# IMPACTS OF CLIMATE CHANGE ON HARMFUL ALGAL BLOOMS (HABs)

**Philip C. Reid**
Sir Alistair Hardy Foundation for Ocean Science

## Executive Summary

There are three contrasting views on the factors contributing to an apparent global increase in HABs; 1. they are caused by increased anthropogenic input of nutrients into the sea (eutrophication); 2. the increase may be an artefact due to increased interest and reporting; and 3. any increase is related to climate change. In some areas of the north-east Atlantic, based on results from the Continuous Plankton Recorder survey (1958-2002), HABs are increasing, especially since the major hydroclimatic change (regime shift) that occurred in the mid 1980s (see plankton). The increase is not spatially homogenous and is restricted to specific habitats affected by lower salinities, such as the Norwegian Trench, and much higher temperatures, such as the German Bight. A general decrease in blooms has been recorded along the eastern coast of Great Britain. Bloom events measured by the CPR survey also show strong similarities with other phytoplankton surveys. Other non-CPR records of blooms show marked interannual and decadal variability in their occurrence with no trends. Some years stand out such as 1988 and appear to be related to an increased incursion of oceanic water from the Atlantic.

The majority of species causing HABs are dinoflagellates. These organisms grow and reproduce more rapidly with higher temperatures due to direct physiological effects and indirectly through increased stability of the water column. In some areas the latter may also be caused by lower salinities due to precipitation or river runoff and exceptionally calm conditions. Climate variability and regional climate warming appear to play a dominant role in the long-term changes in phytoplankton assemblages and biomass and HAB occurrence. Expected higher temperatures and possibly increased water clarity in the future are likely to lead to an increase in toxic and other HABs in UK waters. However, increased levels of nutrients and changing nutrient ratios in coastal waters may also be important; some of the UK regions that are likely to be more susceptible to hydroclimatic fluctuations such as the eastern Irish Sea and estuaries such as the Fal are also thought to be vulnerable to elevated nutrient concentrations. In these areas HABs may be reinforced or accentuated by anthropogenic nutrient input. There has been minimal modelling of HAB occurrence other than for *Phaeocystis* and it is not possible to evaluate the more general observed occurrence of HAB in relation to modelling at this time. While the relative contributions of climate and enhanced nutrients to HAB formation are still under debate there is now a general consensus that hydroclimatic forcing is the dominant factor.

## Level of Confidence

A moderate level of confidence on both axes. There is a great deal of evidence available on the occurrence of HABs, but these are usually records from when the blooms are already established. There is less information on the processes that lead to their development and this is why there is still a lack of consensus on the mechanisms behind bloom formation. Modelling is in consequence at an early stage of development although there is now a general consensus that hydroclimatic forcing is the dominant factor behind bloom variability. The clear linkage with temperature of the dominant group causing blooms means that the level of confidence that HABs may increase with climate change is high. Averaging all the information available suggests a moderate classification on both axes.

## Key sources of Information

Edwards M., Johns D. G., Leterme S. C., Svendsen E. and A. J. Richardson, (2006). 'Regional Climate Change and Harmful Algal Blooms in the Northeast Atlantic', Limnology and Oceanography, 51(2), 820-829. Available at http://aslo.org/lo/toc/vol_51/issue_2/index.html

The IOC Harmful Algal Bloom Programme
http://ioc.unesco.org/hab/

**Please acknowledge this document as: Reid, P. C. (2006). Impacts of Climate Change on Harmful Algal Blooms *in* Marine Climate Change Impacts Annual Report Card 2006 (Eds. Buckley, P.J, Dye, S.R. and Baxter, J.M), Online Summary Reports, MCCIP, Lowestoft, www.mccip.org.uk**