Delineation of Individual Tree Crowns from ALS and Hyperspectral data: a comparison among four methods

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Introduction

- Remote Sensing **Detection Methods** applied **at Individual Tree Crown (ITC) level** are increasingly used **to assist forest inventories** because of their time-saving potential.
- In this study 4 remote sensing methods,based on high density airborne laser scanning (ALS) and hyperspectral data are compared.

Data Pre-treatment

- Field data:
  Individual Stem Volume computed by allometric relationships
- ALS data:
  Raw ALS → DTM subtraction → CHM (Canopy Height Model)
- Hyperspectral data:
  Raw hyperspectral → resampling at 0.5 m → same resolution of other CHM

Data Set Description

Study area:
- 4800 m2 of alpine, 1400 m asl forest in Lavarone (Trento, Italy)

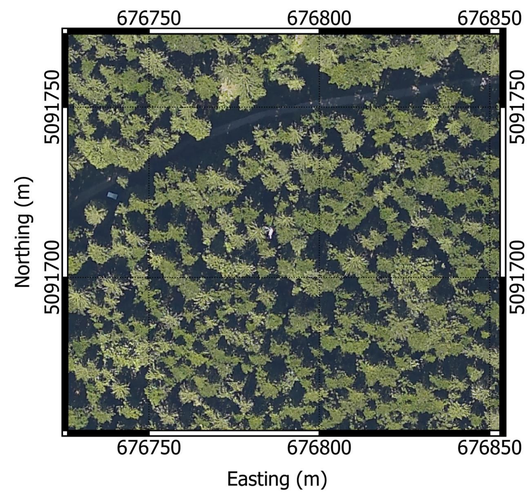
Airborne laser scanning (ALS) data
- Mean first return point density: 8.6 points/m2, up to 4 returns.

Hyperspectral data:
- 130 bands between 400 and 900 nm with a spatial resolution of 0.9 m

DBH class	Number of trees			
	Total	*Norway Spruce*	*Silver Fir*	*European Beech*
< 7.5 cm	236	14	105	117
7.5 – 17.5 cm	136	29	88	19
> 17.5 cm	258	74	173	11
Basal area %		35.5	59.7	4.8

Tabe 1: Summary of the field measured trees

Figure 1: Study Area



Methods

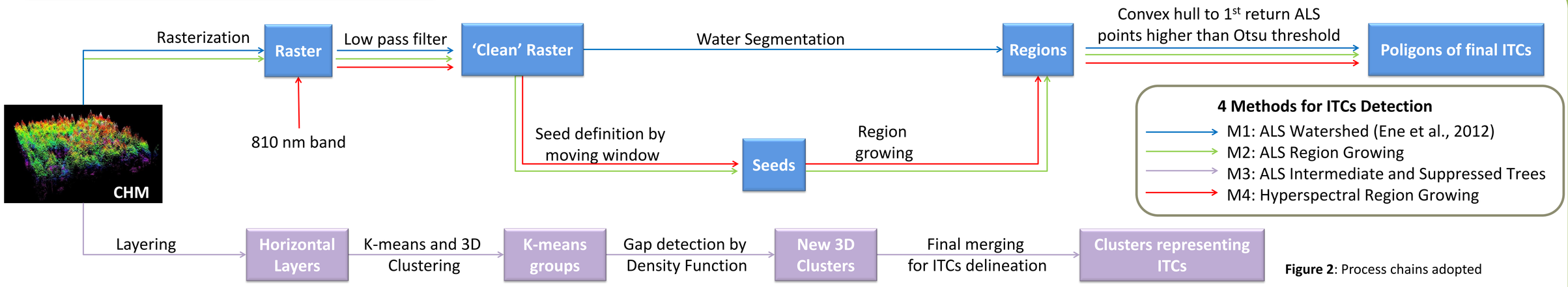
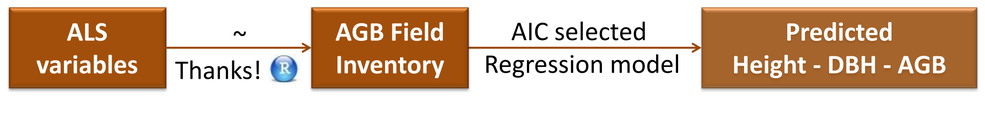


