APCRP: Strategies for early detection of harmful algal blooms and predicting toxin release - linking hyperspectral imaging to molecular techniques

Capability


Figure 1: Algal bloom on the Ohio River in August 2015.

Harmful algal blooms (HABs) have gained greater attention in recent years due to increased frequency and severity as well as the ecological effects and potential impact on human health. A recent large-scale HAB event on the Ohio River (Figure 1), has raised public awareness concerning the magnitude and severity of the problem. The U.S. Army Corps of Engineers (USACE) is responsible for many of the navigable and recreational waterways within the U.S. that provide a variety of services including flood control, energy production, and navigation. Other associated waterway uses include recreation, agriculture, and potable water supplies that are covered by the Clean Water Act. The USACE is therefore responsible for the management of these waterways concerning the occurrence of algal blooms and other HAB related issues. The Aquatic Plant Control Research Program (APCRP) is developing capabilities to improve the early detection of algal blooms, better predicting the likelihood of toxin release and enabling district personnel the ability to manage bloom events. The APCRP is also analyzing historic water quality data to gain greater insight into water quality parameters that may drive the increased frequency of bloom occurrences.

The optimal growing conditions for cyanobacteria and the stressors that can lead to toxin release is well known at the laboratory scale. Much of this knowledge has not yet been incorporated into the field-scale monitoring of blooms and the conditions that lead to bloom growth or toxin release. The APCRP is seeking to identify the stressors that are predictive of toxin release, correlate water quality parameters (temperature, nutrients, and pH) to bloom potential, and identify spectral signatures that will enable the monitoring of species progression or bloom growth by hyperspectral imaging to predict risk of toxin release. Additionally, the APCRP is performing hyperspectral imaging of cyanobacteria species that are associated with HABs to identify the unique spectral signatures associated with these organisms (Figure 2). This information can be used to identify the spectral changes occurring during cellular stress and the possibility of toxin release. Finally, the APCRP is developing molecular capabilities, including polymerase chain reaction (PCR) high throughput sequencing, and Enzyme-linked immunosorbent assay (ELISA) assessments to identify toxin producing cyanobacterial strains, expression of toxin genes, and for toxin detection. The capabilities developed by the APCRP will enable district managers to minimize the impact of HAB events to USACE operations and civilian use.

Applications

Districts have been faced with increasingly frequent HAB events that impede operations. Current HAB response is reactionary in nature since managers are generally not aware of bloom events until they are well developed.

Available methods for detecting HABs range from field observations and water sampling to satellite based imaging. However, all of these methods have limitations. Field based methods are limited by accessibility and single point samples that may not adequately represent a large body of water. In contrast, satellite based sensing can cover large areas but has relatively poor spatial and spectral resolution.

The early detection of blooms and the ability to detect or predict toxin release will minimize waterway closures and decrease the impact to operations.

Status

Ongoing (FY16–19)

Get It Here

The APCRP anticipates releasing several technical notes (TNs), Standard Operating Procedures (SOPs), and manuscripts to provide a basic framework for detecting HABs and assessing the potential for toxin release. In addition, the program will be hosting a webinar with district participants in the fall of 2016 to disseminate any findings.

Documentation and References

Anticipated Fall of 2016.

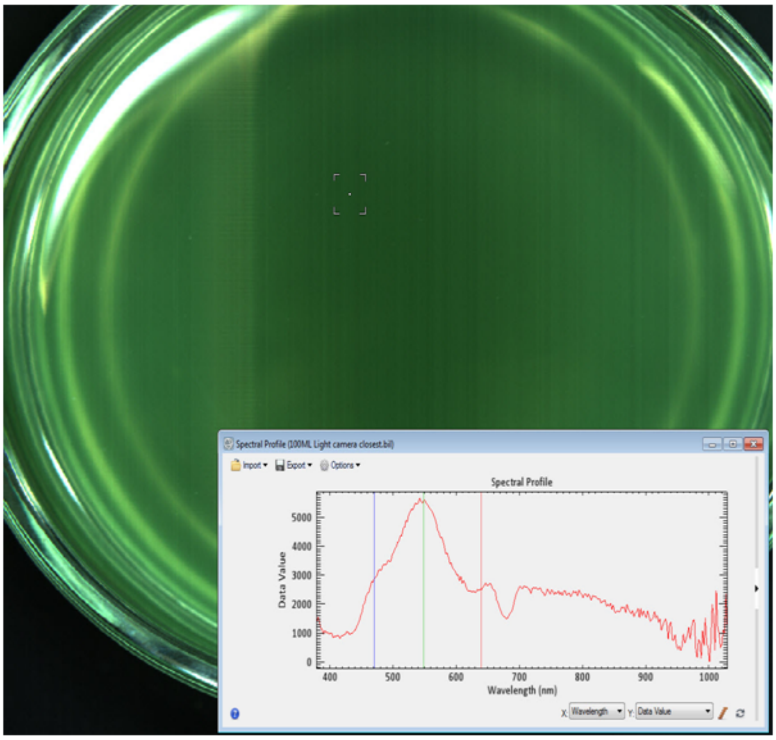

Figure 2: Spectral scan of *Microcystis aeruginosa*.

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