The Use of Spectral Remote Sensing to Detect, Monitor, and Predict Harmful Algal Bloom Location and Intensity

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Research Objective

Use satellite remote sensing from NASA's Landsat 8 Satellite to monitor and predict the location and intensity of Harmful Algal Blooms (HABs) in Lake Chautauqua and Lake Seneca. The ultimate goal is to use hyperspectral remote sensing data create a predictive model that can be applied to all lakes.

Introduction

- Harmful algal blooms are becoming an increasingly prevalent worldwide threat as eutrophic waters are formed from **agricultural runoff and the overuse of fertilizers**.
- Eutrophication increases harmful algal blooms and leads to a condition known as **hypoxia which cause fish kill offs.**
- They cause an estimated **>$50 million in damages annually** from decreased tourism, filtration costs, and the death of shellfish.
- **Current detection methods** are inefficient and **fail to give an accurate depiction of the entire water body**.
- Hyperspectral and satellite sensing has been used in the detection of environmental conditions such as algal blooms based on **chlorophyll levels, cyanobacterial pigments, and phycocyanin.**

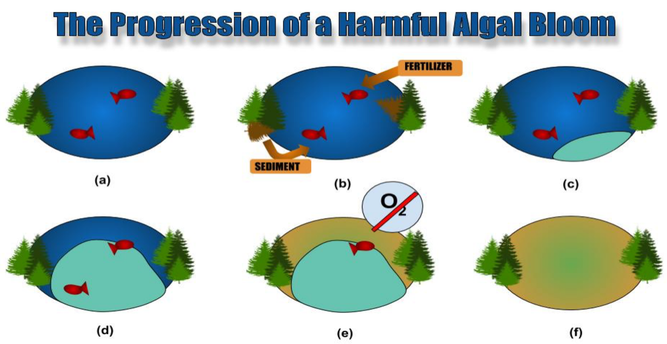


Figure 1: Showing the development of an algal blooms. A) Healthy lake in early spring; B) sedimentation and agricultural runoff leads to nutrient pollution; C) Accelerated algal growth begins in late spring due to eutrophic conditions; D) Algal bloom formation begins; E) Algae depletes oxygen from the water, causing oxygen loss and hypoxia; F) Lake is unable to support life, dead zones replace algae blooms by mid-Fall (Figure made by Keeley Nguyen, Hudson Hyams, Jason Provanzano and Kelly Young)

Methods

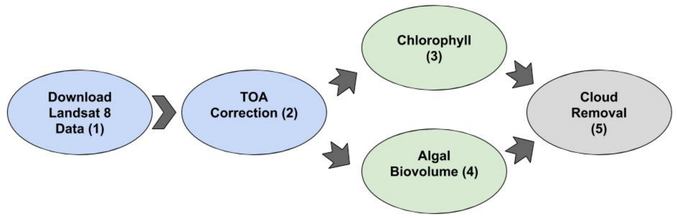
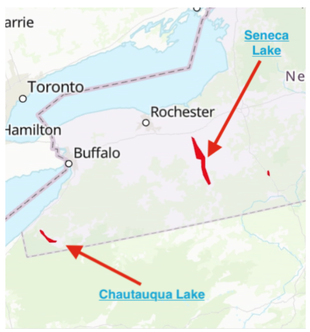


Figure 2: Showing flowchart of methods used for Landsat 8 Satellite Processing. 2018 Data was obtained from EarthExplorer and processed for chlorophyll and algal biovolume levels.



- 2018 Landsat 8 Data was downloaded from EarthExplorer and corrected for Top of the Atmosphere (TOA) interference
- Bands 2, 3, and 4 were used to determine chlorophyll concentrations and algal biovolume in ArcMap
- After processing the data, clouds were removed via the BQA band. This was done to ensure values were not skewed by cloud cover

Figure 3: Showing the lakes of interest, Lake Chautauqua and Lake Seneca, in New York State

Data from satellites can be used to detect, monitor, and predict Harmful Algal Blooms (HABs)

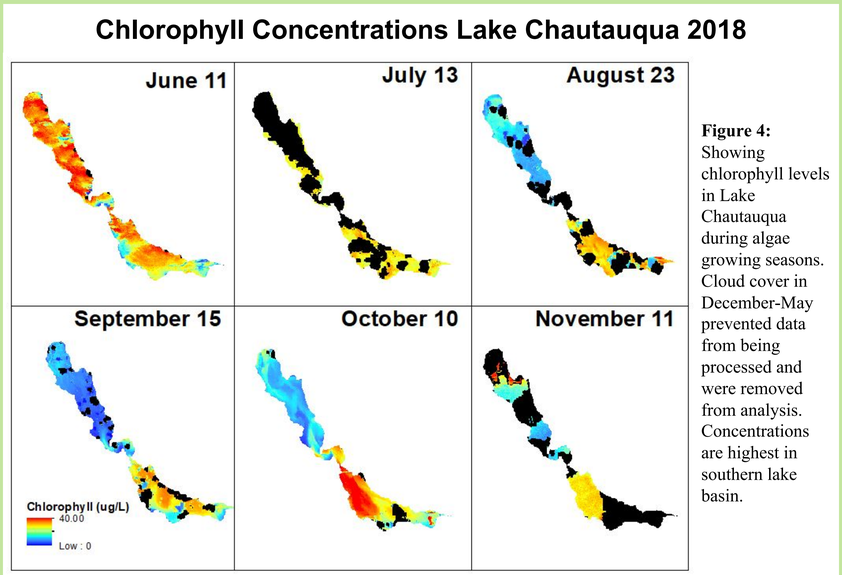


Figure 4: Showing chlorophyll levels in Lake Chautauqua during algae growing seasons. Cloud cover in December-May prevented data from being processed and were removed from analysis. Concentrations are highest in southern lake basin.

