TACKLING A BLOOMING NUISANCE!

DENIS MORAN LOOKS AT THE MENACE OF UNMONITORED ALGAL BLOOMS AND HOW SATELLITE REMOTE SENSING IS HELPING TO TACKLE THE PROBLEM AND IMPROVE WATER QUALITY FOR ONE OF BRITAIN'S BIGGEST WATER COMPANIES

Phytoplankton blooms are the accumulation of microscopic algae in the surface layer of both fresh and marine water bodies. Although some blooms can be beneficial to coastal fisheries production and ecosystem, their exponential growth and uncontrolled spread can cause serious environmental problems. The issue is of particular concern to water companies, not least Anglian Water which provides water and water recycling services to almost seven million people in the East of England and Hartlepool.

Traditionally, water companies and environmental agencies have used a standardised set of practices to combat the threat of unmonitored algal blooms spreading. The most common method involves placing sensors in the targeted water sites to monitor environmental conditions and detect early signs of bloom formation. Although this approach can be valuable in understanding local bloom dynamics, scaling it up to cover larger regions and multiple water bodies has proven challenging and costly.

This is where satellite-based remote sensing can step in. When deployed alongside advanced sensors, satellite monitoring can detect early stages of bloom development, providing critical information for bloom forecasting and management as well as a significant reduction in carbon emissions and energy consumption - resulting in overall better environmental impacts.

Anglian Water's main goal in driving the innovation project of combined satellite tech and traditional sensor monitoring tools is to find new innovative solutions that can help the water industry better align with broader environmental goals and protect the life of critical ecosystems.

The disruptive impact of blooms

The rapid proliferation of phytoplankton blooms can lead to physical and chemical changes in the aquatic environment, disrupting the balance of the ecosystem and worsening climate conditions.

As blooms grow and cover large areas of water surfaces, they block sunlight from reaching submerged vegetation. Certain types of algae have the capability to generate powerful toxins, which can result in harmful effects to animal and human health. For wildlife, dense blooms can physically impede the movement and feeding of fish, shellfish, and other aquatic animals, while for humans, the negative health effects may include harm to the liver and nervous system. The threat is thus urgent and very much real.

To address this challenge proactively, water companies like Anglian Water are currently exploring the innovative approach of merging cutting edge satellite imagery and advanced sensor technology to build robust monitoring tools. This monitoring system will help manage effectively the spread of blooms and, in turn, massively contribute to the fight against the climate crisis.

By integrating satellite-based remote sensing with in-situ sensor networks, water companies can achieve a more comprehensive understanding of bloom dynamics, allowing for early detection and rapid response to potential bloom events. This comprehensive method holds great potential, offering significant benefits such as improved bloom forecasting accuracy, mitigated risk of algal blooms, and sustainable preservation of water bodies in the long run.

