ESTIMATION OF 12 BIOMASS PARAMETERS USING TERRESTRIAL LASER SCANNER

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OUTLINE

1. INTRODUCTION
2. METHODOLOGY
3. ANALYSIS AND DISCUSSION
4. CONCLUSION

INTRODUCTION

Forest is an ecosystem which consists of landscape containing natural resources, dominated by trees in the natural environment where each cannot be separated from the other (Act Number 44 Year 1999).

Forest can act as a regulator to control the climate change and its mitigation through its ability to absorb the carbon particles from an area of the forest.


Sumber: kompasiana.com

Sumber: www.mongabay.co.id

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To maximize the function and potential of the forest, three dimensional information of the biomass spread in a forest area is required.

The biomass parameters that are formed in every tree in a forest represent the interaction process between a tree and another.

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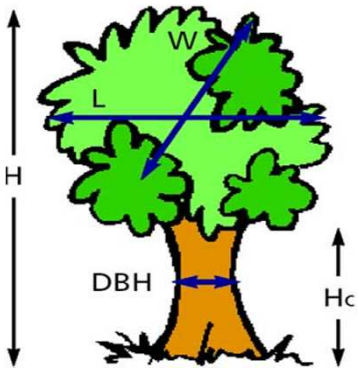
There are several methods to calculate the biomass parameters, namely direct methods and indirect methods.



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Direct Methods

- *Allometrics*
- *Stratified clipping and the scaffolding approach*
- *Litter traps*

Indirect Methods

- *Point quadrat method and inclined point quadrats*
- MacArthur and Horn *photographic method*
- *Hemispherical photography*
- *LIDAR*
- *Radiation measurement*
- *TRAC and MVI*
- *DEMON*
- *Spherical densitometer*
- *The Moosho*rn
- Terrestrial Laser Scanner

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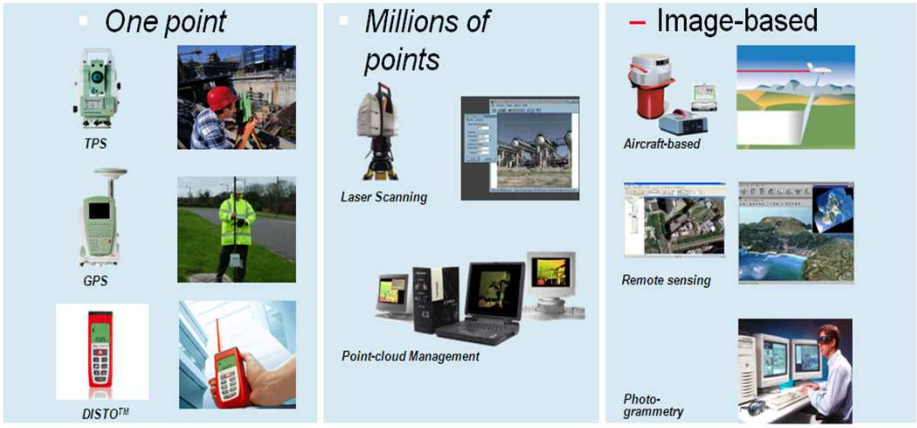
Survey Technology Development

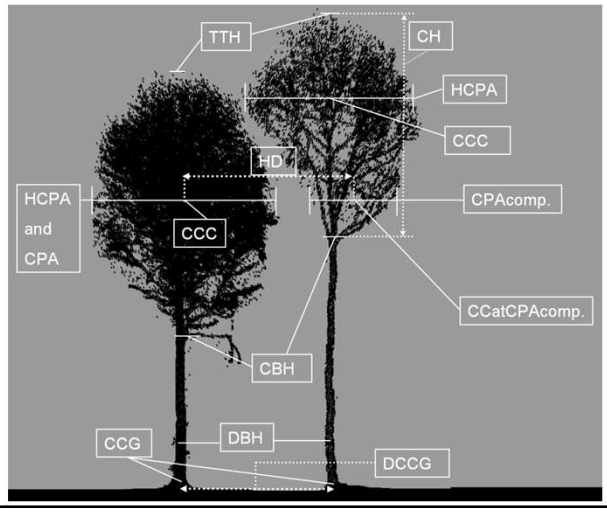


(Courtesy by Leica Geosystem)

METHODOLOGY

Biomassa and Interaction Between a Tree

Biomass is an organic matter produced by photosynthetic process, either as a product or a waste [1]. The biomass parameters that are formed in every tree in a forest represent the interaction process between a tree and another.



