European Commission

SCIENCE FOR POLICY BRIEFS

Algal blooms and their socio-economic impact[1]

A climate change event

Algal blooms are natural phenomena caused by the rapid growth of aquatic algae in waterbodies. Bloom formation is influenced by light intensity, water temperature, pH, climate change, water flow, water column stability and anthropogenic modifications of the aquatic environment, including nutrient over-enrichment (eutrophication).

In recent years, an increasing trend has been reported in algal blooms caused by cyanobacteria (photosynthetic bacteria) in freshwater, due to warmer temperatures (Figure 1). During an algal bloom, the water colour can vary from green to brown, red or yellow, depending on the type and concentration of the organism causing the bloom. Not all algal blooms are dense enough to cause water discolouration.

Blooms of algae that discolour the water are traditionally referred to as "red tides". The occurrence of blooms in aquatic environments is considered to be a serious environmental problem, due to direct and indirect negative impacts on sectors such as fisheries, tourism and public health.

During algal blooms, uncontrolled algal growth can disrupt aquatic organisms and deplete oxygen from the water, causing hypoxic conditions that result in the death of plants and animals.

Figure 1. Green water discolouration caused by cyanobacterial scum during a bloom in Lake Varese (Italy). Cyanobacteria carry out photosynthesis, just like algae

Headlines

- Algal blooms represent a relevant and increasing threat to human health, environmental sustainability and aquatic life.
- Manifestations of algal blooms are significantly correlated with different socio-economic systems.
- In recent years, rising global temperatures have led to increased cyanobacteria blooms in freshwater.

[1] This brief is based on the JRC Technical Report: "Algal bloom and its economic impact" (2016), Isabella Sanseverino, Diana Conduto, Luca Pozzoli, Srdan Dobricic and Teresa Lettieri, EUR 27905 EN, doi:10.2788/660478.

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Joint Research Centre

Quick guide

Algal blooms can affect all aquatic ecosystems, in both marine water and freshwater.

Human activities combined with climate change have contributed to the recent increase in algal blooms.

A multifaceted approach and interdisciplinary studies are required to fully understand all factors that influence the dynamics of algal blooms.

The contribution of molecular techniques and predictive models may prove highly relevant in forecasting algal blooms and in reducing the negative impacts of bloom occurrences.

Blooms of highly toxic algae produce toxins that can cause an array of human and animal illnesses. Marine organisms can bioaccumulate these toxins and transfer them to fish and humans, with consequences ranging from illness to death.

Algal blooms can impact public health through the consumption of contaminated seafood, skin contact and the swallowing of water during recreational activities (swimming, surfing, etc.).

At present, algal blooms are occurring with increased frequency. Although the exact cause is not yet clear, climate change combined with human impacts seem to be implicated in their manifestation.

Globally, there is a need for policy decisions on prevention and mitigation measures in order to attain and ensure the safety of waterbodies.

This requires an understanding of all factors that influence bloom dynamics (including cost-benefit analyses of the monetary losses associated with algal blooms) in order to reduce negative impacts.

Main challenges

Our report identifies human health, fisheries, tourism and recreation, and monitoring and management as the categories most economically affected by algal blooms.

The economic losses caused by blooms in healthcare sectors are principally ascribed to the release of toxins in waterbodies during a bloom episode.

According to the Harmful Algae Event Database (HAEDAT), which contains records of algal blooms worldwide, Diarrhetic Shellfish Poisoning (DSP) and Paralytic Shellfish Poisoning (PSP) were the most reported illnesses associated with contaminated seafood during the period 1980-2015 (Figure 2). These illnesses (the most common symptoms of which are vomiting, nausea and diarrhoea) principally occur as the result of ingesting shellfish contaminated with the toxins okadaic acid and saxitoxins.

Medical treatments, hospitalisation and the loss of individual productivity represent a significant societal cost attributable to algal blooms.

Blooms are also correlated with economic losses in fish markets, as they could potentially lead to a drop in demand for fish (which could also extend to uncontaminated products), and the closure of aquaculture sites infested by blooms. Our study shows that algal blooms can lead to

a worrying fall in coastal tourism and water-based recreational activities. The economic impact on the tourism sector is influenced by the discolouration of water, the accumulation of dead fish on beaches and the smell emitted by algae decomposition.

