



# LANDFIRE Remap:

## Integrating lidar to improve vegetation structure mapping

LF Remap is an innovative vegetation and fuels mapping effort to produce current base maps of the LF product suite. Remap is focusing on advancing LF mapping methodologies spanning several topical areas. Lidar data is being integrated with the LANDFIRE Reference Database to improve the vegetation structure mapping.

**USGS**  
science for a changing world

### LANDFIRE Remap: Integrating lidar for Improving Vegetation Structure Mapping

Jordan Long, Brigit Peterson, and Karin Nelson  
Stinger Charbono Technologies (SCT) contractor to U.S. Geological Survey (USGS) Earth Research Observation and Science (EROS), Sioux Falls, SD. Work performed under USGS contract G16PC00012.  
©2017 USGS EROS Center, Sioux Falls, SD.

**Introduction**

**LANDFIRE Program**  
LANDFIRE (LF), Landscape Fire and Resource Management Planning Tools, is a joint program between the wildland fire management programs of the U.S. Department of Agriculture (USDA) Forest Service and U.S. Department of the Interior (DOI), with involvement of the United States Geological Survey (USGS), The Nature Conservancy (TNC), USDA Forest Service (FWS), and USDA Forest Service Forest Inventory and Analysis (FIA) program. This multi-agency program produces consistent and comprehensive geospatial data that describe vegetation, wildland fuel, and fire regimes across the United States and similar areas to provide agency leaders and managers with a common "at-a-glance" data set of vegetation and wildland fire and fuels information for strategic fire and resource management planning and analysis. Please visit <http://landfire.gov> for additional information about the LANDFIRE program as well as accessing and downloading LANDFIRE geospatial data.

**LANDFIRE Remap**  
LF Remap is an innovative vegetation and fuels mapping effort designed to produce current base maps of the LF product suite. Consistent methodologies and processes, including access to the most current satellite imagery, contemporary data sources and software and hardware technologies, are being combined to create updated LF base layers that improve upon the updated versions of legacy LF National. Learn more about the LF Remap by visiting [http://landfire.gov/documents/LF-2017\\_Remap\\_Final\\_V2.pdf](http://landfire.gov/documents/LF-2017_Remap_Final_V2.pdf).

LF Remap efforts have been focused towards advancing LF mapping methodologies in several prototype areas throughout the conterminous United States (Figure 1). LF Remap prototyping spans several topical areas, including: LANDFIRE Reference Database (LRDB), Satellite Image Compositing, Lidar data modeling, Existing Vegetation Type modeling, and Vegetation Structure modeling (Peterson et al., 2017). This poster focuses on how LF Remap is incorporating lidar (Flight Datastream and Range) data to enhance LF vegetation structure products.

to represent the landscape structure characteristics and variability at a finer thematic resolution, which fire fuel modeling is greatly dependent. These structure enhancements are possible by enhancing reference data through incorporating lidar data in combination with the LANDFIRE Reference Database (LRDB). The LRDB consists of field validated plot reference data covering the United States. Reference plot data are collected from a variety of contributors including federal, state, local, and tribal government agencies, universities, non-governmental organizations, and private groups. Plot information include observed vegetation characteristics of lifeform, EVC, EVH, and Existing Vegetation Type (EVT). Although there are tens of thousands of LRDB plots across the United States, structure data gaps remain in several regions. Incorporating lidar observations will increase reference data and reduce vegetation structure data gaps.

Figure 1. LF Remap EVC and EVH modeling processing steps.

Figure 2. Comparison between FIA validation plots and modeled percent cover using reference plots only (left), lidar data only (center), and combined reference and lidar data (right) at study testing sites.

Figure 3. Comparison between FIA validation plots and modeled percent height using reference plots only (left), lidar data only (center), and combined reference and lidar data (right) at study testing sites.

**Mapping Methods**  
For Remap, lidar observations are used in combination with reference plots to determine variables (i.e., training data) to model EVC and EVH structure characteristics at regional scale (Figure 2). First, an inventory of lidar data is performed to assess lidar availability from open source resources such as EarthExplorer (<http://earthexplorer.usgs.gov>) and OpenTopography ([www.opentopography.org](http://www.opentopography.org)), as well as state distribution sites. Next, a sampling design selects the most current lidar datasets that represent a variety of lifeform cover and heights per LF file. Lidar datasets are then downloaded and processed from point clouds (.las/.laz format) to 30 meter canopy cover and height raster images (tif format) using LAStools software (<http://rapidindex.com>). Next, independent variables, including Landsat composites (circa 2016), vegetation spectral indices, LF disturbance products, and topography composites, are extracted against LRDB plots and lidar data to create modeling files required for decision tree classifiers. Lidar and reference plots that did within recently disturbed areas are discarded from training dataset. Finally, decision tree models are then used to create EVC and EVH products (Figure 3).

