Analysis of Land Cover Change in the Wayne National Forest: An Exploration of the Success of Reforestation

Introduction

The Wayne National Forest is a large forest in Southeastern Ohio which underwent intense deforestation in the early 1900s. After it was established as a national forest, the U.S. Forest Service began conservation efforts such as reforestation, planting millions of new trees in the area. This project will examine the success of these reforestation efforts by comparing land cover types using remotely sensed data across time to determine the growth of forest cover on the landscape.

Study Area

The Wayne National Forest is a forest covering over a quarter million acres of land in the Appalachian region of Ohio. It sits at the foothills of the Appalachian Mountains and has a very diverse landscape. It also has very high biodiversity, supporting over 100 species of trees. It was historically heavily forested, but in the early 1900s faced widespread deforestation due to logging and other human activities. In 1911, the federal government established the Wayne National Forest as part of a larger effort to conserve and reforest the region. Over the next several

decades, the forest underwent extensive reforestation efforts, with thousands of acres of land being replanted with new trees. It is currently managed by the U.S. Forest Service, which works to maintain its health and diversity through a variety of conservation programs and initiatives.

Methods

Data was obtained and processed using Google Earth Engine geospatial analysis software. Data was retrieved from Landsat 7 database using the US Geological Survey Global Visualization Viewer (USGS GloVis). Imagery processed in Google Earth Engine was from 1999 and 2014, as these were the most widely spread apart datasets available on that software. These are temporally distant enough to get a comprehensive idea of the land use change over a significant time span.

In Google Earth Engine, masks were applied to subset the data to the area of interest (Wayne National Forest and surrounding area). Surrounding area was included for ease of subsetting, as only a rectangle was needed rather than a polygon with many vertices. The surrounding area is relatively small compared to the area of interest, and is not expected to have a significant impact on the final results which would make it worth using a polygon approach. After applying the mask, points were manually selected on the map to correspond with three land

cover classes: Urban, Vegetation, and Water. Twenty points were selected for each class. A Random Forest classification algorithm was used to train the model with a resolution of 30m. This process was repeated for both the imagery from 1999 and 2014. The resulting models were visually compared in Google Earth Engine to detect changes in land cover class.

