Absolute Fixing of Tide Gauge Benchmarks and Land Levels:

Measuring Changes in Land and Sea Levels around the coast of Great Britain and along the Thames Estuary and River Thames using GPS, Absolute Gravimetry, Persistent Scatterer Interferometry and Tide Gauges

Technical Summary: FD2319

Joint Defra / EA Flood and Coastal Erosion Risk Management R&D programme

Background to R&D project

Since 1997, Defra and the Environment Agency have been funding research to measure long term changes in land and sea levels around the coast of Great Britain and along the Thames Estuary and River Thames. The aims of these measurements are to obtain direct estimates of current changes in land level on the scale of millimetres per year, in a stable reference frame, both at tide gauges and at other specific locations, and to use these to obtain estimates of changes in sea level (decoupled from changes in land level). Such measurements represent a major challenge and the research carried out has essentially included three complementary monitoring techniques: the Global Positioning System (GPS); Absolute Gravimetry (AG); and Persistent Scatterer Interferometry (PSI) and an investigation of how best to combine the information from these to meet these aims.

From 2003 to 2006, the research work was carried out as a national study and a regional study. For the national study, continuous GPS (CGPS) stations have been established at ten tide gauges around the coast of Great Britain and AG measurements have been made at three of these. For the regional study, episodic GPS (EGPS) data from a network of stations in the Thames Region and PSI data for hundreds of thousands of persistent scatterer (PS) points in the Thames Region have been analysed and the changes in land level interpreted using various geoscience data sets.

Results of R&D project

The Technical Report presents the results from all three monitoring techniques, including the estimates and uncertainties obtained for the changing land and sea levels.

The results for the national study demonstrate how:

- the combined AG and CGPS estimates of changes in land level
  - correlate with long term geological and geophysical evidence for the ‘tilt’ of Great Britain, which have Scotland rising by 1 to 2 mm/yr and the South of England subsiding by up to 1.2 mm/yr.
  - are in general agreement with long term geological and geophysical evidence, in terms of whether there is subsidence or uplift at individual stations, although in some cases there are differences which are of the same order as the changes in land level themselves and are, therefore, significant in relation to any assumptions made regarding future changes in land level.
- when the combined AG and CGPS results are considered along with tide gauge estimates of changes in sea level, our ‘best’ current estimate for the average change in sea level (decoupled from changes in land level) around the coast of Great Britain over the past few decades/past century suggests that sea level has risen by 0.9 to 1.2mm/yr.

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The results for the regional study demonstrate how:

- when the AG and CGPS estimates of changes in land level from the national study are combined with the EGPS and PSI estimates of changes in land level from the regional study, the estimates of changes in land level for the Thames Region, which range from approximately 0.3mm/yr uplift to 2.1mm/yr subsidence, correlate with certain aspects of the geoscience data sets to explain the pattern of land movements observed on a regional scale.
- when the AG and CGPS estimates of changes in land level from the national study are combined with the EGPS and PSI estimates of changes in land level from the regional study and considered along with the results of a new analysis of tide gauge data
  - the estimates for the changes in sea level (decoupled from changes in land level) along the Thames Estuary and River Thames are consistent with those obtained around the coast of Great Britain.
  - our 'best' current estimate for the combined effect of changes in land and sea levels is a 1.8 to 3.3mm/yr rise in sea level with respect to the land along the Thames Estuary and River Thames over the past few decades/past century.

R&D outputs and their uses

The Technical Report explores the implications for predicting future risk from sea level rise at national and regional scales and should be of use to planners, policy makers, and those with an interest in dealing with sea level rise and coastal flood risk management.

This R&D Technical Summary relates to R&D Project FD2319 and the following R&D output:
R&D Technical Report FD2319/TR – Absolute Fixing of Tide Gauge Benchmarks and Land Levels: Measuring Changes in Land Level and Sea Level around the coast of Great Britain and along the Thames Estuary using GPS, Absolute Gravimetry, Persistent Scatterer Interferometry and Tide Gauges*.* Published April 2007.

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Defra/EA and EA TE2100 project officers: Ian Meadowcroft, Environmental Policy – Risk & Forecasting, Environment Agency, Kings Meadow House, Kings Meadow Road, Reading, RG1 8DQ. (ian.meadowcroft@environment-agency.gov.uk). Owen Tarrant, Environment Agency Thames Estuary 2100 project, Thames Barrier, Eastmoor Street, Charlton, London, SE7 8LX. (owen.tarrant@environment-agency.gov.uk).

The above outputs may be downloaded from the Defra/EA Joint R&D FCERM Programme website (www.defra.gov.uk/environ/fcd/research). Copies are also available via the Environment Agency's science publications catalogue (http://publications.environment-agency.gov.uk/epages/eapublications.storefront) on a print-on-demand basis.

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Defra Flood Management, Ergon House,
Horseferry Road, London SW1P 2AL

Tel: 020 7238 6000

Info-fm@defra.gsi.gov.uk
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