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:		Quantification of Phenological Observations of Tree Crowns with UAV-based Multispectral Imagery
Take-home message:		*Traditional phenological field observations of tree foliar are typically accomplished through subjective measures. The use of spectral and geometric information derived from UAV photogrammetry show a potential to quantify phenological phases.*
Presenter name:		Stuart Krause
Presenter contact info:		Thünen Institute of Forest Ecosystems Alfred-Möller-Straße 1, Haus 41/42, 16225 Eberswalde Germany, Tel: +49 3334 657-118, stuart.krause@thuenen.de
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.		

Quantification of Phenological Observations of Tree Crowns with UAV-based Multispectral Imagery

Stuart Krause[1,2], Tanja Sanders[1], Jan-Peter Mund[2]*

Introduction: Phenological observations at long-term intensive forest monitoring plots aid us in better understanding the effect of climatic changes on tree foliar development. In particular, they provide information on the development of trees throughout the course of a year as well as the timing of particular biological changes in relation to meteorological variables and site conditions (Vilhar et al. 2013). Within the operational European forest monitoring system (i.e. Level II/ICP Forests), the phenological phases of selected trees are observed at regular intervals throughout the growing season. This method, though informative, is based on the subjective assessment of the observer. Thanks to recent developments in Unmanned Aerial Vehicle (UAV) technology, the possibility to quantify phenological phases can be realised through near-field aerial photogrammetry (Lisein et al. 2015). Multispectral consumer-grade sensors can be mounted on low-cost UAVs enabling highly repeatable spectral and geometric data acquisition at a very high resolution (< 5 cm). The aim of this study is to assess the feasibility of quantifying the phenological phases of tree crowns in order to replace or compliment traditional subjective observation methods.

Materials and methods: Phenological field observations of European Beech and Scot's Pine trees were acquired by an experienced technician during the spring phenology period between April 17th and May 24th, 2018 in Britz, Germany. Multispectral UAV imagery was also collected synchronous to field observations. Canopy Height Models (CHMs) and the Normalised Differenced Vegetation Index (NDVI) were calculated for each photogrammetric dataset. Segmentation polygons for each individual tree crown were generated from the dataset originating from the end of the spring phenological phase and used as a reference to quantify the various developmental phases. Photogrammetric estimations were then categorized in to 5 percentage intervals for shoot growth and foliation and compared to field observations.

Results: The NDVI was calculated for selected datasets of the phenological phases. Initial results show a potential to quantify individual tree crowns in terms of changes in foliage coverage similar to that of field observations. The CHM was also calculated for each selected dataset. The pixel values (Z-values) derived from the CHMs within the crown polygons show a potential to quantify shoot growth during the spring phenological phases.

Conclusion: This study explores the possibility to quantify the phenological phases of European Beech and Scot's Pine trees with the use of UAV-based multispectral imagery. NDVI and CHM Z-values were implemented to measure changes in foliage coverage as well as shoot growth within selected tree crown polygons. Initial results show a potential to quantify spring phenology using photogrammetric spectral and geometric data which could enhance or even replace qualitative phenological ground observations.

References:

Lisein, et al., 2015. "Discrimination of Deciduous Tree Species from Time Series of Unmanned Aerial System Imagery." *PLOS ONE* 10 (11): e0141006.

Vilhar et al., 2013. "Tree Phenology." In *Developments in Environmental Science*, 12:169–82. Elsevier.

1. Thünen Institute of Forest Ecosystems, Alfred-Möller-Str. 1, Haus 41/42, 16225 Eberswalde

2. Eberswalde University for Sustainable Development, Alfred-Möller-Str. 1, 16225 Eberswalde, Germany

** Corresponding author: stuart.krause@thuenen.de*