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NATIONAL CONSORTIUM FOR REMOTE SENSING EDUCATION, RESEARCH, AND APPLICATIONS

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Using Remote Sensing in the Estimation of Economic Impact of a Tornado Event

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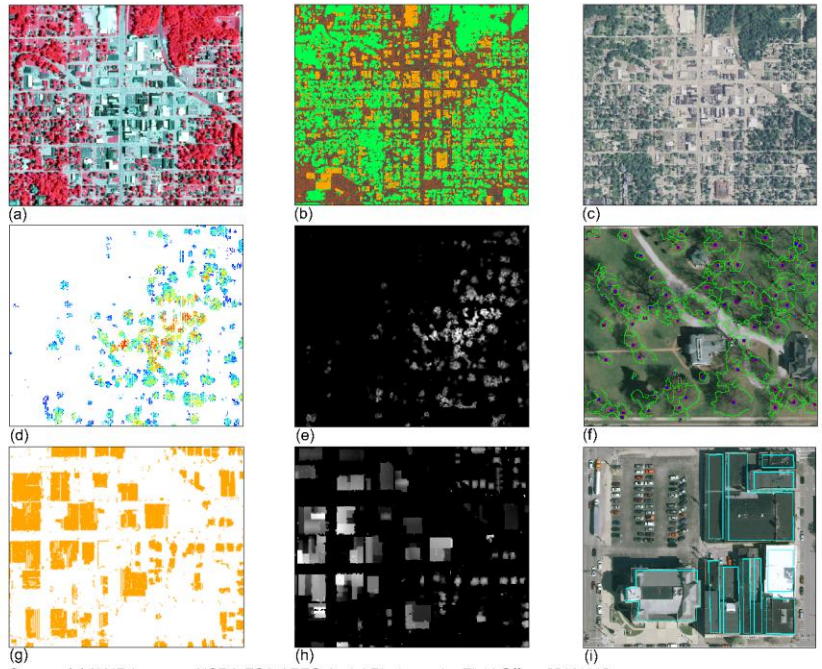
The objectives of this study are:

- To estimate the economic impact of an F-5 rated tornado (approx. 6 miles long up to 0.5 mile wide) through the urban Indiana community of Crawfordsville in Montgomery County
- To examine the potential of employing geographic information systems (GIS) in planning, debris forecasting and post disaster data collection
- To create a debris forecast model

This paper focuses on the use of remotely sensed data to create GIS layers for buildings and trees within the project area.

Methods/Results:



Source: (a) NAIP Imagery, USDA-FSA-APFO Aerial Photography Field Office, 20141118
(b) 2011-2013 Indiana Statewide Lidar, IndianaMap Framework Data (http://www.indianamap.org)

Figures A-I (a) NAIP 2014 Image (b) Classified LiDAR points (c) R,G,B LiDAR points (d) Tree LiDAR points (e) Tree DEM (f) Treetop points and Tree crowns (g) Building LiDAR Points (h) Building DEM (i) Building footprints

Multi-spectral imagery (4-band, 1 meter resolution) collected in 2014 and LiDAR point cloud data (1.5 meter post spacing) acquired in 2013 were fused using LAStools. Filtering based on the Normalized Difference Vegetation Index (NDVI) allowed for separation of trees and buildings and the creation of object specific digital elevation models.(DEM) The threshold applied for buildings was NDVI<0 and height>1.5 meters and for trees was NDVI > 0.2 and height >5 meters. Land use and geography include water, urban, agriculture and woods.

Utilizing ArcMap 10.4.1, building footprints, with height, were created from the DEM files. Three test sites were analyzed for objects other than buildings and missing/co-joined buildings. Site selection included samples of all the land classes and covered locations west, central and east. Visual comparison with 2015 6-inch resolution using Think GIS produced an overall percentage of error for building polygons of 30% with a commission error of 50% and an omission error of 20%.

R/RStudio with the ForestTools package was utilized for the tree count and canopy analysis. Ground truth established by a physical field survey provided a count of trees in four test sites, including one public ground and three areas of public trees in the road right of way. The sampling contained a majority of hardwoods. The tree points created by ForestTools were counted using spatial selection from a polygon with Think GIS. An overall accuracy of 98% was achieved. While the accuracy results are promising, note that an official tree survey of a larger sample may produce a less accurate result. Further study is ongoing in estimating tree volume for use in the vegetation debris forecast model for the overall project.

Once complete, the findings of this project will be presented to the Indiana District IV Emergency Management Director for use in planning, training exercises and most importantly to increase awareness of the impact to the Community should a tornado event of this magnitude occur.

FOR FURTHER READING:

Huang, M.-J. S.-W.-H.-C. (2008). “A Knowledge-Based Approach to Urban Feature Classification Using Aerial Imagery with Lidar Data.” *Photogrammetric Engineering and Remote Sensing 74* (12), 1473-1485.

Zhang, C. Y. (2015). "Individual Tree Segmentation from LiDAR Point Clouds for Urban Forest Inventory". *Remote Sensing 7 (6)* , 7892-7913.