Using Digital Images and Spectral Reflectance to Quantify Colored Dissolved Organic Matter (CDOM) in Water

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ABSTRACT

The use of digital cameras to collect scientific data for environmental research is a newly developing technique. We want to see if digital image data and spectral reflectance data can be used to measure CDOM (Colored Dissolved Organic Matter) accurately We are going to compare and analyze data collected from digital images, a laboratory reflectance spectrometer, and a colorimeter. A colorimeter, known to measure CDOM accurately, was used to compare the digital imagery techniques and spectral reflectance techniques to determine their usefulness in measuring CDOM concentrations. Results showed that reflectance techniques and normal camera blue brightness worked well, and enhanced digital imagery with all colors worked exceedingly well for predicting variations in water color.

INTRODUCTION

Digital cameras provide a cost affective way for researchers to conduct studies. Since not everyone has the use of expensive equipment such as the VIRIS(a high end reflectance spectrometer), or a LaMotte 3001 colorimeter, but most digital cameras are affordable to the public. Digital images, and satellite data are very similar to one another. They both image object, for the surface to the Earth in a variety of remote sensing applications. Digital cameras also collect light reflectance data as well.

HYPOTHESIS

CDOM concentration can be quantified with digital images and VIRIS spectral reflectance measurements.

OBJECTIVES

The use of a digital camera is used to capture images of water collected from Lake Drummond at the Great Dismal Swamp, where there is a very high concentration of CDOM in the water. The comparison of RGB (Red, Green, Blue) brightness from digital images and VIRIS GER 2600 spectral reflectance data to the LaMotte 3001 colorimeter, will provide us with an accurate measure of the water color.

METHODS

Each sample was put into a Petri dish. Using the digital cameras, we took images of each water sample in the Petri dish. We also took a *VIRIS GER2600* reflectance measure and LaMotte 3001 color measurement of each sample. We used digital imaging software, *Analyzing Digital Images* (*ADI*) (Figure 1) to measure the RGB brightness values from digital images. Finally, we will compared the results from the digital imaging software (*ADI*) to the results from the *VIRIS GER 2600*.

Using a Kemmerer Water Bottle, we collected one gallon of water from Lake Drummond at the Great Dismal Swamp. In order to test our hypothesis, we needed to test several samples. In order to test more samples, we diluted the water first using a 1 to 1 ratio (one part GDS water and one part distilled water) and diluting the water 10 times successively lowering the CDOM concentration.





