period natural variability, as seen in a long Liverpool record analysed by Woodworth and Blackman, 2002.

During the 21st century the characteristics of extreme flood events are expected to change due to: the increase in time average sea level, the expected changes in atmospheric storminess (which alter the storm surge component) and local vertical land movements. The first two components are likely to be driven by future human induced changes in the climate but in the UK the final term is mostly due to the long term natural response of the system to the shrinkage of land ice since the end of the last ice age. A number of recent studies (von Storch and Reichardt, 1997; Flather *et al*, 2001; Lowe *et al*., 2001; Debernard *et al*., 2002; Lowe and Gregory, 2005; Woth, 2005; Woth *et al*., 2006) have attempted to estimate the change in the storm surge component using computer models of the atmosphere and either models of the shelf seas or a statistical downscaling technique to estimate the surges. Lowe and Gregory (2005) showed that there is a significant spread in the predictions of 21st century storm surge results and a research priority is to quantify the range of this uncertainty.

When the projected future changes in storm surges are combined with those in time average sea level and vertical land movements an estimate of the change in the height of extreme sea level events can be obtained. Figure 1 shows the predicted changes under SRES A2 and B2 emission scenarios, as presented in United Kingdom Climate Impacts Programme 2002 report

(UKCIP, 2002). An alternative way to express these results is as the change in the frequency of a given size of event seen from the land. At Immingham, on the east coast of the UK, an event with a return period of around 150 years in the present day climate is estimated to occur on average more frequently than once per decade by the end of the 21st century under an SRES A2 emissions scenario. The confidence in the predictions of changes in sea level extremes at any particular location are currently low. A major program of work is being undertaken to produce a new set of extreme water level projections for the 21st century and will be delivered as part of UKCIP next.

Figures

Figure 1. Simulated change in the height (m) of a storm surge with a 50-year return period during the 21st century under SRES A2 scenario. The results were produced with the Hadley Centre climate models and POL storm surge model.

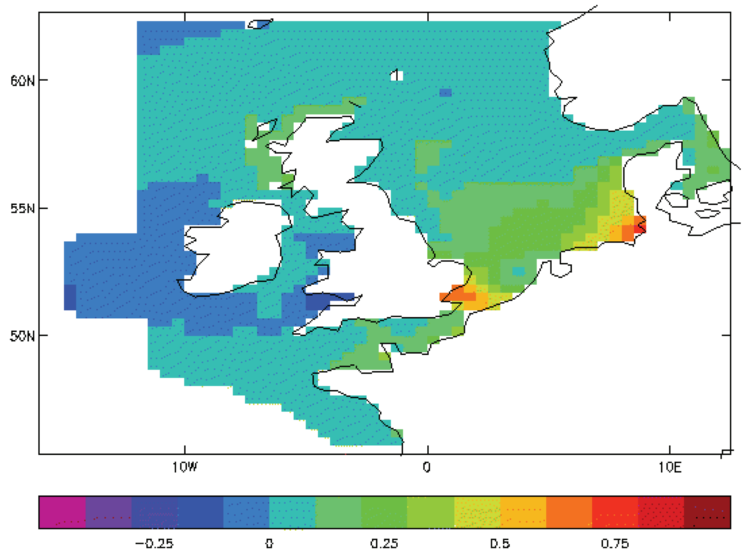
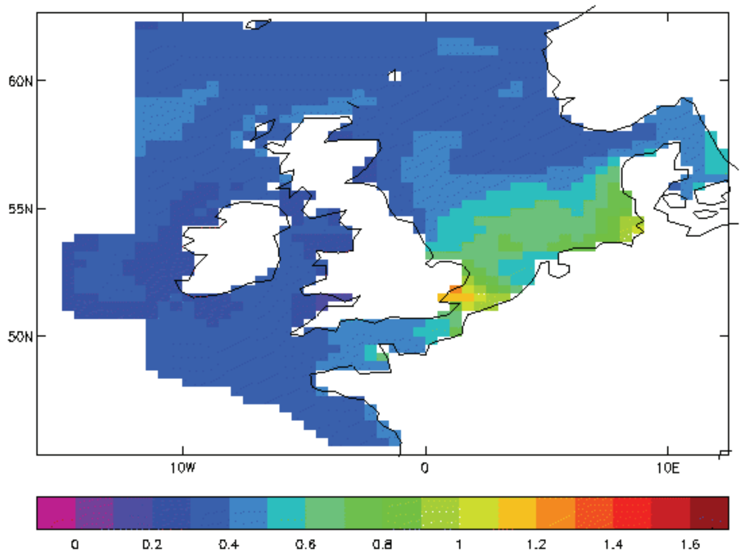


Figure 2. Simulated change in the height (m) of extreme water levels (measured relative to the present day tide) with a 50-year return period during the 21st century under SRES A2 scenario. The results include changes in storm surges, a rise in time average sea level and vertical land movements.



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