ELEKTRONIKAS UN DATORZINĀTŅU INSTITŪTS

BSS Baltic Satellite Service

Estimating Stand Volume at Microstand Level Using High Spatial Resolution Satellite and Lidar Data

INTERNATIONAL SYMPOSIUM ON APPLIED GEOINFORMATICS 2021

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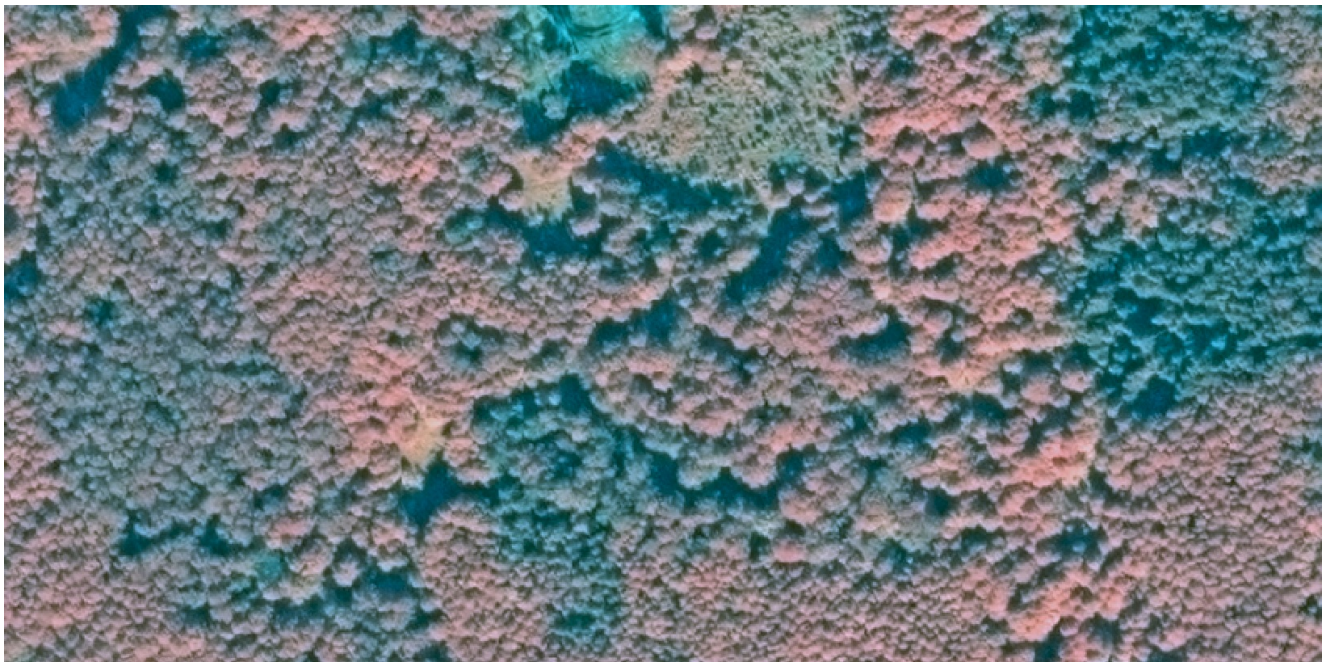
02.12.2021.

1. Introduction

The aim: to develop a workflow for estimation of stand volume using microstands as a spatial unit and high spatial resolution satellite and Lidar data.

Why microstands?

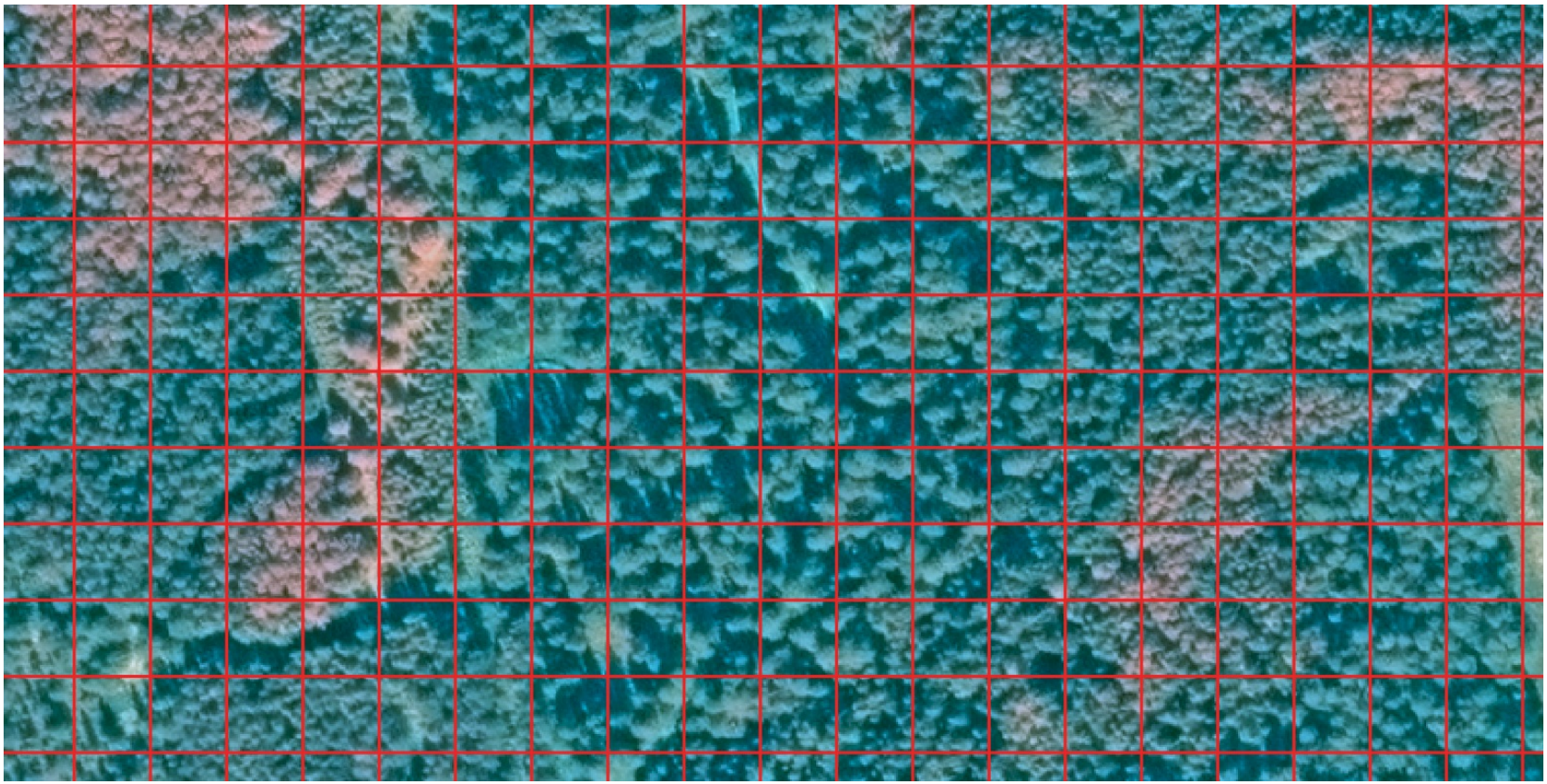
Microstands can be defined as homogeneous forest patches in relation to forest inventory parameters



1. Introduction

Why microstands?

