

Enhanced Canopy Fuel Mapping by Integrating Lidar Data

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Background

The Wildfire Sciences Team at the U.S. Geological Survey's Earth Resources Observation and Science Center produces vegetation type, vegetation structure, and fuel products for the United States, primarily through the Landscape Fire and Resource Management Planning Tools (LANDFIRE) program. LANDFIRE products are used across disciplines for a variety of applications. The LANDFIRE data retain their currency and relevancy through periodic updating or remapping (Nelson and others, 2013). These updating and remapping efforts provide opportunities to improve the LANDFIRE product suite by incorporating data from other sources. Light detection and ranging (lidar) is uniquely suitable for gathering information on vegetation structure and spatial arrangement because it can collect data in three dimensions. The Wildfire Sciences Team has several completed and ongoing studies focused on integrating lidar into vegetation and fuels mapping.

Integration of Geoscience Laser Altimeter System Data

A prototype study was initiated in 2010 to explore the utility of lidar data for the derivation of canopy structure and fuels in the Yukon Flats Ecoregion of interior Alaska (Peterson and others, 2013). Airborne lidar data were collected for a subset of the Yukon Flats Ecoregion and field plots were established within the area surveyed for training and validation purposes. To extrapolate canopy height beyond the area surveyed by airborne lidar, Geoscience Laser Altimeter System (GLAS) data were used to train regression tree models to predict height. GLAS is a space-borne lidar instrument that provides global samples of vegetation structure. This prototype effort culminated in the remapping of forest canopy height for all of Alaska. The higher precision afforded by incorporating GLAS data expanded the legend of the original forest height product from two (less than or equal to 10 meters and greater than 10 meters) to five classes. The five classes of forest canopy height now align with the LANDFIRE forest canopy height classes of the conterminous United States. The spatial distribution of the forest canopy height classes across Alaska are shown in figure 1. Additionally, a remap of forest canopy cover in Alaska using GLAS data for LANDFIRE was recently completed, improving the existing forest canopy cover legend and expanding the utility of the product.

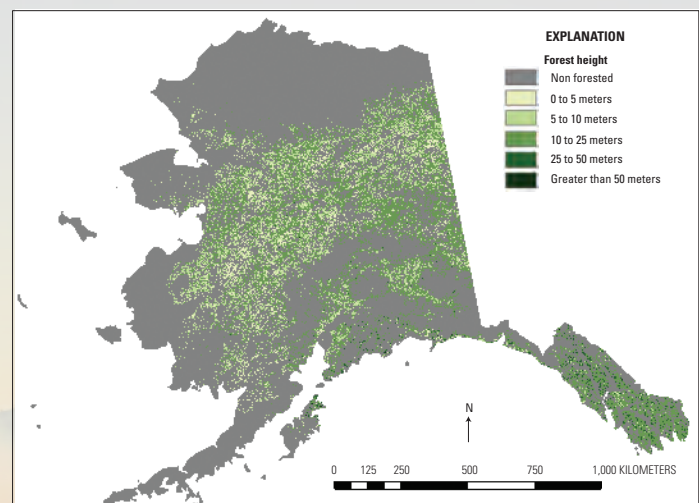


Figure 1. Landscape Fire and Resource Management Planning Tools (LANDFIRE) Program 2012 Alaska forest canopy height product reflecting revised legend. Shades of green indicate different forest height classes. Gray shading indicates areas of shrub lands, ice, snow, and water, among others.

Creating Hybrid Structure from LANDFIRE/Lidar Combinations Application Development

The Creating Hybrid Structure from LANDFIRE/Lidar Combinations (CHISLIC) tool is designed so that those not familiar with lidar data can develop meaningful products from lidar point cloud datasets (Peterson and others, 2015). The CHISLIC tool was developed through partnerships with the U.S. Forest Service, University of Montana, and National Aeronautics and Space Administration in response to a demonstrated need to provide a mechanism for local land managers, who lack the

skills and experience in processing lidar data, to update local fuel data. Algorithms to generate canopy structure and fuel metrics were adapted from published literature and tested at study sites representing different forest types (Peterson and others, 2015). Compared to LANDFIRE products that were trained on Landsat imagery, the lidar-derived CHISLIC outputs provide a better representation of structural heterogeneity across the landscape (fig. 2). Approximately 1,663,000 square kilometers of publicly available airborne lidar data have been collected throughout the United States. CHISLIC also enables the integration of GLAS data into the mapping process to extrapolate canopy structure and fuel metrics outside of the areas surveyed by airborne lidar.

