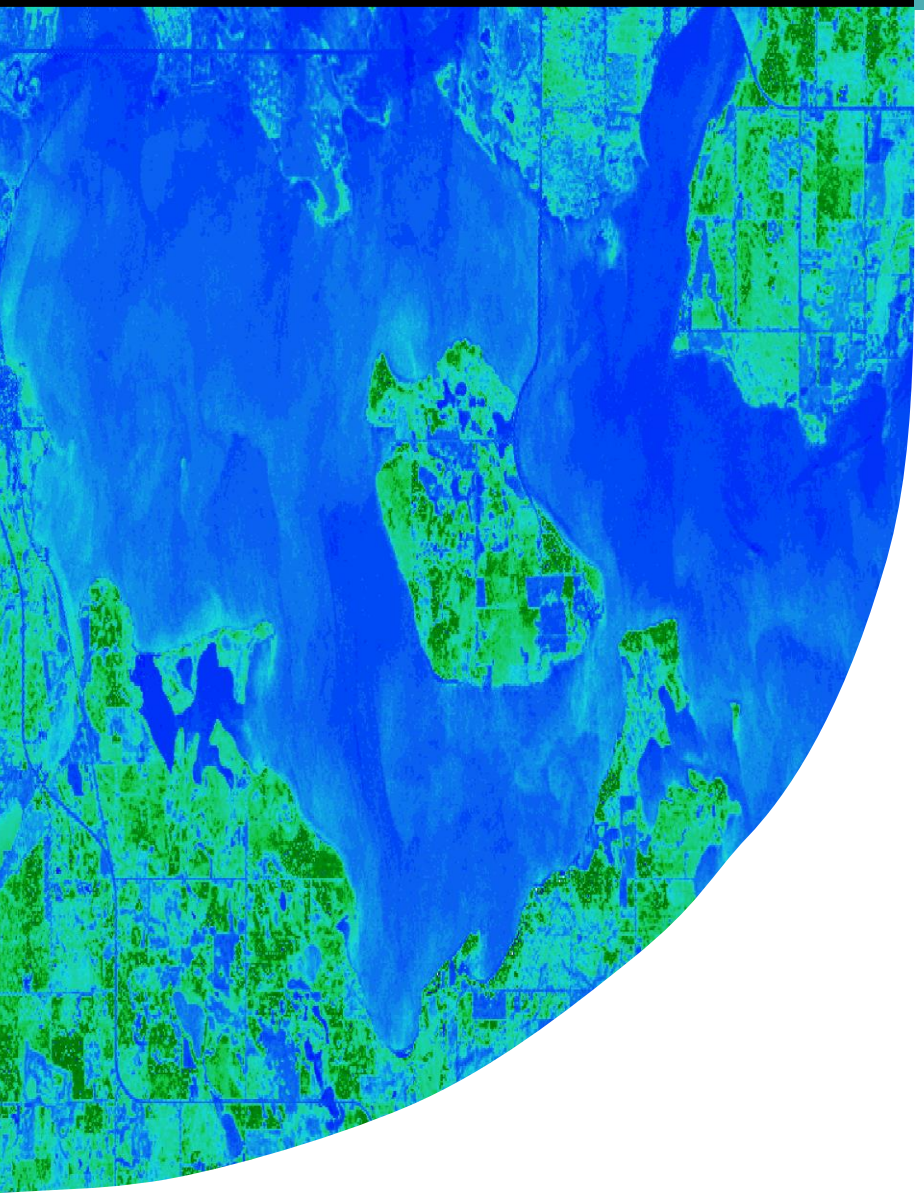
National Aeronautics and Space Administration



North Dakota Water Resources

Implementing Earth Observations Data to Assess Water Quality of Inland Lakes in North Dakota

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Our Team

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Background

North Dakota is home to over 295 public lakes and reservoirs

Many inland lakes are classified as eutrophic based on lake water quality indicators (LWQI)

Increased water temperature and precipitation have increase harmful algal bloom (HAB) incidence

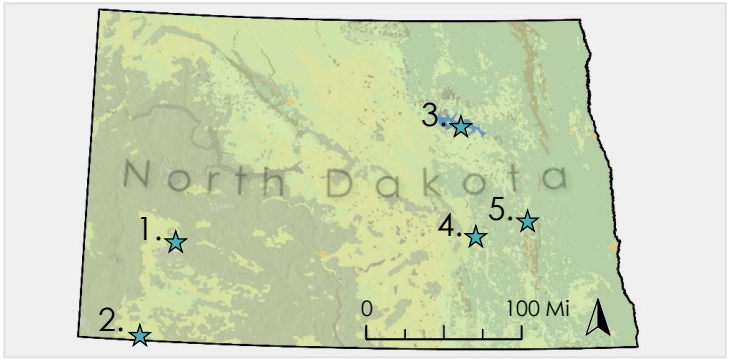
Image Credit: ND DEQ, Division of Water Quality

