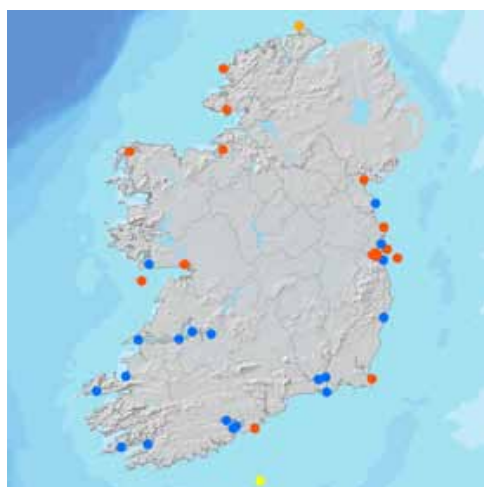


3.5 Sea Level

Ned Dwyer and Robert Devoy

All major cities in Ireland are in coastal locations subject to tides and any significant rise in sea levels could have major economic, social and environmental impacts. Estimates for the twentieth century show that the global average sea level rose at a rate of about 1.7 mm per year whilst estimates derived from satellite measurements for the period 1993 to 2012 indicate a rise of 3.18 mm per year. Sea levels are rising primarily because increasing global temperatures cause thermal expansion of the oceans as well as increasing freshwater input due to melting ice sources (e.g. glaciers and ice sheets, permafrost). An additional contributor to sea-level change, called 'isostatic glacial adjustment', has caused the north of Ireland to rise differentially as the land recovers from the loss of the huge mass of ice which covered it during the last Ice Age.

Photo: © Sean Kennedy



Map 3.5. Location of tide gauges for sea-level observation.

'Satellite observations indicate that the sea level around Ireland has risen by approximately 4–6 cm since the early 1990s.'

Measurements

Measurements of sea level rely on tide gauges which provide sea-level change relative to the land on which they lie. The longest and most reliable continuous records for Ireland are from Malin Head, Co. Donegal (orange) where a tide gauge has been in operation since 1958. A national tide gauge network (red), coordinated by the Marine Institute, is currently under development

with 17 gauges operational in 2012. Gauges are also operated by other organisations (blue) and include one deployed at the Marathon oil platform (yellow).

Sea level can also be retrieved with measurements from space-borne sensors. These sources indicate a sea-level rise around Ireland of approximately 2–3 mm per year since the early 1990s. However, satellite measurements need to be calibrated carefully, the most common method being the use of tide gauges.

Time-series and Trends

Tide gauge measurements have been made at Malin Head since 1958. However, it is difficult to access and compile a complete dataset as operation of the gauge has resided with a number of different organisations over the period. Since 2004 the Office of Public Works has been responsible for the operation of the gauge. [Figure 3.10](#) shows the monthly mean sea level as

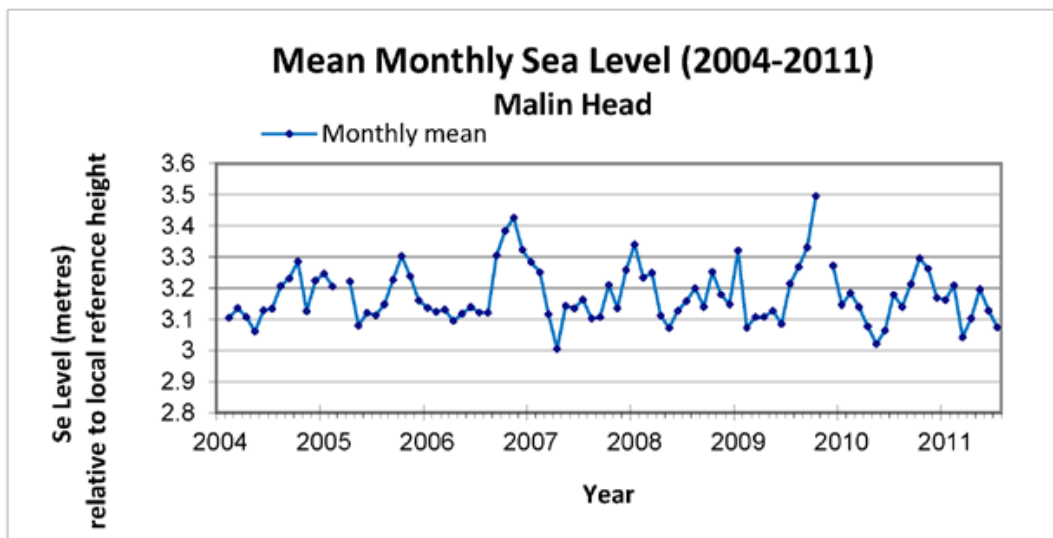


Figure 3.10. Mean monthly sea level observed at Malin Head (2004–2011).

