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Vegetation Health Improvements from the Effects of Soil Contamination Near Tree Canopy at Annapolis Lead Mine, Annapolis, MO

GSP. 216



Introduction

The United States Environmental Protection Agency (EPA) had listed The Annapolis Lead Mine site, located in Annapolis, MO, on the National Priorities List (NPL) as seen in figure 1. The NPL is a list of hazardous waste sites, in which known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States and its territories (EPA, 2015). The area of interest consists of a 200-acre Annapolis Lead Mine Site that's located in Annapolis, Missouri. Lead mining activities occurred from 1919 to 1940, which generated over one million tons of mining wastes, contaminating soils and sediments with heavy metals, primarily lead. Although, heavy metals are naturally present in soil, geologic and anthropogenic activities increase the concentration of these metals to an amount where they can become harmful for vegetation and animals. These activities consist of mining and smelting of metals, burning fossil fuels, use of fertilizers and pesticides in agriculture, etc. High levels of heavy metal concentrations can result in growth reduction from changes in physiological and biochemical processes in plants growing on heavy metal polluted soils (Chibuike and Obiora, 2014). The construction to remediate the site was completed on September 25th, 2007. Human exposure status is under control, and this site isn't a contaminated ground water site. The protectiveness status is a short-term protection, and is not ready for anticipated use. The following cleanup, operation and maintenance activities are ongoing. The focus of this analysis will attempt to answer what's the improvement on vegetation health from the remediated site due to the previously contaminated soil and heavy metals, and what the visual representations mean from these results.



Figure 1: Site of the Annapolis Lead Mine in Annapolis, MO.

Methods

The data for this analysis consisted of NAIP JPG2000 images and was obtained through the USGS EarthExplorer portal with a resolution of one meter with a spatial reference of UTM_NAD83_Zone_15N for both images. The two images consisted of the Annapolis Lead Mine site from two different periods, one from June 19th, 2009, and June 24th, 2014. To visually distinguish the images, both were transformed from a true color composite to a false color composite. Both exhibited change in color bands, Red for Band 4, Green for Band 3, and blue for band 2. The next process was to determine the spectral profiles for the following features: unhealthy trees, healthy trees, and contaminated soil within the abandoned mine region of interest. This will compare and contrast the spectral values of each feature for both images, at relatively the same locations picked for each feature as seen in figure 3. Next was to compare the NDVI values for each of the features as an alternative method to compare and contrast the changes from the three year time difference.