Mitigation strategies

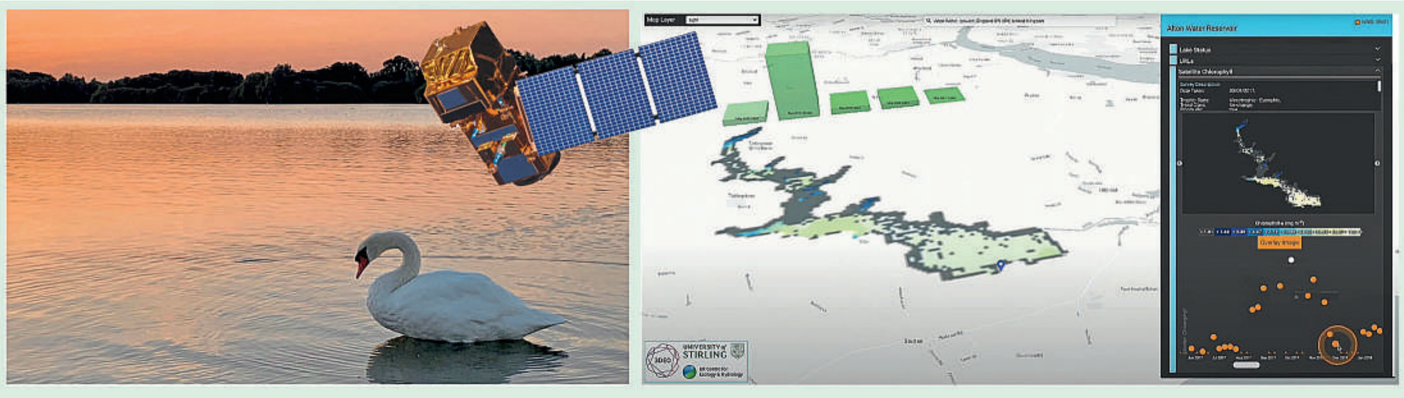
To counteract the detrimental effects of phytoplankton blooms, water companies and environmental agencies have implemented various mitigation strategies. These strategies include adjusting water treatment processes, managing nutrient inputs and water flow, and in some cases, employing algaecides or chemical treatments to control bloom populations. However, these solutions can have an equally detrimental impact on the environment and fall short of providing an ideal compromise to the problem of bloom spreading.

Additional strategies include long-term management. These strategies usually encompass watershed management practices, land-use planning, and public education campaigns to raise awareness about the factors contributing to bloom formation.

Despite the efforts to mitigate blooms through traditional approaches, there are inherent limitations to these methods. For instance, localised monitoring through in-situ sensor networks provides valuable data but does not offer a comprehensive view of large water bodies or enable real-time monitoring across wide geographic areas. Gathering comprehensive data across vast regions requires an extensive network of sensors, which comes with higher costs, complexity, and an increased carbon footprint from the materials and energy involved.

Conversely, satellite monitoring offers unique advantages, such as the possibility of creating detailed maps of water bodies enabling the identification of patterns that traditional sampling methods cannot detect. For instance, the Earth Observation Group at the University of Stirling successfully used Earth observation data from the European Space Agency Sentinel-2 satellite to detect early stages of algae bloom development within Anglian Water's Alton Water Reservoir in Suffolk. By detecting these early signs, water companies can take timely actions to prevent or mitigate potential bloom-related issues.

An additional example of what these tools can offer is given by the use of near-real-time data and analytics from satellites like ESA Sentinel-1 and Sentinel-2, through which water companies can gain access to valuable environmental and agricultural metrics on a global scale. This application has proven successful to Anglian Water's study in the River Wensum catchment, where using satellite data to investigate the impact of rainfall to bare soil and water quality enabled the identification of potential risks to water quality and the formulation of targeted interventions. The combination of these



The use of data from the ESA Sentinel-2 satellite (inset) has been successfully applied at Anglian Water's Alton Water Reservoir in Suffolk (pictured left) and forms part of the pilot AquaWatch UK Lakes Observatory water quality service being developed at the University of Stirling (pictured right) (https://www.geoaquawatch.org/)

tools can better support water companies to predict the spreading of phytoplankton blooms, and monitor the impact of climate changes on the heath of water bodies over longer timescales, helping future-proof the water industry's response.

Beyond bloom monitoring

Shifting away from heavy reliance on sensor monitoring offers several environmental benefits. One of these advantages lies in the reduced production of electronic components, which are known to carry a carbon footprint associated with their manufacturing process. By minimising the number of sensors required, satellite-based monitoring significantly lessens the environmental impact stemming from the production and eventual disposal of these electronic devices. This reduction translates into a smaller carbon footprint along the entire lifecycle of these sensors, contributing to more sustainable practices.

Water quality monitoring plays a pivotal role in allowing sustainable water management, enabling an effective assessment and understanding of the condition of water resources. By gathering crucial data and information, this process helps to characterise the physical, chemical, and biological aspects of water, contributing to informed decision-making and effective resource management.