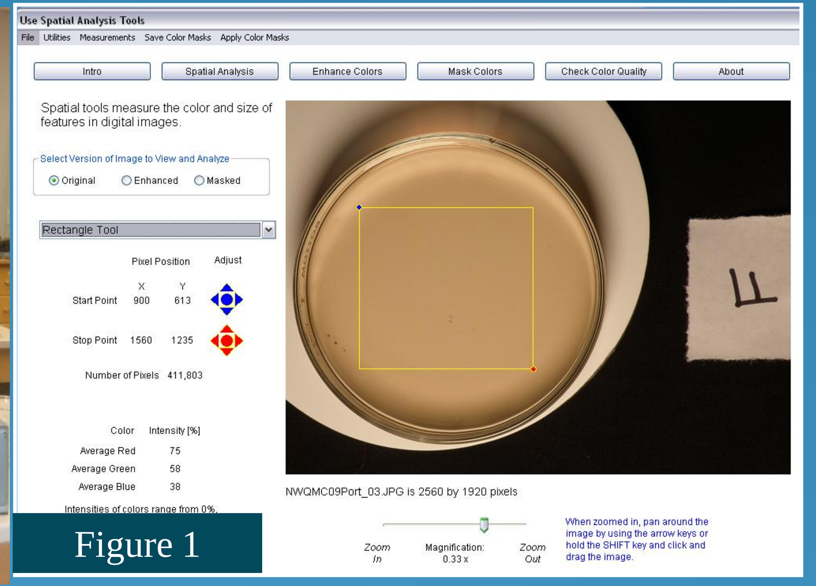

Figure 1

RESULTS

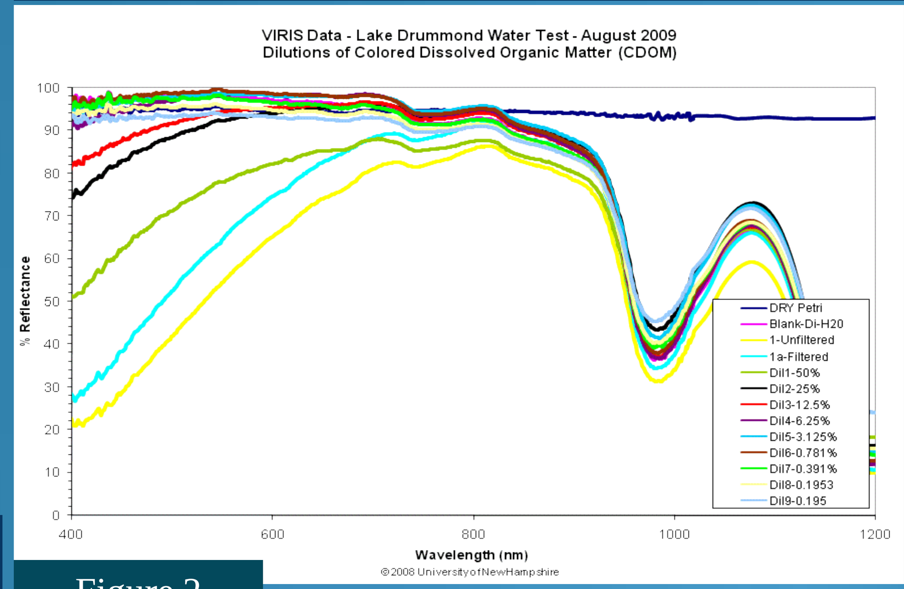

Figure 2

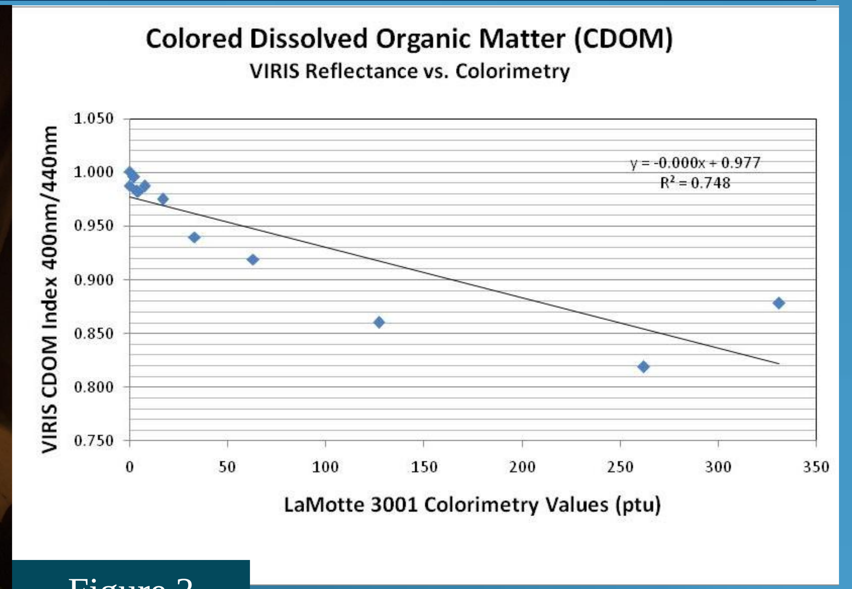

Figure 3

Above in figure 2, reflectance curves are shown for varying concentrations of CDOM. The visible spectrum (400-700nm) shows a great amount of variation as CDOM concentration changes. A ratio of 400nm/440nm was created to measures these changes. Using the low wavelengths minimized effects which may be caused by chlorophylls or other pigments which may be present in the sample. Figure 3 shows the relationship between the VIRIS reflectance index 400/440 versus the LaMotte 3001 colorimeter. The VIRIS index 400/440 was able to predict 74.8% of the variation in changes in CDOM concentration.