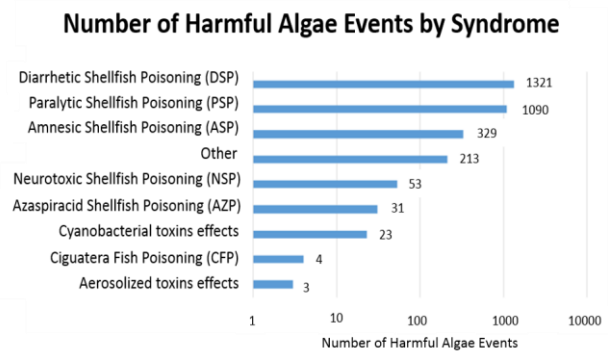

Figure 2. Total Number of Harmful Algae Events by syndrome caused by toxins released during bloom episodes and reported globally during the period 1980-2015 to the Harmful Algae Event Database (HAEDAT)

These impacts negatively affect visitors' recreational experiences and can lead to a drop in numbers visiting affected areas, with a knock-on reduction in bookings for accommodation and restaurants, and the closure of fishing activities.

Monitoring and management programmes address these issues in order to protect public health and the water environment, and minimise the economic losses caused by blooms. These programmes include preventive and remedial actions, such as the reduction of nutrient loads in waterbodies and the use of algaecides to kill algae. However, as these strategies also have a cost, particular attention has been devoted to prevention methods that can help alleviate future algal bloom episodes.

Key conclusions

A JRC report on algal blooms and their economic impact shows that four sectors are seriously affected by algal blooms: human health, fisheries, tourism and recreation, and monitoring and management (Figure 3).

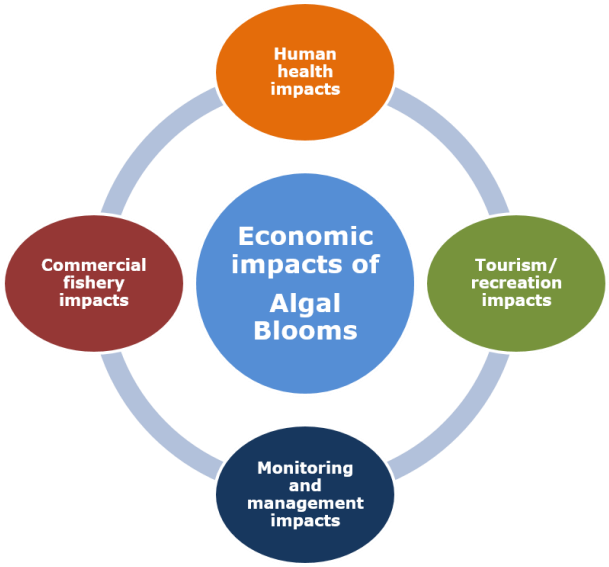

Figure 3. Economic impacts of algal blooms on four sectors: human health, tourism, fisheries, and monitoring and management

Scientific data about the costs associated with algal blooms reveal that impacts on human health are less investigated than the other three categories, probably because of the wide range of symptoms that toxins can cause in humans.

The data refer to both marine and freshwater algal blooms (e.g. cyanobacteria blooms), with a significant prevalence of cost estimates regarding blooms in seawater. It is difficult to evaluate the economic losses caused by blooms in Europe due to the lack of available data. By contrast, there is a lot of economic data regarding algal blooms in the USA. An economic evaluation of the cost of algal blooms can help carry out a cost-benefit analysis to help identify the most effective protective measures. The negative consequences of algal blooms can be mitigated through coordinated management plans, scientific research and satellite surveillance (F. Mélin et al., 2011).

The data in the JRC report can be used in cost-benefit analyses, help raise awareness about algal bloom events, and promote management processes to reduce their occurrence. Greater public awareness of algal blooms and promotion of their effective monitoring and management can significantly help to recognise the phenomena, understand their causes, predict their manifestations, and mitigate their effects.

Related and future JRC work

Due to the relevant impact of algal blooms on socio-economic systems, water monitoring management plans should be integrated with efficient predictive models that help avoid blooms and their consequences.

Molecular techniques for detecting toxin-producing microorganisms can give information about the toxic potential of a bloom, and help devise mitigation measures.

The combination of experimental molecular biological data with climate modelling in an early warning crisis management support system could help anticipate the outbreak of water-related microorganisms, and mitigate the impact on human and environment health.

Investigating the occurrence of algal blooms will potentially help determine "biomarkers" of specific stresses, such as temperature or nutrient inputs. Once "equilibrium" and stress conditions are known, models that can predict the occurrence and potential harmful impacts of algal blooms can be developed based on real-time measurements of the variables that influence algal blooms. The JRC is addressing this issue in order to help develop strategies for predicting and identifying potentially harmful blooms at their very early stages.

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