

Variance Estimation in Spatially Balanced National Forest Inventory Sampling

Minna Rätty*, Annika Kangas, Mikko Kuronen and Juha Heikkinen
*minna.raty@luke.fi

Study in a nutshell

Systematic sampling, e.g. square grid of sample plot clusters, is commonly used in National Forest Inventory (NFI). Local pivotal method (lpm) is another option for spatially balanced sampling.

Matérn variance estimator is useful for square grids.

VSB estimator has been suggested for lpm.

SRS estimator is design-unbiased under simple random sampling, but cannot quantify the improvement in precision gained through good spatial spread.

We compared SRS, Matérn, and VSB in the case of **square grid sampling** using both real NFI data and sampling simulation from forest resource map (Landscape).

Outcomes

1. All estimators overestimate true variance, SRS the most
 2. Matérn and VSB are at the same level
- ⇒ **VSB is expected to be as good for lpm and other well spread irregular samples as Matérn is for the square grid.**

Variance estimators: general and SRS

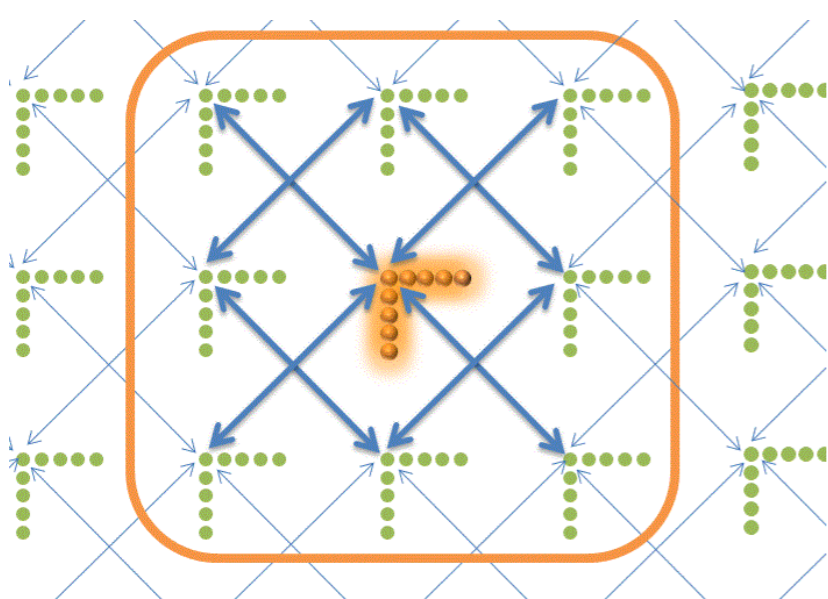
Our variance estimators had the general form

$$\hat{V}(\bar{y}) = \frac{1}{n} \sum_{i=1}^n Q_i^2$$

The standard SRS estimator is obtained by selecting $Q_i = y_i - \bar{y}$.

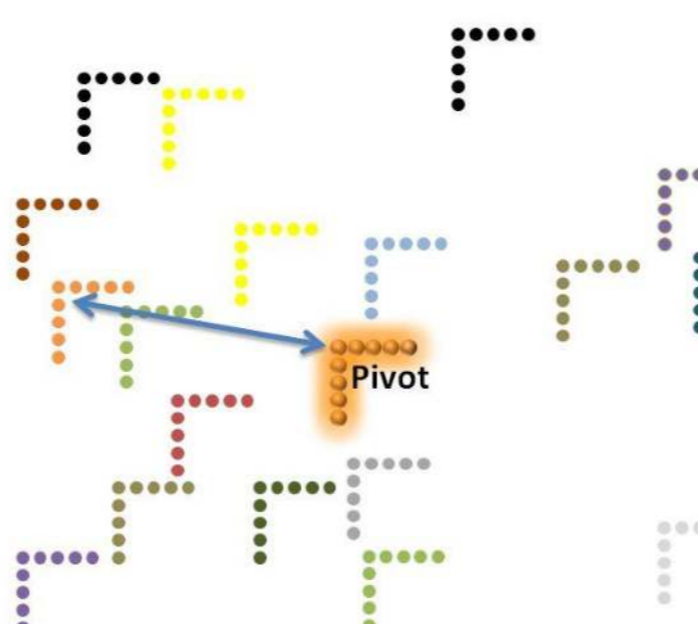
Square grid design and Matérn estimator

Q_i is a suitably scaled quadratic form over a group of four sample units including i .