Results

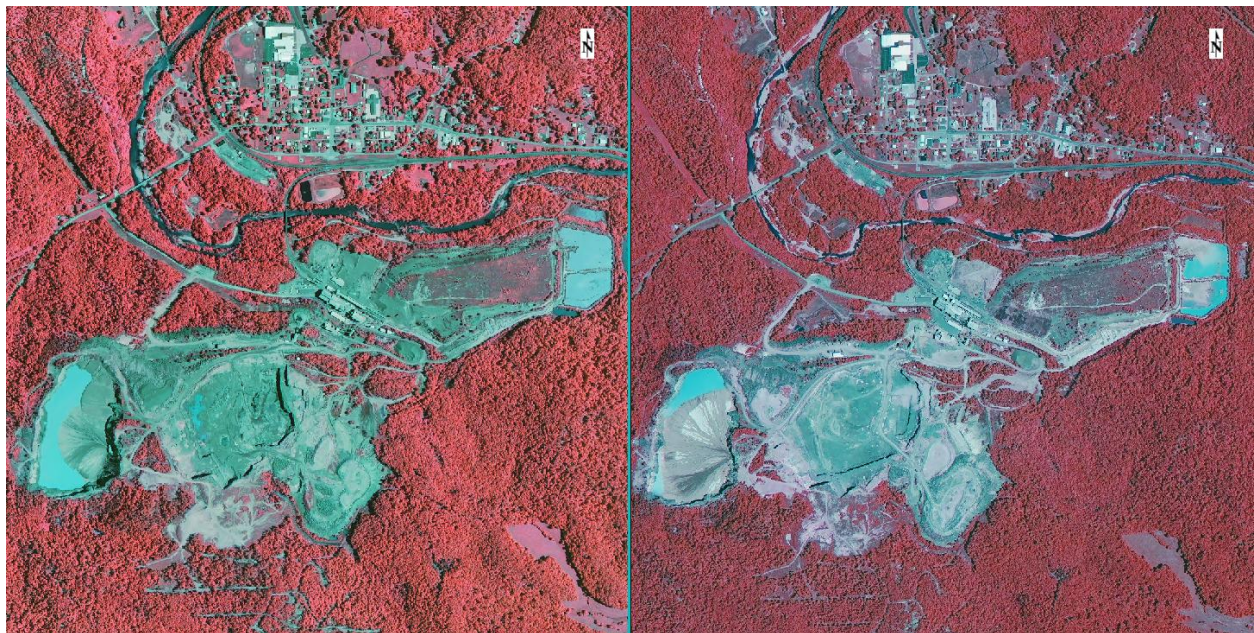


Figure 2: False color composite of Annapolis Lead Mine site. Left is from June 19th, 2009, and right is from June 24th, 2012.

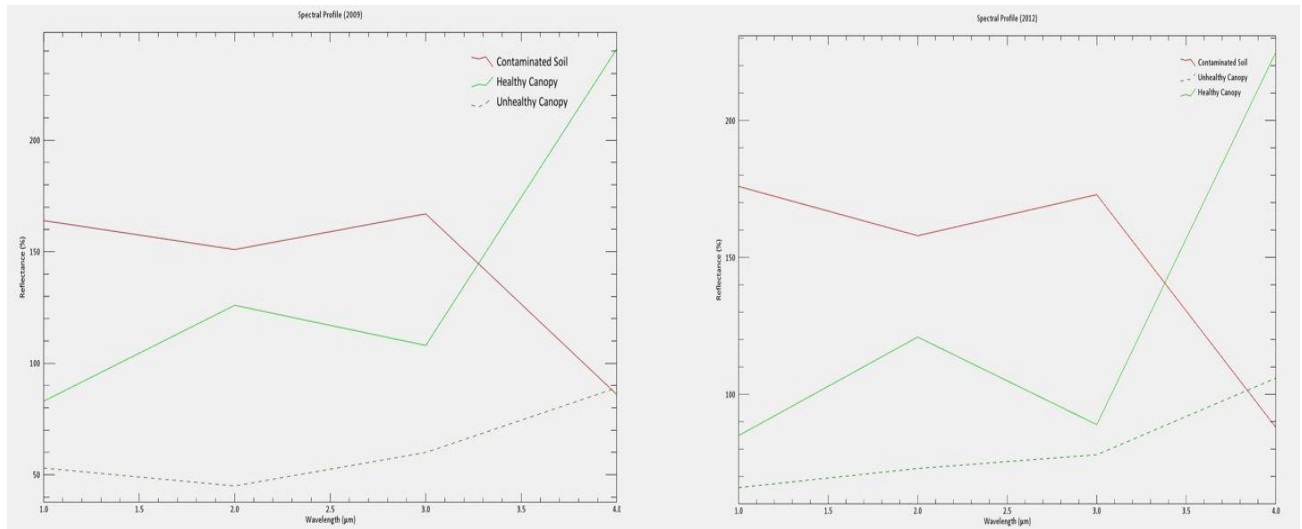


Figure 3: Spectral profiles for both images. Left is from June 19th, 2009, and right is from June 24th, 2012.

