Monitoring Water Quality and Evaluating Potential Drivers of Algal Blooms in the Upper Yampa River Watershed



Abstract

The Upper Yampa River Watershed (UYRW), located in northwestern Colorado, plays a key role in providing water to the Colorado River. However, the UYRW has been impacted by increasingly frequent and widespread harmful algal blooms (HABs) that emit cyanotoxins and deteriorate the water quality. Due to these cyanotoxins, recreational closures have been enacted and drinking water has been impaired, leading to adverse health, economic, and ecological effects. Partnering with the Upper Yampa Water Conservancy District (UYWCD) and the Colorado State University (CSU) Agricultural Water Quality Program, the DEVELOP team utilized Earth observations from Landsat 5 Thematic Mapper (TM), Landsat 7 Enhanced Thematic Mapper Plus (ETM+), and Landsat 8 Operational Land Imager (OLI) to analyze trends in water quality from 1984 to 2021 for nine waterbodies of interest: Lake Catamount, Lake Dumont, Elkhead Reservoir, Fish Creek Reservoir, Sheriff Reservoir, Stagecoach Reservoir, Steamboat Lake, Stillwater Reservoir, and Yamcolo Reservoir. The team generated time series plots and maps exhibiting parameters such as greenness, temperature, Apparent Visible Wavelength (AVW), and Broad Wavelength Algae Index (BWAI). Finally, evaluation plots were created to analyze the correlation between spectral indices and in-situ measurements. Surface temperature has risen on Lake Catamount, Stagecoach Reservoir, and Steamboat Lake. All other water quality parameters varied in trend and significance across all nine waterbodies. The limited amount of in-situ validation data made it difficult to determine the viability of satellite remote sensing as a tool for monitoring water quality in the UYRW.

Earth Observations





Objectives

Analyze trends in water quality over time and fill historical data gaps Assess the viability of remote sensing to monitor water quality in the Upper Yampa Watershed

Methodology



(c) Lake Catamount Change Map



(d) Evaluation Plots



Study Area



Conclusions

Figure 2 (a) & (b). Time series plot of green band reflectance and surface temperature.

(c). Map displaying AVW, true color imagery, green band values, BWAI, and temperature for Lake Catamount during significant chlorophyll-a or cyanobacteria concentration peak days.

(d). The first 3 plots (from the left) show the evaluation of the spectral bands and indices with the in-situ chlorophyll data, and the last plot exhibits temperature spectral bands with in-situ temperature at Stagecoach Reservoir.

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Figure 1. Study area map showing Yampa river and our areas of interest.

Team Members



(Project Lead)







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- We constructed time series plots of lake color and temperature from 1984 to 2021 for 9 waterbodies of interest and maps for 3 lakes of interest in the Upper Yampa River Watershed.
- The lack of significant evaluation data made it difficult to assess the viability of using remote sensing to monitor water quality.
- There was a strong correlation between remotely sensed temperature and in-situ temperature.
- Mixed trends were found among the 3 lakes for the AVW, BWAI, and green band timeseries.

Project Partners

- Upper Yampa Water Conservancy District
- Colorado State University, Agricultural Water Quality Program
- Colorado State University

Acknowledgements

Science Advisors

- Dr. Anthony Vorster, Science Advisor, Colorado State University
- Cristopher Tsz Hin Choi, Science Advisor, Colorado State University
- Dr. Paul Evangelista, Colorado State University
- Dr. Catherine Jarnevich, Colorado State University
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This material is based upon work supported by NASA through contract NNL16AA05C. Any mention of a commercial product, service, or activity in this material does not constitute NASA endorsement. Any opinions, findinas, and conclusions or recommendations expressed in this material does not constitute NASA endorsement.