Using NASA Earth Observations to Identify Spatial and Seasonal Trends of Harmful Algal Events in Lake Champlain

Abstract

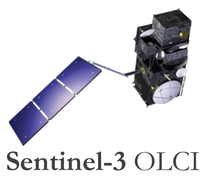
Lake Champlain provides clean drinking water for 35% of the surrounding watershed and offers recreational opportunities to millions of tourists. However, current levels of cyanobacteria and phosphorus created breeding grounds for harmful algal blooms (HABs). The excess of phosphorus runoff into Lake Champlain over the past decade encouraged toxic cyanobacterial formations, thereby increasing the severity of HABs and their impact on local economy and ecology. In partnership with the Natural Resources Conservation Service (NRCS) Northeast Region, this project utilized Earth observations to identify risk factors associated with toxic algal blooms. The team detected historic algal bloom trends with Sentinel-2 MultiSpectral Instrument (MSI), Sentinel-3 Ocean and Land Color Instrument (OLCI), Landsat 8 Operational Land Imager (OLI), and Landsat 9 OLI-2. The team also used Sentinel-3 OLCI and the German Aerospace Center's Earth Sensing Imagery Spectrometer (DESIS) to visualize algal bloom patterns and Landsat 8 OLI, Landsat 9 OLI-2, and the Shuttle Radar Topography Mission (SRTM) to identify phosphorus sources within the watershed. The team's analyses indicated an increase in cyanobacteria blooms during summer months from 2016–2022, with Missisquoi and St. Albans Bay exhibiting the greatest concentrations of toxic events. Furthermore, 16% of the watershed was identified as posing an immediate threat to the lake's hydrology. The area of greatest concern was the Missisquoi Bay sub-watershed, with 229,044 acres of land prone to excessive phosphorus runoff. Providing this information to the NRCS Northeast Region enabled the organization to quantify risk factors associated with algal blooms and modify mitigation efforts to better target future bloom events.

Objectives

- **Generate** a time series analysis of cyanobacteria, turbidity, and temperature to identify runoff trends
- **Analyze** algal bloom trends and identify potential sources of runoff contamination through cyanobacteria concentration maps
- **Produce** a phosphorus runoff potential map to identify risk factors within areas contributing to watershed contamination and highlight areas of greatest concern for phosphorus buildup

