

Risks for Cyanobacteria Harmful Algal Blooms in Georgia Piedmont Waterbodies Due to Land Management and Climate Interactions

Authors : Sam Weber, Deepak Mishra, Susan Wilde, Elizabeth Kramer

Abstract : The frequency and severity of cyanobacteria harmful blooms (CyanoHABs) have been increasing over time, with point and non-point source eutrophication and shifting climate paradigms being blamed as the primary culprits. Excessive nutrients, warm temperatures, quiescent water, and heavy and less regular rainfall create more conducive environments for CyanoHABs. CyanoHABs have the potential to produce a spectrum of toxins that cause gastrointestinal stress, organ failure, and even death in humans and animals. To promote enhanced, proactive CyanoHAB management, risk modeling using geospatial tools can act as predictive mechanisms to supplement current CyanoHAB monitoring, management and mitigation efforts. The risk maps would empower water managers to focus their efforts on high risk water bodies in an attempt to prevent CyanoHABs before they occur, and/or more diligently observe those waterbodies. For this research, exploratory spatial data analysis techniques were used to identify the strongest predictors for CyanoHAB blooms based on remote sensing-derived cyanobacteria cell density values for 771 waterbodies in the Georgia Piedmont and landscape characteristics of their watersheds. In-situ datasets for cyanobacteria cell density, nutrients, temperature, and rainfall patterns are not widely available, so free gridded geospatial datasets were used as proxy variables for assessing CyanoHAB risk. For example, the percent of a watershed that is agriculture was used as a proxy for nutrient loading, and the summer precipitation within a watershed was used as a proxy for water quiescence. Cyanobacteria cell density values were calculated using atmospherically corrected images from the European Space Agency's Sentinel-2A satellite and multispectral instrument sensor at a 10-meter ground resolution. Seventeen explanatory variables were calculated for each watershed utilizing the multi-petabyte geospatial catalogs available within the Google Earth Engine cloud computing interface. The seventeen variables were then used in a multiple linear regression model, and the strongest predictors of cyanobacteria cell density were selected for the final regression model. The seventeen explanatory variables included land cover composition, winter and summer temperature and precipitation data, topographic derivatives, vegetation index anomalies, and soil characteristics. Watershed maximum summer temperature, percent agriculture, percent forest, percent impervious, and waterbody area emerged as the strongest predictors of cyanobacteria cell density with an adjusted R-squared value of 0.31 and a p-value ~ 0 . The final regression equation was used to make a normalized cyanobacteria cell density index, and a Jenks Natural Break classification was used to assign waterbodies designations of low, medium, or high risk. Of the 771 waterbodies, 24.38% were low risk, 37.35% were medium risk, and 38.26% were high risk. This study showed that there are significant relationships between free geospatial datasets representing summer maximum temperatures, nutrient loading associated with land use and land cover, and the area of a waterbody with cyanobacteria cell density. This data analytics approach to CyanoHAB risk assessment corroborated the literature-established environmental triggers for CyanoHABs, and presents a novel approach for CyanoHAB risk mapping in waterbodies across the greater southeastern United States.

Keywords : cyanobacteria, land use/land cover, remote sensing, risk mapping

Conference Title : ICHA 2017 : International Conference on Harmful Algae

Conference Location : San Diego, United States

Conference Dates : December 18-19, 2017