Department for Environment Food & Rural Affairs
Department for Business, Energy & Industrial Strategy
Met Office Hadley Centre
Environment Agency
Working together on UK Climate Projections

Coastal cliff recession under climate change

How UKCP18 sea level rise data can be used to better understand increase in shoreline erosion

Published May 2018

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Environment Agency

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- Mapping of future shore position over the next century using draft UKCP18 data for Newlyn.
- The UKCP18 sea level rise data will look similar to UKCP09, allowing existing methods to be applied easily.
- UKCP18 will provide uncertainty estimates which will give a clearer picture of future sea level rise.
- Appropriate historic tide gauge datasets will be made available.

Shoreline Management

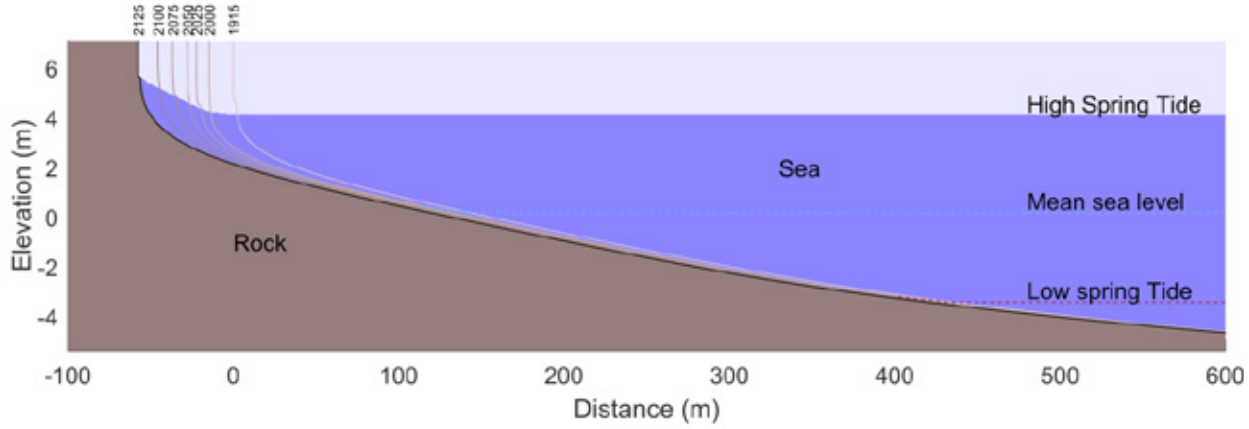
Local authorities normally take the lead in managing coastal erosion risk, under the overview of the Environment Agency (EA). The processes of this management range from local projects through broader strategic studies to regional Shoreline Management Plans (SMP) and national assessments. It is normal for such studies to include mapping of future shore position across different epochs extending 100 years into the future; occasionally this timeframe is much longer. Planning authorities will typically refer to SMP mapping to decide whether a new coastal development is allowable.

Exploiting UKCP18 data

We use observations and projections of waves, tides and coastal surge, and have been provided with draft data at the Newlyn tide gauge to analyse for this demonstration project. We anticipate using the UKCP18 sea level and storm surge data which will be available along the UK coastline.

We welcome the estimates of uncertainty that will be provided alongside the projections that are essential for understanding what is really being said about future sea level rise. Helpfully the projections will be accompanied by the appropriate historic tide gauge data set, to avoid the need for users to acquire that from another source.

Figure 1. Shore profile retreat under the upper limit of the UKCP18 RCP 8.5 sea level trajectory: 1915 to 2125. Note that this is based on draft data.



Find out more

This project is part of a portfolio of demonstration projects that have worked with the UKCP18 team to understand the implications of the next set of UK Climate Projections for their sector.

To find out more about the UKCP18 project and other demonstration projects, please visit https://www.metoffice.gov.uk/research/collaboration/ukcp

The approach

This demonstration project has run simulations of future shore erosion under climate change, using the Soft Cliff And Platform Erosion (SCAPE) modelling tool. These were driven by draft UKCP18 sea level rise projections for Newlyn, alongside data on historic sea levels, waves, tides and coastal surge. These data were drawn from different regions to produce an intentionally artificial example; neither the sea level rise trajectories nor the derived recession sensitivities should be interpreted as representative of a particular location.

