IMPACTS OF CLIMATE CHANGE ON BUILT STRUCTURES

Jon Rees
Centre for Environment, Fisheries and Aquaculture Science (Cefas), Pakefield, Lowestoft

Executive Summary

There are three main types of built Marine Structures around the UK – firstly, platforms and installations for the Oil and Gas sector, secondly those for the renewable energy sector and thirdly structures along the coastline to protect the coastline from extreme wave and tide events. With the current drive for renewable energy (a Government target of 20% by 2020), a whole series of Marine structures have been and will be built in the seas around the UK. For all three types of structure, the key parameters in the design for engineering calculations are sea-level rise and extreme wave heights. Indirect effects also include impacts of the structure on the seabed e.g. scour pits and the changes in the sediment transport pathways due to changes in wave heights and directions.

Sea-level rise is a key consideration for the design of coastal protection structures as well as any soft structure through managed re-alignment. A well developed observation programme has been in place for many years and produces real-time information for the Environment Agency (for the Storm Tide Forecast Service) as well as historic changes in mean sea level (UK Tide gauge network and Permanent Service for mean sea level). Predicted changes in mean sea level have been incorporated in Policy with Defra recommendations for sea-level rise such that any new coastal structure has to allow for a sea level rise of 6mm/yr.

Comparison between models and observations can be split into two categories. Firstly, the long record of sea-level observations has lead to a series of models with good intercomparisons between observations and models. Secondly, the much shorter wave records have not facilitated development of decadal wave models.

Similar to model/observation intercomparisons, the timescales and magnitudes of changes in sea level are relatively well understood, whereas waves have been historically poorly recorded around the UK and the 100 year return period currently used doesn't adequately take into account future wave climatology. However, since 2001 the WaveNet programme has developed a systematic observation programme. Other programmes including JERICHO and MAXWAVE have started to produce extreme wave data in a spatial form.

The largest driver for change on marine structures is the modification in the frequency, intensity and direction of wave heights. This has subsidiary effects on the sediment transport patterns and pathways and any indirect effects from the structure (e.g. scour pits and wakes). Other impacts include surge

currents generated either by pressure/wind forcing or from density driven effects from seasonal temperature or riverine stratification. The CRU programme STORMS, although for Forestry impacts, has implications for the frequency, intensity and duration of marine based storms.

There is a strong negative correlation between offshore renewable energy and climate change as energy is generated from renewable sources with a low carbon footprint and thus helps to reduce CO_2 emissions. Historically, sea defences have been constructed from concrete (with its high energy requirement) but a trend towards more sustainable soft defences is gaining pace.

The Oil and Gas sector is concentrated in the Southern North Sea (gas) Northern North Sea (Oil), North of Scotland (oil) and Liverpool Bay (Gas). Currently, offshore renewables are mainly concentrated in three development zones – Liverpool Bay, Greater Wash and Thames Estuary.

Level of Confidence

As the sea-level timeseries of observations and models is relatively long, confidence in the results falls in the "medium" category. The reason it does not fall in to the "high" category is that regional variations need to be fully established and short-term variation from the general trend needs to be better understood.

High quality wave height time-series are short and concentrated in relatively few locations – therefore confidence is "low".

Key sources of information

WaveNet -www.cefas.co.uk/wavenet

Jericho - http://www.satobsys.co.uk/Jericho/

MaxWave - http://w3g.gkss.de/projects/maxwave/

Satellite wave studies at NOC - http://www.soc.soton.ac.uk/JRD/SAT/Waves/GWC_pt1.htm

CEFAS renewables - www.cefas.co.uk/renewables

British Wind Energy Association - www.bwea.com/offshore/

UK National Tide Gauge network - http://www.bodc.ac.uk/data/online_delivery/ntslf/

Permanent Service for Mean Sea Level - http://www.pol.ac.uk/psmsl/

STORMS - http://www.cru.uea.ac.uk/cru/projects/storms/