Estimation of Estuary Phytoplankton using a Web-based Tool for Visualization of Hyper-spectral Images

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ABSTRACT

The development of web-based tools for visualization and processing of hyper-spectral images has been driven by the need to rapidly acquire and process large amounts of data. This paper presents a web-based visualization tool for exploring NASA's MODIS data, which provides access to real-time data and allows for the rapid visualization of phytoplankton concentrations in estuarine environments. The tool is designed to provide a user-friendly interface for the analysis of MODIS data and to enable scientists to estimate phytoplankton concentrations in real-time.

OBJECTIVE

This research presents a web-based tool for visualization of MODIS spectral reflectance data. The main objective of this research is to develop a web-based tool for the estimation of phytoplankton concentrations in estuarine environments.

METHODS

1. Web-based tool
   - This tool allows for the visualization of MODIS spectral reflectance data.
   - It provides interactive tools for the analysis of spectral reflectance data.

2. Chlorophyll-a calculation
   - Chlorophyll-a concentrations are estimated using the following equation:
     \[ \text{Chl-a} = a \times \left( \frac{R_{12} - R_{11}}{R_{10} - R_{9}} \right) \]
   - Where:
     - \( a \) is a constant
     - \( R_{12}, R_{11}, R_{10}, R_{9} \) are the reflectance values at bands 12 (546-556 nm), 11 (438-448 nm), 10 (483-493 nm), and 9 (403-413 nm), respectively.

3. Phytoplankton carbon estimation
   - Phytoplankton carbon concentrations are estimated using stoichiometric ratios available in the literature.

RESULTS

The tool is applied to estimating chlorophyll-a and phytoplankton-carbon concentrations for the estuary located in the Saint Louis Bay watershed (Mississippi). Chlorophyll-a estimations produced from the web-based tool are compared with field measurements, and the tool is found to be effective for visualization of MODIS datasets. The tool has been tailored to read .geotiff files equivalent to MODIS multi-spectral data-cubes.

BACKGROUND

Phytoplankton biomass in aquatic ecosystems is an indicator of water quality and ecosystem health. Chlorophyll-a is a pigment associated with phytoplankton, and it is commonly used for estimating phytoplankton concentrations using spectral reflectance data. The web-based tool developed in this research is presented as an initial exploration of web-based chlorophyll-a concentrations estimation. Future studies will include identification of seasonal and annual trends for calibration of the tool.

METHODS (continued)

1. Spectral reflectance and chlorophyll-a field data
   - MODIS spectral reflectance data were retrieved from the NASA's Ocean Color web site.
   - The chlorophyll-a and phytoplankton concentrations calculated through the web-based tool are compared with field measurements.

CONCLUSIONS

The web-based tool developed in this research has proven to be very effective for visualization of MODIS data and for the estimation of chlorophyll-a and phytoplankton concentrations. However, further studies are needed to validate the methodology for chlorophyll-a and phytoplankton concentrations estimation. Future studies will include identification of seasonal and annual trends for calibration of the tool.

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Study area

Initial view of the web-based tool

Control panel and spectral reflectance curve

Normalized Difference Vegetation Index (NDVI) image

Spectral reflectance curve

Chlorophyll-a concentration (mg/m³)

Normalized Difference Vegetation Index (NDVI) image

Phytoplankton role in water quality

Figure 1: Chlorophyll-a concentrations in the Saint Louis Bay estuary (Mississippi) estimated using the web-based tool.

Figure 2: Chlorophyll-a concentrations in the Saint Louis Bay estuary (Mississippi) estimated using the web-based tool.

Figure 3: Chlorophyll-a concentrations in the Saint Louis Bay estuary (Mississippi) estimated using the web-based tool.

Figure 4: Chlorophyll-a concentrations in the Saint Louis Bay estuary (Mississippi) estimated using the web-based tool.