Using sUAS for the Development and Validation of Surface Water Quality Models in Optically Deep Mine Waters[1]

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Abstract: This study was undertaken to demonstrate novel remote monitoring techniques for mining-impacted surface waters utilizing spectral data from two different platforms (multispectral sUAS and handheld hyperspectral sensors) and to highlight the feasibility of using sUAS-derived multispectral imagery to estimate in-situ metal concentrations in two passive mine drainage treatment systems. Results describe strong linear relationships (e.g., $R^2_{adj.} > 0.74$) between multispectral reflectance and various in-situ constituent concentrations (e.g., Fe, Li, Mn, Pb, and Zn). Developed ordinary least squares (OLS) models estimated mean metal concentrations within 1% of the observed value and a 70% confidence interval. Validation at a separate site treating waters of a different geologic origin allowed us to assess the models' site specificity. Validation of some models was not possible within this study's statistical constraints (e.g., ± 25% of the observed in-situ value). However, two models were validated and when the linear relationships were examined with site-specific spectra (i.e., sUAS-derived multispectral imagery), significant improvements to the models were observed. Employing hyperspectral remote sensing techniques yielded a novel identification procedure for optically shallow waters. This exponential relationship (e.g., $R^2 = 0.73$) provides an evaluation of the feasibility of using remote sensing technologies to assess water quality before any model development efforts. A tool capable of identifying remote sensing interferences will be crucial for the future of environmental remote sensing. Using sUAS to estimate in-situ water quality provides a new way to monitor passive mine water treatment systems, potentially advancing the efficiency and cost-effectiveness of monitoring and altering traditional environmental remote sensing strategies.

Additional Key Words: Regression, Remote Sensing, Multispectral, Hyperspectral, Optical Depth.

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3. Work reported here was conducted near 36.922350, -94.873297 (MRPTS); 34.847659, -95.535299 (HPTS),