Utilizing Remotely-Sensed Data to Monitor Algal Blooms and Water Quality in Arizona Reservoirs.

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Overview

In the face of a fast-growing population and limited reservoir capacity, closely monitoring algal blooms, especially noxious ones, which can impact water quality in the reservoirs that supply water to the Phoenix metropolitan area will only become more essential. Furthermore, with changing climate conditions, understanding long-term trends and predicting future scenarios will also become increasingly important. This research utilizes historical and newly generated in situ data on water properties and algal populations in three terminal reservoirs, Saguaro Lake, Bartlett Lake, and Lake Pleasant, to gain a fuller understanding of any existing trends in reservoir water quality and to make reasonable predictions about future scenarios. In addition, remotely sensed reflectance data have the potential to allow for monitoring of algal populations on a greater spatial and temporal scale at a lower cost, and without the need for direct lake sampling. In the proposed research, I will use the collected in situ lake water properties and data on algal populations to ground truth remotely-sensed data from Landsat 8's Operational Land Imager and to select and refine a variety of bio-optical algorithms. These refined algorithms will allow me to create future water quality monitoring protocols and will also fill in historical gaps in knowledge of water quality when no field data are available.

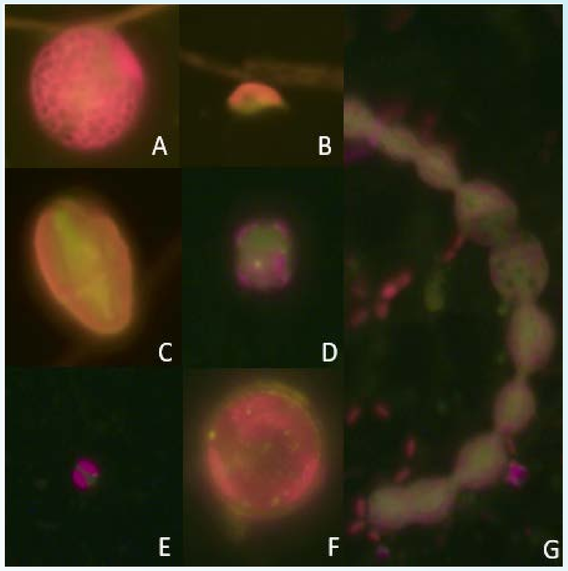
Research Objectives

- Obtain available remotely sensed satellite data for sites of interest.
- Utilize ongoing sampling to build a data set of in situ water quality properties, including total suspended matter, phytoplankton abundance, zooplankton abundance and chlorophyll concentration as a proxy for phytoplankton biomass in reservoirs of interest.
- Determine appropriate band ratio algorithms for each reservoir of interest to correlate satellite data with algal biomass, abundance, and total suspended matter.
- Compare past and present water quality in reservoirs of interest, using both data generated via sampling, and remotely sensed data to reconstruct the "gap" in sampling activities.
- Design protocol for ongoing remote water quality monitoring.
- Apply band ratio algorithms to historical remotely sensed data to gain a better understanding of how water quality has fluctuated over time, and identify implications for future water management.

Methods

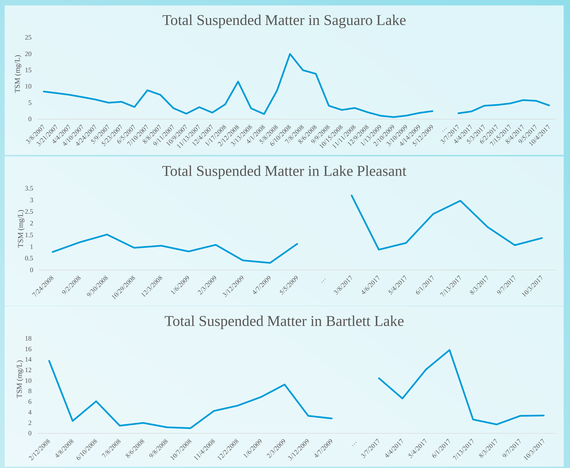
Field sampling is being undertaken from March 2017 to April 2018 at three Arizona reservoirs, Lake Pleasant, Saguaro Lake, and Bartlett Lake. A *Secchi* depth is taken to visually measure water transparency, which can be used as a coarse measure of underwater light penetration. Total suspended sediment is calculated using the gravimetric method for non-filterable residue by filtering 100 mL of sample though Whatmann GF/F filters, which are then dried at 105° C in an oven for at least 2 hours. Samples are tested for chlorophyll-a by filtering 50-250 mL of water through 25 mm GF/F filters in triplicate, and extracting the samples to 10 mL of 90% acetone. The extracted chlorophyll-a is then read on a Turner Designs TD-700 fluorometer. Phytoplankton abundance is determined by filtering volumes from 5 to 20 mL onto a 0.22 µm black polycarbonate filters. Each volume is preserved with 0.1-0.2 mL of 50% Gluteraldehyde and stained with 1 mL of a solution of DAPI (4′,6-Diamidino-2-phenylindole dihydrochloride, 1 mg/100m). The filters are then fixed on glass slides and examined via epifluorescence microscopy under blue light and UV excitation.

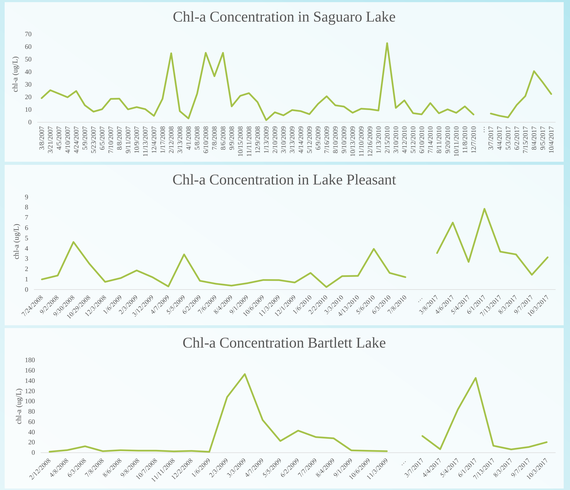
Algae Identifications



Images of algal cells taken with an epifluorescent microscope. (A) *Platymonas* sp. (B) small cryptophyte (C) euglenoid (D) dinoflagellate (E) small prymnesiophyte (F) large centric diatom. (G) *Anabaena* sp.

Preliminary Results





Future Work

Appropriate satellite data will be identified and obtained from Landsat 8, selected for appropriate temporal scale and resolution, and downloaded. The data will be corrected from top of atmosphere reflectance to reflectance at ground level using sun angle, elevation, and atmospheric corrections. The reflectance at ground level will then be used to estimate chlorophyll-a concentration and total suspended matter in the reservoirs of interest using both simple band ratios and established bio-optical algorithms. The resulting estimates will be compared with the field data to determine which estimation tool is best suited for the characteristics of the study sites. The best-suited estimation tool will then be applied to reflectance data on a wider temporal scale to generate estimates of the values of the parameters of interest over a longer time period.

Significance

The results of this research have the potential to greatly reduce the amount of resources required to monitor water quality. This has positive implications for the way water is managed in the Phoenix metro area. There is also potential to detect the onset of noxious and harmful algal blooms more quickly and to monitor them in greater detail. The results of this study have the potential to deepen our understanding of how the algal communities and water quality have changed in the last ten years.

References

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