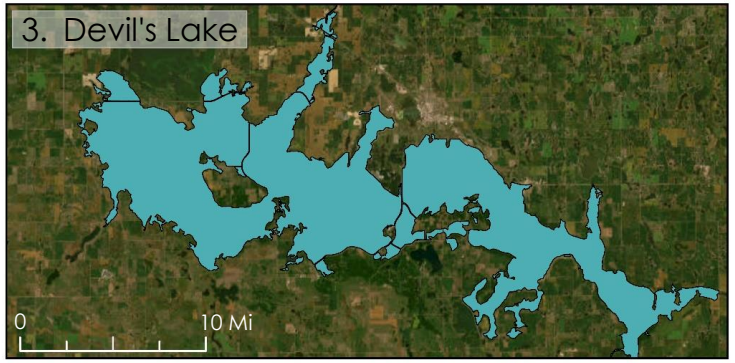
Study Area and Period

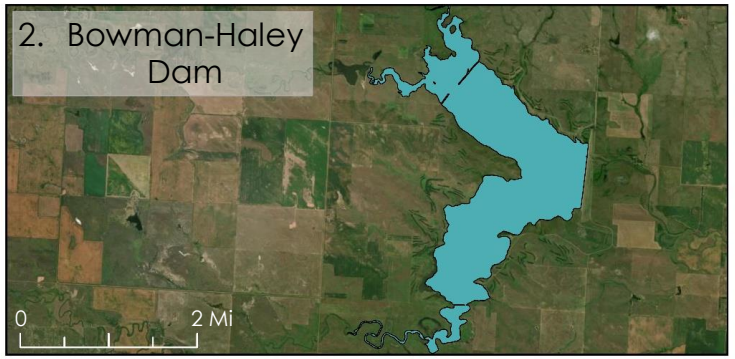
Study Period:

2015 – 2023 Summer Months

(April – October)



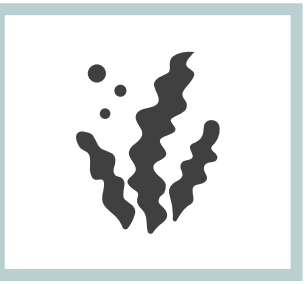




Basemap: Earthstar Geographics, Esri, USGS, Maxar

Project Objectives

Identify spatiotemporal trends in chlorophyll-a, Secchi depth, and turbidity to track HABs



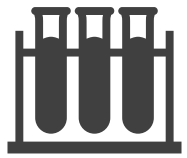
Increase remotely sensed LWQI data availability in North Dakota lake regions to fill in spatiotemporal gaps for partners

Investigate the feasibility of LakeSense in providing remote sensing insights to address community concerns

Community Concerns

Environmental Concerns

- Highly eutrophic lakes in summer months
- HABs



Health Concerns

- Lack of near-real-time water quality updates
- Drinking water quality standards

Economic Concerns

- Impacts on recreation, fishery, and tourism

Partner

North Dakota Department of Environmental Quality (ND DEQ), Division of Water Quality

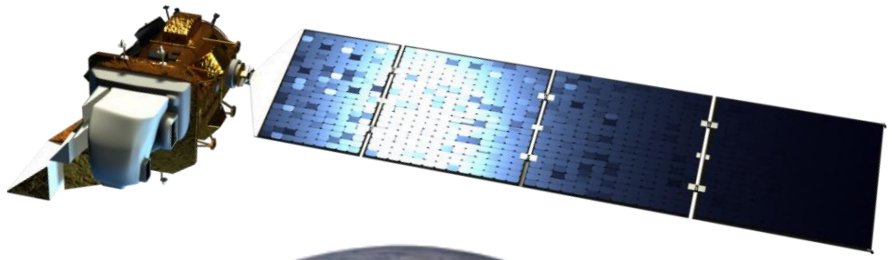
Image Credit: ND DEQ, Division of Water Quality

