Using UAS-data for estimating Scots pine stand parameters in Lahemaa National Park

Raul S. de Lima[1]; Diana Laarmann[2]; Miguel Villoslada[1]; Ants Vain[1]; Mait Lang[2,3]; Kalev Sepp[1]

[1] Institute of Agriculture and Environmental Sciences, Estonian University of Life Sciences, Tartu, Estonia; [2] Institute of Forestry and Rural Engineering, Estonian University of Life Sciences, Tartu, Estonia; [3] Tartu Observatory, Tartu University, Tõravere, Estonia

Correspondence address: raul.sampaio@student.emu.ee

1. Study Purpose

This study aimed to develop models for estimating and describing structural and functional properties of forest plots located in Lahemaa National Park, linking data collected with UAS to ground-data from forest inventory.

2. Study Area

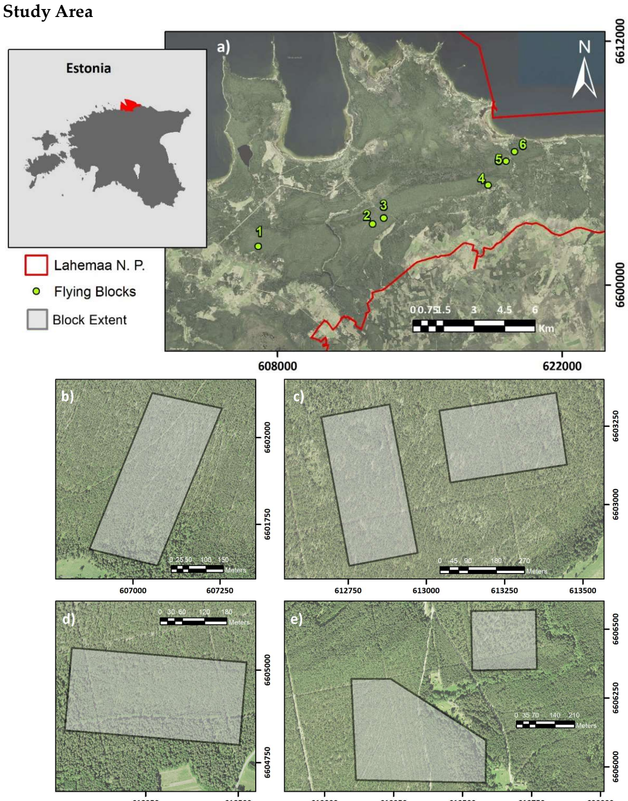

Fig. 1: (a) Location of flying blocks within Lahemaa National Park, Estonia; Extent of Flying Area in (b) Block 1, (c) Blocks 2 and 3, (d) Block 4, and (e) Blocks 5 and 6.

3. Method

1) Data Acquisition
   - Ground data from the Forest Register.
   - UAS data (Parrot Sequoia, and S.O.D.A. camera).
2) Calculation of Vegetation Indexes **(Table 1)** and height distribution

Table 1: . List of vegetation indices used in the present study.

Index	Abbreviation	Equation
Normalized Difference Vegetation Index	NDVI	(NIR-RED)/(NIR+RED)
Green Red Difference Index	GRDI	(GREEN-RED)/(GREEN+RED)
Simple Ratio	SR	NIR/RED
Red-edge Simple Ratio	SR_{RE}	NIR/REG
Red-edge Normalized Difference Vegetation Index	$NDVI_{RE}$	(NIR-REG)/(NIR+REG)
Red-edge Triangular Vegetation Index (core only)	RTVIcore	(100*(NIR-REG))-(10*(NIR-GREEN))
MSRed edge	MSRed edge	((NIR-REG)-1)/(((NIR+REG)^(0.5))+1)

3) Calibration of Models
   - Random Forest Regression.
     - Response Variables: **Height Index, Tree Cover, Tree Density, and Basal Area**.
     - Explanatory variables: **Canopy Height Model (CHM), Reflectance of Multispectral Bands, and Spectral Indexes.**
4) Model Assessment
   - Predictions compared to the **validation dataset (25%).**
     - Coefficient of Determination (R^2).
     - Variable importance (Node purity).

4. Results

SR was the most important variable in the Height Index's model (Fig. 2). The model explained 55.7% of the validation dataset, and 66.6% of the calibration dataset (Fig. 3).