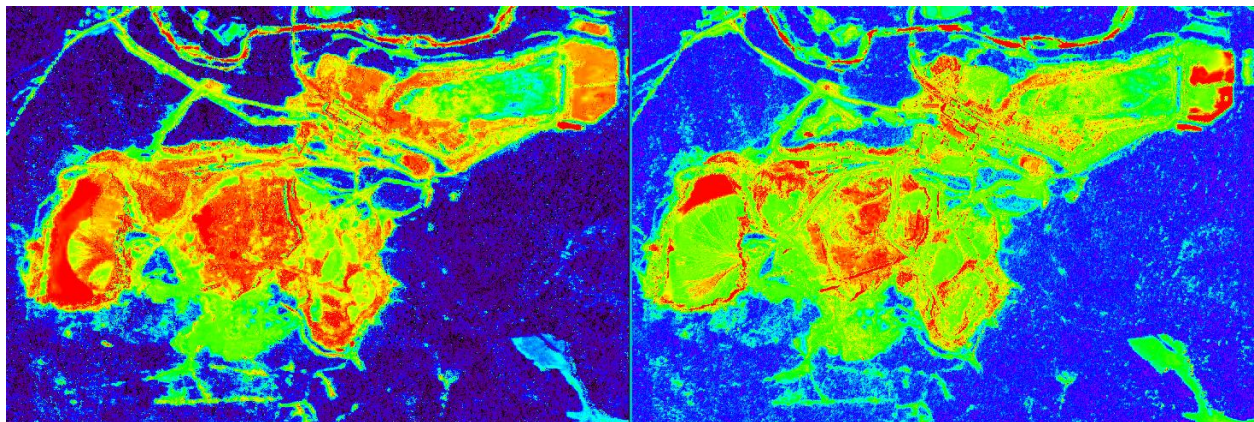


Figure 4: NDVI analysis for both images. Left is from June 19th, 2009, and right is from June 24th, 2012.

Discussion and Conclusion

The false color composite images were intended to display the difference between the healthy and unhealthy vegetation, in this case, trees were the primary vegetation of interest, specifically ones adjacent to the site. Lighter the hue of the false color composite of trees in the (red color spectrum), equates to healthier conditions, and vice versa with unhealthy conditions. The intent of the spectral profiles for both images was to display changes of the reflectance percentages of the healthy and unhealthy trees, as well as the contaminated soil from the three year time frame. As seen in figure 3, changes in healthy canopies are relatively the same reflectance values from the three year difference. The unhealthy canopy spectral graph shows some improvement in reflectance, meaning that there are healthier conditions that occurred in the

three year time frame. The soil reflectance curve is relatively the same conditions between the three year difference. These results from this analysis proves that the site has been remediated, as construction for remediation has been completed since 2007, not to mention the following cleanup, operation and maintenance activities are ongoing. The intent of the NDVI analysis, as seen in figure 4, was to also display the changes between healthy and unhealthy conditions for tree health. As was previously mentioned, the site has been remediated since the images were collected from NAIP. Both images exhibited their own dark hue of blue. For the 2009 NDVI image, the result was expected to visually see a less saturated color of blue around the edges of the site, but it was difficult to discern the improvement of overall vegetation health from the 2009 images. The 2012 NAIP image, shows light blue hues of color around the edges of the site, but shouldn't be interpreted as a decrease in vegetation health conditions. Instead, more in this color is falsely displayed, probably due to the time of day, which may explain the color reduction of soil from the 2009 image to the 2012 image. As indicated from the spectral profile graphs, the soil reflectance are relatively the same values, and not much has changed between the time difference. Recommendations to improve this analysis are try to obtain data from an earlier time prior to the cleanup date of 2007, to easily see the improvement of vegetation health.

References

- Environmental Protection Agency (EPA). "Superfund: National Priorities List (NPL)" 16 Dec. 2015. 17 December 2015. <<http://www.epa.gov/superfund/superfund-national-priorities-list-npl>>.
- Chibuike, G. U. & S. C. Obiora. "Heavy Metal Polluted Soils: Effecton Plants and Bioremediation Methods" Published 12 August 2014.