USING STATIONARY AND MOBILE LASER SCANNER TO DETECT FOREST DEFOLIATION

A. Krooks, J. Hyyppä, P. Lyytikäinen-Saarenmaa, A. Jaakkola, S. Kaasalainen, M. Holopainen

Finnish Geodetic Institute, Department of Remote Sensing and Photogrammetry, P.O. Box 15, 02431 Masala, Finland
Department of Forest Ecology, University of Helsinki, Finland

The recent knowledge on needle biomass and its changes are almost entirely based on subjective ground measurements. Therefore there is a great need for remote sensing methods, which are currently being developed. Airborne and terrestrial laser scanning are promising techniques for efficient biomass detection because of their capability of direct measurement of vegetation structure and stand attributes. We have investigated a needle defoliation hazard caused by the European pine sawfly (*Neodiprion sertifer*) in a Scots pine (*Pinus sylvestris*) dominated forest in Eastern Finland. The study area around Outokumpu consisted of 20 test plots with over 600 measured and assessed trees. A phase shift terrestrial laser scanner (TLS) and a car mounted mobile mapping system (MMS) were used to collect data. Two sets of measurements were carried out in mid June and at the end of July 2009 together with standardized visual observations of ongoing defoliation.

The TLS and MMS results are compared with simultaneous visual estimation of the defoliation intensity as percentage of needle loss in the living crown. Clear trends of defoliation were observed in both visual and TLS-based analysis of the tree canopies. The accuracy was affected by, e.g., the time gap between the visual estimation and laser scanning in June, and the upward scanning direction preventing some parts of the canopy from being measured. Defoliation from MMS data was analyzed by comparing laser hits from tree trunks to hits from canopy as point density depends on platform motion. The scanner used in the MMS was Time-of-Flight (TOF) based and recorded the first 3 return pulses. Relative laser returns from defoliated canopies were decreased in comparison to non-defoliated trees and similar trend as in visual and TLS-based data could be seen. The accuracy of MMS was affected by, e.g., quality of GPS-IMU solution, large laser footprint and obscuring trees in test plots. In the future studies, more accurate synchronization of different methods is essential, as well as the development of mobile and UAV-based approach.

The capability of TLS of deriving changes on the standing tree biomass and defoliation degree was also confirmed by destructive, consecutive defoliation operations in laboratory. The biomass of the tree was measured simultaneously with the TLS measurements. The point cloud agreed with standing biomass with 92-99% coefficient of determination implying that terrestrial laser can be a powerful tool for biomass change reporting, and thus, usable for defoliation measurement.