Satellites, microscopes, AI, citizen science: Enhancing algal bloom forecasting and water quality monitoring in the face of climate change

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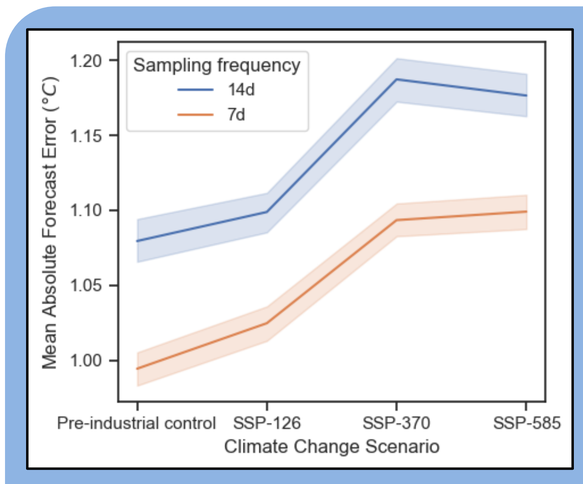
Harmful algal blooms are an issue for freshwater bodies in Scotland and across the world. They pose a threat to the security of drinking water supplies; can lead to health issues for swimmers and other recreational water users; and can cause irreversible damage to ecosystems and biodiversity.

Certain harmful algae such as blue-green algae (cyanobacteria) are well adapted to warmer temperatures and are therefore expected to further proliferate due to climate change (CREW, 2022).

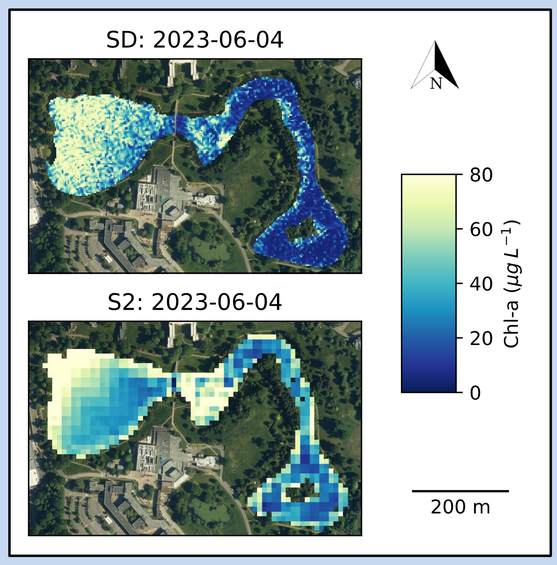
Understanding the best ways to collect data and use this to monitor, forecast and ultimately manage the risks associated with algal blooms is therefore essential.

Short-term water quality forecasting is harder in more severe climate change scenarios



The error of short-term water temperature forecasts on modelled lake data (Windermere (UK), ISIMIP) for different climate change scenarios was elevated in the more extreme scenarios due to higher variance in summer temperatures, and warmer, less predictable spring and autumn weather. This effect would likely be seen for algal bloom forecasts too, given that algal growth is temperature dependent. The reduced errors associated with increasing sampling frequency points to a way to overcome this challenge.

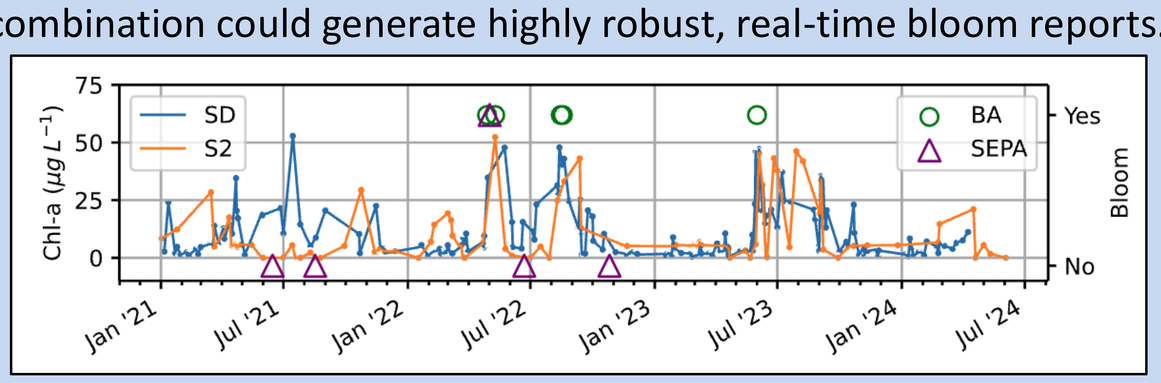
New satellite missions show potential for widespread monitoring of algal blooms at scales previously impossible



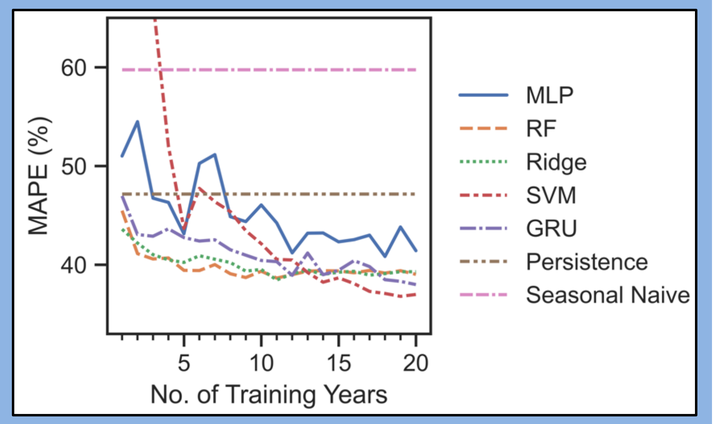
A comparison of Planet SuperDoves (SD) data with ESA Sentinel-2 (S2) data over Airthrey Loch (UK) for algal bloom monitoring showed that the new, higher resolution Planet data is likely suitable for monitoring algal blooms in vast numbers of very small water bodies which were previously unresolvable with satellite imagery.

Citizen science and agency data pairs excellently with satellite imagery to increase certainty of bloom reports

Data from the Bloomin' Algae app (BA), and SEPA were found to match satellite bloom detections on Airthrey Loch (UK). These approaches all have very different sources of uncertainty, and so in combination could generate highly robust, real-time bloom reports.



Short-term machine learning algal forecasts reach close to max performance with 5-10 years' fortnightly training data



Algal forecasts trained with fortnightly data from Blelham Tarn (UK) suggest that exceptionally long (>10 yrs) data sets are not required to achieve good performance. If performance is not satisfactory with a dataset of this length, managers should look to increase sampling frequency or upgrade monitoring to include additional predictors.

- Satellite data courtesy of Planet Labs, ESA
- CREW 2022: *'Assessing climate change impacts on the water quality of Scottish standing waters'* https://www.crew.ac.uk/publications
- Modelled lake data for different climate change scenarios courtesy of ISIMIP: https://www.isimip.org/
- Long term monitoring data from Blelham Tarn courtesy of UKCEH