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:		Variance estimation of total growing stock volume in spatially balanced national forest inventory sampling
Take-home message:		*Please provide a short take-home message from your study and your results' implications.* In spatially balanced sampling the variance might be estimated through differences between the closest neighbours in auxiliary space, but still further investigations are needed.
Presenter name:		Minna Räty
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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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Variance estimation of total growing stock volume in spatially balanced national forest inventory sampling

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Introduction: Local pivotal method (LPM) has proven to be an efficient approach to enhance the design phase of National Forest Inventories (NFI; Grafström et al., 2017, Räty et al., 2018a). It utilizes auxiliary information in sample selection aiming at a sample, which is similar to the population in terms of its distribution in the multidimensional auxiliary space (Grafström et al., 2012). In Finland, LPM was applied in the inventory of Åland region in summer 2018 (Räty et. al, 2018b).

The increased efficiency should be reflected in our estimates of sampling error. For that we need a variance estimator, which acknowledges the gain in precision obtained by utilizing the auxiliary information. One option is the vsb estimator suggested by Grafström and Ringvall (2013). It sums squared differences of observations between each pivot and its nearest neighbour in the auxiliary space, which is similar in spirit to the Matérn variance estimator developed for square grid sampling.

The aim of this simulation study was to assess the suitability of vsb to operational NFI. We focused total growing stock volume and compared vsb variance estimates to 1) empirical sample variance over the simulations, and 2) naive variance estimates associated to simple random sampling (SRS).

Materials and methods: Our study region was the whole Finland excluding the northernmost Lapland. Forest resource maps from the 10th Multi-Source NFI (MS-NFI10) served as auxiliary information. They are based on NFI10 field data from years 2004-2008, satellite images and other spatial data. MS-NFI10 estimates of land use, total growing stock volumes and volumes by tree species were extracted for the sample plot locations of NFI11 (2009-2013), the reference dataset.

In operational NFI, LPM can be implemented through double sampling: The first phase is a dense grid of sample plot clusters for which auxiliary data is collected and the second phase is a subsample from this finite population, obtained with LPM. In our study, NFI11 plays the role of the first phase sample. We replicated LPM sampling with various auxiliary variable combinations. Variance was estimated from each sample by both vsb and the SRS-based estimator, and the performance of estimators was judged by the empirical coverage of the resulting confidence intervals over the simulations.

Results: Both variances SRS and vsb gave conservative estimates for the variance. The coverage of SRS-confidence intervals ranged from 0.96 to 1.0 and that of vsb-intervals from 0.92 to 0.96.

Conclusion: vsb appears to give safely conservative estimates of sampling error. However, its theoretical properties are not as well understood as those of the Matérn estimator. Our hypothesis for future work is that the overestimation of variance can be reduced by further developing the variance estimators using Matérn-type approaches.

References:

Grafström et al., 2012, Biometrics, 68, 514 – 520

Grafström et al., 2017, Can J For Res, 47, 1161 – 1167

Grafström and Ringvall, 2013, Can J For Res, 43, 1015 – 1022

Räty et al., 2018a, Can J For Res, 48,749 – 757

Räty et al., 2018b, Utilizing auxiliary information when designing field survey of National Forest Inventory, poster at ForestSat 1. – 6.10.2018

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