Figure 2: Process chains adopted

- All ALS methods start from a point cloud in the *'.las'* format, representing a Canopy Height Model.
- Regression models are calibrated on the correctly identified trees, in order to predict Height, DBH and AGB from ALS data.
- A regression model, selected by means of Akaike Information Criterion (AIC), is used for prediction over the whole dataset.



Results

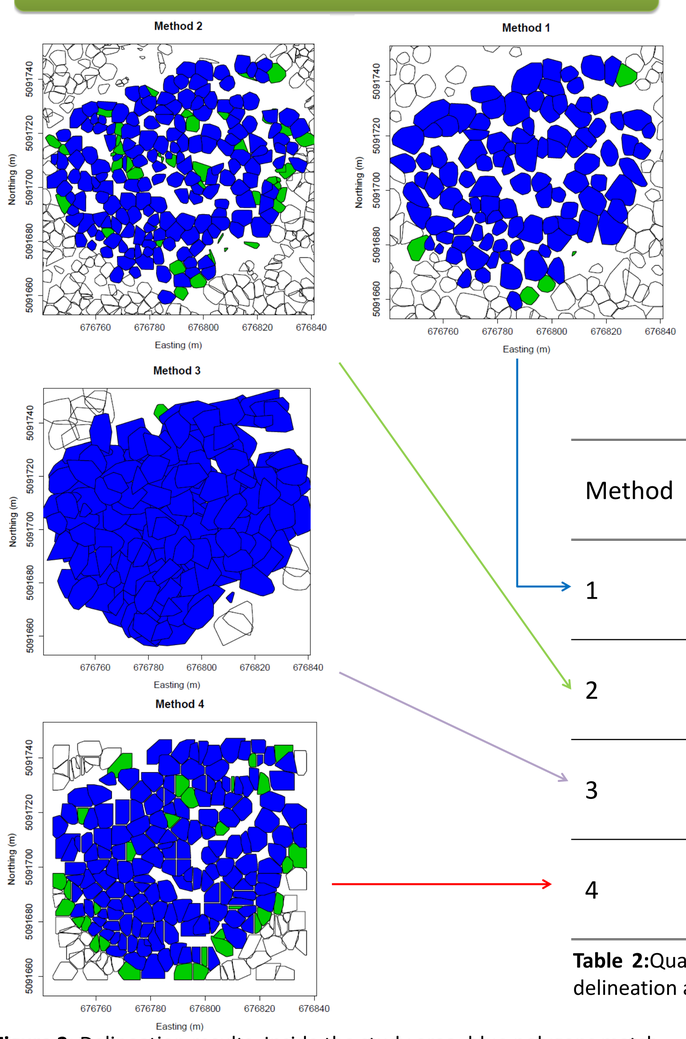


Figure 3: Delineation results. Inside the study area: blue polygons match with field measurements, green ones are the commission errors.