By reducing an overreliance on sensor programs, the strategic shift to satellite monitoring promises significant cost savings and a reduction in carbon emission.

More specifically, transitioning to satellite-based monitoring reduces the need for deploying and maintaining extensive sensor networks. As a consequence of this, fewer resources get dedicated to the purchasing, installing, calibrating, and servicing sensors - resulting in overall reduced costs. Even the additional costs of travel expenses from sending personnel to remote sites for maintenance and data collection will get less frequent, if not obsolete through satellite innovation tools.

As phytoplankton blooms continue to pose a serious threat to water bodies worldwide, water companies need new advanced monitoring systems and early warning capabilities. The combined use of satellite technology and sensors offers a transformative solution able to better safeguard water bodies worldwide. By embracing this integrated approach, water companies can stay ahead in the fight against algal blooms while striving for a sustainable water future, enabling more informed decisions and precise action plans.

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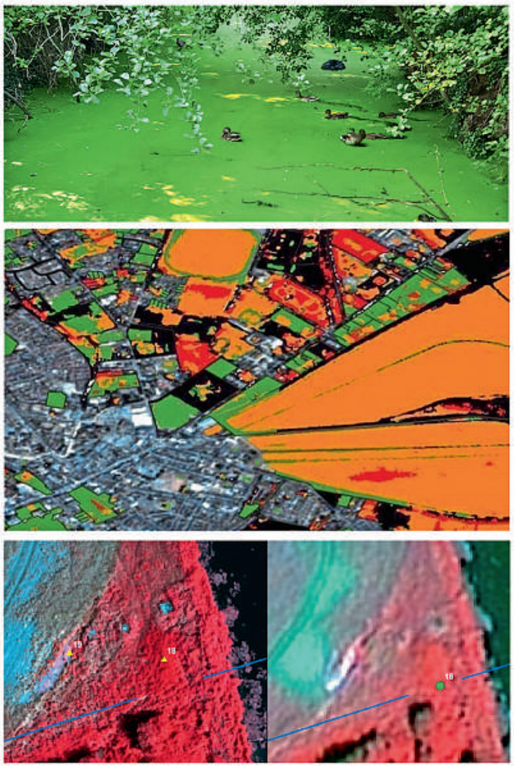

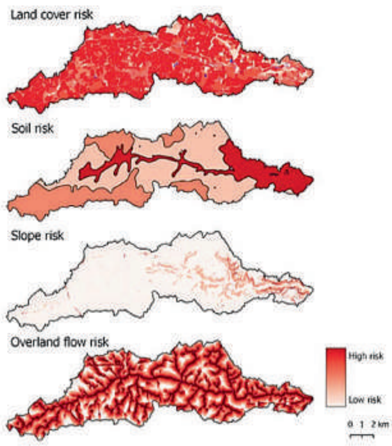

love every drop. anglianwater

Top left: Some algal blooms can produce dangerous toxins in fresh or marine water, but even non-toxic blooms can hurt the environment and local economies. Left centre: Satellite imagery is analysed here with an evapotranspiration model to identify areas of irrigated land during the prolonged dry weather and to estimate the volumes of water used. A 75km^2 area of Newmarket (Anglian Water's Shop Window initiative) was reviewed in the trial which estimated more than 500ML was used by unmetered customers to irrigate land over the summer months. Lower left: Aerial and satellite imagery was analysed here for high vegetation growth over underground assets during prolonged dry weather to identify leaking water mains. The trial successfully demonstrated that it was possible to detect leaks using this method with both aerial (5cm resolution) and satellite (50cm resolution) data sets. Top right: This series of images from the Environment Systems Satellite Data Services (ESDS) is a spatial comparison of land cover, soil, slope and overland flow risk within the Tud sub-catchment in Norfolk. The analysis-ready data spatial scale is 10m., is available every 6-12 days world-wide, and can be accessed via API. The data is used to produce environmental and agricultural metrics as input for modelling, monitoring, land management, and policy formulation in multiple countries.