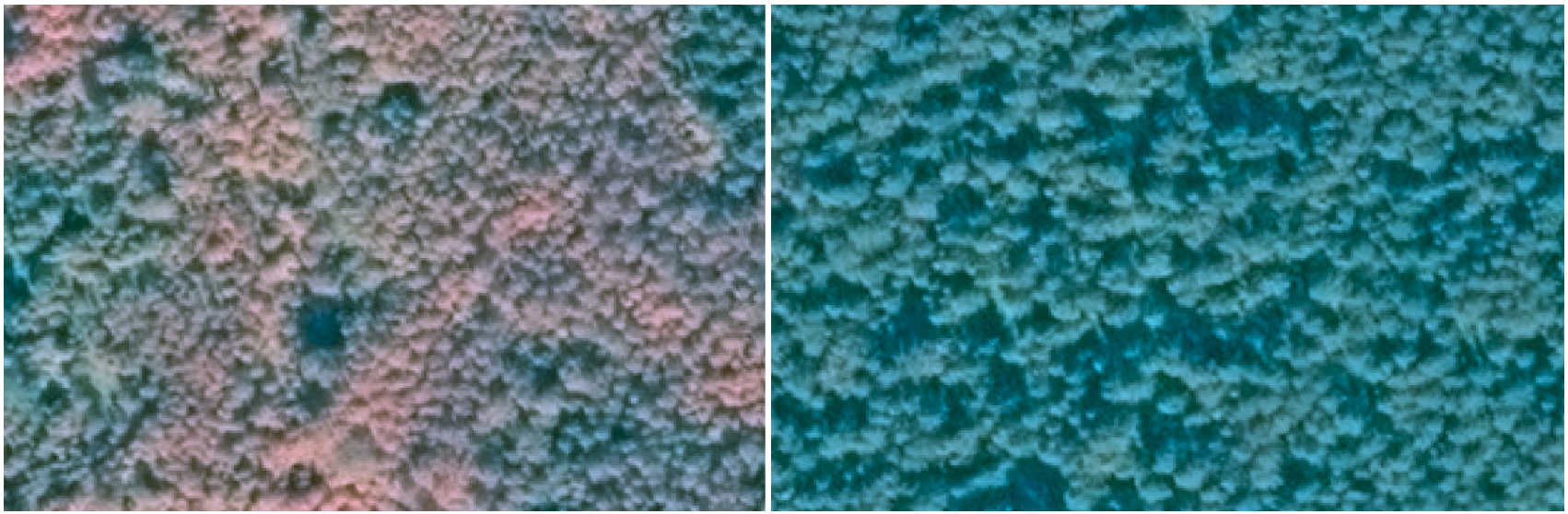
Basic unit	**Advantages**	**Disadvantages**
Pixel or its neighborhood	Simple and convenient	Not a land cover related unit



1. Introduction

Why microstands?

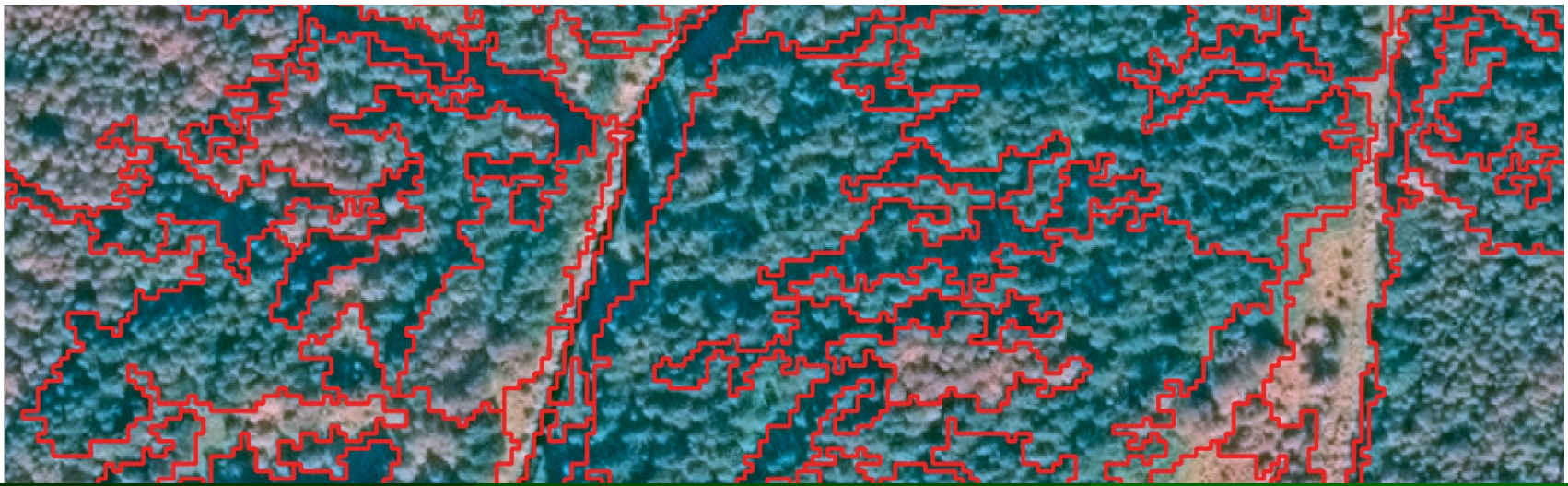
Basic unit	**Advantages**	**Disadvantages**
Single tree	Highest accuracy in forest inventory variable estimation	Interaction between forest structure and spatial resolution might result in weak performance of single tree detectors



