Comprehensive Satellite-Based Algorithims for Broadscale cHAB Detection and Monitoring

Lead: Richard Johansen, ERDC, Richard.A.Johansen@usace.army.mil

USACE Harmful Algal Bloom Research & Development Initiative

Delivering scalable freshwater HAB prevention, detection, and management technologies through collaboration, partnership, and cutting-edge science.

Problem

Satellite-derived algorithms to estimate cyano-harmful algal blooms (cHABs) water quality indicators tend to be locally optimized for a particular study, limiting the use of satellite-based remote-sensing approaches across geographies and bio-physical conditions.

Objective

Improve the accuracy and estimation of satellite-derived cHAB algorithms under varying conditions to aid district managers in their monitoring efforts.

Approach

Aggregate recent (2019–2022) HAB/water quality data from across the entire continental United States with coincident remote-sensing imagery to evaluate the performance of eight Sentinel-2 algorithms for the quantification of HAB-associated pigments (chl-a and phycocyanin). Develop a baseline data set to demonstrate the ability of these simple algorithms to be utilized as regional or global algorithms across the multiple variants: water quality parameter (chl-a, phycocyanin), data acquisition method (i.e., sonde, lab, etc.), geographic region, and seasonality.

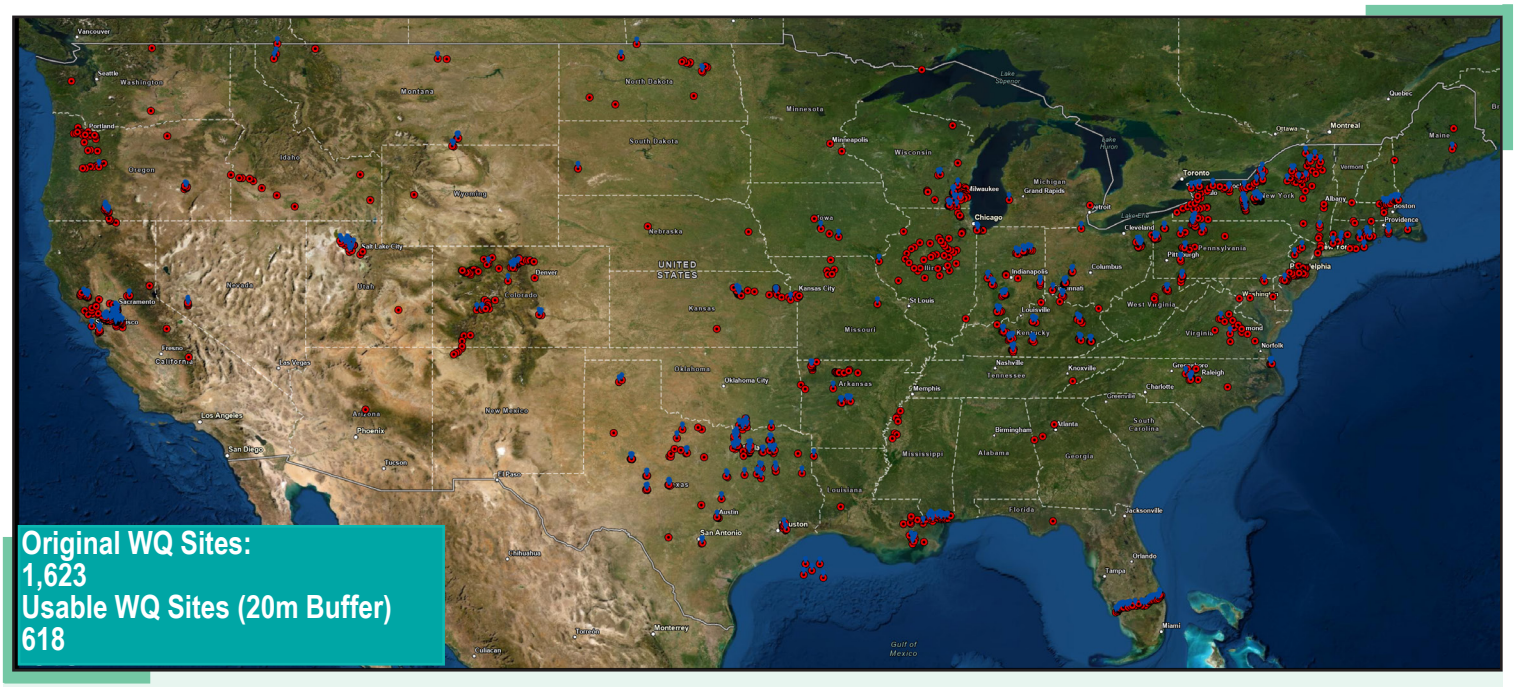

Figure 1. *After preprocessing, a total of 618 water quality (WQ) sites were selected to be matched up with coincident remote-sensing imagery from 01 January 2019 to 31 May 2022. Each algorithm was developed from pixel spectra, which correlated to a specific ground sample site location and date, and then was evaluated using k-means cross validation.*

