Mapping aboveground forest biomass using airborne data

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Introduction

Recently, considerable attention has been paid to forest aboveground biomass (AGB) estimation due to its role in carbon storage calculations and our current understanding of the carbon cycle. Generally, traditional methods of estimating AGB at the tree level use allometric equations derived from field data. Data collection for this method is time-consuming, expensive, not always reliable and limited to accessible areas. Such issues can be addressed through the use of automated airborne hyperspectral and/or laser scanning (LiDAR) sensor data and their processing.

Methods

The study area is located in Beskydy Mountains, the North-East part of the Czech Republic (Fig. 1). Norway spruce and European Beech dominate the forest cover there. Airborne hyperspectral and LiDAR data have been acquired in territory on 8th September 2013 and 14th May 2013, respectively. Field data were collected in 2013 by Institute of Forest Ecosystem Research.

HS data
AISA Eagle, 65 bands, 0.4 m, 400-1000 nm

Field data
25 plots: species, height, DBH

LiDAR data
Riegl LMS-Q680i, 50 points/m2

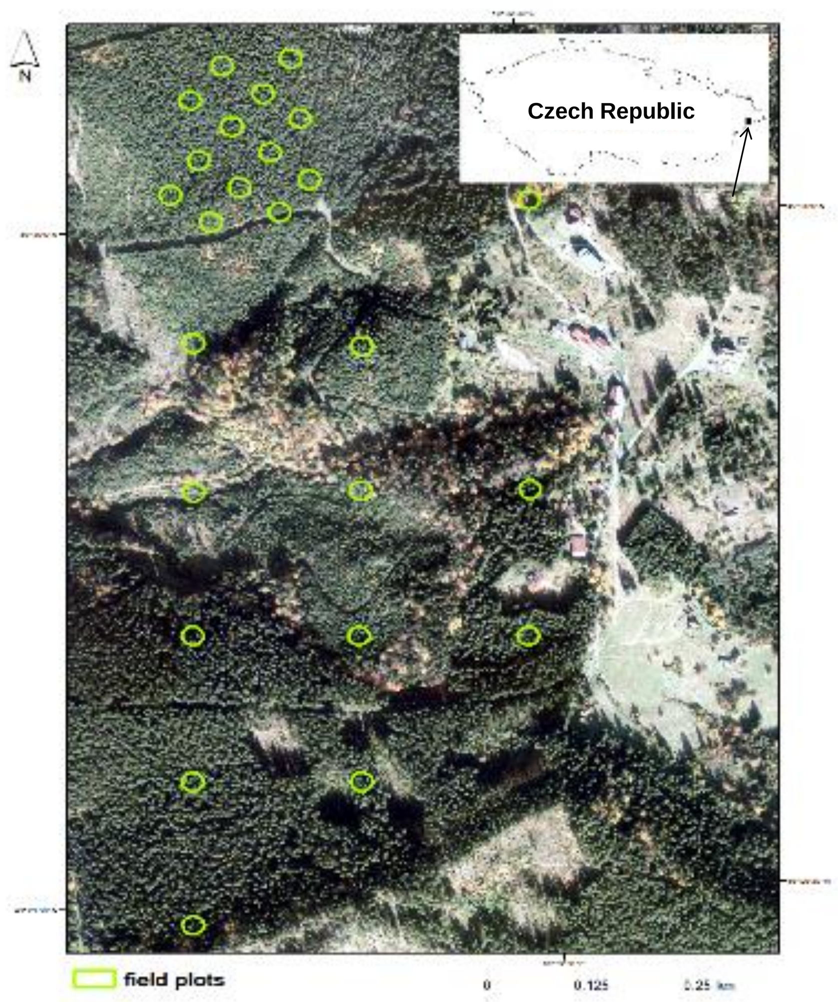

Fig. 1 Location of study area

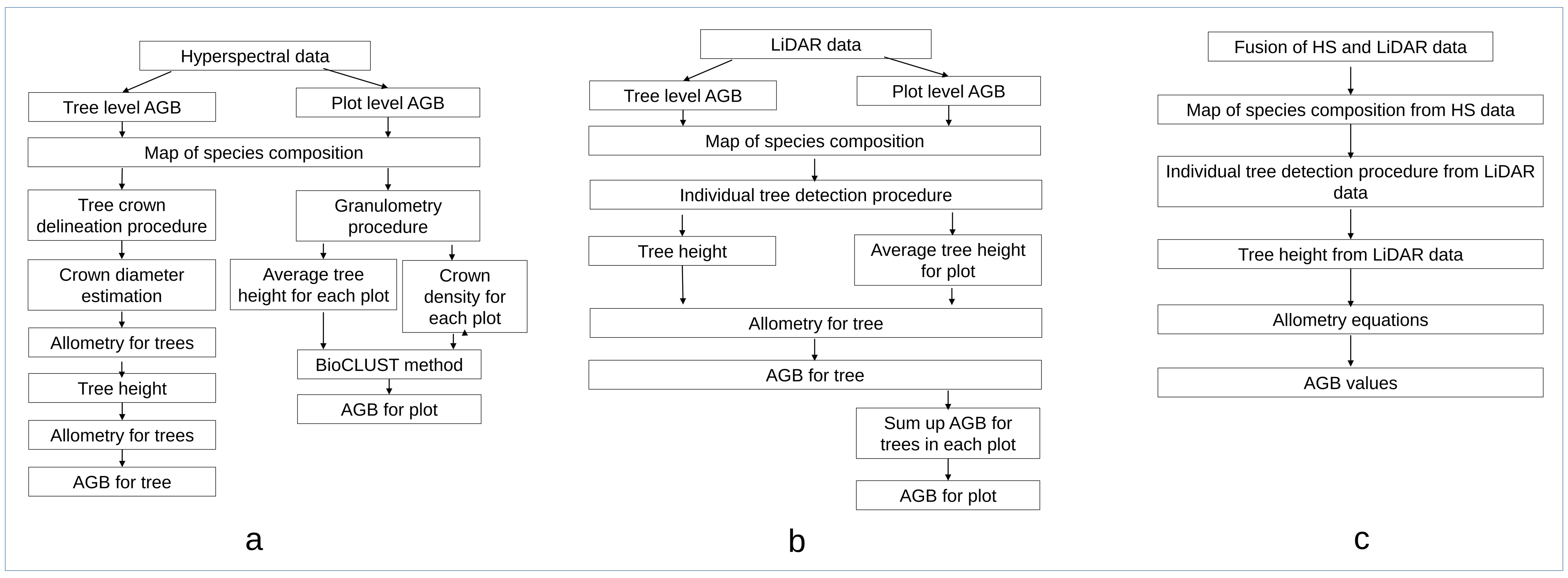

Fig. 2 Frameworks for AGB estimation using airborne data (three methods)

Three methods are presented for estimation of forest aboveground biomass (AGB) using different categories of airborne data. The first method (Fig. 2a) estimates AGB from high spatial resolution hyperspectral data. The second method (Fig. 2b) estimates AGB from airborne laser scanning data. The third method (Fig. 2c) explores synergy between hyperspectral and LiDAR data to estimate AGB.

Tree level and plot level AGB assessment is made for each of the three methods. The results are compared with biomass estimated from field measurements.