1. Introduction

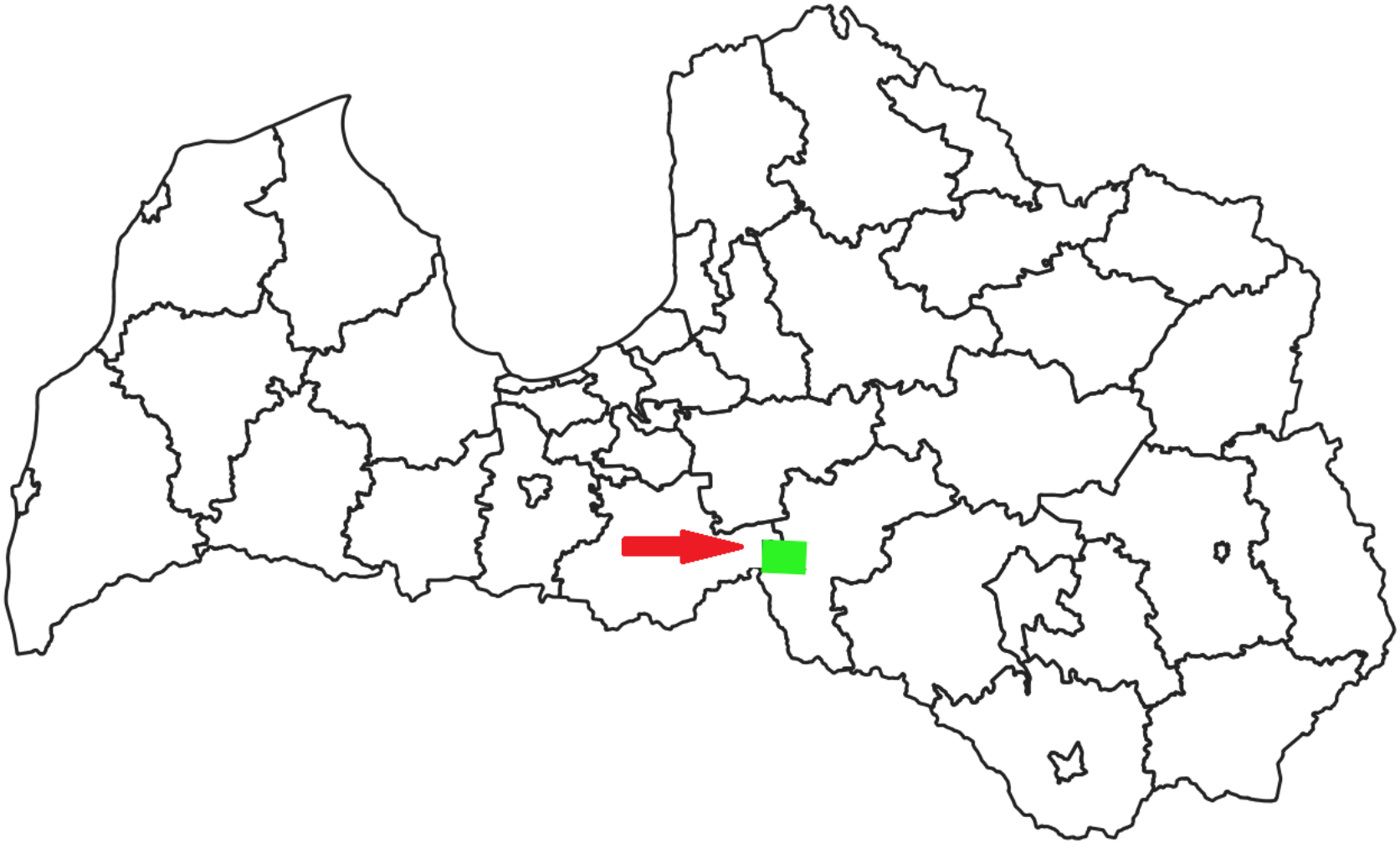
Why microstands?

Basic unit	**Advantages**	**Disadvantages**
Microstand	Object related with land cover Robust unit also in the complex cases Useful for both stand border refinement and automated forest inventory parameter estimation	How to define homogeneity? Ill-posed problem with many solutions



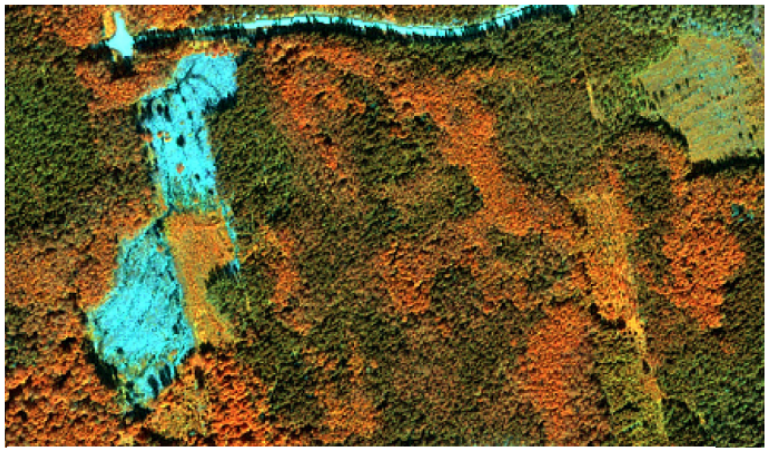
2. Study site

- 161 km^2, located in the central southern part of Latvia
- Hemiboreal mixed forest (dominant tree species: Scots pine, Norway spruce, birch and black alder, average stand age 66 years)

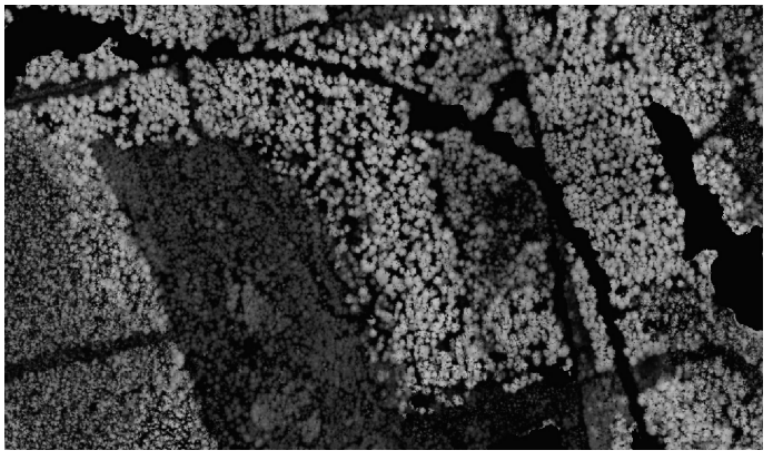


3. Data sets

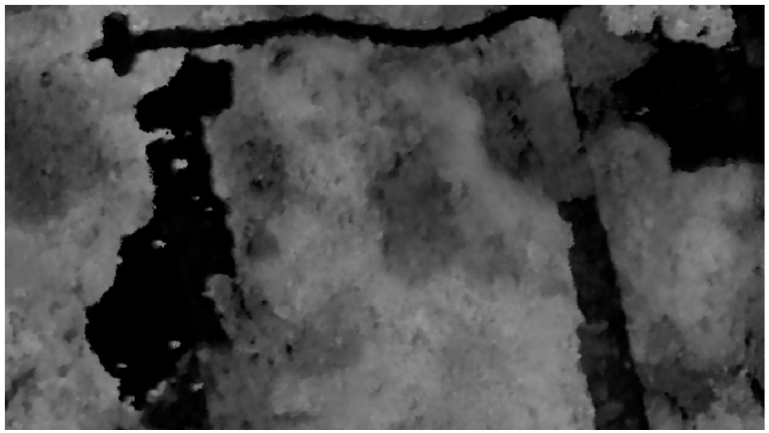
GeoEye satellite images (0.5 m/pix panchromatic, 2 m/pixel 4 bands (R, G, B, NIR) 07.08.2020. 9:27