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Terrestrial Laser Scanner

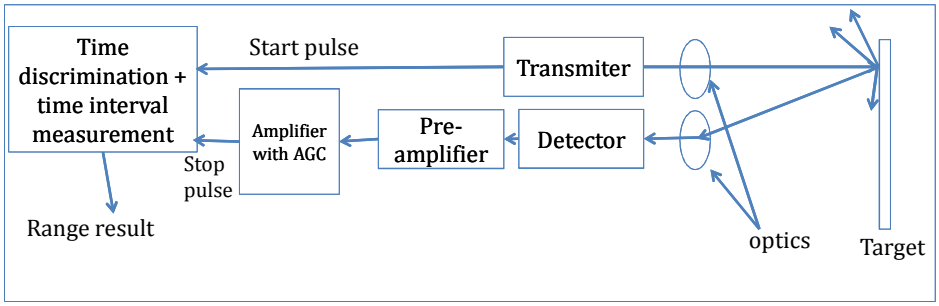
Laser Scanning describes a method where a surface is sampled or scanned using laser technology. It analyzes a real-world or object environment to collect data on its shape and possibly its appearance (e.g. colour). The collected data can then be used to construct digital, two-dimensional drawings or three-dimensional models useful for a wide variety of applications.

The advantage of laser scanning is the fact that it can record huge numbers of points with high accuracy in a relatively short period of time. It is like taking a photograph with depth information.

Terrestrial Laser scanners are line-of-sight instruments, so to ensure complete coverage of a structure multiple scan positions are required (Quintero et al, 2008).

(Quintero dkk. 2008).

Block diagram of a pulsed laser rangefinder



$R=(c\ x\ t)/2$ (**Reshetyuk, 2009**).

R: the distance between the TLS and the object;
c: the speed of light on air (≈ $3 \cdot 10^8$ m/s);
t: the time travel of the laser when it is emitted and received

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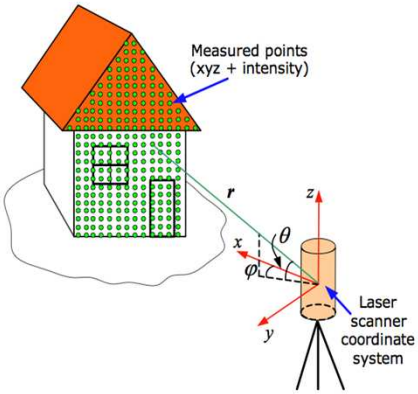
Principle of Terrestrial Laser Scanner (Reshetyuk, 2009)



r_j : distance from the time travel of the laser to the object;
φ_j : horizontal angle between the aim of the laser and the e-axis of the device;
θ_j : vertical angle between the horizontal plane and the aim of the laser to the object;
e_j : coordinate e of point clouds in the device coordinate system;
n_j : coordinate n of point clouds in the device coordinate system;
u_j : coordinate u of point clouds in the device coordinate system;.

Scheme of Research Methodology

- TLS data acquisition
- Registration process
- Filtering
- Georeferencing process
- 3D modelling