Image Credit: ND DEQ, Division of Water Quality

Image Credit: Josh Anderson, Walsh County SCD

Earth Observations

Landsat 9 OLI-2



Landsat 8 OLI

Sentinel-2 MSI

Image Credits: NASA and ESA

In Situ Sampling Data

Image Credits: ND DEQ, Division of Water

Chlorophyll-a

ND DEQ,
Division of Water Quality

Image Credits: ND DEQ, Division of Water

Secchi Depth

ND DEQ,
Division of Water Quality

Image Credits: USGS Oklahoma-Texas Water Science Center

Turbidity

National Water Monitoring
Council Water Quality Portal

Methodology

LakeSense Pipeline

Data Acquisition

Sentinel-2 MSI, Landsat 8 OLI, & Landsat 9 OLI-2

Data Processing & Analysis

Retrieve reflectance from atmospheric corrections

Derive LWQI from aquatic remote sensing algorithms

Perform comparisons on atmospheric corrections and flag combinations

Compare in-situ data for validation

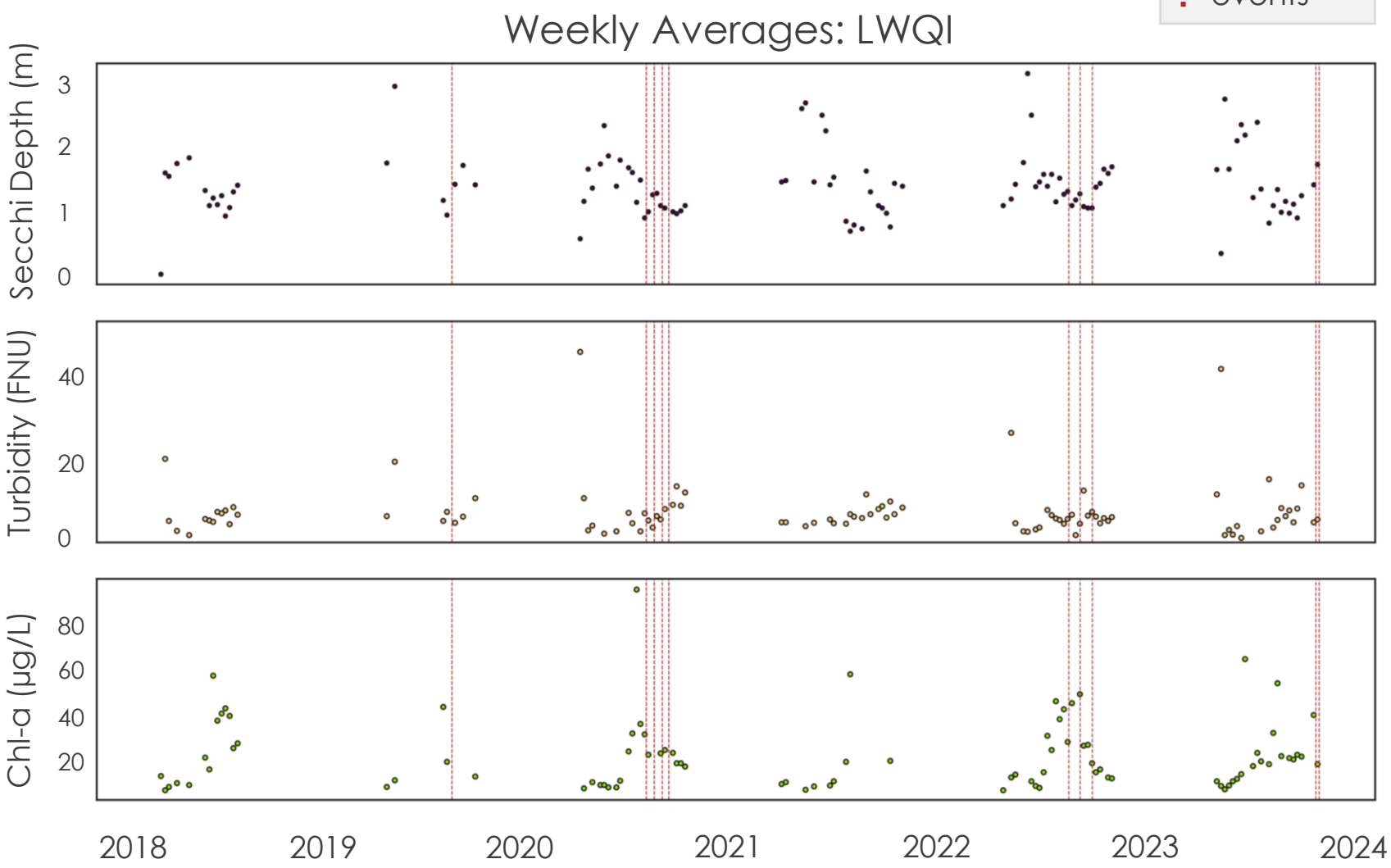
End Products

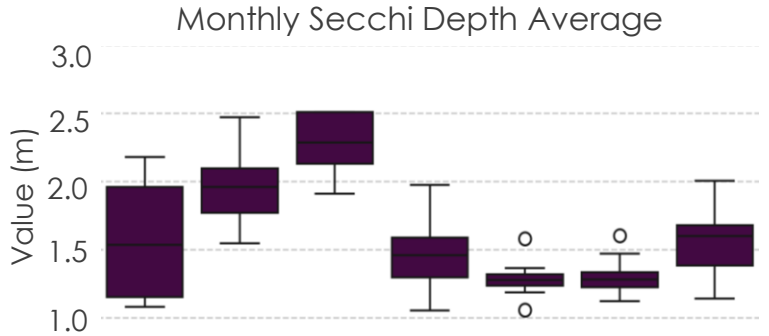
Time series

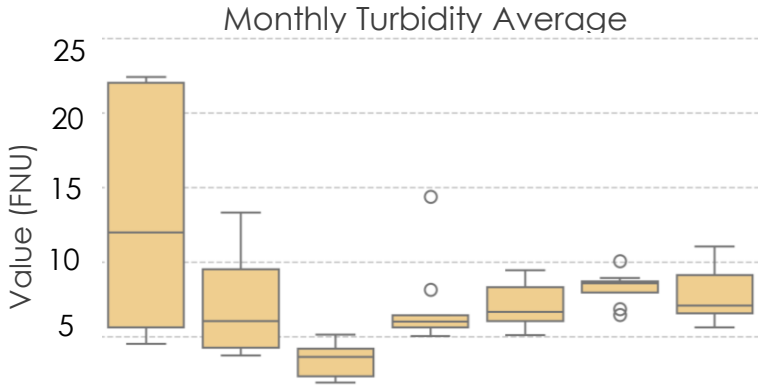
- Chlorophyll-a
- Turbidity
- Secchi depth