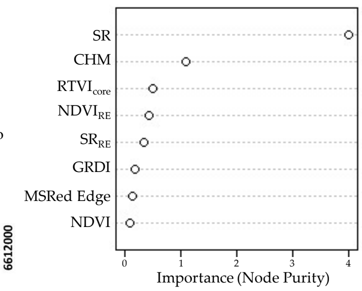

Fig. 2: Importance values for the input variables in the RF Regression for Height Index.

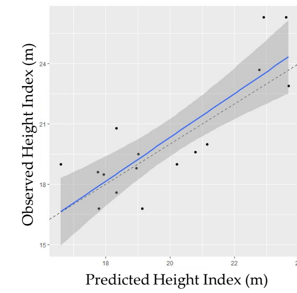

Fig. 3: Scatterplot of observed and predicted values for validation dataset of Height Index. 1:1 dashed line. Slope = 1.088, Intercept = 1.44, R^2 = 0.666

CHM was the most important variable in the Basal Area's model (Fig. 4). The model explained 4.7% of the validation dataset, and 10.3% of the calibration dataset (Fig. 5).

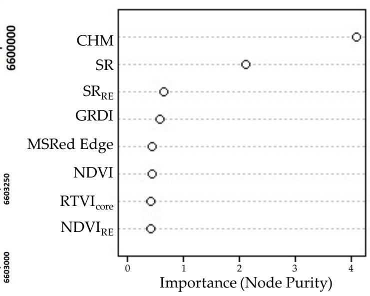

Fig. 4: Importance values for the input variables in the RF Regression for Basal Area.

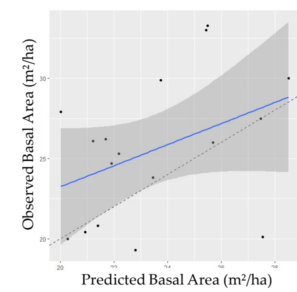

Fig. 5: Scatterplot of observed and predicted values for validation dataset of Basal Area. 1:1 dashed line. Slope = 0.657, Intercept = 10.11, R^2 = 0.103

SR and CHM were the most important variables in the Tree Density's model (Fig. 6). The model explained 26.1% of the validation dataset, and 57.1% of the calibration dataset (Fig. 7).

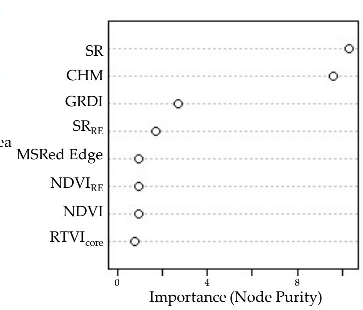

Fig. 6: Importance values for the input variables in the RF Regression for Tree Density.

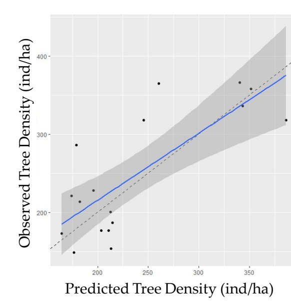

Fig. 7: Scatterplot of observed and predicted values for validation dataset of Tree Density. 1:1 dashed line. Slope = 0.858, Intercept = 44.13, R^2 = 0.571

CHM were the most important variable in the Tree Cover's model (Fig. 8). The model explained 32.6% of the validation dataset, and 36.8% of the calibration dataset (Fig. 9).

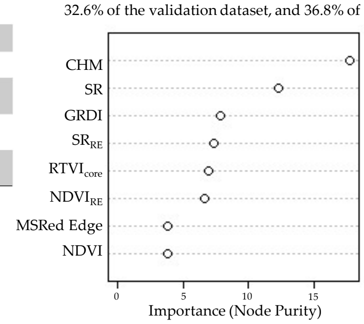

Fig. 6: Importance values for the input variables in the RF Regression for Tree Cover.

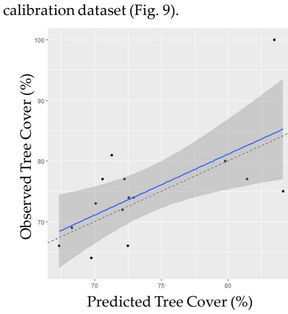

Fig. 7: Scatterplot of observed and predicted values for validation dataset of Tree Cover. 1:1 dashed line. Slope = 1.01, Intercept = 0.73, R^2 = 0.368

5. Conclusions

- 3D models showed a good predictive performance when estimating Scots pine stand parameters.
- NDVI was not a good index for modelling stand parameters.

6. Acknowledgements

The authors acknowledge the support on data collection from Kai-Yun Li, and Thaisa Bergamo.