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NRS 533  
Final Project

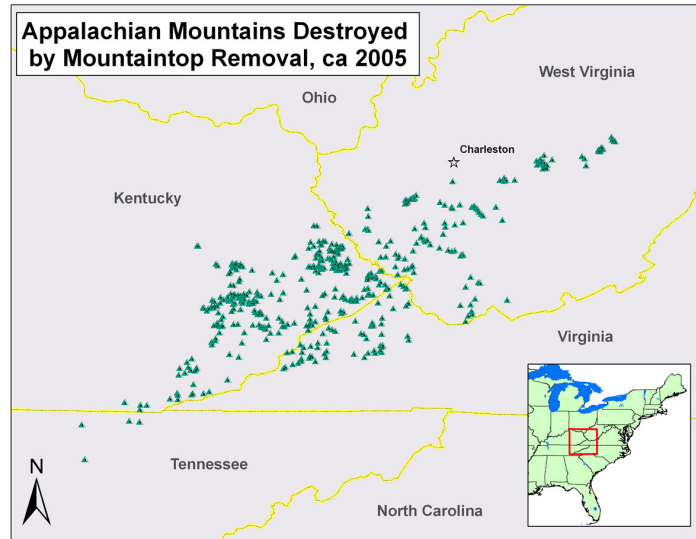
## **Objective**

The objective of this project was to utilize ERDAS Imagine technology to come up with a classification system for mountaintop removal sites. This classification scheme could be used for a variety of purposes, such as determining landscape change in different categories over time.

## **Introduction**

### *Mountaintop Removal Mining*

Mountaintop removal is “a mining practice where the tops of mountains are removed, exposing the seams of coal” (U.S. Environmental Protection Agency, 2011). This is a practice that takes place in the Appalachian states, including Kentucky, Tennessee, Virginia, and West Virginia. Figure 1 shows the extent of mountaintop removal mining as of 2005. According to Pond et. al., at least 500 mountaintops have been removed in Appalachia, and approximately 1.4 million acres of forest have been removed (2008).



**Figure 1.** The extent of mountaintop removal in Appalachia, based on the previously destroyed mountains. [Source: [http://ilovemountains.org/images/FAQimages/Map\\_Mountains.jpg](http://ilovemountains.org/images/FAQimages/Map_Mountains.jpg)]

The process of mountaintop removal involves six steps. The first step is clearing the mountaintop. The land is deforested, and the trees are either sold as lumber or burned. Topsoil is then removed, and is sometimes set aside to be used in the reclamation process, though sometimes will be placed into adjacent valleys. The second step is blasting. This involves the use of explosives to remove the overburden, subsoil and rocks, and expose the coal seams. These seams can be located 500-800 feet below the surface; therefore millions of pounds of explosives are often moved. The third step is digging, using a dragline, to move the debris from blasting away from the coal seams. The overburden is removed to either be used in areas that have been previously mined, or are dumped into adjacent valleys if the topography is too steep. The fifth step is to remove the coal and transport it to treatment facility. The final step is the reclamation process. This involves backstacking and grading overburden to recreate the mountain peak, and then layering overtop topsoil or topsoil substitute. Grass seed is then laid overtop the

topsoil, and occasionally trees or other woody shrubs are also planted (Appalachian Voices, n.d.).

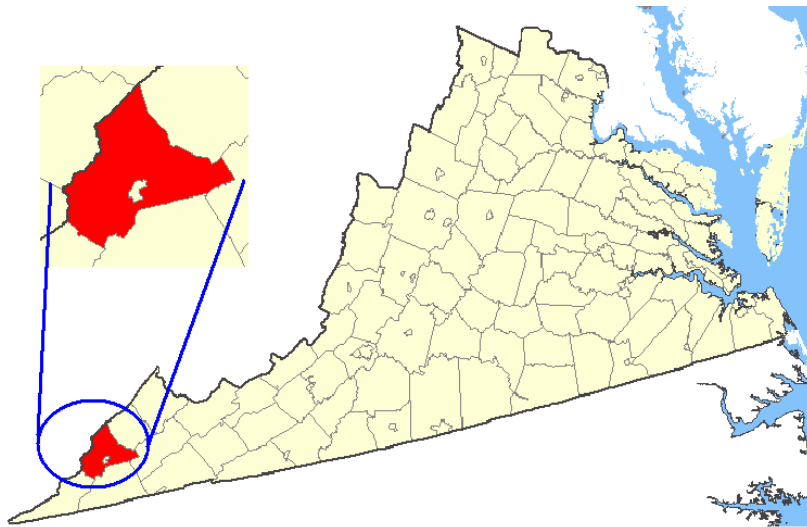
Mountaintop removal mining can have a major impact on the environment—especially water quality and nearby forest quality. By-products of the mountaintop removal process can get into water and increase minerals such as zinc, sodium, and sulfates, as well as affect pH, increase total dissolved solids, and conductivity. These can negatively impact fish and benthic macroinvertebrates, and may lead to less diverse and more pollutant-tolerant species. Valley filling can oftentimes fill streams, and it has been estimated that approximately 2,000 miles of streams have been covered or re-routed due to this process. The base flow of streams below valley fills is often greater than above, which can lead to increased flooding. One last impact on water quality can be the inadvertent creation of wetlands that are often of a poor quality. The deforestation of mountaintops to access coal seams below the surface can often lead to fragmentation of forests. In areas of reclamation, compacted soils may hinder the growth of trees and other woody plants. These two factors can lead to a decrease in biodiversity. (U.S. Environmental Protection Agency, 2011). Mountaintop removal mining can also have an impact on the socioeconomic climate of a region. There is frequent loss or contamination of drinking water wells, along with airborne toxins and dust that can lead to health problems. Health problems include chronic pulmonary disorders, hypertension, higher rates of birth defects, and increased risk of cancer, among others. Mountaintop removal mining is a process that is highly mechanized and therefore requires far fewer workers than underground mining. This process predominantly occurs in impoverished counties, and does not contribute to employment rates (Appalachian Voices, n.d.).