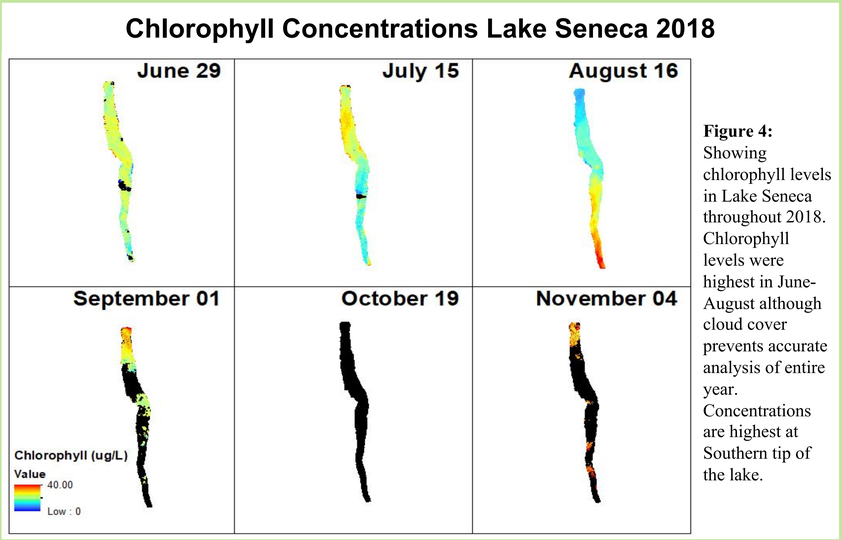


Figure 4: Showing chlorophyll levels in Lake Seneca throughout 2018. Chlorophyll levels were highest in June-August although cloud cover prevents accurate analysis of entire year. Concentrations are highest at Southern tip of the lake.

Results & Conclusion

- Landsat 8 imagery was successful in determining trends in algal intensity and location in Lake Chautauqua and Lake Seneca.
- In both Lake Chautauqua and Lake Seneca, blooms are located in the southern basin of lake and are most dense between May and August.
  - This is likely due to higher temperatures that cause algae to bloom.
  - Water movement in the lake pushes bloom formation into the southern stagnant water, thus creating build up in the southern basin/tip of the lake

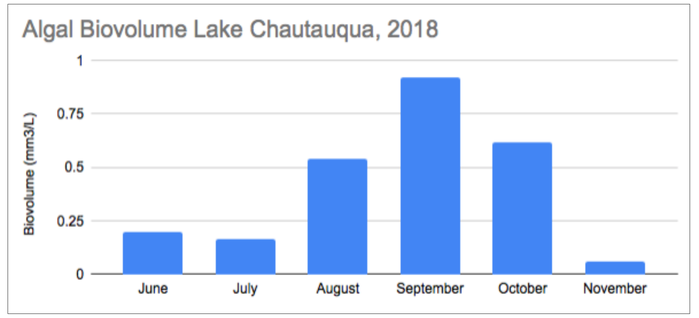


Figure 5: Algal biovolume in Lake Chautauqua peaked in September and October with a general increase during the summer months which indicates algal blooms were most intense during this time period.

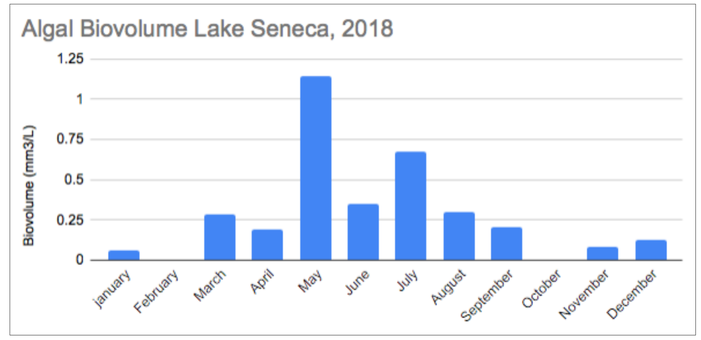


Figure 6: Lake Seneca's Algal biovolume peaked in May and July. The months of May-August had higher overall values, indicating heightened intensity. February and October contained complete cloud cover, and thus the values are represented as 0.

Future Research

Figure 7: DJI Matrice 600 Drone that will be used to collect hyperspectral data in the future

- Landsat 8 Data will be used to determine nitrogen and phosphorous concentrations for 2018
- Hyperspectral sensors will be used to obtain time series data in accordance with Landsat 8 starting in the 2020 growing season
- Data obtained in this preliminary study will help determine sampling locations
- Correlations and time series data will be obtained and used to create a predictive model for algal blooms

References

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