Results

In Google Earth Engine, output models showed a slight increase overall in the amount of land classified as vegetation. The majority of the change took place around an urban center in the southern portion of the site. Additionally, throughout the rest of the site, the analysis indicated that the vegetation class in 2014 is more uniform and less interrupted by patches of urban class than in 1999. Figures 1 and 2 show the output models for 1999 and 2014, respectively.
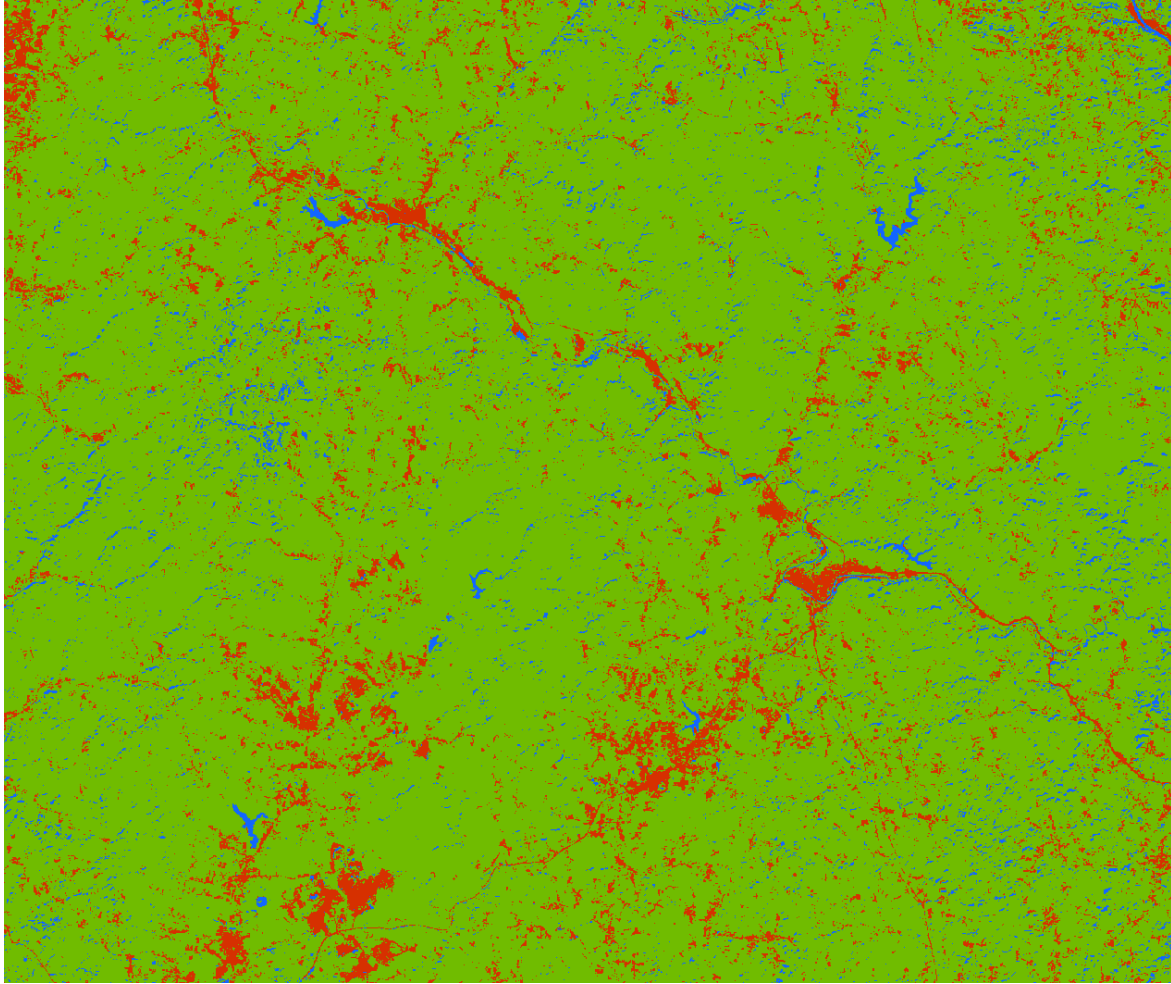
Figure 1. Land cover type of Wayne National Forest and surrounding area, 1999. Green pixels represent vegetation, red represent urban, and blue represent water.
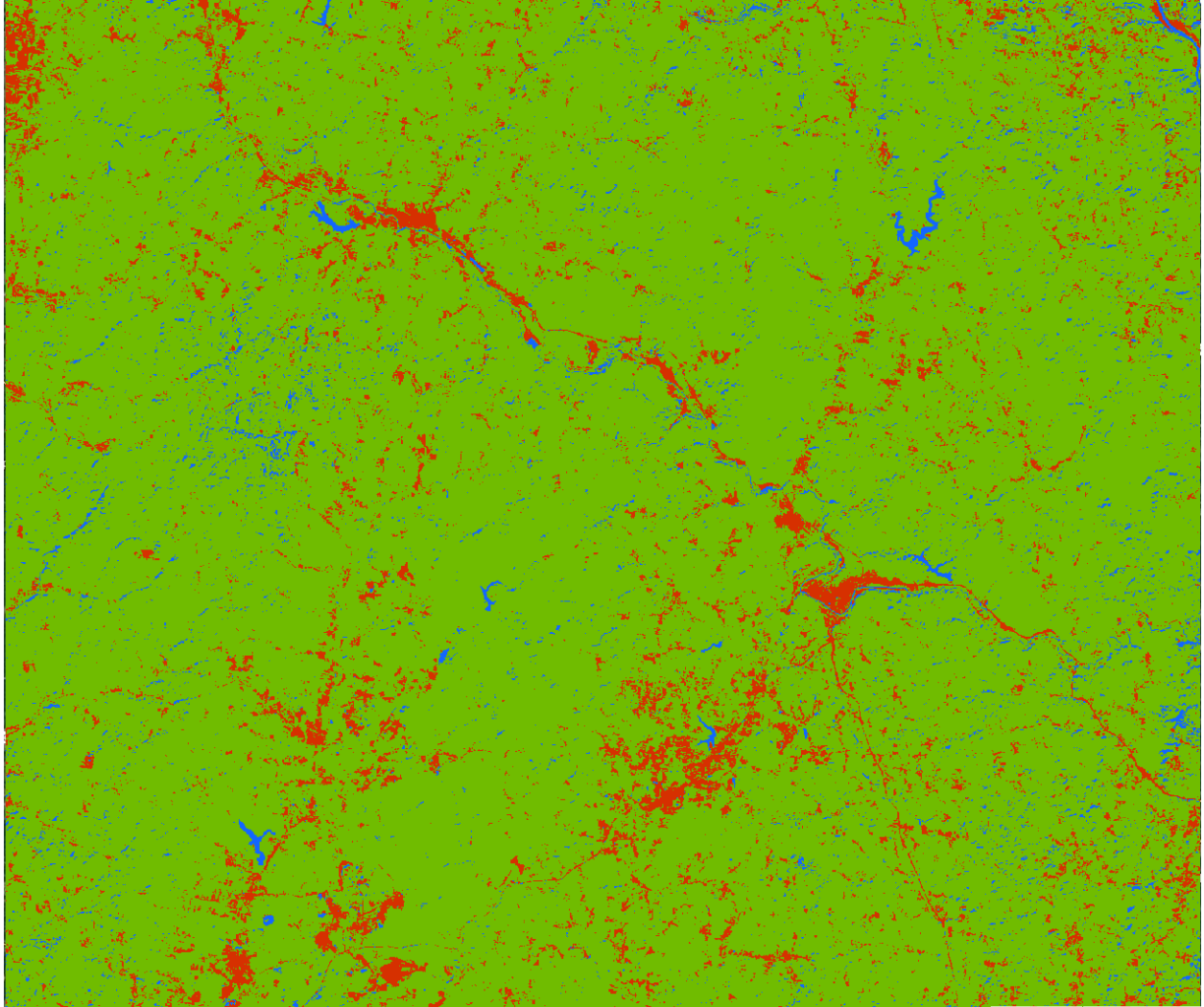
Figure 2. Land cover type of Wayne National Forest and surrounding area, 2014. The same color scheme as above is used.