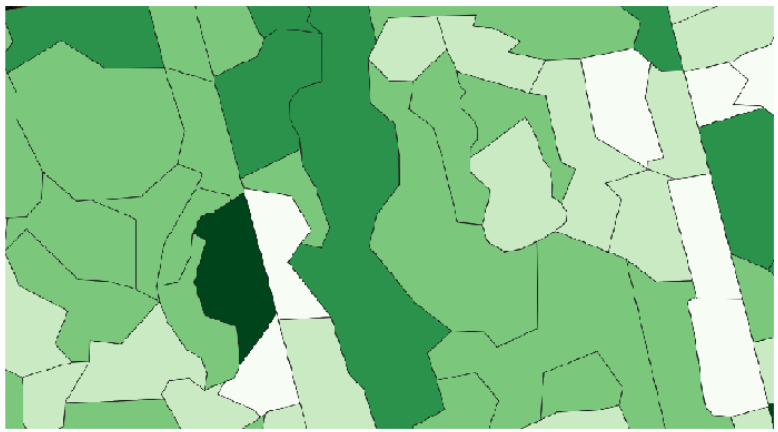
Countrywide, Lidar based CHM (0.5m/pix)



GeoEye stereo based CHM (0.5 m/pix)



Stand volume from Regular Forest Inventory data base (m3/ha), in forest compartment level



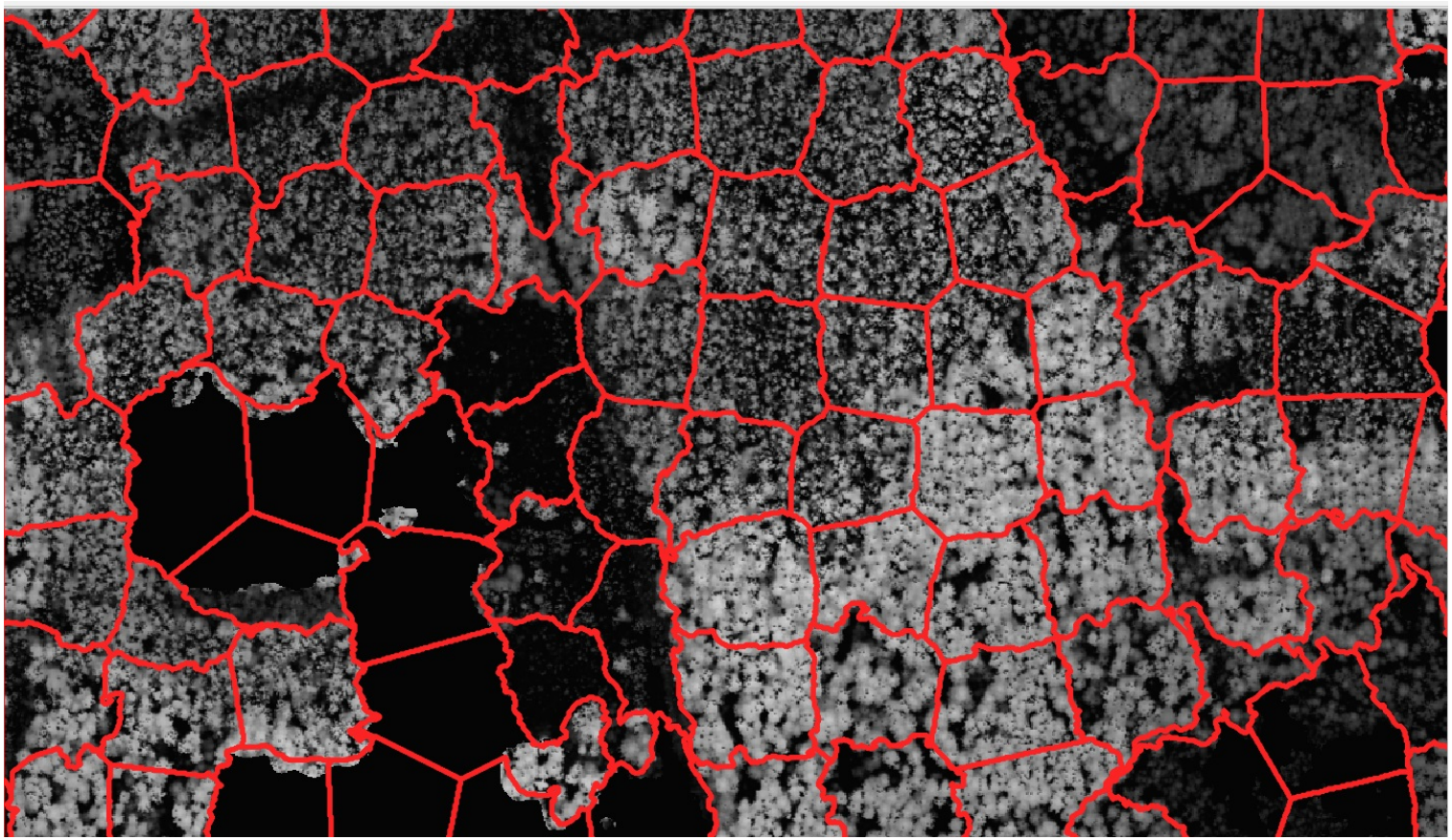
9599 forest compartments

4. Methodology

1. Microstand segmentation
2. Assignment of the reference stand volume values to the microstands
3. Preparation of hand-crafted features
4. Stand volume estimation using Random Forest
5. Accuracy estimates (RMSE, nRMSE)