**Results**  
We found that incorporating lidar data increased the amount of EVC reference data by 310% in the Grand Canyon prototype area (LF files r0600 and r0610 - Figure 2) and EVC reference data by 70% in the Northwest prototype area (LF files r1000, r1005, r1010, r1015, r1020, r1025, r1030, r1035, and r1040 - Figure 2). The addition of lidar data increased reference data in areas that are under-represented by the reference plots alone, for example, tree cover ranging from 10 to 15 percent had very few plots in the Northwest (Figure 4, left) and Grand Canyon (Figure 5, left) reference plots, but including lidar considerably increased plots in this range as well as most other percent covers (Figure 4, right and Figure 5, right).

A comparison of lidar tree cover and height derivatives with FIA reference plot observations show a general agreement between lidar observations and field observations with height being slightly more correlated than cover (Figure 6). Yebes et al. (2015) reported similar findings that lidar derived tree canopy height corresponds very well with traditional field observations of canopy height.

**Conclusions**  
Results of LF Remap prototyping at the Grand Canyon and Northwest study areas confirmed that incorporating lidar-derived plots increases reference data considerably, resulting in a more comprehensive reference database that better represents the continuous nature of vegetation structure characteristics than using reference plots alone. Furthermore, including lidar reference plots resulted in higher correlations with validation plots for both EVC and EVH, indicating the inclusion of lidar reference data increases vegetation structure model accuracy. Our improved vegetation modeling procedures will permit the enhancement of LF EVH and EVC products from limited ranges to continuous field height and cover. As LF Remap transitions from prototyping to production, LF will continue to leverage lidar to enhance vegetation structure mapping for the conterminous United States, Alaska, and similar areas.

**References**  
Peterson, B., Long, J., Peterson, B., and Nelson, K., 2017. "LANDFIRE 2015 Remap: Evaluation of Remap's Remote Data to Classify Existing Vegetation Type and Structure to Support Strategic Planning and Fuel Management." *unpublished*.  
Yebes, M., Melnick, J., Van Dyke, A., Carr, C. and Chen, Y., 2015. Using LiDAR for forest and fuel mapping: system, benefits, requirements and costs. *Proceedings of National Fire Plan Conference*, Austin, Texas.

U.S. Department of the Interior  
U.S. Geological Survey

October 2017

Click on image above for larger picture

Remap is amending Existing Vegetation Height and Existing Vegetation Cover legends to represent continuous percent cover and height to represent the landscape structure characteristics and variability at a finer thematic resolution on which fire fuel modeling is greatly dependent.

Remap has focused efforts towards advancing LF mapping methodologies spanning several topical areas. These areas include LF Reference Database (LFRDB), Satellite Image Compositing, Lifeform modeling, Existing Vegetation Type (EVT) modeling, and Vegetation Structure modeling.

For Remap, LF is amending the Existing Vegetation Height (EVH) and Existing Vegetation Cover (EVC) legends to represent continuous percent cover and height to represent the landscape structure characteristics and variability at a finer thematic resolution, on which fire fuel modeling is greatly dependent. Continuous structure products are possible by enhancing reference data through incorporating lidar data in combination with the LFRDB. Although there are tens of thousands of LFRDB plots across the United States, structure data gaps remain in several regions. Incorporating lidar observations will increase reference data and reduce vegetation structure data gaps. LF is aware that lidar data are not available everywhere and is building a modeling process that attempts to mitigate this issue.

What LF found was that incorporating lidar data in the two prototype areas (Grand Canyon and Northwest) increased the amount of EVC reference data by 310% in the Grand Canyon area and by 79% in the Northwest area. Further results of LF Remap prototyping in the two study areas confirmed that incorporating lidar-derived plots increases reference data considerably, resulting in a more comprehensive reference database that better represents the continuous nature of vegetation structure characteristics than using reference plots alone. Including lidar reference plots has shown higher correlations with validation plots for both EVC and EVH, indicating the inclusion of lidar reference data increases vegetation structure model accuracies.

For more information, please review the poster: [\*LANDFIRE Remap: Integrating lidar for Improving Vegetation Structure Mapping\*](#)