The models were found to have very high accuracy. The 1999 model had 100% overall validity, and the 2014 model had 98% overall validity. These are considered very high scores. Tables 1 and 2 shows the error tables of the models from 1999 and 2014, respectively. Numbers represent the percentage of each land cover type that was classified correctly, or misclassified as another cover type.

	Urban	Vegetation	Water
Urban	100	0	0
Vegetation	0	100	0
Water	0	0	100

Table 1. Error table for 1999 model. Numbers represent the percentage of each land cover type that was classified correctly, or misclassified as another cover type.

	Urban	Vegetation	Water
Urban	100	0	0
Vegetation	0	100	0
Water	0	5	95

Table 2. Error table for 2014 model.

Discussion

These results indicate that the reforestation efforts of the US Forest Service are indeed working. In 1999, the forest was broken up by patches of urban cover throughout the landscape. This means there was a relatively significant amount of habitat fragmentation, which can lead to negative ecological impacts such as higher predation for some species and lower resistance to invasive species in the ecosystem. In 2014, the forest appeared to be more uniform, indicating lower levels of habitat fragmentation.

Further management should take place at this level as well, working to reduce the amount of small urban cover areas and make the forest more uniform. By concentrating the urban areas into larger but fewer spaces, habitat

fragmentation can continue to be reduced, and overall forest cover can be increased without displacing people living in this region from their homes.

Conclusion

The Wayne National Forest has been a focus of conservation efforts to try to reforest this landscape after intense deforestation in the early 1900s. Remote imagery analysis of the landscape shows that these efforts have been overall successful in increasing the amount of forest cover in the park. This conservation work is important to protect the many species of trees that grow in this forest, as well as the animals who call it home.