

# Memorandum

To: Dr. Bradley Rundquist, Director, North Dakota View, University of North Dakota  
From: Dr. Paul E. Todhunter, Professor of Geography, University of North Dakota  
Date: 9/28/2007  
Re: Time Changes Detection of Total Crown Area in North Dakota – Final Report

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**INTRODUCTION:** Although the global carbon budget has been studied extensively, researchers are still unable to provide closure on the various sources and sinks of global carbon. Deforestation in the equatorial and tropical regions of the world is widely recognized as a net source of atmospheric carbon. However, there much is unknown about afforestation in the middle and high latitudes and the impact it has on balancing the global carbon budget. The original study involved examining the tree crown area over a historical period of time and estimating the amount of carbon sequestration by trees in North Dakota cities. The final goal of the project was to use the tree cover estimate to determine the amount of carbon sequestration and pollution mitigation in an urban environment. However, as research on this topic commenced, the means for determining tree cover in an urban environment was a project in itself. It became apparent that a good methodology first needed to be developed before carbon sequestration could be modeled across a city. The current study explores the object-oriented approach as a means for extracting urban tree cover. The objectives of this study are: 1) to become well-acquainted with the eCognition software, 2) to explore the object-oriented approach as a means of determining land cover, 3) to apply the techniques learned above to develop an accurate, inexpensive, and timely methodology for estimating tree crown area for the city of Grand Forks, North Dakota, and 4) to be able to apply the methodology to other regions across the state. As of date, objectives one and two have been fulfilled.

**METHODS:** In the object-oriented approach, objects, or grouping of pixels of similar spectral and spatial properties, are analyzed as objects rather than individual pixels. The process in which objects are created from grouping pixels with common properties is known as segmentation. The software used for this approach is e-Cognition, developed by Definiens of Munich, Germany. This software includes the patented heuristic algorithm that creates image segments based on scale, color, smoothness, and compactness (Navulur, 2007). The first step was to obtain imagery for Grand Forks, North Dakota. This was a color NAIP aerial photograph taken in the summer of 2005. Then the image was segmented according to the heuristic algorithm and samples were selected for trees, water, vegetation, and built-up land (buildings, roads, and parking lots). After preparing the data, the image was classified based on sample selection.

**RESULTS:** The object-oriented approach using eCognition software provided a relatively accurate representation of tree cover for the City of Grand Forks, North Dakota. Based on the sample selection method ( $n=100$ ), the overall accuracy was 0.8109 for the four basic land cover types of trees, vegetation, water, and built-up lands. The producer accuracy for tree cover was 0.7219 and the user accuracy was 0.9820. These accuracies were based on hand-selecting segments for training that represented a certain type of land cover.

**CONCLUSIONS:** The object-oriented based classification is an useful approach for determining land cover types. However, when determining percentage of tree cover it would be best to use a type of texture-based classification in the conjunction with NDVI or other vegetation index. The NAIP images are true color digital images that lack in the near-infrared band, which eliminates the possibility of determining NDVI. The accuracies could be improved in many different ways. First, eCognition allows multi-level segmentation based on different scale factors, colors, shapes, compactness, and smoothness. This is advantageous for trees in that they have an unique texture and shape. eCognition also has many different classification methods that can be implemented in determining tree cover. Although eCognition software is very powerful, it appears to be time-consuming for large files with high spatial resolution at small scale factors.

**REFERENCES:** Navulur, K. 2007. *Multispectral Image Analysis Using the Object-Oriented Paradigm*. CRC Press: Boca Raton, FL.