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

Abstract title:		Post-stratification based on satellite imagery for deriving municipal forest statistics in the Finnish NFI
Take-home message:		*Using the current NFI sampling, main forest statistics can be estimated accurately with post-stratification for municipalities with a certain minimum size, such as 390 km^2 in Southern Finland. Post-stratification has the advantage of enabling design-based variance estimation for target areas of different sizes.*
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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
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Post-stratification based on satellite imagery for deriving municipal forest statistics in the Finnish National Forest Inventory

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Introduction: National Forest Inventories (NFI) are designed to provide accurate information on forest resources at national and regional levels, but there is also a demand for such information at smaller spatial scales. In Finland, municipality-level results have been produced by the multi-source NFI (MS-NFI) method, which utilizes satellite imagery, digital map data and NFI sample plot data, as well as the k-nearest neighbor (k-NN) method. However, the k-NN method is inherently model-based, and design-unbiased estimation of uncertainty is thus impossible (Breidenbach et al., 2018). Post-stratification (PS) is a design-based alternative for utilising auxiliary information. It has been shown to improve the precision of forest resource estimates at national and regional levels. Thus, it has potential for estimation of results for smaller areas than with field data only while allowing for design-based variance estimation. The objectives of our study were: 1) to investigate the precision of PS estimates for growing stock volume, volumes by tree species, and forest area at the municipality level; 2) to compare PS estimates with MS-NFI estimates; and 3) to discuss whether PS could provide municipal results in the operational NFI.

Materials and methods: We selected two distinct provinces, Kainuu in North-East Finland and Pirkanmaa in South-West Finland for the study. The study areas covered altogether 30 municipalities, with sizes of 104–5,858 km^2. For estimation, we used the sample plot data from the 11th NFI measured in 2009–2013, and for post-stratification, we used the mean volume MS-NFI map based on the sample plot data of the 10th NFI. Four volume strata plus three strata for other land uses were formed. The boundaries of the volume strata were determined separately for the two study area. An approach producing an optimal (Neyman) allocation of plots to the strata was used.

Results: Relative standard errors (SEs) of total volume estimate ranged from 2.3% to 5.2% for the municipalities in Kainuu, and from 3.8% to 26.9% in Pirkanmaa. The SE was lower than 10% for municipalities with an area of 390 km^2 or larger. The estimates of pine, spruce and birch volumes were less precise, but the SEs were mostly below 15% for municipalities larger than 390 km^2. For small proportions, such as the volume of other deciduous trees, PS resulted in rather high estimation errors.

The MS-NFI estimates of total volume were compatible with the PS estimates in all municipalities except one. For the volumes by tree species, the estimates differed more than ±2 × SE in nine municipalities, where MS-NFI appeared to overestimate pine volume and underestimate spruce volume. These were municipalities with a relative low proportion of pine or with a high proportion of spruce.

Conclusion: The results suggest that using the current NFI sampling, main forest statistics can be estimated accurately with post-stratification for municipalities with a certain minimum size, such as 390 km^2, corresponding to the sample size of 123 plots in Southern Finland. In addition to the sampling intensity, the precision depends on the landscape, the tree-species structure in the area and the quality of the auxiliary data used for post-stratification. The practical advantage of post-stratification over k-NN is that it enables design-based variance estimation for target areas of different sizes. The data users can then assess whether the accuracy is sufficient for their needs.

References:

Breidenbach et al., 2018, Remote Sensing of Environment, 212, 199 – 211

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