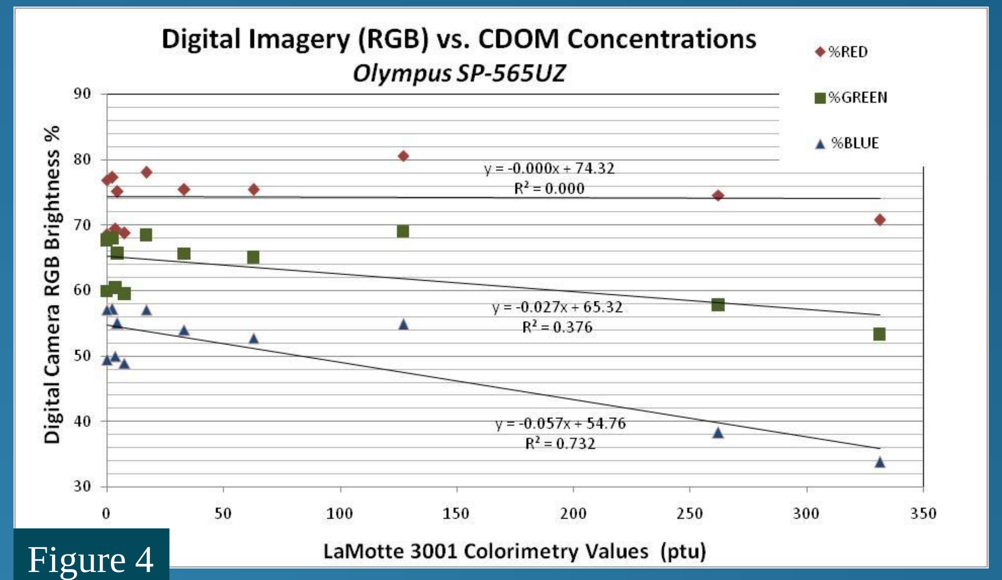

Figure 4

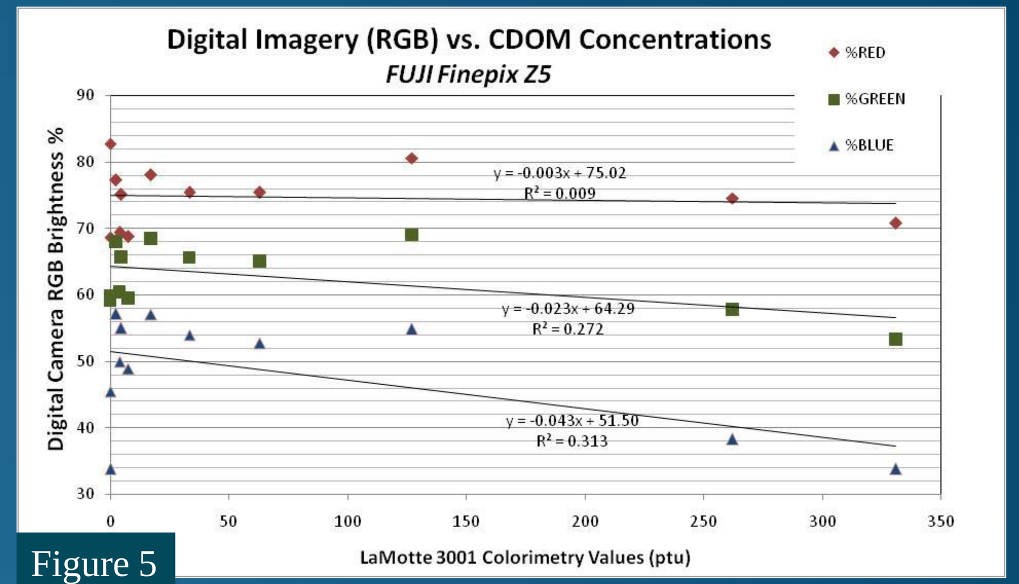

Figure 5

Figures 4 and 5 show normal red, green, and blue camera brightness values compared to CDOM concentrations measured in platinate cobalt units (pcu). Images were taken with the cameras on auto setting without flash. The color with the closest r^2 value to 1 was the blue value using the *Olympus SP-565UZ*. For both cameras the blue camera data showed the strongest relationship, while the reds displayed the weakest relationship with green falling in the middle.

