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

Dear author. This is a two-page template that in the first page will ask for information on presenter name, topic, and preferred presentation form.

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:		UAS-LiDAR supported forest inventories: Possibilities and limitations
Take-home message:		*Please provide a short take-home message from your study and your results' implications.* Only survey-grade UAS-LiDAR devise have the capability to acquire 3D point clouds in mm-accuracy, which is required for high precision 3D stem modelling. Based on the derived stem curves local adjusted allometric functions can be derived, which is not feasibly with traditional forest inventory methods.
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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

Abstracts will be reviewed by members of our scientific committee and you will be given information on decisions in due time after the submission deadline has passed.

UAS-LiDAR supported forest inventories: Possibilities and limitations

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Traditional forest inventories (FI) are commonly based on plot level and require extensive in-situ measurements leading to high costs. Often FIs are carried out with simple field measurement tools (i.e. calliper, inclinometer) due to the fact that these tools are relatively cheap and lightweight for easily carrying it also to remote FI plots. The common parameters that are acquired for each plot is the diameter at breast height (DBH), tree height and tree species. Only for few FIs an additional stem diameter e.g. at 30% of the tree height is measured to derive local adapted allometric functions. Furthermore, forest structure information (e.g. number of layers, crown coverage) as well as the health status of the trees are assessed.

In the last years several lightweight, survey-grade LiDAR sensors mounted on unmanned autonomy systems (UAS) were developed and are available on the commercial market. These so-called UAS-LiDAR devices opens up new possibilities for forest inventories. The acquired 3D point clouds enable the 3D modeling of individual trees up to branch level. Therefore, tree position, tree height, stem curve, DBH and forest structure can be derived from this data and can be used as basis for in-situ field measurements.

Besides these technological developments there are still several open questions for using these devices for operational FIs. First of all the different devices have different technical specification leading to different accuracies of the derived 3D point cloud. The open question is how these specifications affect the derived forest attributes such as tree detection rate, DBH estimation or taper function accuracy? Second, what is the optimal flying pattern and flying heights? And thirdly, what is the optimal processing chain to pre-process the UAS-LiDAR data and to derive the tree parameters such as stem curve and DBH?

Within this contribution the aforementioned questions are investigated and the achieved accuracies and completeness of the derived forest attributes for several coniferous as well as deciduous forest sites in the eastern part of Austria will be shown and discussed. As reference terrestrial laserscanning data as well as in-situ measurements are used. The UAS-LiDAR data are acquired with a Riegl VUX1, a Riegl miniVUX-DL and a 4DU-Scanner (2 x Velodyn Lidar Puck Lite) with different flight pattern (i.e. parallel lines, pentagrams) and flying heights (i.e. 65 m to 100 m above ground level).

To ensure a high geo-location accuracy a full rigorous strip adjustment was done to minimize strip discrepancies. The terrain model was derived with the method of hierarchic robust interpolation. The normalized 3D point clouds are used as basis for cylinder and cone fitting approache to derive 3D stem models. The derived stem curve/taper functions are compared with the TLS derived ones. The derived DBH values are compared with in-situ measurements.

The results show that the best results in terms of completness of detected trees and accuracy of DBH and taber function can be achieved from the Riegl scanners VUX1 and miniVUX-DL. For 75% of the trees DBH could be estimated with a bias of -3 cm and a standard deviation of 7 cm. The accuaracy strongly depends on the point coverage/number on the stems. Due to the the range accuracy of the 4DU Scanner with ~3 cm and the small stem point coverage the 4DU Scanner data was not usable for DBH modelling. Finally, possible integrations of UAV-LiDAR into operational forest inventories will be presented and its strengths and limitations will be discussed.

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