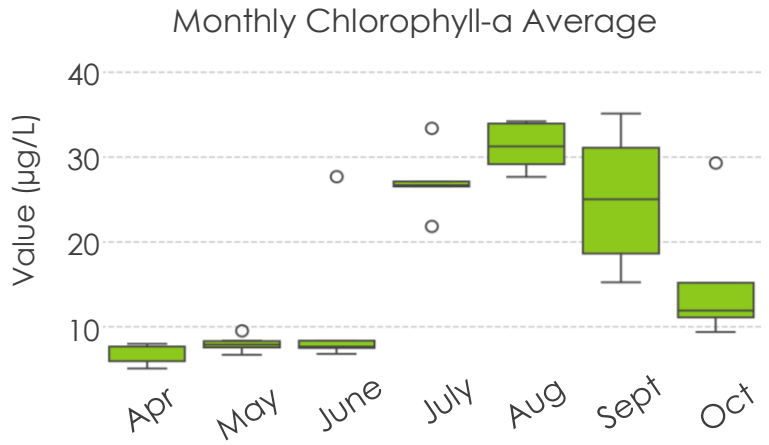
HAB case study maps

Results: Devil's Lake

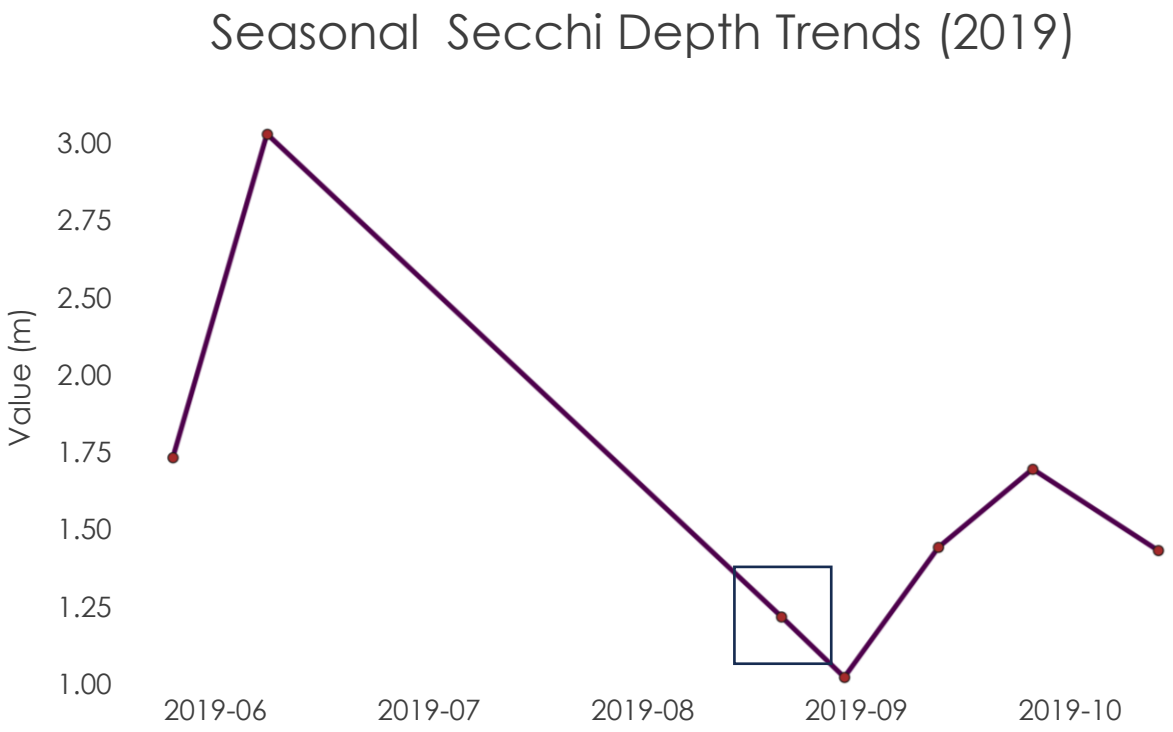


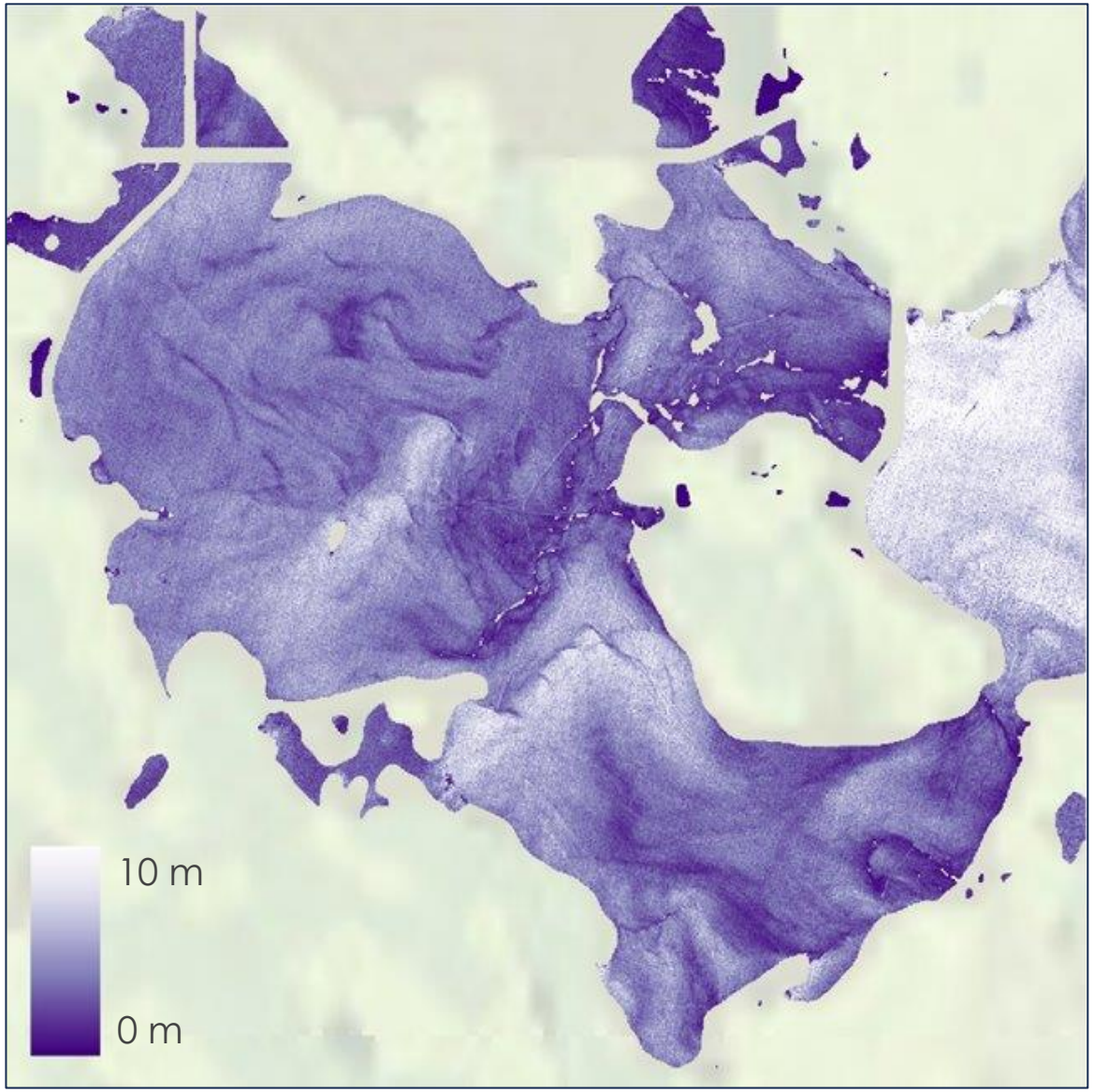




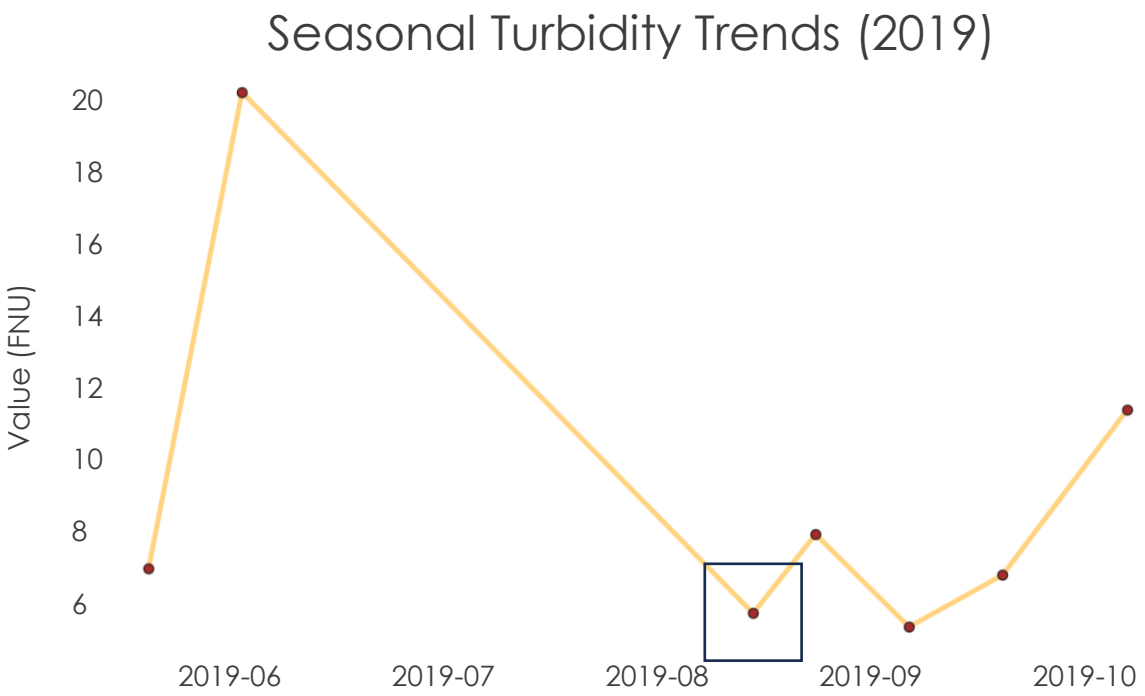


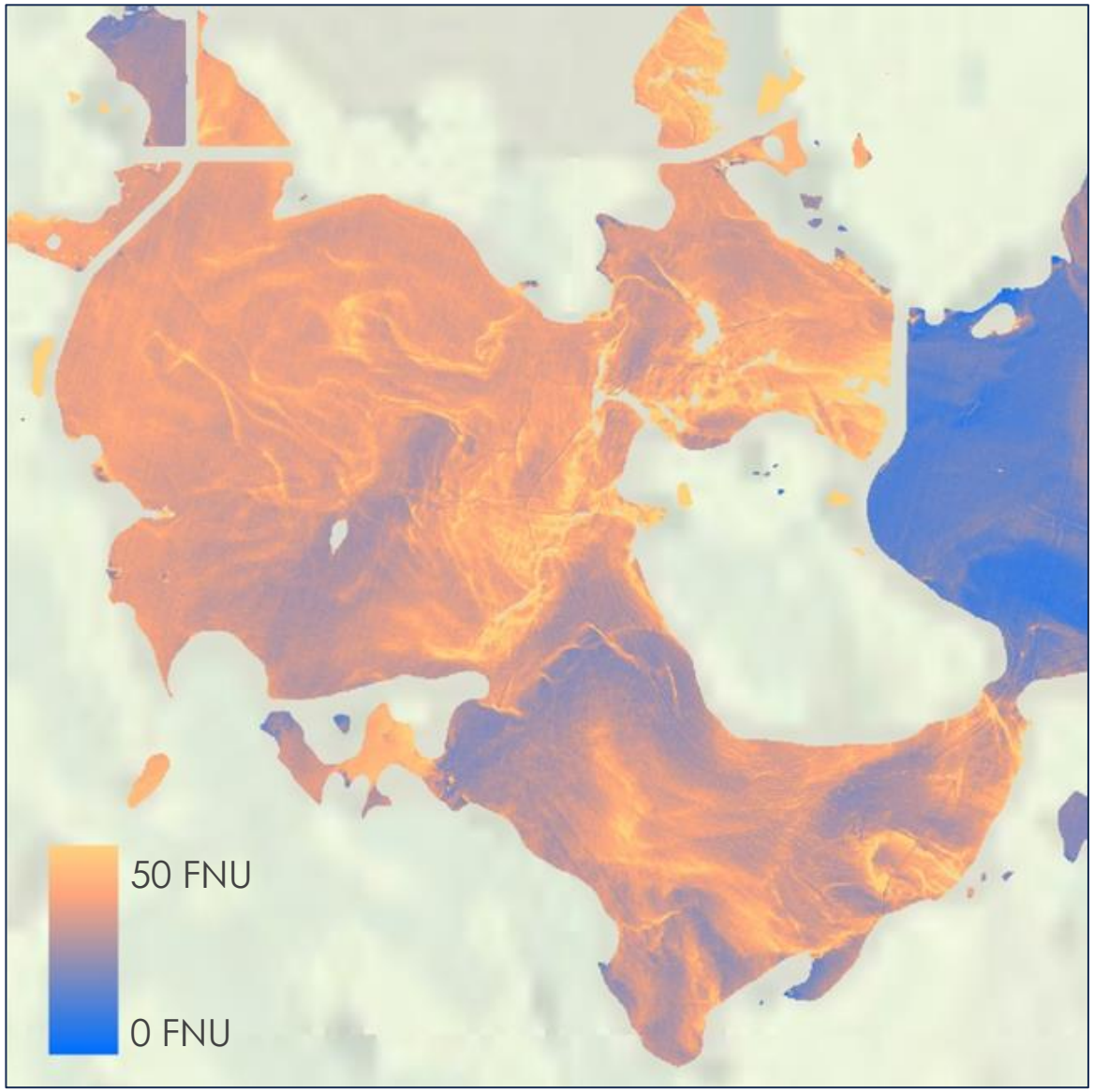
Results: Devil's Lake



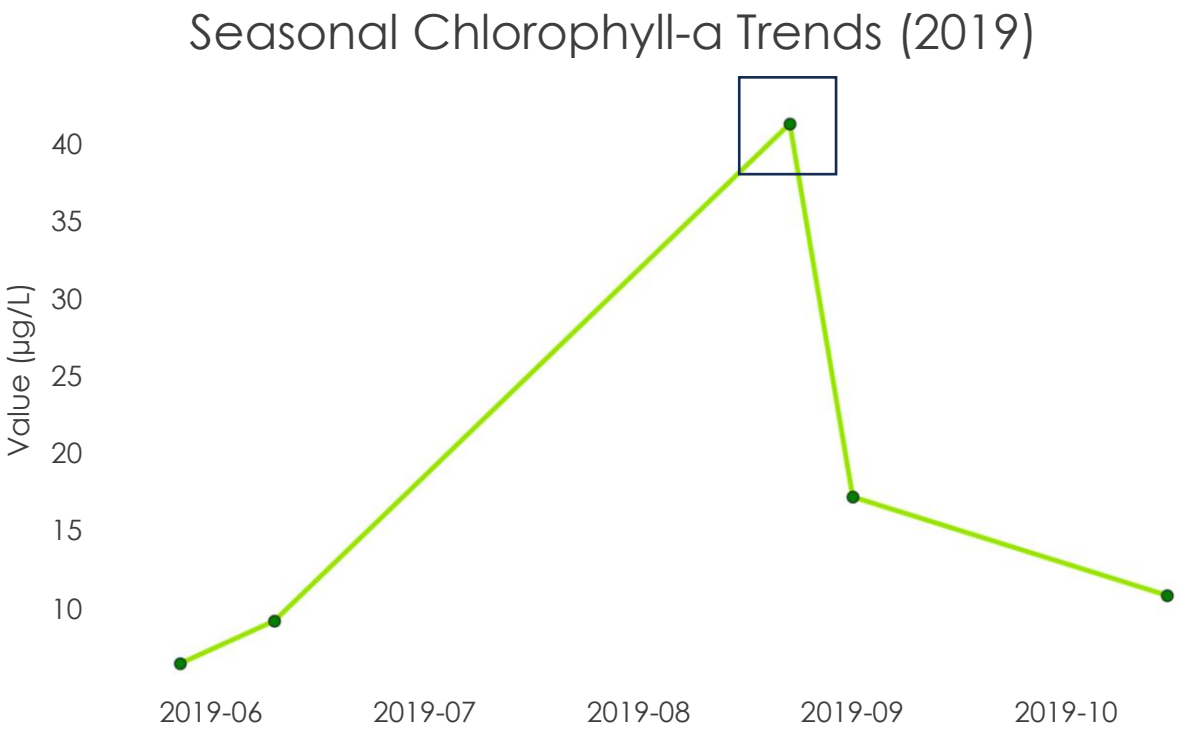


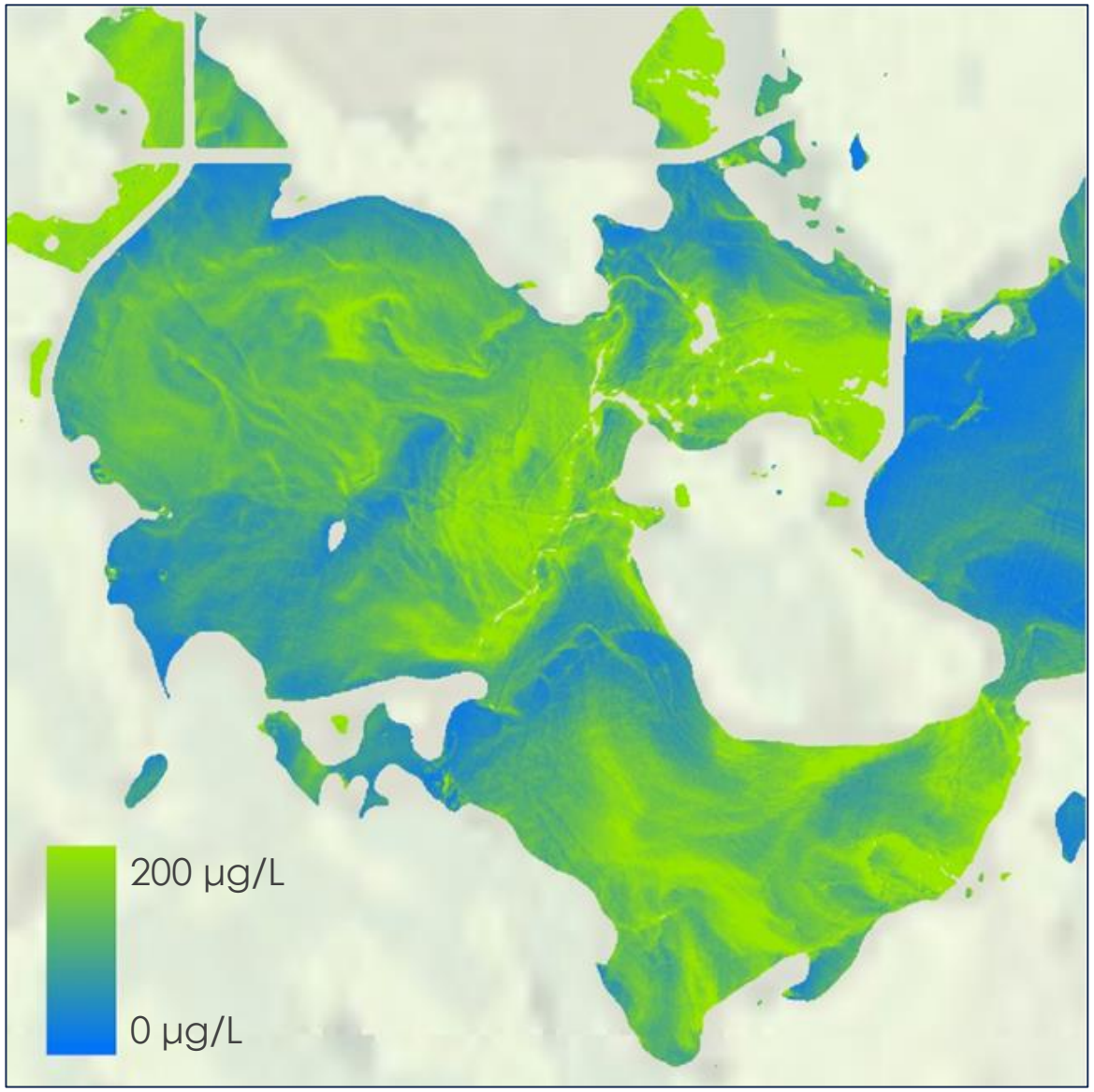
Results: Devil's Lake



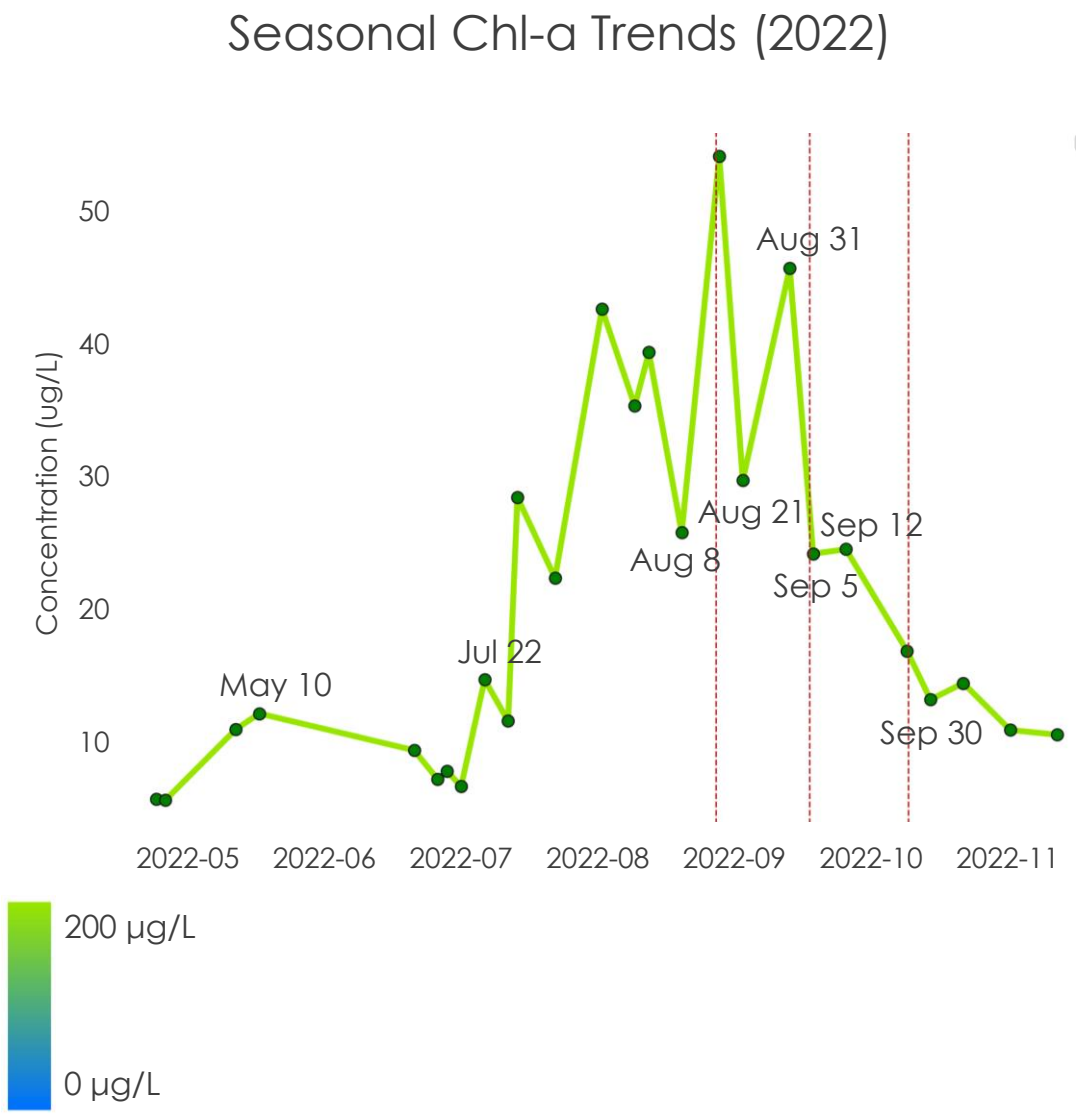