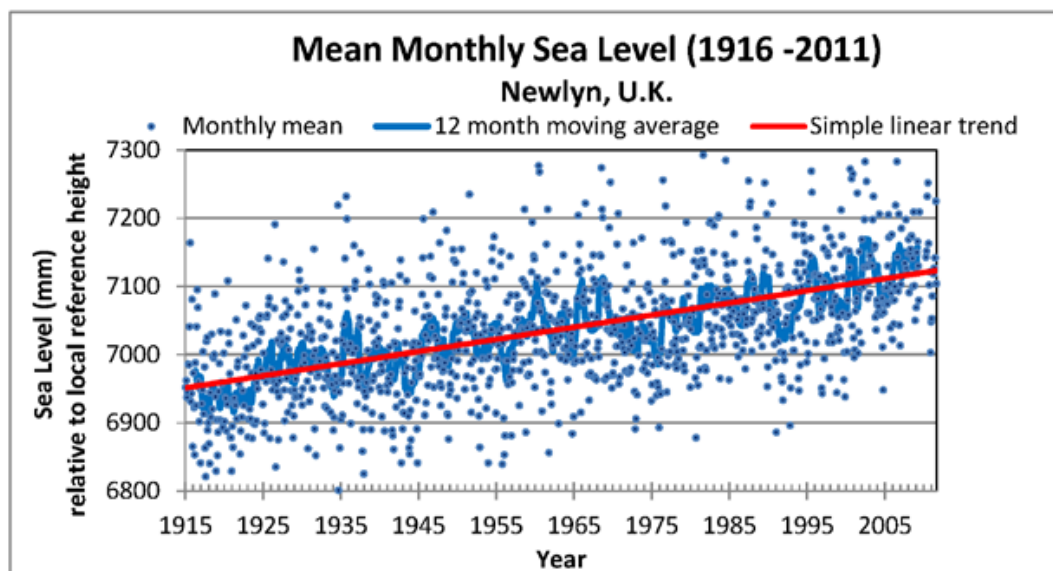


Figure 3.11. Mean monthly sea level observed at Newlyn, UK (1916–2011).