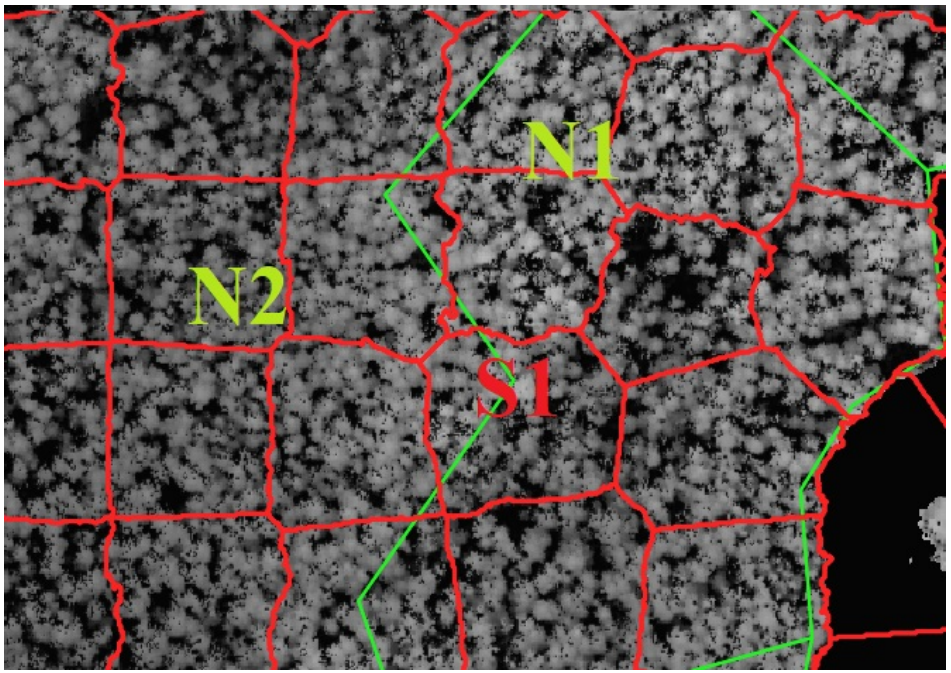
4.1. Microstand segmentation

Simple Linear Iterative Clustering (SLIC)



4.2. Assignment of the reference value

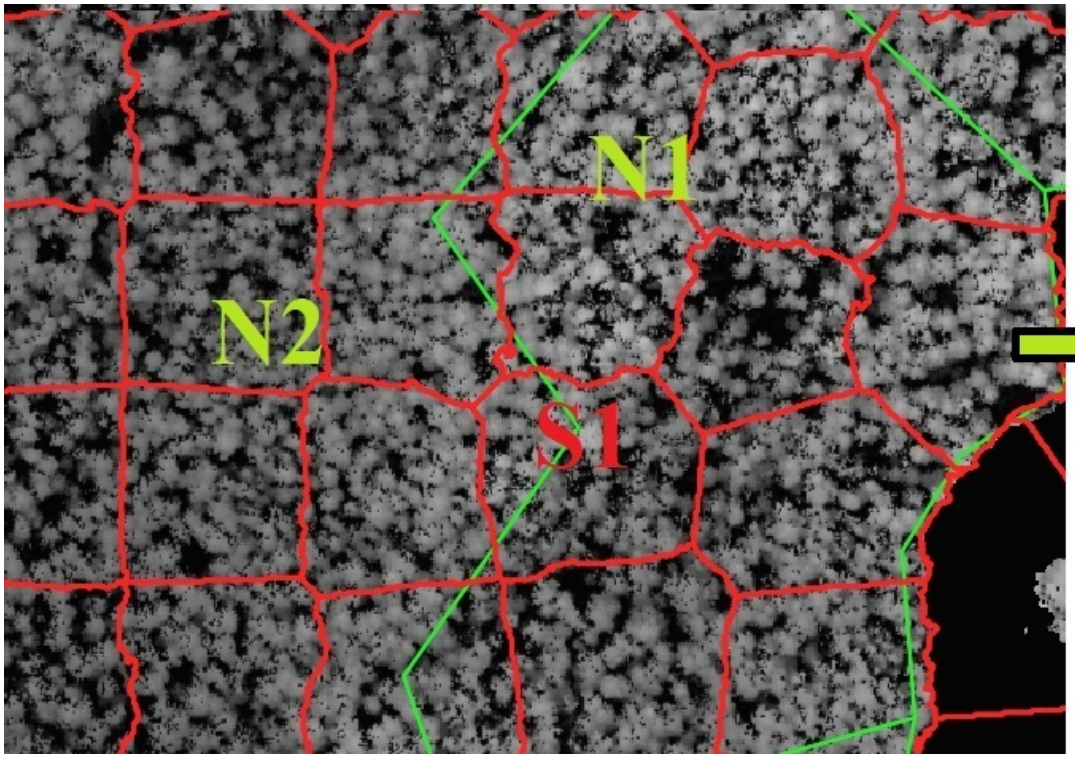
- We find the forest compartment with the largest spatial overlap with the microstand
- Ground truth stand volume value from this forest compartment is assigned to the microstand
- Additional filtering is required



Example: stand volume value from the forest compartment N1 is assigned to the microstand S1

4.3. Preparation of hand-crafted features

Each microstand is described by 10 features



For all CHMs:
Average CHM value
Standard deviation of the CHM
Only Lidar based CHM:
Number of local maximas
Average value of local maximas
Multispectral image:
Average value for all 4 bands