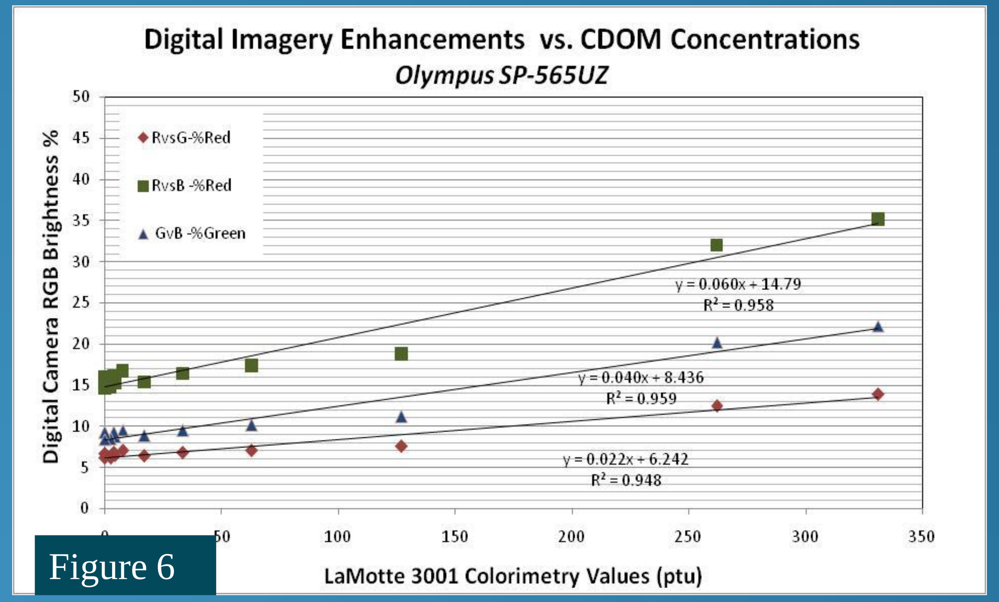

Figure 6

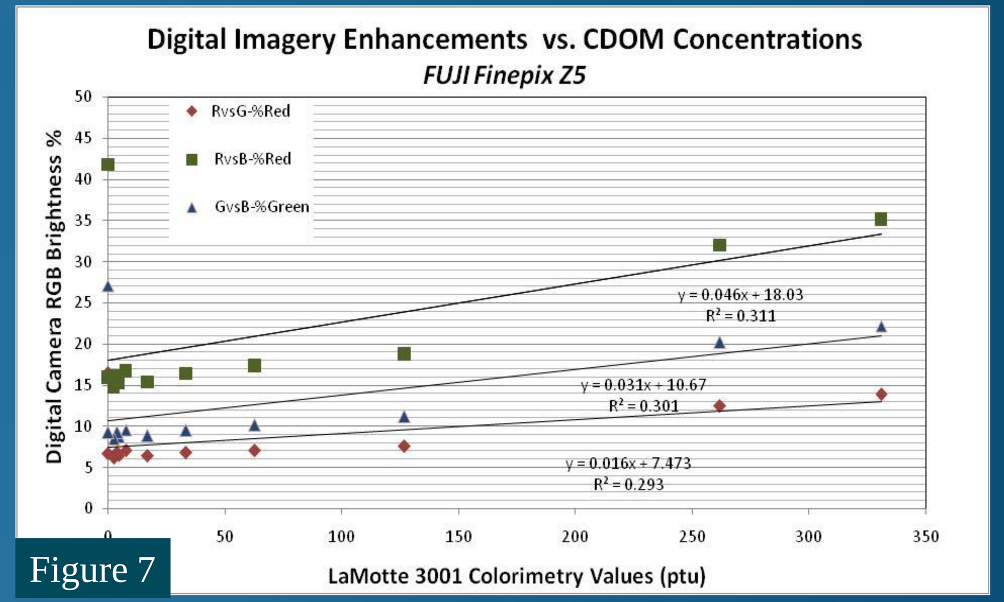

Figure 7

Figures 6 and 7 show color enhancements that provide a comparison between two colors. Using this normalization process minimizes variation with in the area of study and amplifies the difference between the two colors. All enhancements using the *Olympus SP-565UZ* showed very strong relationships signified by very high r-squared values. The *Fuji Finepix Z5* enhancements were not as strong due to one significant outlier. This outlier significantly lowered the strength of the relationships, but when removed the r-squared values for all three enhancements matched the results from the *Olympus Sp-565UZ* camera.

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