Estimating the water quality condition of river and lake water in the Midwestern United States from its spectral characteristics

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Jing Tan received her Bachelor's degree from the department of Geography, Beijing Normal University, China in 2009. After that she came to Purdue and was enrolled in the Ecological Sciences and Engineering (ESE) interdisciplinary program. She got her Master's degree from the department of Agricultural & Biological Engineering, Purdue University in August 2011. Jing's Master research is of using thermal infrared remote sensing to study stream temperature and its relationship with land use patterns. She continued her PhD study with emphasis on remote sensing of water quality in inland waters. Her current research interests lie in the analysis of remote sensing data (in situ, airborne and satellite) and algorithms development for water quality monitoring. After her PhD, she will work as a postdoctoral scholar at the Scripps Institute of Oceanography at UCSD.

Abstract

This study focuses on developing/calibrating remote sensing algorithms for water quality retrieval in Midwestern rivers and lakes. In the first part of this study, the spectral measurements collected using a hand-held spectrometer as well as water quality observations for the Wabash River and its tributaries in Indiana were used to develop empirical models for the retrieval of chlorophyll (CHL) and total suspended solids (TSS). A method for removing sky and sun glint from field spectra for turbid inland waters was developed and tested. Empirical models were then developed using a subset of the field measurements with the rest for model validation. Spectral characteristics indicative of waters dominated by different inherent optical properties (IOPs) were identified and used as the basis of selecting bands for empirical model development. The second part of this study focuses on the calibration of an existing bio-geo-optical model for studying the spatial variability of CHL, non-algal particles (NAP), and colored dissolved organic matter (CDOM) in episodic St. Joseph River plumes in southern Lake Michigan. One set of EO-1 Hyperion imagery and one set of boat-based spectrometer measurements were successfully acquired to capture episodic plume events. Coincident water quality measurements were also collected during these plume events. A database of inherent optical properties (IOPs) measurements and spectral signatures was generated and used to calibrate a bio-geo-optical model. Finally, a comprehensive spectral-biogeochemical database was developed for the Wabash River and its tributaries in Indiana by conducting field sampling of the rivers using a boat platform over different hydrologic conditions during summer 2014. In addition to the various spectral measurements taken by a handheld field spectrometer, this database includes corresponding in situ measurements of water quality parameters (CHL, NAP, and CDOM), nutrients (TN, TP, dissolved organic carbon (DOC)), water-column IOPs, water depths, substrate types and bottom reflectance spectra. The temporal variability of water quality parameters and nutrients in the rivers was analyzed and studied. A look-up table based spectrum matching (LUT) methodology was applied to the collected observations in the database to simplify the retrieval of water quality parameters and make the data accessible to a wider range of end users. This study demonstrates the ability of remote sensing in monitoring water quality retrieval in inland rivers and lakes. In addition, the datasets collected in this study provide useful ground truth data for remote sensing of water quality in inland waters and valuable sources for further investigation of the relationship between optical and biogeochemical properties.