Evaluating the Role of Optical Depth on Spectral Reflectance Data from sUAS-Mounted Multispectral Sensors and Handheld Hyperspectral Radiometers with Relation to Development of Water Quality Models in Mine Drainage Systems[1]

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Abstract: Remote sensing of terrestrial and aquatic ecosystems is a demonstrated tool in environmental monitoring. As part of a larger study to develop water quality models based on the spectral reflectance of surface waters, this project examined the influences that underlying substrates (e.g., iron oxides in mine drainage systems) may play in model development. The work was completed at the Mayer Ranch Passive Treatment System (MRPTS) in the Tar Creek Superfund Site, the Oklahoma portion of the historic Tri-State Lead-Zinc Mining District. A high-resolution, small Unmanned Aerial System (sUAS)-mounted multispectral sensor and a hand-held hyperspectral radiometer were used to examine the effects of physical water depth (from water surface to substrate surface) and optical depth (depth of light penetration through the water column) on resulting spectral reflectance data and its relationship to *in-situ* water quality data. Both instruments produce reflected radiant energy signatures which may be impacted by underlying substrates if the optical depth exceeds the physical water depth. Three locations within the PTS were examined three times. Samples from three locations were collected and analyzed for moisture content, loss-on-ignition, total metal concentrations via field portable X-ray fluorescence, and wet and dry spectral reflectance. Results from these analyses revealed the following means: moisture content of 82 ± 1.5 %, organic matter of 12 ± 2.7 %, and total metal concentrations for Pb, Zn, and Cd of 50 ppm, 9000 ppm, and below detectable limits, respectively. When comparing the peak reflectance within the visible portion of the electromagnetic spectrum, wet substrates reflected approximately 55 percent more light energy. If the depth of the water column exceeded the optical depth of light penetration, the spectral reflectance of the substrate did not impact the overall spectral signature measured from either device. However, when the optical depth of light penetration exceeded the physical water depth, the overall signature was impacted. When applying statistical models relating spectral reflectance to water quality in optically shallow waters, not only do constituents in the water (e.g., total suspended solids, chlorophyll-a, and colored dissolved organic matter) impact the overall signature, but the surface of the underlying substrate does so as well. Therefore, spectral reflectance and *in-situ* water quality may not be strongly correlated.

Additional keywords: Spatial Modeling, Iron Oxides, Tar Creek

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3. Work reported here was conducted near N 36.922, W 94.872.