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Estimation of timber volume and stem density based on scanning laser altimetry and expected tree size distribution functions

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Abstract

Laser scanners of small footprint diameter and high sampling density provide possibility to obtain accurate height information on the forest canopy. When applying tree crown segmentation methods, individual single trees can be recognised and tree height as well as crown area can be detected. Detection of suppressed trees from a height model based on laser scanning is difficult; however, it is possible to predict these trees by using theoretical distribution functions. In this study, two different methods are used to predict small trees. In the first method, the parameter prediction method is utilised with the complete Weibull distribution, the parameters of which are predicted with separate parameter prediction models; thus, small trees are determined from the predicted tree height distribution. In the second method, the two-parameter left-truncated Weibull distribution is fitted to the detected tree height distribution.

The results are presented by using timber volume and stem density as predicted stand characteristics. The results showed that the root mean square error (RMSE) for the timber volume is about 25% when using only information obtained from laser scanning, whereas the RMSE for the number of stems per ha is about 75%. Predictions for both characteristics are also highly biased and the underestimates are 24% and 62%, respectively. The use of the parameter prediction method to describe small trees improved the accuracy considerably; the RMSE figures for estimates of timber volume and number of stems are 16.0% and 49.2%, respectively. The bias for the estimates is also decreased to 6.3% for timber volume and 8.2% for the number of stems. When a left-truncated height distribution is used to predict the heights of the missing small trees, the RMSEs for the estimates of timber volume and number of stems are 22.5% and 72.7%, respectively. In the case of the timber volume, the reliability figures for both the original laser scanning-based estimates and for the estimates that also contain small trees are comparable to those obtained by conventional compartment-wise Finnish field inventories.

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Keywords

Inventory; Lidar; pdf; Segmentation; Truncation point; Weibull

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