Abstract template for the conference "A century of national forest inventories – informing past, present and future decisions"

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On page two, you are asked to fill in your abstract in the format and font size indicated. Please remember to include authors affiliation information in the footer section of page two. The length of the abstract may not be more than one page including references.

Abstract title:		Toward the development of total volume and biomass functions using terrestrial lidar and NFI data
Take-home message:		*Terrestrial lidar data have the potential to support NFIs in the development of more precise and flexible volume and biomass functions.*
Presenter name:		Cédric Vega
Presenter contact info:		Cedric.vega@ign.fr
General topic, see website: (please double click on the check box and activate the relevant one)	☐	Improving future NFIs by learning from the past
	☐	NFIs today and in the future
	☒	Cutting edge and futuristic inventory techniques and technologies
Preferred presentation form:	☒	Oral presentation
	☐	Poster
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Toward the development of total volume and biomass functions using terrestrial lidar and NFI data

C. Vega[1], J. Hacbenberg[1,2], L. Jarboui[1]

Introduction: The diversification of wood usages and the information needs for international reporting require detailed information on total tree volume and biomass. National Forest Inventories have traditionally estimated merchantable volume based on diameter and height measures and allometric models, but they need to get new efficient ways to estimate of total tree volume and biomass (Vallet et al. 2006). In France, current approaches suffer from databases restricted to a limited number of species or tree size range (Henry et al. 2010), and their long term validity could be limited by the impact of climate change on tree growth (Charru et al. 2017). Terrestrial Laser Scanning (TLS) is seen as a promising tool to model tree geometry and estimate total tree volume and biomass without - or limited - destructive measurements. Various approaches have been proposed in the litterature to extract tree attributes, from single measurements (i.e. dbh) to full tree reconstruction (Liang et al. 2018). The latter were initially developed for tree-level processing and relied on of very high density points clouds. Such point clouds were found suitable to estimate total tree volume and biomass. The challenge for NFIs is to acquire and process TLS data acquired over a large number of forest plots at a marginal cost. The purpose of this presentation is to provide experience feedback on the development of such a paradigm in the French NFI.

Materials and methods: The TLS processing chain included both data acquisition protocols and point cloud processing methods. The acquisition part started in 2010 with 4 scan positions per plot, without any additional field measurements. After scanning ~ 1,500 plots, this setup was revised in 2016 to improve the point cloud quality and validation data. The current setup includes 9 scans per plot in a 10 m circle. The traditional volume table protocol is currently applied to obtain additional measurements along the main stem. The point cloud processing chain was implemented under Computree processing platform in the framework of the H2020-project DIABOLO, to extract individual tree geometry and volume. It is based on the SimpleTree approach (Hackenberg et al. 2015), and includes the following main steps: terrain modelling, tree localisation and segmentation, tree reconstruction and consolidation, and volume computation. It was tested on both NFI (25 plots) data and detailed databases based on destructive sample from various sources (Lin2Value, Emerge projects, 76 trees).

Results: The developed method allowed to estimate total tree volume with a mean error of -0.1 m^3 (±0.4 SD) and a RMSE of 23.47%. In terms of NFI measurements, the DBH and Diameter at 2.6 m were estimated with a precision of 0.24 cm (±0.4 SD) or 0.27 cm (± 1.95 SD) and RMSE of respectively 5.82 % and 8.93 %. As regards cut height and total tree heights, errors were 0.78 m (± 2.5 SD) and 1.48 m (± 1.93 SD). The corresponding RMSE were 27.91 % and 13.84 % respectively (Hackenberg et al. 2017).

Conclusion: The current TLS data acquisition and processing chain provides promising results toward the development of total volume and biomass functions for NFIs. Future work will focus on improving the field validation protocols and the reconstruction method of the upper canopy, where the point density is limited due to distance and occlusions.

References: Charru et al., 2017, Ann Forest Sci, 74, 33; Hackenberg et al., 2017, DIABOLO report L2.6, 62p.; Hackenberg et al., 2015, Forests, 6, 4245-4294; Henry et al., 2010, Forest Ecol Manag , 260, 1375-1388; Liang et al., 2018, ISPRS J Photogramm Remote Sens, 144, 137-179; Vallet et al., 2006 Forest Ecol Manag , 229, 98-110.

1 : Institut National de l'Information Géographique et Forestière (IGN), Laboratoire d'Inventaire Forestier (LIF), Nancy, France
2 : INRA, Biogéochimie des Ecosystèmes Forestiers (BEF), Champenoux, France
Cédric Vega, cedric.vega@ign.fr