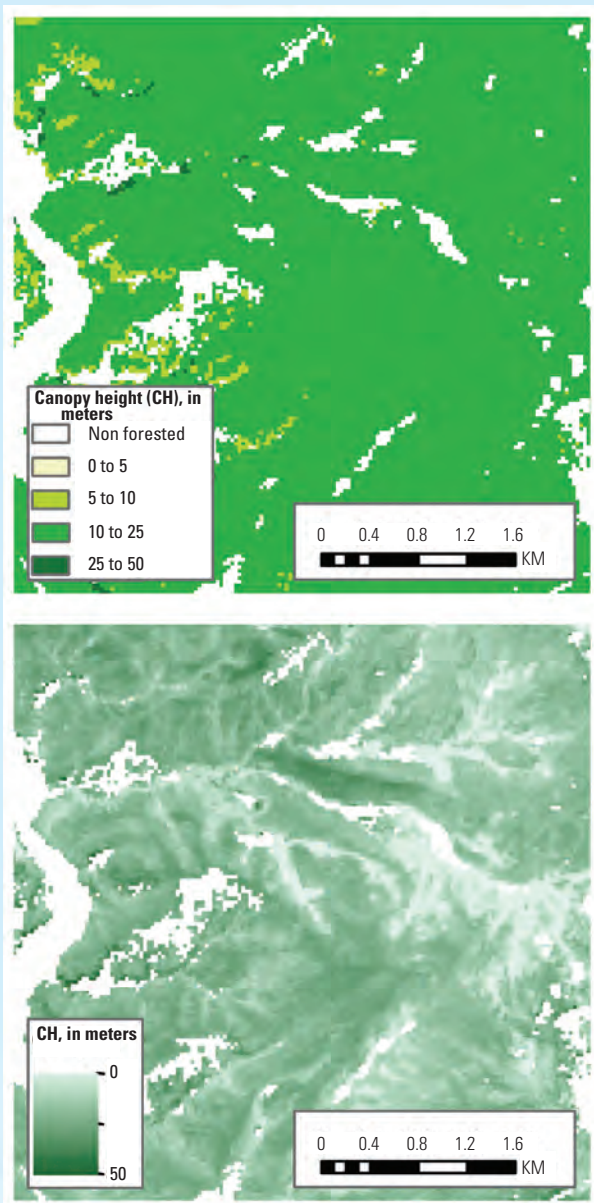


Figure 2. The spatial heterogeneity of canopy height as captured by different products for the same area in Grand County, Colorado. *A*, Landscape Fire and Resource Management Planning Tools (LANDFIRE) program and *B*, Creating Hybrid Structure from LANDFIRE/Lidar Combinations tool height products for the same area in Grand County, Colorado.

Potential Research Opportunities

Dynamic fire simulation models, which have recently been adapted to describe wildfires, provide detailed, physics-based representations of fire processes. These models require detailed 3-dimensional fuel distributions as inputs, and represent the next generation of strategic and tactical fire behavior modeling systems. Future opportunities exist to explore how these inputs can be derived from lidar data. A prototype study using lidar data collected in 2012 for parts of Grand Canyon National Park and Kaibab National Forest is currently underway. Gridded canopy heights at 1-meter spatial resolution (fig. 3) were derived from the lidar, from which individual tree stems were identified. Using these stem locations, detailed canopy structure can be inferred, directly or indirectly, from the lidar data, including canopy height, crown diameter, and diameter at breast height. Ultimately, these measurements can be used to develop 3-dimensional fuel profiles and tested within the dynamic fire simulation models.

Future work on CHSLIC includes developing algorithms for mapping canopy bulk density from lidar. Canopy bulk density describes the amount of biomass in a forest canopy and is often used for modeling crown fire behavior. Research at various study sites is currently underway.

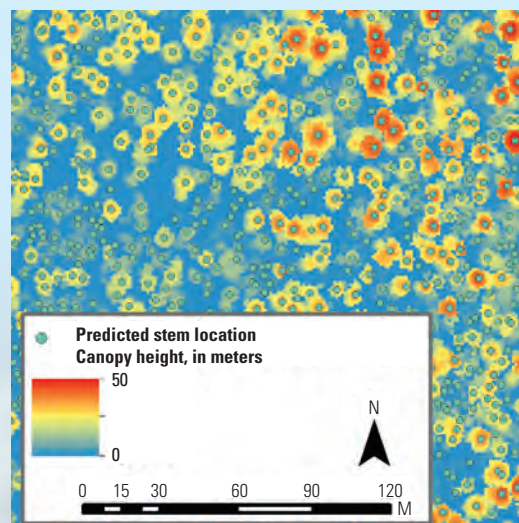


Figure 3. A gridded canopy height layer, at 1-meter spatial resolution, was derived from the light detection and ranging (lidar) data for areas in Grand Canyon National Park and Kaibab National Forest in northern Arizona. Orange/red shades indicate taller heights and individual tree crowns can be recognized. Points indicate lidar-inferred stem locations, for which canopy heights have been derived.

References Cited

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- Peterson, B., Nelson, K., and Wylie, B., 2013, Towards integration of GLAS into a national fuel mapping program: *Photogrammetric Engineering & Remote Sensing*, v. 79, p. 175–183.
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