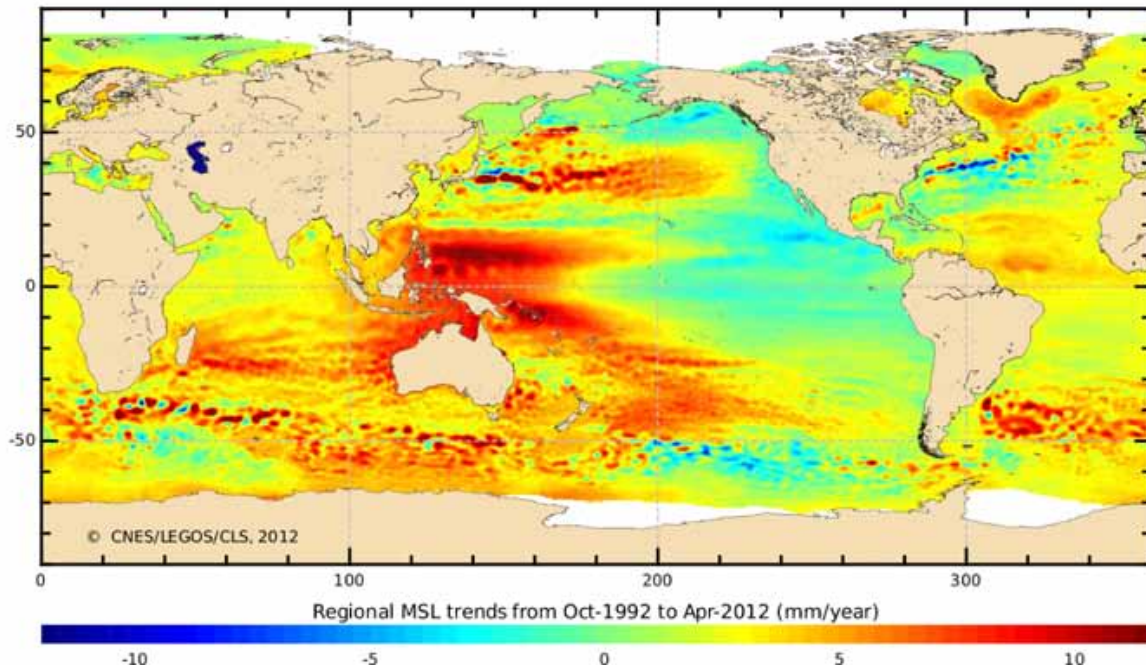


Figure 3.12. Global trends in sea level derived from satellite observations. © CLS/CNES/Legos.

derived from 15-minute measurements since 2004. As the data have not been corrected for glacial isostatic rebound, they cannot be readily used to make estimates of sea-level rise.

An extensive network of tide gauges has been in operation around the UK for many years. One of the longest time-series is available from the gauge at Newlyn in Cornwall ([Fig. 3.11](#)). Recent published analysis of these data indicates a rise in mean sea level of $1.7 (\pm 0.10)$ mm per year since 1916. This is consistent with measurements made using geological and geodetic approaches and has been attributed to climate-related change. These observations are indicative of the situation in the south of Ireland.

[Figure 3.12](#) illustrates a global map of trends in sea level derived from data from a number of satellite altimeters, including *TOPEX/Poseidon* and the *Jason* series over the period 1992 to 2012. It reflects the impact of decadal scale climate variability on the regional distribution of sea-level rise.

'Long-term support of the Malin Head and Castletownshend tide gauge measurement sites must be guaranteed.'

Maintaining the Observations

The tide gauges installed around Ireland are owned by a number of organisations including the Office of Public Works, Met Éireann, the Marine Institute, Ordnance Survey Ireland and a number of local and port authorities. The Office of Public Work has operated the gauge at Malin Head since 2004 and is upgrading the site in 2012 to address some data-quality issues. It is also installing continuous GPS capability to assess the glacial isostatic rebound on an ongoing basis. Historical data from the Malin Head tide gauge should be collated and analysed to provide a consistent record of sea-level measurements. For climate change purposes it is vital that the Malin station and Castletownshend, Co. Cork adhere to the Global Sea Level Observing System (GLOSS) standards and are maintained for long-term monitoring. Institutional support is needed to guarantee the long-term integrity of such sites.

Further Information and Data Sources

Haigh, I., Nicholls, R. and Wells, N. (2009) Mean sea level trends around the English Channel over the 20th century and their wider context, *Continental Shelf Research*, Vol. 29, pp. 2083–98.

Woodworth, P.L., Teferle, F.N., Bingley, R.M., Shennan, I. and Williams, S.D.P. (2009) Trends in UK mean sea level revisited, *Geophysical Journal International*, Vol. 176, pp. 19–30.

A special issue of *Oceanography* in July 2011 focused on sea level:
<http://www.tos.org/oceanography/archive/24-2.html>

Royal Irish Academy, *3rd Scientific Statement, Climate and Sea Level Change, Irish Committee on Climate Change, Dublin*, [http://ria.ie/About/Our-Work/Committees/Committees-for-Science/climate-change/statements-\(1\).aspx](http://ria.ie/About/Our-Work/Committees/Committees-for-Science/climate-change/statements-(1).aspx)

Tide gauge data from around the world are available from: <http://www.psmsl.org/data/obtaining/>

Irish National Tide Gauge Network:
<http://www.irishtides.ie>

Hydrometric data from the Office of Public Works is available from: <http://www.opw.ie/hydro/>

Maps and data from a range of satellite altimeter missions can be found at:
<http://www.aviso.oceanobs.com/en/news/ocean-indicators/mean-sea-level/>

Information and data from ESA's Climate Change Initiative, Sea Level project:
<http://www.esa-sealevel-cci.org/>