## *ERDAS Imagine*

ERDAS Imagine is a software system that can be used for remote sensing applications. Using this software it is possible to manipulate imagery data for a variety of purposes, including vegetation analysis, linear feature extraction, orthorectification, and more. ERDAS Imagine inputs a variety of file types, including .img, .jpg, .tiff, and more.

## *Study Area*

This study area for this project was the Indian Mountain mine area in Wise County, Virginia (Figure 2). Wise County is located in the southwestern part of the state, contains approximately 400 square miles, and is home to over 41,500 people. Eleven percent of the county's industry is mining. According to the 2010 census, the median household income is \$33,608, which is approximately half that of the state of Virginia (U.S. Department of Census, 2011). The county's unemployment rate in the month of September was 7.7% (Bureau of Labor Statistics, 2012).



**Figure 2.** Wise County, Virginia [Source: [http://upload.wikimedia.org/wikipedia/commons/a/a6/Map\\_showing\\_Wise\\_County,\\_Virginia.png](http://upload.wikimedia.org/wikipedia/commons/a/a6/Map_showing_Wise_County,_Virginia.png)]

The specific study site for this project was at Indian Mountain in the northern portion of the county. This area has already been surface mined, the evidence of which can be seen in Figure 3.



**Figure 3.** A Google Earth aerial image of Indian Mountain and the surrounding mined areas.

## **Methods and Results**

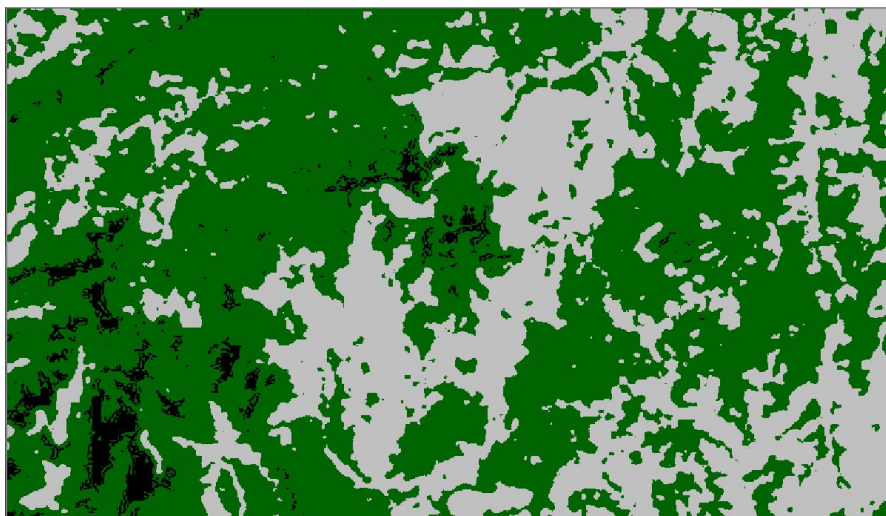
The data for this project was accessed from the USGS Earth Explorer. This tool allows users to search for and download satellite images, aerial photographs, and cartographic products. The software provides data from several sources including Landsat, MODIS, and ASTER. The data used for this project was downloaded from Earth Explorer, and were images from the Landsat Thematic Mapper (TM). This is a multispectral scanning mapper, and the data is served in seven bands simultaneously. The bands of the data for this project were 4 ( $0.76\text{-}0.90\mu$ ) and 5 ( $1.55\text{-}1.75\mu$ ), both of which have a resolution of 30 meters (National Aeronautics and Space Administration, 2011).

The methodology of this project was to import the images from Earth Explorer into ERDAS Imagine and to create a classification system of forested or mined. The two

images used were from June 2000 and June 2003. These images were opened in true color. The study area was zoomed to from the larger image, and the same extent was used for both time periods based on a geographic link in the two image windows. An unsupervised classification was done on each image, both times creating 10 classes, and running 6 iterations. After the classification was completed, each class was assigned a value of either “forested” or “mined”.



