Model-assisted estimation of growing stock in a three-phase sampling survey utilizing ALS sample and wall-to-wall satellite optical data. (Poster)

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Abstract

Airborne Laser Scanning (ALS) and satellite optical data for use in large-area forest inventories are evaluated with the intent to both increase the estimation accuracy and decrease costs. The aim of the study is to efficiently utilize both wall-to-wall satellite optical data combined with a sample of laser scanning data using model assisted sampling scheme for a growing stock variable. Variables derived from a Landsat 7 ETM+ satellite image are spectral values of bands 1,2,3,4,7. Data set on Kuortane area (30 000 ha) in Western Finland is being used with a sampling unit defined as a square plot with size 16m X 16m. Three ALS strips 1 070 m width and 14 km of length are located in 4 km apart from each other, covering approximately 25% of entire study area. Sample plots measured using a modification of the 10th National Forest Inventory measurement system, are used as field data. In two-phase sampling, the regression estimator is given by

$$\hat{t}_{diff} = \sum_{U} \mathring{y}_{1k} + \sum_{s_a} \frac{e_{1k} - e_k}{\pi_{ak}} + \sum_{S} \frac{e_k}{\pi_k^*},$$

where $\pi_k^* = \pi_{a_k} * \pi_{k|s_a}$, $e_{1k} = y_k - \mathring{y}_{1k}$, $e_k = y_k - \mathring{y}_k$, and $\mathring{y}_{1k}$ and $\mathring{y}_k$ are proxy values for the element k from first and second phase respectively [1].
The approximate variance is given by

$$\hat{V}(\hat{t}_{\pi^*}) = \sum\nolimits_{S}\sum \frac{\Delta_{a_{kl}}}{\pi_{kl}^*} \check{e}_{a_k} \check{e}_{a_l} + \sum\nolimits_{S}\sum \frac{\Delta_{kl|s_a}}{\pi_{kl|s_a}} \check{\check{e}}_k \check{\check{e}}_l,$$

where $\pi_{kl}^* = \pi_{a_{kl}} * \pi_{kl|s_a}$, $\check{\check{e}}_k = \sum_{k=1}^{n} \frac{\check{e}_{a_k}}{\pi_{k|s_a}}$, $\check{e}_{a_k} = \frac{e_k}{\pi_{a_k}}$ and $\check{\check{e}}_l$ respectively for *l* sample size.
Specific features of the design are handled through the specific first and second order inclusion probabilities of pixels that the design leads to. Our results show that such sampling design utilizing fusion of ALS and optical satellite data tends to increase model-assisted estimation accuracy based on ALS data, which allows the potential to decrease costs on ALS.

References

[1] Sändral, C.-E., Swensson,B., & Wretman, J. *Model Assisted Survey Sampling*, Springer-Verlag New-York, Inc, 695 pp, April 1992.