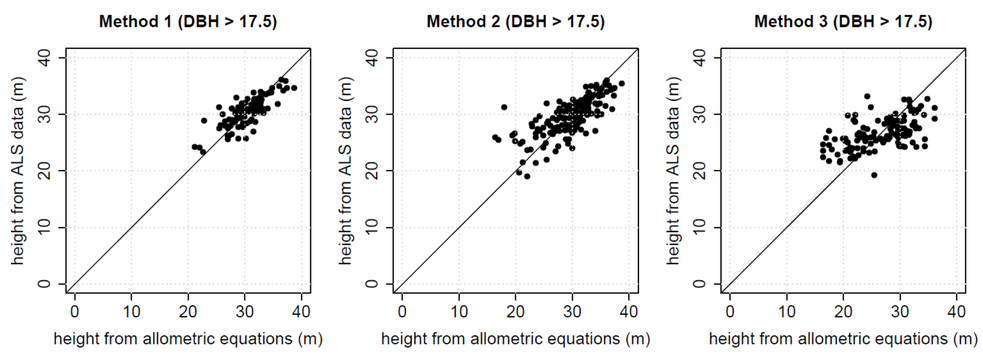
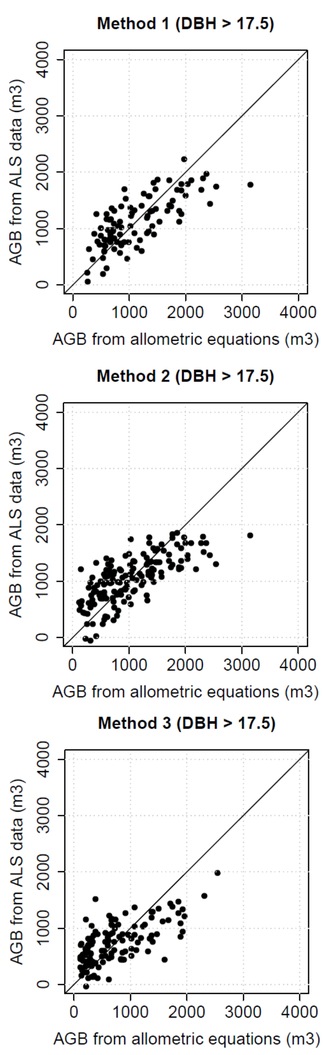


Figure 4: Height (above) and AGB (right) estimation results with the three methods based on ALS data.



Method	DBH	N field	N ITC matched	DET (%)				AI (%)	OE (%)	CE (%)
				Total	*Picea abies*	*Abies alba*	*Fagus sylvatica*			
1	all	630	102	16.2	20.5	19.4	4.8	11.5	83.8	4.7
	>7.5 cm	394	100	25.4	23.3	27.2	16.7	18.9	74.6	6.5
	>17.5 cm	**258**	**100**	**38.8**	**32.4**	**41.0**	**45.5**	**32.3**	**61.2**	**6.5**
2	all	630	175	27.8	43.6	29.5	10.9	7.0	72.2	20.8
	>7.5 cm	394	167	42.4	49.5	39.8	40.0	18.0	57.6	24.4
	>17.5 cm	**258**	**157**	**60.9**	**64.9**	**57.8**	**81.8**	**31.8**	**39.2**	**29.0**
3	All	630	155	24.6	28.2	28.1	12.9	24.0	75.4	0.6
	>7.5 cm	394	150	38.1	33.0	38.7	50.0	34.2	61.9	3.9
	>17.5 cm	**258**	**140**	**54.3**	**40.5**	**58.4**	**81.8**	**44.0**	**45.7**	**10.3**
4	all	630	157	24.9	18.8	23.5	33.3	8.4	75.1	16.5
	>7.5 cm	394	144	36.6	35.9	35.6	46.7	13.1	63.5	23.4
	>17.5 cm	**258**	**127**	**49.2**	**33.8**	**53.8**	**81.8**	**16.7**	**50.8**	**32.5**

Table 2: Quantitative results of the ITC delineation of the four methods. DET: detection rate, OE: omission error, CE: commission error. AI: delineation accuracy index (as 100 - OE + CE).

Conclusions

- Methods with high DET are capable to identify the majority of commonly inventoried trees.
- Methods with high DET are also associated to relatively high CE, which is followed by higher errors in predicting ITCs structural characteristics as AGB and height.
- No methods perform well in identifying small trees, the same trees that are normally omitted in forest inventories.

References

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