Results

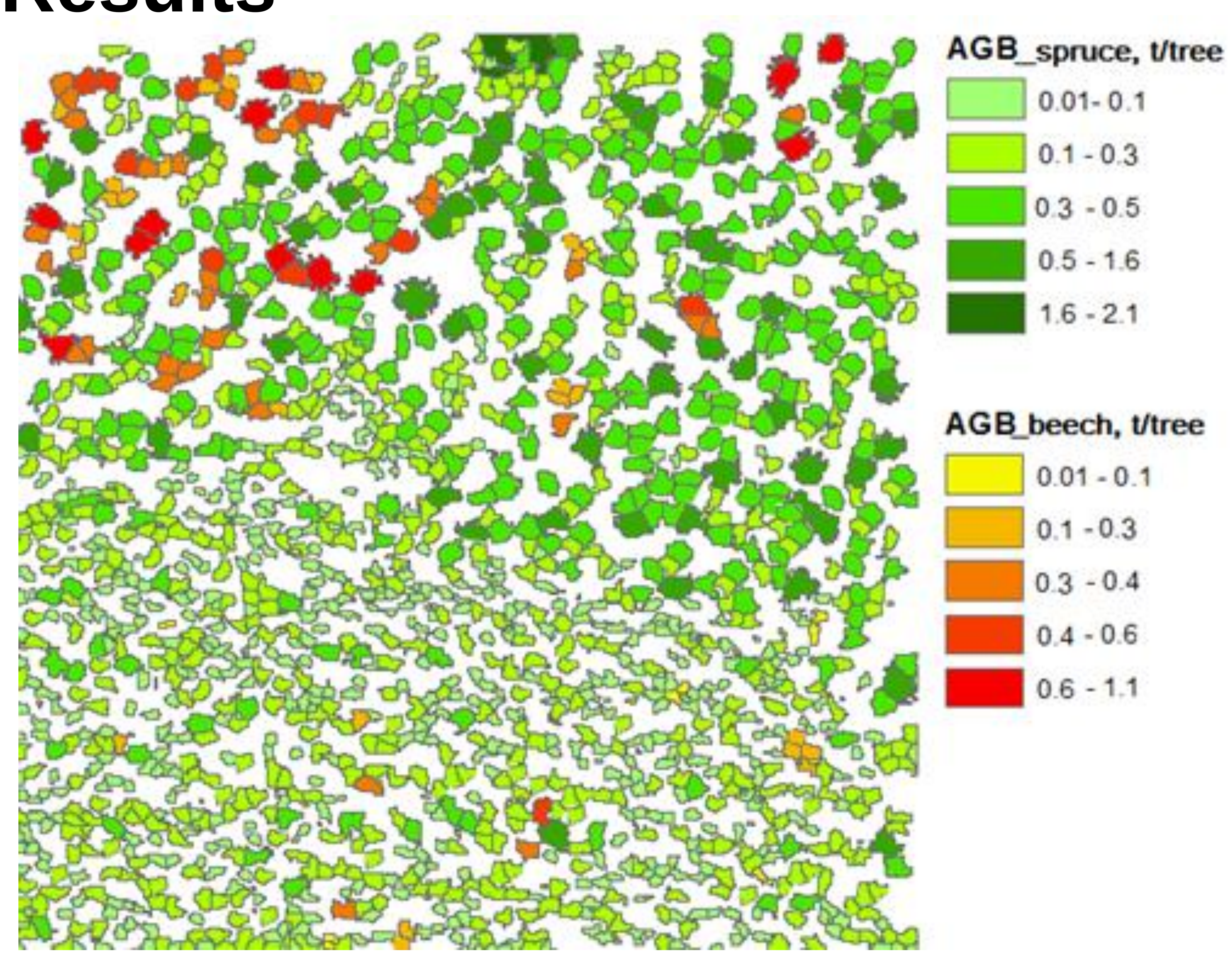

Fig. 3 Fragment of AGB map for tree level from HS data

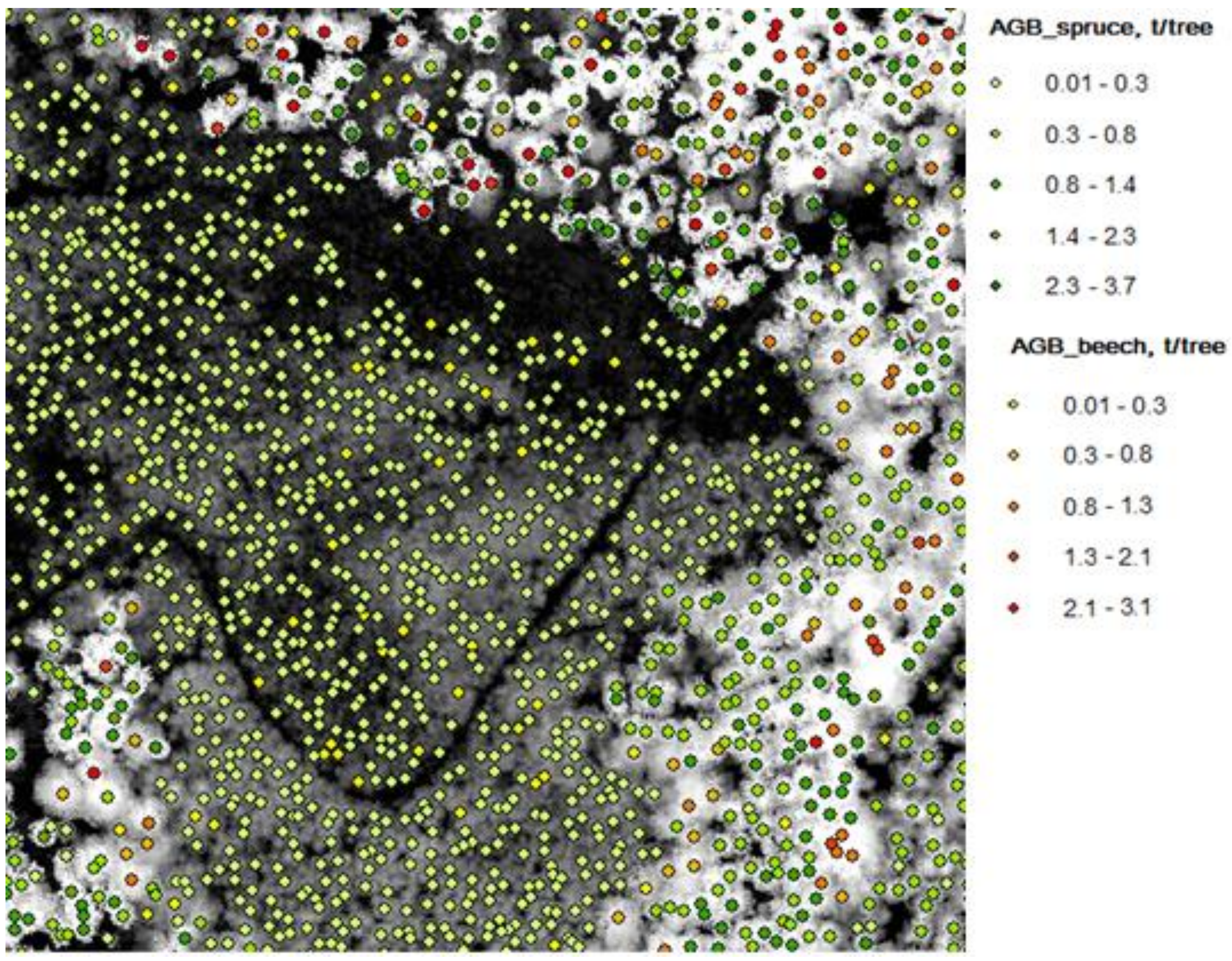

Fig. 4 Fragment of AGB map for tree level from LiDAR data

Table 1. Results obtained for AGB estimation based on hyperspectral data, LiDAR data and fused (HS and LiDAR) data for tree level and plot level.

AGB	R^2	Equation	MEAN	CV_{RMSE} [%]
Tree level, [t/tree]				
AGB_HS_spruce	0.54	y = 0.8x + 0.01	0.335	45
AGB_HS_beech	0.61	y = 0.8x + 0.09	0.446	54
AGB_HS_all	0.56	y = 0.8x + 0.03	0.345	51
AGB_LiDAR_spruce	0.85	y = 0.9x - 0.02	0.344	28
AGB_LIDAR_beech	0.78	y = 0.75x + 0.03	0.477	48
AGB_LIDAR_all	0.81	y = 0.9x - 0.01	0.351	33
AGB_fusion_spruce	**0.87**	y = 1.1x - 0.01	0.341	**22**
AGB_fusion_beech	**0.81**	y = 0.77x + 0.05	0.468	**41**
AGB_fusion_all	**0.85**	y = 0.9x - 0.06	0.362	**28**
Plot level, [t/plot]				
AGB_HS	0.62	y = 1.3x - 1.82	10.37	52
AGB_LiDAR	0.78	y = 1.02x - 0.44	9.03	27
AGB_fusion	**0.84**	y = 1.2x - 1.57	9.71	**24**

Conclusion

This analysis proves the efficiency of using the synergy of hyperspectral and LiDAR data in Central European forests for biomass estimation for tree and plot levels. Results also show that high resolution HS data alone could be used for AGB estimates when LiDAR data is not available.

Acknowledgements This work was supported by a postdoc project in technical and economic disciplines at Mendel University in Brno (reg. no. CZ.1.07/2.3.00/30.0031), by the Ministry of Education, Youth and Sports of CR within the National Sustainability Program I (NPU I), grant number LO1415, and COST project No. OCO9001

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