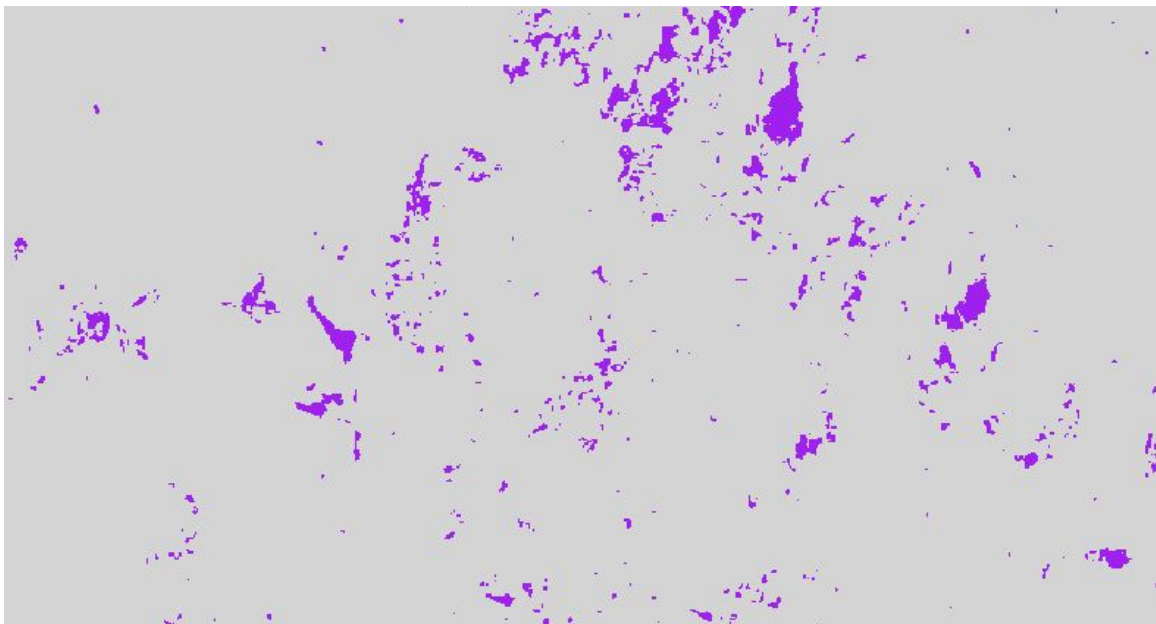
**Figure 4.** Classified landscape of Indian Mountain from June 2000. Green symbolizes forested areas, and grey symbolizes mined areas.



**Figure 5.** Classified landscape of Indian Mountain from June 2003. Green symbolizes forested areas, and grey symbolizes mined areas.



Landscape change over time was shown using a quantitative method called multiple-date composite image change detection. First, the two images from 2000 and 2003 were shown in the same viewer in ERDAS Imagine and geographically linked. The layer stack function was then used by adding all available layers into the layer list, which created the multiple-date composite image. Areas of change were then extracted through the use of an unsupervised classification, and were identified based on a visual comparison of the two initial images.



**Figure 6.** The areas of change between 2000 and 2003.

## **Discussion**

While the intention of the project was to classify areas of mountaintop removal mining in Wise County, it is important to note the ways that this classification is useful or not. This could be a useful mechanism for qualifying and quantifying landscape change in these controversial areas. However, this particular study did not most effectively utilize the tools and information available. An evaluation of land use based on only two types would not be particularly effective in demonstrating actual land use. The “forested” land

use type was based on anywhere that appeared to be dark or relatively dark after the unsupervised classification, but could have included water features, non-forested areas, or other land use types. The “mining” areas would have included mining, but also could include urban areas, roads, open pits, or anything else that may show up as a lighter color in the classification scheme. A classification scheme such as this would be most effective if it included more land use types, including water, urban, wetlands, forest, industrial, etc; it would take more effort, very high resolution data, and most likely would have a high cost to be able to use the ERDAS software to do a very detailed and accurate classification analysis. The image of change over time shows all changes in the three year time frame, including any areas that go from forest to mined (which is the change being studied), but also could include places of reclamation where mined areas change to forested, or completely unrelated changes in the area. There are a variety of sources of error that could have impacted the study. One large source of potential error is human error, including problems with downloading the data from Earth Explorer or lack of familiarity with the ERDAS Imagine software. Another problem with the change mapping is the short time frame between the images being classified. Potentially more change could be noted using data from ten years away.

The classification of land around mountaintop removal mining sites could have implications for energy generation and legislation in the United States. Were the changes in land classification quantified over time, information could be gathered about such information as area of land deforested for surface mining, miles of streams covered or re-routed due to valley fills, levels of localized flooding downstream of valley fills during large storms or spring snowmelt, and more. This information may prove useful to



government lawmakers looking to create regulations regarding surface mining, or to those living in these areas regarding the changes in the landscape adjacent to their homes.

## **Conclusion**

Doing landscape classification and change analyses using aerial imagery in ERDAS Imagine could be greatly beneficial in many facets of natural resource sciences. Mountaintop removal mining is a contentious issue in Appalachia with limited regulation, and therefore deeper knowledge of its impacts on the environment and the Appalachian Mountains landscape could result in increased awareness of the associated issues and further regulation for coal companies.

## **References**

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