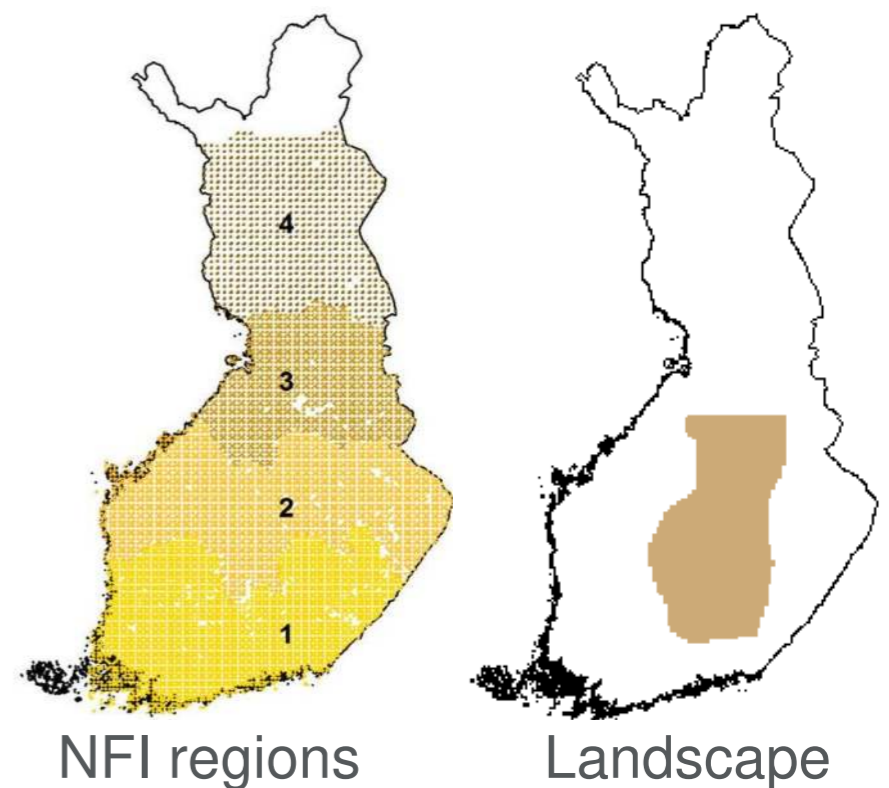


Irregular design and VSB estimator

$Q_i = y_i - y_{nn(i)}$, where $nn(i)$ is the nearest neighboring sample unit in the auxiliary space.



Study regions in Finland



NFI regions

Landscape

Results

Estimates of standard error

Region	Tree species	SRS	Matérn	VSB
1	Pine	0.785	0.717	0.714
	Spruce	0.968	0.876	0.874
	Broadleaf	0.520	0.478	0.480
	All	1.132	1.063	1.071
2	Pine	0.776	0.709	0.711
	Spruce	0.865	0.711	0.707
	Broadleaf	0.456	0.422	0.418
	All	1.032	0.956	0.953
3	Pine	0.735	0.649	0.659
	Spruce	0.686	0.606	0.593
	Broadleaf	0.442	0.416	0.410
	All	1.040	0.909	0.902
4	Pine	0.869	0.846	0.809
	Spruce	0.603	0.551	0.548
	Broadleaf	0.413	0.340	0.307
	All	0.968	0.908	0.912
Landscape Estimated	Pine	0.712	0.651	0.662
	Spruce	1.010	0.854	0.867
	Broadleaf	0.469	0.432	0.440
	All	1.176	1.030	1.045
Landscape True	Pine	Standard deviation over simulated samples		0.657
	Spruce			0.790
	Broadleaf			0.438
	All			0.971