4.4. Stand volume estimation using Random Forest

Random Forest

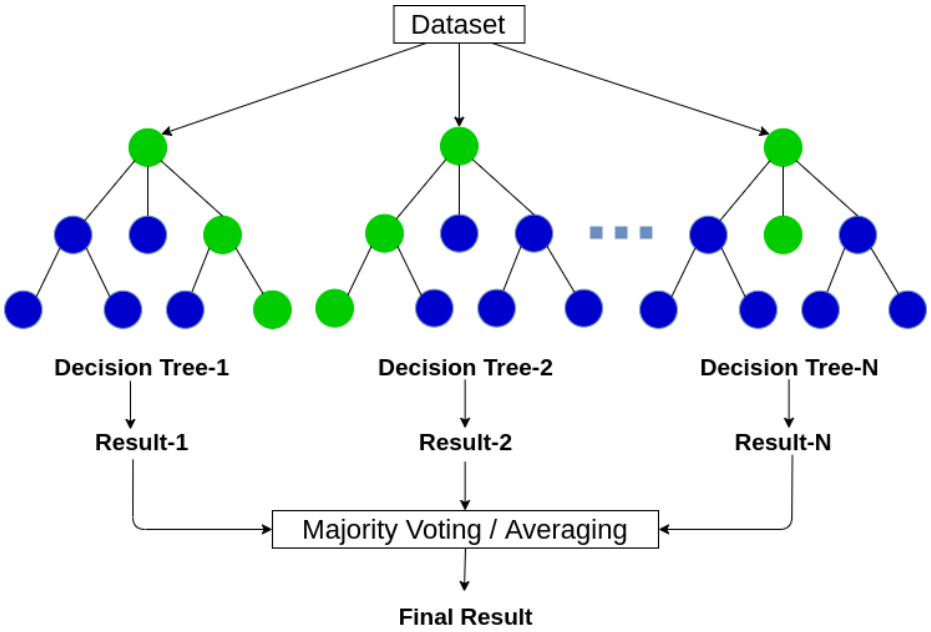
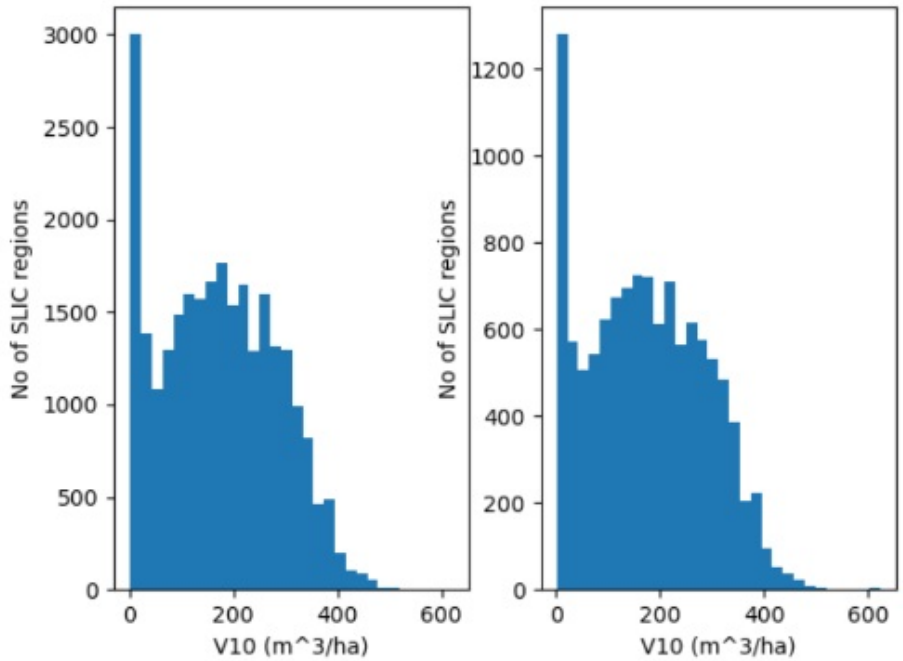


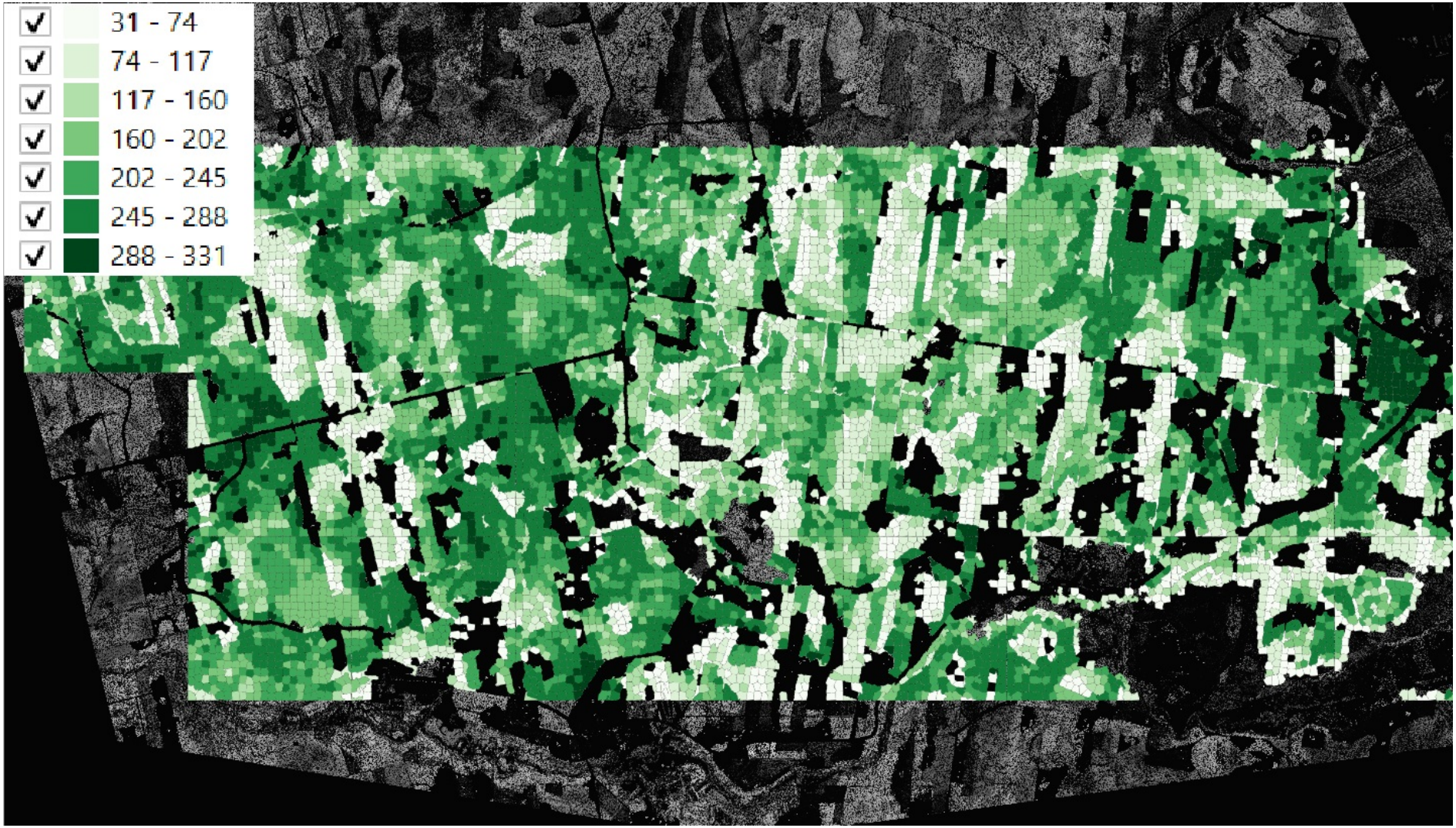
Image:
https://www.analyticsvidhya.com/blog/2020/05/decision-tree-vs-random-forest-algorithm/

Train/test data split



5. Results

V10 estimates at microstand level (m^3/ha)

