

# FORESTSCAN

## Terrestrial laser scanning technology for multi-resource forest inventories

### PROJECT TEAM

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**COMPLETION DATE:** April 2012

### BACKGROUND

Ireland is a high cost economy, and this is reflected in the delivered-in price of wood. Research and development aimed at reducing costs, and thereby increasing competitiveness in roundwood production, is the key driver behind this project. Effective planning and decision-making in modern multi-purpose and sustainable forest management requires up to date and accurate data in order to evaluate the range of potential options for the future management and utilisation of a forest.

### OBJECTIVES

The three main objectives of the study are:

- An investigation of the basic principles of terrestrial laser scanning technology and its applicability to (multi-resource) forest inventories.
- An evaluation of existing data analysis software for forestry applications. Development of new software, for a range of applications, will be investigated.
- A cost-benefit analysis for the introduction and use of this technology over a range of potential inventory applications

### PROGRESS

Research continued with two stands of Sitka spruce (*Picea sitchensis* (Bong.) Carr.) of different ages at Clonmel and Kinnity scanned early in the year. Measuring different aged stands addresses the effect of size and density of the stand on estimating diameter and height using the laser scanner (Figure 1). Trees in the stands within a 15 m radius of the laser scanner were scanned before and after removing the lower branches (up to a height of 3 m). Sample trees of different diameters were felled and prescribed measurements taken from the felled trees. The



Figure 1: Data collected from the scanning device (foreground) is uploaded to a computer. The resulting point cloud data is processed to arrive at stem diameter distributions.

resulting point cloud data were extracted using FARO Scene software, and were processed with AutoStem software to derive dbh, tree height and number of stems for estimating basal area, volume and stand density. The results were compared with the manually measured parameters (i.e. obtained after felling the trees).

Generally, tree diameters in the scanned forest are estimated from the point cloud data with acceptable accuracy, except in the upper stem due to the occlusion by branches, and in the lower stem (i.e. the first 1.5 m) due to interference from ground unevenness and the irregular shape of the lower stem. The number of trees per plot and the diameters of a number of trees were under-estimated in some cases due to occlusion of the stem by other trees in the stand. Pruning did not significantly improve diameter estimation. The position of trees within the plot (i.e. distance from the scanner) did not show a significant effect on the accuracy of diameter estimation.

In the autumn, PTR and TreeMetrics initiated a second phase of measurement and scanning operations in the Clonmel plots. This will provide a second set of sample plot data representing two full growing seasons between Phase 1 and Phase 2 measurement and scanning operations. These data will be used to study the use of terrestrial laser scanning technology in forest crop growth/yield monitoring.

Martin van Leeuwen completed his Masters thesis entitled: *On the use of laser range-finding techniques for forest inventory studies*. It includes interesting work on the concepts of branch recognition algorithms and the complexities involved in attempting to train software to recognise real branches on the tree and exclude artefacts.

## ACTIVITIES PLANNED

- Other plots in different terrain, broadleaved stands and stands which are ready for clearfelling will be identified to be measured during the second phase of scanning.
- Scanning will be done in the previous plots to monitor annual growth by measuring and scanning plots before and after growing seasons.
- Scanned data will be processed and analysed.
- Paper writing and presentations at workshops and international conferences (e.g. Silvilaser 2010 in Germany).
- Identify stands which were previously scanned with aerial LiDAR and ready to be harvested will be scanned by terrestrial LiDAR for comparison.

## OUTPUTS

- Mengesha, T. and Nieuwenhuis, M. 2009. *Retrieving forest parameters using laser scanning technology* [Poster Presentation]. The 9th international conference on LiDAR applications for assessing forest ecosystems. Texas A&M University, College Station, Texas USA
- Van Leeuwen, M. 2009. *On the use of laser rangefinding techniques for forest inventory studies*. Unpublished MSc thesis, University College Dublin, Ireland.
- Nieuwenhuis, M. 2009. *COFORD's PLANSFM Research Programme: Planning and Implementation of Sustainable Forest Management*. Presentation to the COFORD Council, AFBI Field station, Hillsborough, Co Down, 24 July 2009.
- Harper, C. and Nieuwenhuis, M. 2009. *PLANSFM - Planning and implementation of sustainable forest management* [Poster presentation.] UCD School of Agriculture, Food Science and Veterinary Medicine Research Day, 8 December 2009.