Mapping Matters

By Qassim A. Abdullah, Ph.D., PLS, CP

Your Questions Answered
The layman's perspective on technical theory and practical applications of mapping and GIS

Q: Can lidar data be used to classify vegetation maturity and/or density?

Anonymous, Tampa, Florida

Dr. Abdullah: Many large county and statewide lidar projects are being flown by a multitude of local, state, and federal agencies for a single resource management use (e.g., flood risk mapping, updating digital elevation models or contours database, etc.), frequently without consideration as to how the data might be used for forest vegetation measurements and monitoring. Vendors often are not required to provide the lidar point cloud data that are removed from the reflective surface model during generation of the bare-earth digital elevation model (DEM). The main reason behind such practice is that the mapping community was the first to realize the importance of 3D terrain modeling using as lidar and IFSAR technologies. Their primary interest in the lidar is limited to creating bald-earth DEMs to provide an accurate topographic map model. The natural resource management community, who could make use of the point cloud data, has been slower to appreciate the capability of lidar to simultaneously collect high-resolution bio-spatial data. This is true especially in the United States when compared to the European community, which has moved at a much faster pace to embrace these new technologies for forest inventory and management.

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Densely collected lidar data can be used for forest inventory to provide accurate estimates of forest vegetation characteristics such as:

- Quantity
- Quality
- Growth
- Extent
- Health
- Composition with the area of interest

Such spatial data ultimately can be used to achieve the following resource management goals:

- Accurate inventory and composition of forested land
- Harvest planning
- Habitat monitoring
- Watershed protection
- Fuel management (for fire management)

Several applications and studies conducted during the last decade confirm the suitability of lidar data with or without the help of imagery for the following forest resource management tasks:

1. **Individual Tree Attributes:** lidar data at 4-5 points per square meter can be used for identification and measurements of individual tree attributes such as crown structures, total height, crown height, and crown diameter. A lower density can suffice for some of these attributes such as tree height, which can be achieved accurately with only one lidar point per square meter.
2. **Forest Ecology:** Combining high density lidar data with digital imagery (preferably color infrared) results in more accurate studies of forest ecology and forest management variables such as tree identification, assessing the forest for selective logging, and basal area determination.
3. **Canopy fuel mapping:** lidar surface models are effective to explicitly estimate the forest canopy fuel parameters such as canopy cover, canopy height, crown bulk density, and canopy base height to support fire behavior modeling and fuel mitigation programs.
4. **Growth Monitoring:** Multiple sets of lidar data that are collected over different years can provide an effective way to estimate growth rates in the individual tree canopy as well as the effects of the forest ecology on such growth rates.

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The above four applications are just a few of many possible uses of such powerful 3-D lidar data. Finally, most users are not concerned about or have no use for the valuable information in the part of the digital surface model removed during the process of vegetation removal in order to obtain the bare-earth DEM. Foresters and natural resources managers have a great opportunity to explore and therefore efficiently utilize the discarded lidar data for their natural resources management. This opportunity is aided by the following two factors:

1. Having a role model in the European community, which already has explored and capitalized on such techniques. This provides smooth sailing for the natural resources management to utilize lidar surface modeling in their daily activities.

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2. The introduction of the latest generation of airborne lidar system that are equipped with multiple pulse capabilities. These new sensors are presented in the context of their benefits for the users and for most demanded applications such as the management of natural resources, whether it is forestry, agricultural practices, river bed mapping, flood prediction modeling, coastal mapping, or erosion monitoring. A lidar system with multiple pulse capability provides very affordable, extremely dense surface models needed for many of the natural resources management and monitoring programs. Many such programs require lidar point cloud density of 0.1 to 10 points per square meters.

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Dr. Abdullah is the Chief Scientist at Fugro EarthData, Inc, Frederick, MD.