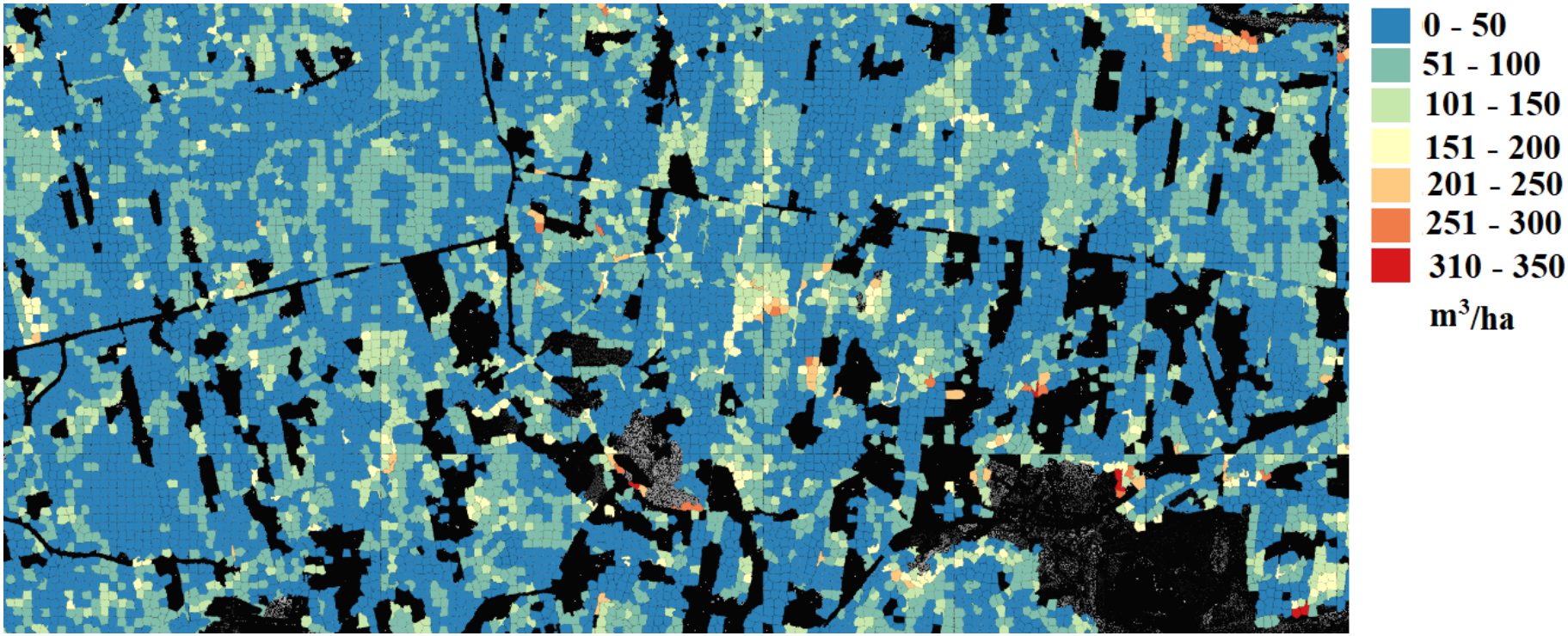


5. Results

Testa apraksts	RMSE (m^3/ha)	NRMSE (%)
Lidar based CHM, young stands included	76.2	12.3
Lidar based CHM, young stands excluded	75.9	12.2
Lidar based CHM, coniferous only	74.4	12.0
Lidar based CHM, deciduous only	65.7	12.9
Lidar and GeoEye-1, coniferous only	71.7	11.6
Lidar and GeoEye-1, deciduous only	60.7	11.9

5. Results

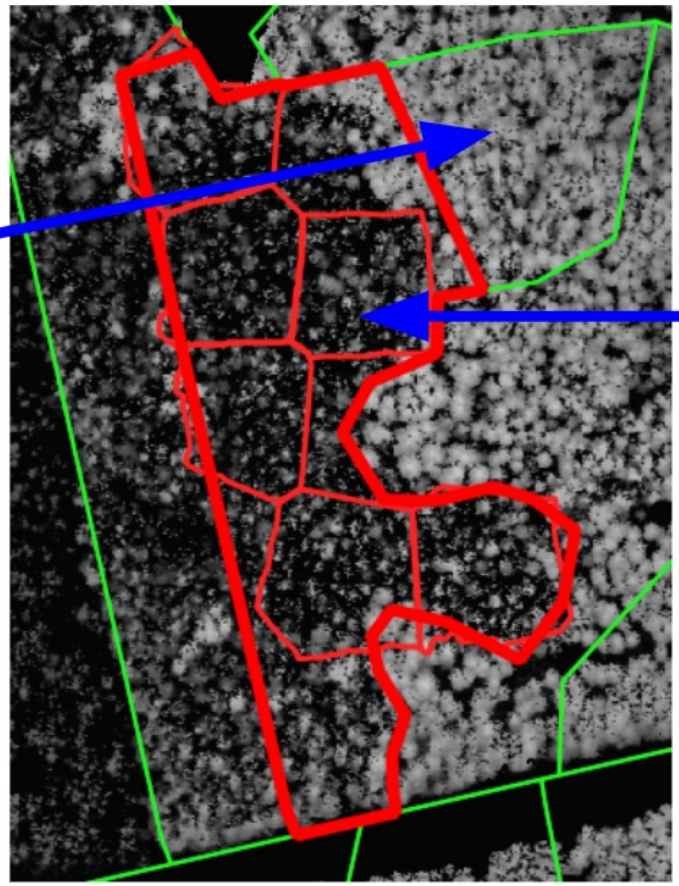
Absolute error at microstand level (m^3/ha)