Earth Observations

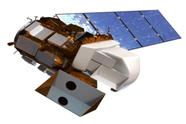
Sentinel-2 MSI



Sentinel-3 OLCI

ISS DESIS

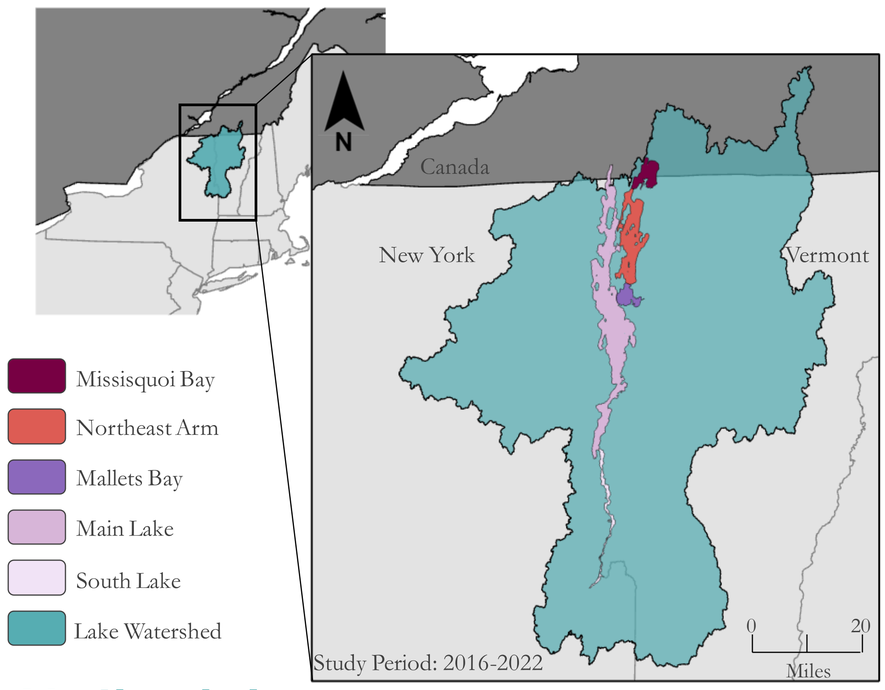
SRTM



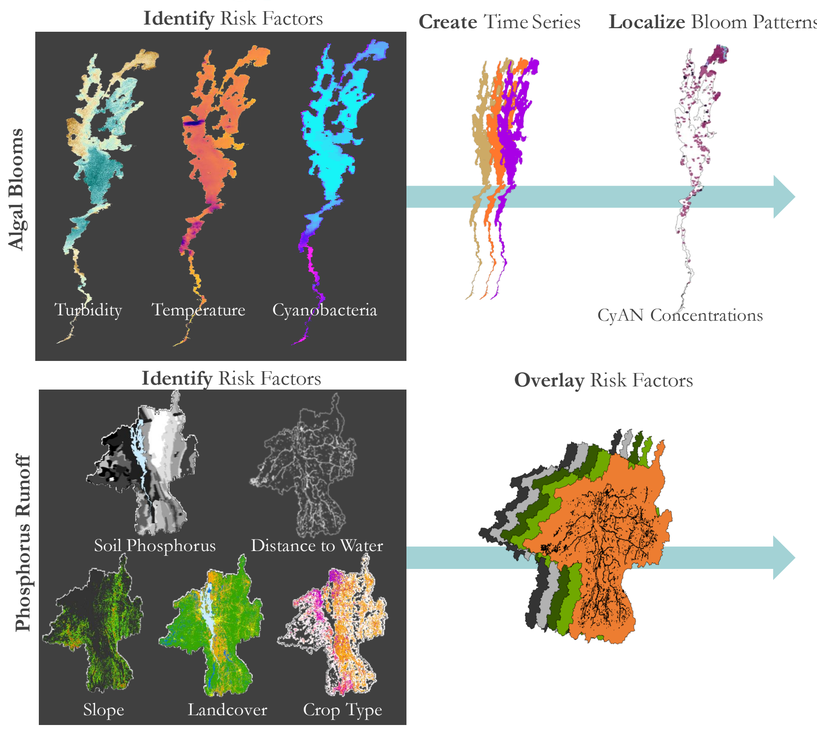
Landsat 8 OLI

Landsat 9 OLI- 2

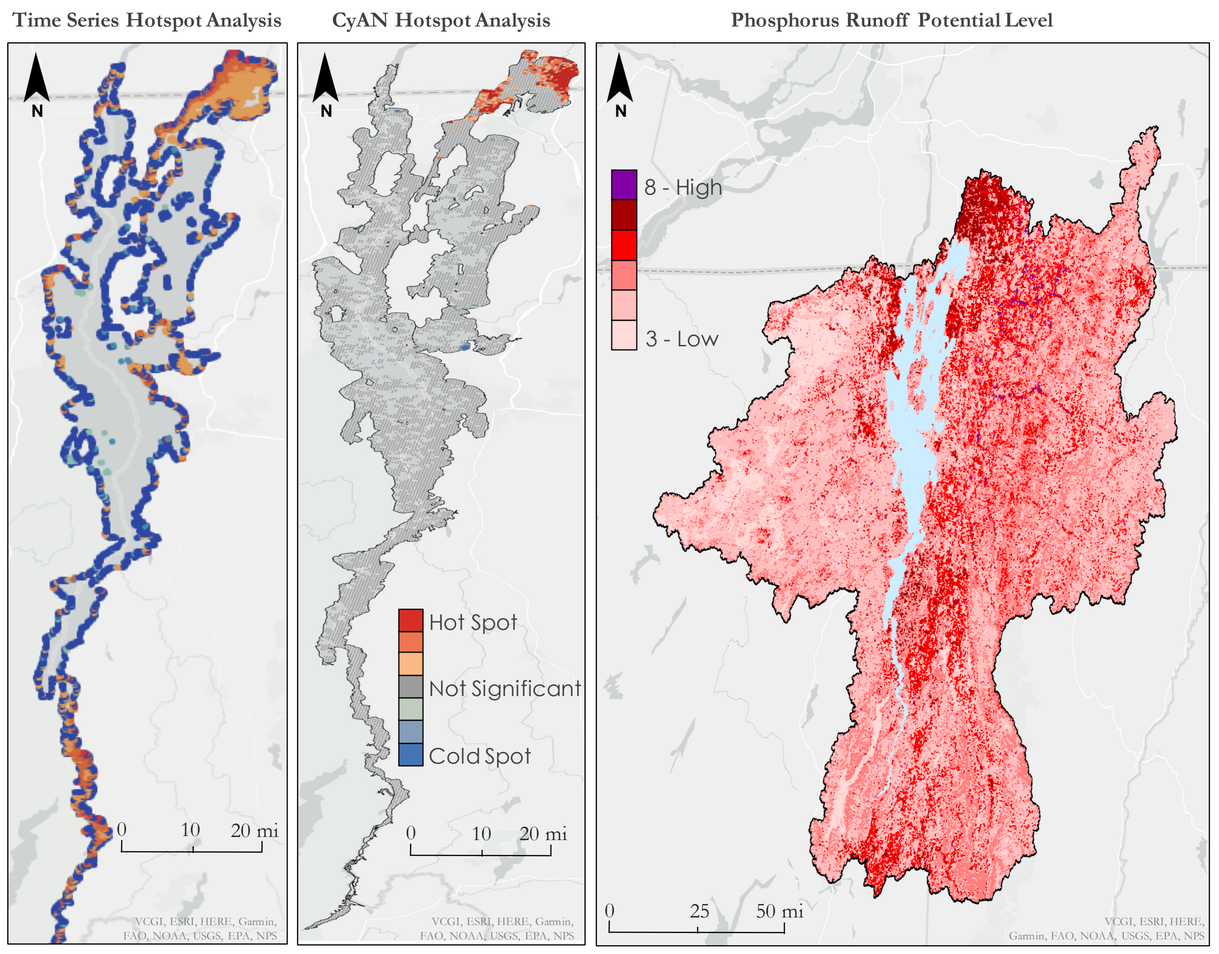
Study Area



Methodology



Results



Conclusions

- Cyanobacteria blooms proliferate through June and July and peak in August. Summer 2016 and 2021 exhibited the most severe bloom events.
- The greatest concentrations of cyanobacteria from 2016-2022 occurred within Missisquoi Bay and St. Albans Bay, reaching 7 million cells/mL of cyanobacteria.
- 16% of the entire watershed is classified as areas of greatest concern.
- The Missisquoi Bay sub-watershed presents the greatest threat to the lake, with 229,044 acres (30%) being classified as areas of greatest concern.

Project Partners

USDA United States Department of Agriculture
Natural Resources Conservation Service

Northeast Region

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