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Results

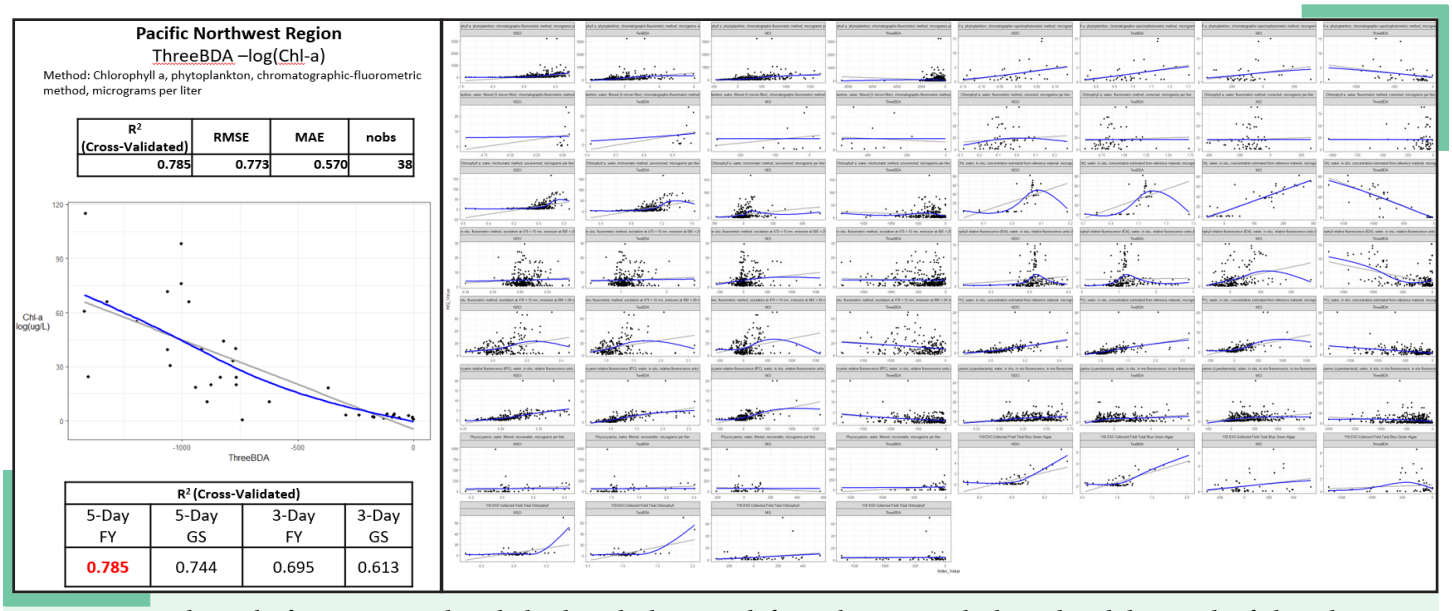

Figure 2: *Sample results from iterating though the described approach for each variate, which produced thousands of algorithm performances for all possible combinations.*

Major Milestones

Deliverable	Description
Publications	**Special Report:** Johansen et al. 2023. *A Review of Empirical Algorithms for the Detection and Quantification of Harmful Algal Blooms Using Satellite-Borne Remote Sensing.* ERDC/EL SR-22-2. https://hdl.handle.net/11681/44523. **Journal Article:** Johansen et al. In prep. "Spatiotemporal assessment of Sentinel-2 algorithms for broad-scale detection of HABs utilizing Google Earth Engine." *Ecological Indicators.*
Products	**Project data and code:** GitLab: https://public.git.erdc.dren.mil/RJohansen/regional-hab-algorithms
Tech Transfer	**Webinar:** "Selecting Satellite-Based Algorithms for Detection and Estimation of HABs" (Pending)

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Partnership/Leveraging Opportunities

This work will leverage ongoing field studies within USACE's Aquatic Nuisance Species Research Program, such as HABITATS, which includes collaborations with the New York State Department of Environmental Conservation and the Florida Department of Environmental Protection. In addition to government collaborations, commercial products are being evaluated, modified, and optimized in the rapid algae flotation technology (RAFT) study.

Value to USACE Mission

This effort intends to aid district managers in HAB monitoring efforts by providing technical guidance on the selection of the most appropriate spectrally derived algorithms and helping to transform district water quality monitoring practices, reducing the need for specialized remote-sensing skills or geospatial backgrounds.