Detecting the Presence of Coal Mining Impacts by Predicting Acid Mine Drainage Impacted Streams Using Aerial Imagery[1]

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Abstract: Coal mining leaves an environmental legacy in Appalachia; the process is disruptive to ecosystems and incurs both chemical and physical changes that alter water and habitat quality in receiving water bodies. To attempt to restore impacted streams, treatment systems are necessary. Before systems can be designed and deployed, an intensive and costly series of field work is performed to find, identify, assess and plan for acid mine drainage (AMD) restoration. If the identification can be accomplished by using remotely sensed data, then the cost and time of preparing a treatment plan is drastically decreased. Four-band aerial imagery collected by Woolpert for five counties in Appalachia Ohio and water quality data from Ohio University's Database (www.watersheddata.com) were employed for this study. A data set was established in a GIS system based on AMD-impacted (8,065 pixels) versus non-AMD impacted (3,747 pixels) sites using pH, Fe, and Al values. Custom software written in Python was deployed to calculate and retrieve values from the imagery. The analysis was performed via an iPython notebook (scipy, pandas, sklearn). The analysis process involved structuring the data, descriptive statistics, hypothesis testing to determine if AMD and non-AMD impacted streams appear to be from different populations, and then applying machine learning algorithms to see if AMD can be successfully classified. From the infrared band, the Mann-Whitney U test was run, which yielded a U of 13,921,607(p=0.000) indicating that infrared values for AMD and non-AMD are from different populations. For all five of the machine learning classification attempts, a random sample of 25% was used to fit each model (training set), then the other 75% was used to test the predictions as the testing set. Machine learning algorithms were able to correctly classify 70-75% of all sampled pixels, with many of the misclassifications explainable from the same few water bodies.

Additional Key Words: Appalachia, Python, GIS, machine learning.

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[1] Oral paper presented at the 2017 National Meeting of the American Society of Mining and Reclamation, Morgantown, WV: ***What's Next for Reclamation?*** April 9 - 13, 2017. Published by ASMR, 1305 Weathervane Dr. Champaign, IL 61821.

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