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:		Remote sensing based countrywide NFI products – must-haves or nice-to-haves?
Take-home message:		*Remote sensing based countrywide NFI products such as tree cover, biomass or species composition, provide spatially explicit information which is complementary to existing NFI data. We show the additional value of such a data set by presenting a novel approach of tree type and species mapping based on free available multi-temporal remote sensing data and novel classification algorithms for the whole of Switzerland. We also show how we deal with the challenges for alpine countries with complex topography and heterogeneous, mixed and patchy forests.*
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Presenter contact info:		Swiss Federal Institute for Forest, Snow and Landscape Research WSL, waser@wsl.ch
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.		

Remote sensing based countrywide NFI products – must-haves or nice-to-haves?

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Introduction: Forest attribute maps such as area, biomass or species composition, based on remote sensing techniques, are reliable and complementary sources of information for NFIs (Barrett et al. 2016). After a short introduction of the new remote sensing based countrywide NFI products of Switzerland, i.e. tree cover map (Waser et al. 2015, 2017a) and forest biomass (Price et al. 2018) we will focus on the tree type and species mapping. Our research is motivated by the increasing need of spatially explicit information on tree species composition, on the former focus of the research reduced to case studies, and thus the lack of research for countrywide applications (Fassnacht et al. 2016). This is particularly challenging for alpine countries such as Switzerland with its complex topography and heterogeneous, mixed and patchy forests. While repeated and routinely acquired digital aerial images have been incorporated into operational NFIs, limitations of optical data remain particularly in complex terrain. In their pioneer work of a high-resolution countrywide tree type map, Waser et al. (2017b) showed that such limitations resulted in an overestimation of conifers. In the present study, a novel approach is introduced that minimizes these limitations and allows to generate repeatable and objective tree type maps (broadleaved, coniferous) and a further distinction of 5 tree species with a spatial resolution of 10 m for the whole of Switzerland (41,285km^2).

Materials and methods: The approach incorporates machine (Random Forest) and deep learning (Convolutional Neural Network) classification algorithms, explanatory variables from Sentinel-1/-2 data, a DTM from a countywide ALS data set, and independent validation data from NFI surveys. The training data consists of a huge existing and continuously up-dated data set for tree species as provided by national research, monitoring and inventory programs. Combining both Sentinel-1/-2 time series and training the classification models in the specific problem areas (terrain, shadows, heterogeneous forests) with Sentinel-1 SAR backscatter data minimized the typical overestimations of conifers.

Results: 10-fold-cross-validation revealed model accuracies (95-98%) for the distinction of broadleaved and coniferous trees. A comparison with independent NFI plot data revealed differences in the range of 5-8%. First results of classifying 5 different tree species are very promising (overall accuracies of 85%) and the whole of Switzerland will be calculated within the next few months.

Conclusion: Tree type and species maps of Switzerland are superior to existing products due to their national coverage, high level of detail and specific design to cope with heterogeneous forests. The presented approach fully exploits the potential of multi-scale and multi-temporal remote sensing data using deep learning classification algorithms. The usage of R and free available high-quality remote sensing data sets guarantee a flexible adapting of the approach, regular updating and the possibility to apply it to other countries. Remote sensing based countrywide tree type and species maps are complementary to existing NFI data, of great practical relevance and thus potentially useful for optimizing forest management and planning activities.

References: Barrett et al., 2016, Remote Sensing of Environment, 174, 279-289. Fassnacht et al., 2016, Remote Sensing of Environment, 186, 64-87. Waser et al., 2015, Forests, 6(12), 4510-4528. Waser et al., 2017, Mapping forest landscape patterns. New York, Springer. 263-304. Waser et al., 2017b, Remote Sensing, 9(8), 766. Price et al., 2018, in prep.

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