Prediction of Optical and Non-Optical Water Quality Parameters in Oligotrophic and Eutrophic Systems Using a Small Unmanned Aerial System[1]

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Abstract: Continuous monitoring can not only be used to measure changes of conditions over time, but also to provide qualitative and quantitative parameters used to develop regulations, policies or guidance in order to protect those ecosystems. Traditional on-the-ground monitoring has proven to be time consuming, susceptible to errors and only to be related to single points in time and space (particularly when monitoring water quality in lakes, rivers, and streams). The purpose of this study was to create statistical water quality models for optical (Total Suspended Solids (TSS), Secchi Disk Depths (SDD) and Chlorophyll-a (Chl-a)) and non-optical (Total Phosphorus (TP) and Total Nitrogen (TN)) water quality parameters in an oligotrophic system (Grand River Dam Authority (GRDA) nursery ponds) and a eutrophic system (City of Commerce, Oklahoma, Wastewater Lagoons) using images from a small Unmanned Aerial System (sUAS) equipped with a multispectral sensor. Statistically relating optical and non-optical water quality parameters to multispectral imagery allows expansion of extrapolated water quality indicators to larger spatial databases. To develop these relationships two sets of data were acquired 1) in-situ water quality measurements and 2) the real reflectance values from sUAS imagery. These reflectance values were extracted under three scenarios: (1) a value to point extraction, using the GPS location of each sampling station, (2) an average value extraction using a buffer zone of 12 ft. (3 meters) around the sampling stations and (3) a point extraction of 162 points using the different kriged surfaces. By using a single variable and multiple variables linear modelling approach, a total of 375 linear models were created and evaluated (315=single variable and 60=multiple variables). The best-fit models were determined by the coefficient of determination (R^2) and the Akaike information criterion (AIC). Results indicate that multiple variables linear regressions in the visible portion of the electromagnetic spectrum (blue, green, and red) best describe the relationship between TSS (R^2 =0.87), Chl-a (R^2 =0.93), TN (R^2 =0.92), TP (R^2 =0.92), and SDD (R^2 =0.86). In addition, this study concluded that statistical interpolation (ordinary kriging) does not improve the relationship between the different water quality parameters and the reflectance values.[3]

Additional Key Words: Remote Sensing, Small Unmanned Aerial System, Water Quality, Optical and Non-Optical Parameters.

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3. Work reported here was conducted near 36° 34’ 08’’ N, 94° 58’ 03’’ W.