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Coastal Environmental Change
During Sea-Level Highstands:
A Global Synthesis with implications
for management of future coastal change

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Shennan I.*

Relative sea-level change in Great Britain: observations, tidal and glacio-hydro-isostatic modelling and the broader implications for sea-level research

*Environmental Research Centre, Department of Geography, University of Durham, Durham, DH1 3LE, U.K.,fax +44 191 334 1801, E-mail ian.shennan@durham.ac.uk

Abstract

A significant increase over the last decade in the number and distribution, spatially and through time, of reliable observations of past relative sea level in Great Britain has attracted the attention of those modelling the glacial isostatic adjustment (GIA) processes. Although small in global terms, the ice sheet that covered much of the British Isles at the Last Glacial Maximum (LGM) was large enough for GIA processes to produce vastly contrasting relative sea level (RSL) changes at different locations. Due to the size of the British Isles LGM ice sheet the glacial isostatic component of RSL change is highly sensitive to shallow earth structure, especially lithospheric thickness and the viscosity of the upper mantle. This is in contrast to, and independent from, rheological constraints derived from regions beneath the Fennoscandia and Laurentide ice sheets where RSL changes show more sensitivity to deeper earth structure.

Despite improvements in GIA models, coupled with models of tidal range changes during the Holocene, there remain some significant disagreements between model predictions and RSL observations. At the national scale the models typically underestimate the spread of observations, both for the maximum RSL values, from sites under thickest ice in Scotland, and for minimum RSL values, from sites bordering the southern North Sea. Until the reasons for these discrepancies are solved, the best estimates of current relative land- / sea-level change come from analysis of the observations, supplemented with estimates from models where there is a good fit. Analysis of more than 1200 sea level index points and 180 limiting dates for 52 locations in Great Britain over the last 16kyr provides estimates of late Holocene land-level changes (negative of relative sea-level change). Maximum relative land uplift occurs in central and western Scotland, ~1.6mm/yr, and maximum subsidence in southwest England, ~1.2mm/yr. Sediment consolidation, arising from autocompaction as the sediment accumulates and from land drainage, increases the subsidence in areas with thick sequences of Holocene sediments, with an average effect equivalent to an extra ~0.2mm/yr land subsidence, but more in parts of southeast England, 0.5 – 1.1mm/yr.

Modelled changes in tidal range during the mid to late Holocene in eastern England suggest that the calculated rate of land subsidence is overestimated unless such changes are quantified. The effect is most significant, equivalent to ~0.4 – 0.6mm/yr, for large coastal lowlands, the Humber and Fenland, that were tidal embayments during the mid to late Holocene.

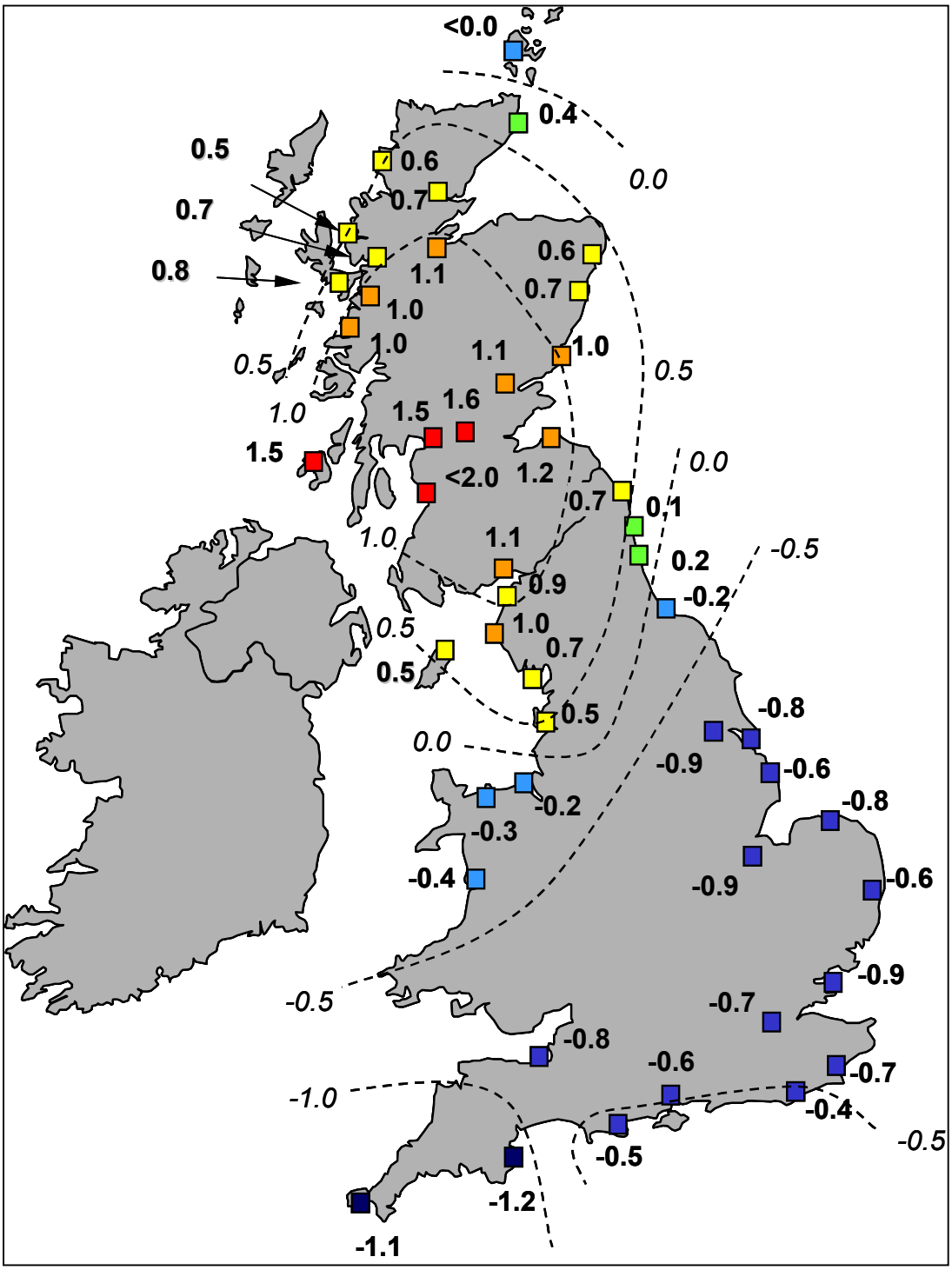

Figure 1. Late Holocene relative land / sea level changes, mm/yr, in Great Britain, positive values indicate relative land uplift or sea-level fall, negative values are relative land subsidence or sea-level rise (after Shennan and Horton, 2002).

References

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