5. Results

Error sources

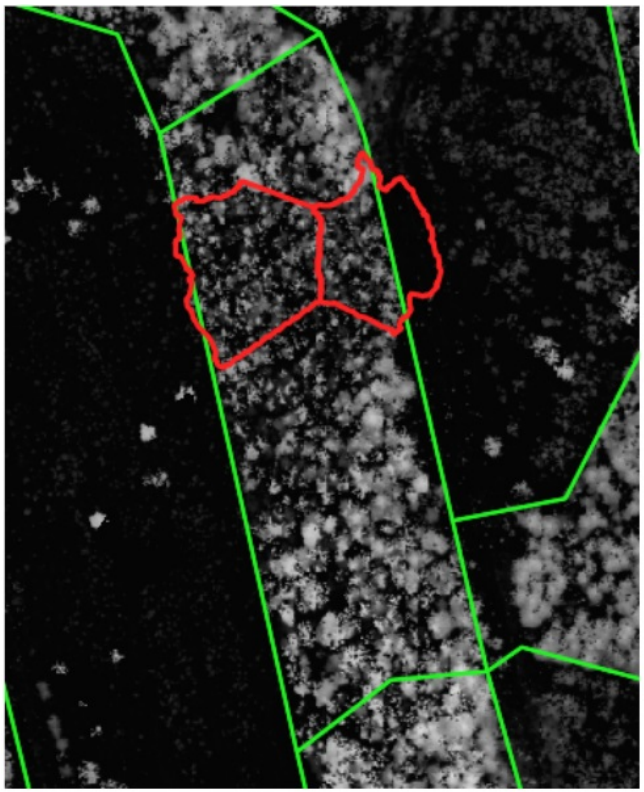
S10=1
V10=290
H10=26

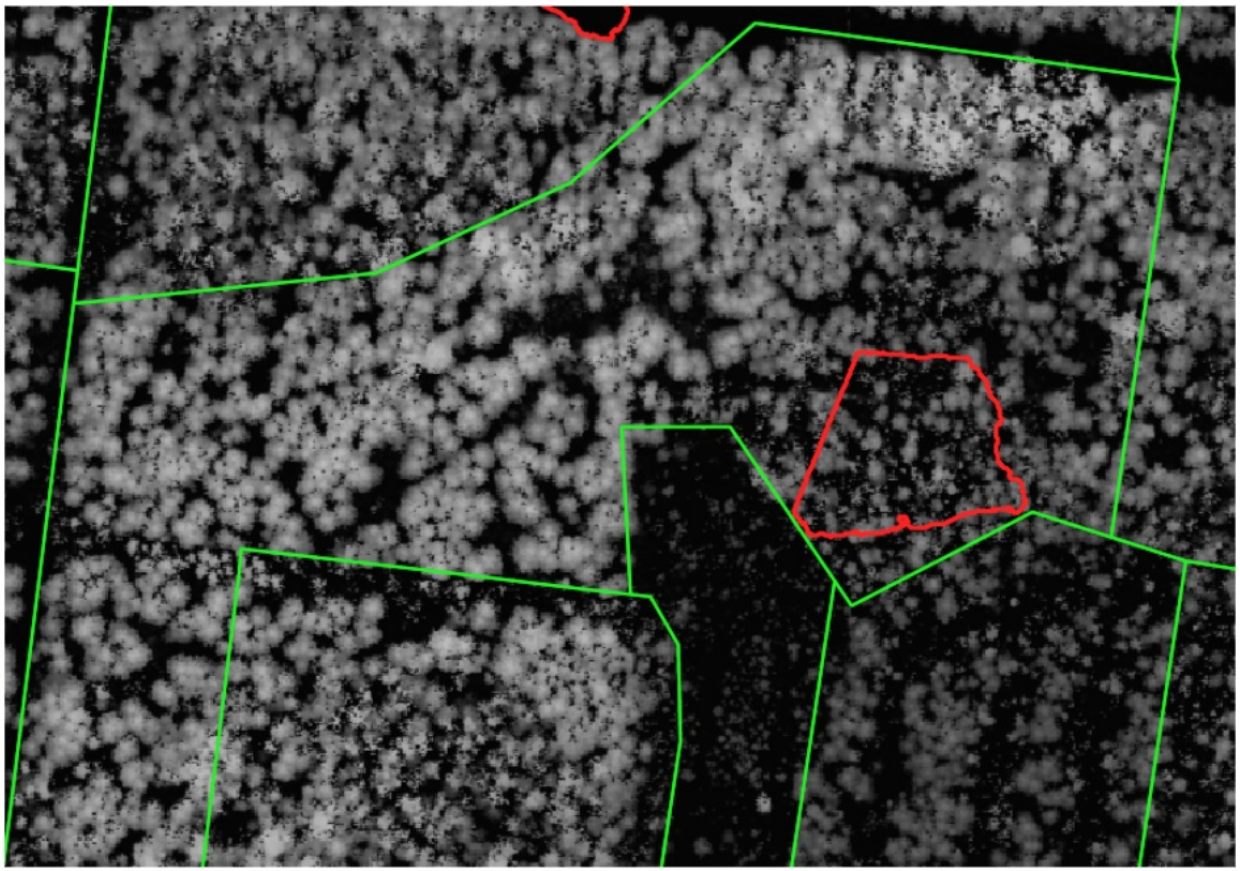


S10=6
V10=442
H10=29
CHM mean=5.2 m
RF V10 estimate = 94

5. Results

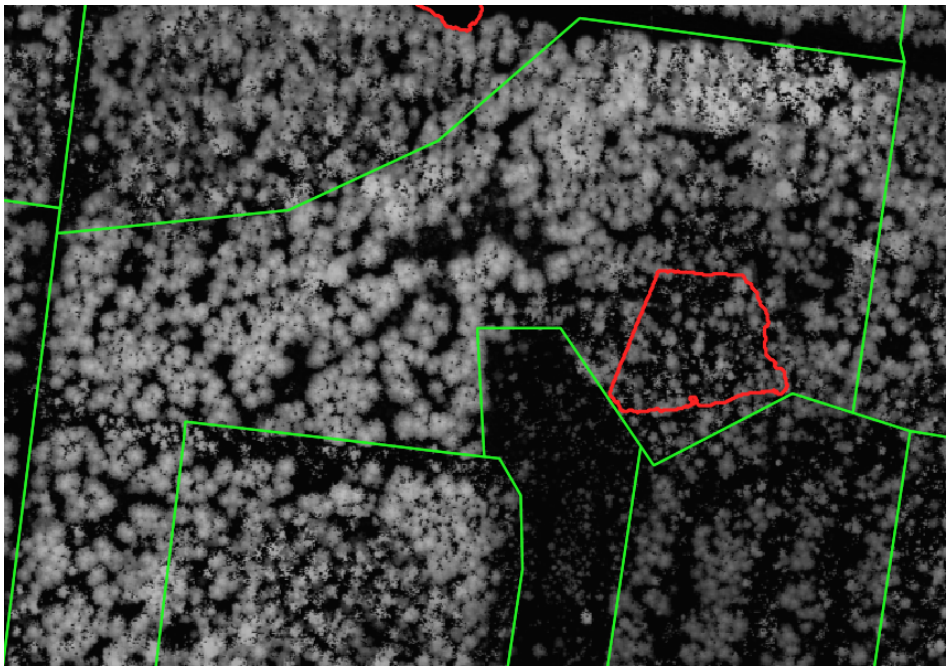
Error sources





6. Conclusions

1. Error visualization at the micro-level shows high potential for understanding error sources
2. Regardless of the segmentation method, machine learning method or filtering method, the error could not be reduced by more than about 12%
3. Possible sources of error: inaccuracies in the inventory data and internal inhomogeneity of the plots



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IEGULDĪJUMS TAVĀ NĀKOTNĒ

This study was a part of the ERDF-funded project entitled "Satellite remote sensing-based forest stock estimation technology" (Project No. 1.1.1.1/18/A/165)

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