Results: Devil's Lake





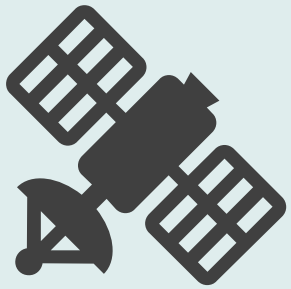
Results: Devil's Lake



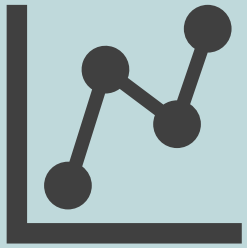
Errors and Uncertainties

Earth Observations	In Situ Data	LakeSense Pipeline
Spatiotemporal resolution	Low availability of sampling measurements	Limited lake availability depending on geometry
Cloud cover	Poor temporal density	Novel Workflow
Lack of red-edge band on Landsat platforms for chlorophyll-a retrieval	Sampling locations	Atmospheric correction failures
		Algorithmic limitations

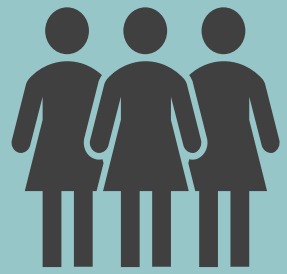
Feasibility and Partner Implementation



Earth observations and the LakeSense pipeline can be used to analyze lake water quality and predict algal bloom dynamics



Remote sensing data can be used to enhance and streamline current water quality monitoring efforts across North Dakota



Results will assist our partners in creating a front-facing algal bloom dashboard to increase public awareness

Conclusions

Remote sensing through LakeSense creates accurate representations of LWQI trends and HAB occurrences

Inland-specific water corrections in LakeSense improve upon generic Landsat and Sentinel atmospheric correction and flagging processes

Results indicated that high chlorophyll-a concentrations, high turbidity, and low Secchi depth are generally observed between June and August

Image Credit: ND DEQ Division of Water Quality

Acknowledgements

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  - Joshua Wert (ND DEQ Division of Water Quality)

- **Lead**
  - Madi Arndt (Massachusetts – Boston)

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