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Source: Varunan, T. and Shanmugam, P. (2017). An optical tool for quantitative assessment of phycocyanin pigment concentration in cyanobacterial blooms within inland and marine environments. *Journal of Great Lakes Research*, 43 (1): 32–49. DOI:10.1016/j.jglr.2016.11.001.

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Science for Environment Policy

New light-based method for detecting and monitoring algal blooms

Algal blooms in inland and marine waters could be detected and monitored more accurately in future, thanks to a new assessment method. Scientists have developed a new algorithm for sensors which identify emerging blooms of cyanobacteria based on the behaviour of light reflected by the algae's pigment. Importantly, the algorithm may reduce uncertainty in estimations of algal concentrations by distinguishing between two different types of pigment.

There are increasing efforts to predict and manage blooms of cyanobacteria (commonly referred to as blue-green algae) in water bodies around the world, given that some of them are toxic and have potentially fatal impacts on humans and wildlife. Exposure to these harmful algal blooms can lead to health issues ranging from skin irritation and gastrointestinal illness to cancer and liver damage. All algal blooms also have negative impacts on the environment, leading to turbid, or cloudy, waters and sometimes anoxic (depleted of dissolved oxygen) conditions that may cause fish mortality. This new tool could help monitoring eutrophication events in surface water bodies as requested by European water policies (e.g. under Annex 1, point 5, of the Marine Strategy Framework Directive).

Cyanobacterial blooms are generally detected and monitored by analysing the way that phycocyanin — a pigment in the algae — absorbs and reflects light. The pigment can be identified by its 'optical signature', which is based on the complex relationship between light absorption and reflectance.

This study presents a new algorithm for analysing optical data for phycocyanin, gathered using remote sensing methods, i.e. those which do not have direct access to the water bodies (as with laboratory tests of water samples), but which use light sensor technologies or satellite imaging.

A number of algorithms already exist for this purpose, but they are not always accurate. For example, sediment and organic matter in turbid (cloudy) productive water (waters containing both living phytoplankton and non-living particulate matter — typical of coastal and inland environments) can interfere with phycocyanin's optical signature. In addition, the optical behaviour of chlorophyll-a, another pigment in algae, can sometimes be very similar to phycocyanin's (for example, in waters with a mixture of phytoplankton). The concentration of cyanobacteria may, therefore, be overestimated in the existing studies, if both pigments are mistakenly detected.

The researchers developed the algorithm following detailed analysis of optical data, which were gathered by taking images of algae-containing coastal water from a boat and by analysing samples of algae in the laboratory. This led to a series of equations which can be used to establish the presence of phycocyanin and to distinguish it from other substances, including chlorophyll-a. The algorithm focuses on the distinctive way that phycocyanin absorbs light with wavelengths of 620 nanometres.

To test the algorithm, the researchers compared its results with *in situ* data measured using hyperspectral radiometers (light-analysis technologies) in three coastal locations of south-east India. The waters here suffer with cyanobacterial blooms, the result of recent urban and residential development, which has led to an excess of bloom-fuelling nutrients entering the water. The algorithm's results were very similar to those from the water sample results, carried out in the laboratory, which suggest it performed well.

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European Commission

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In addition, the researchers compared the algorithm's results with the results of another algorithm developed by Simis, *et al*., (2005)[1], which is widely used and considered to work well. Both sets of results were checked against the in situ data, plus satellite images which showed the blooms.

This new algorithm appeared to be better at accurately detecting phycocyanin concentrations in waters with dense blooms, while the Simis method overestimated in these circumstances. When the study's validation results were compared to those of Simis, the performance of the new method was shown to be better in both bloom and non-bloom waters. The researchers suggest that, although the Simis method yields similar results to the present study in bloom-dominated waters, it starts to overestimate the phycocyanin concentration when the ratio of phycocyanin pigment and chlorophyll-a pigment (PC:Chl-a) decreases.

With further testing and refinement, the researchers suggest that their algorithm could be applied to a broader range of waters and used by satellites to assess regional and global waters.

1. Simis, S.G.H., Peters, S.W.M., Gons, H.J., (2005). Remote sensing of the cyanobacterial pigment phycocyanin in turbid inland water. *Limnology and Oceanography*, 50: 237–245. DOI: 10.4319/lo.2005.50.1.0237.