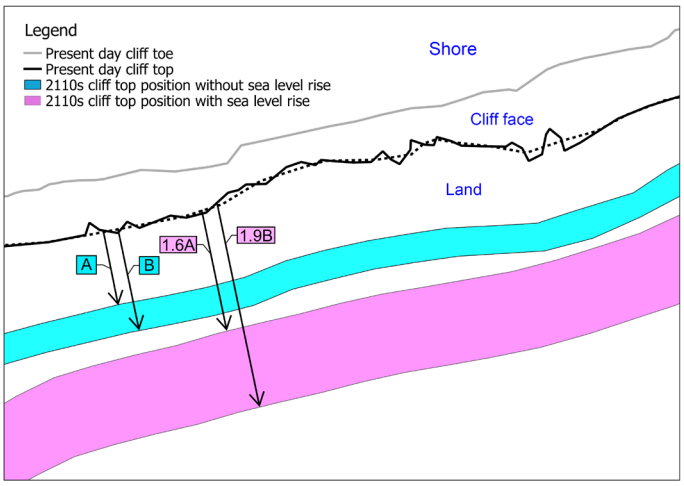


Figure 2. Mapping of future shore position (in magenta) based on the high limits of the UKCP18 RCP 2.6 and RCP 8.5 sea level rise trajectories. Note that this is based on draft data.

Firstly, a set of models was run to represent present day shore profile shape. The results were used as starting conditions for a set of 900 forecast simulations (100 for each of nine draft UKCP18 projections). This large number was adopted to explore uncertainties in wave conditions, water levels and profile shape. Example model outputs are shown in Figure 2.

The behaviour of the models was recorded, with specific attention given to the growth in cliff recession due to the accelerated sea level rise. This was described relative to 20th century recession rates. The maximum sensitivity shown for the RCP 8.5 trajectory in 100 years' time was, for example, 1.9 times the recession that would have occurred if sea levels had continued rising at their 20th century rates. This result is represented in map form in Figure 2, with the equivalent result (1.6) obtained from the RCP 2.6 trajectory.

The blue band in this figure represents the range of positions (from distance 'A' to distance 'B') that the coast might have been expected to reach in 100 years without acceleration in sea level rise. The width of this band represents the fact that cliff recession is naturally variable. The magenta band, in contrast, represents the range of positions expected when accelerated sea level rise is accounted for. It can be seen that the shore has retreated further inland, and that the band width has increased, reflecting uncertainty in future sea levels as well as variability in cliff recession processes.

Such information is crucial for landowners and organisations that need to know the future position of coastlines to understand the risk that erosion presents to communities, assets and infrastructure.

Accounting for present day climate change

The UKCP18 baseline year was adopted and sea levels before this year were assumed to follow the trend recorded by the Newlyn tide gauge (taken to be 1.68 mm/year). A method was needed to bridge the gap between this 'historic' data and the UKCP18 projections, which have a start date of 2007. Curves were fitted to each UKCP18 dataset and projected (backwards) from 2007 to 1995. In parallel, the historic trend in sea level rise was projected forward. The sea level at each year after 1995 was assumed to be the higher of the values provided by these two methods, as illustrated in Figure 3.

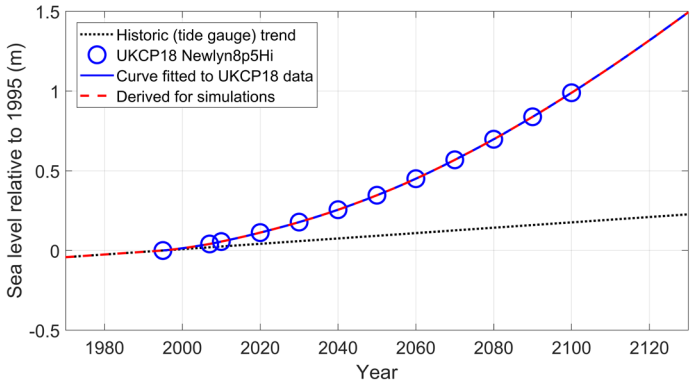


Figure 3. Example joining of tide gauge and UKCP18 sea level data (Newlyn RCP 8.5, high). Note that this is based on draft data.

What to be aware of with UCP18

- This study analyses projections up to 2100 only. However, exploratory projections up to 2300 provided by a separate Environment Agency will also be made available.
- Future wave conditions will not be updated in the UKCP18 project. Users will be guided to other relevant information.

Previous studies using UKCP09

The UKCP09 sea level rise database was one of several that have been used for this purpose in recent years. It was a particularly valuable resource for research (see for example http://www.tyndall.ac.uk/research-areas/cities-coasts) and was also used to inform the EA's guidance on sea level rise as well as the Flood and Water Management Act, which is typically used in the design and assessment of publically funded coastal defence schemes. Although very useful, the UKCP09 projections are limited in that they stop at 2100; users must use extrapolation to represent conditions beyond this date.

Acknowledgments:

This study was funded by WSP Group and the Environment Agency and was supported with data provided by the Channel Coastal Observatory, the British Oceanographic Data Centre and Sarah Bradley (University of Utrecht).