Environment Agency

Evidence

Climate change and eutrophication risk in English rivers

Project summary SC140013

This study shows how climate change may increase the risk of eutrophication (a process in which too much nutrient in water causes algae and higher plants to grow excessively) in English rivers, reducing water quality. Algal blooms can be toxic to people and animals as well as requiring additional treatment for drinking water. This study found that residence time, water temperature and exposure to sunlight are particularly important. Managing these factors will help to reduce the risk of algal blooms in the future.

Algal blooms are one manifestation of eutrophication. By understanding future risk, people involved in water quality management can implement a range of cost-effective management solutions to ensure that improvements in water quality in England continue to be achieved.

Overall approach

A modelling study was used to examine current eutrophication risk and explore how this might change in the future. Initially this involved identifying the 5 main climate-related controls on eutrophication risk (see Results). Risk was measured by the amount of chlorophyll in the water, an indicator of algal biomass in lowland rivers, as eutrophication can lead to excessive and undesirable algal growth.

For 26 selected sites, thresholds were identified from plots of the 5 climate-related controls of water quality against chlorophyll concentration. A spreadsheet-based model was then used to determine the change in the number of days on which these thresholds would be met between baseline and future periods using climate impacts information developed from the UK Climate Projections 2009.

Results

For most of the rivers studied, a chlorophyll threshold of 30µg per litre indicated the onset of an algal bloom. A bloom was found to be only likely to occur if all the following conditions are met at the same time:

- Residence times are 4 days or more. The residence time is how long water takes to travel from an upstream location to a site and was used to select the study sites.
- Phosphorus concentration exceeds 30µg per litre. This occurred at all the studied sites.
- For all sites studied, the sunlight duration threshold equates to daily radiation greater than 65 Watts per m^2 per day when averaged over the preceding 3 days. This requires at least 3 hours of full sunshine on each of these 3 days.

In addition, flow and water temperature thresholds varied from site to site, which also have to be met.

Eutrophication risk will generally increase in the future (relative to the baseline period of 1961 - 1990) at the studied sites. The study found that:

- By the 2050s, the number of days where blooms are likely to occur increased at 95% of sites
- By the 2080s, the number of days where blooms are likely to occur increased at only about 50% of sites. This appears to be due to the limited number of days the sunlight duration threshold is exceeded by this time.

Conclusions

Residence time is the primary control on the occurrence of an algal bloom: there needs to be sufficient river length and time for algal biomass to develop. Phosphorus concentrations are high enough in all the time periods studied for algal blooms to develop and flows are regularly low enough to contribute to bloom risk. Eutrophication risk is dependent on conditions that are warm enough and sunny enough.

Residence time is a useful high level indicator of eutrophication risk and could be used in future as part of river basin management planning. The study highlighted that better estimates of future water quality will depend on better information about how water temperature will change. Climate change is one of many drivers and its impact relative to others such as population growth and land use change also needs to be considered.

Management implications
The results suggest that phosphorus reduction strategies will only be effective in reducing the incidence of algal blooms if concentrations can be lowered sufficiently to be below trigger thresholds. There may be better value in targeting sunlight and temperature regimes (for example through managing riparian shade). The methods developed in this study could help to evaluate the most effective options for reducing bloom risk and preventing deterioration in water quality.

This summary relates to information from project SC140013, reported in detail in the following output(s):

Report: SC140013/R2
Title: Climate change and eutrophication risk thresholds in some lowland English rivers

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