output

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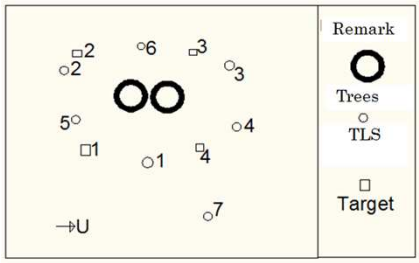
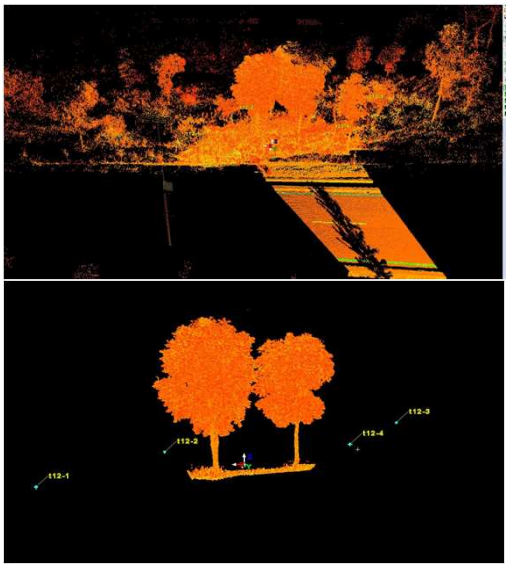
Data Acquisition

Leica C-10 Performance	
Spot size	4.5 mm @ 0-50 m
position	6 mm @ 50 m
Distance	4 mm @ 50 m
Angle (H/V)	(12”/12”)
Modeled surface precision	2 mm
Target acquisition	2 mm



The scheme of placements of device and targets (a), documentation of TLS data acquisition (b), and GPS data acquisition (c)

Registration and Filtering



The registration technique used in this research is target based registration. This technique uses a minimum of 3 target points.

The error valus of the registration are obtained from the target scanning process which is used as reference points. In this research, the average value of the registration error is 0.002 m. The largest registration error value is 0.006 m.

During the TLS data acquisition, all objects were scanned, both the necessary and unnecessary ones.

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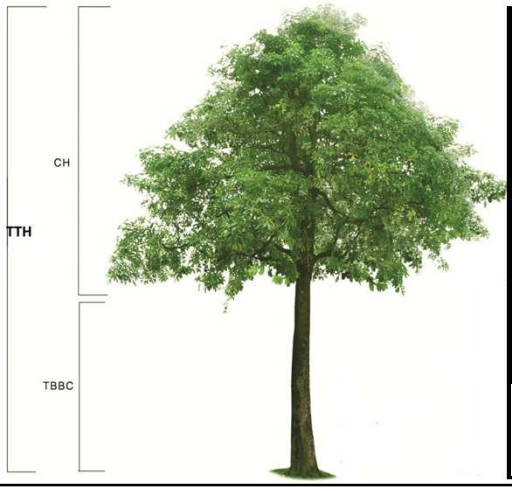
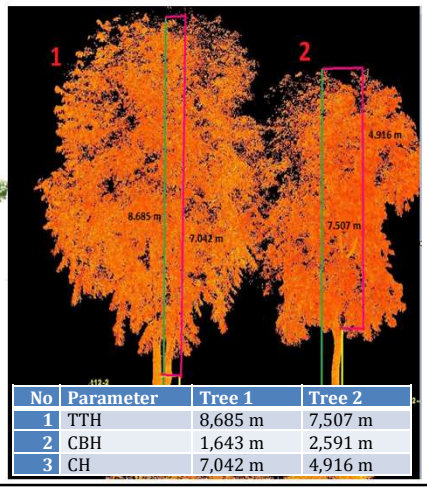
RESULT AND DISCUSSION

Parameter Estimation

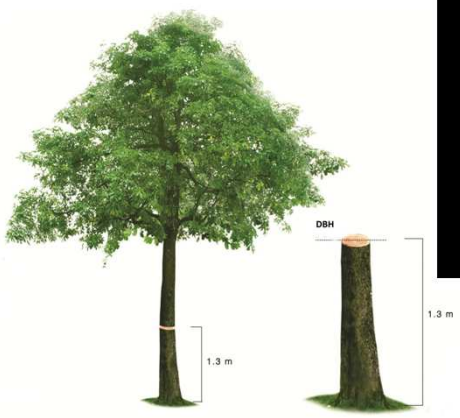
Total tree height (TTH)*, Crown base height* (CBH), *Crown height* (CH)

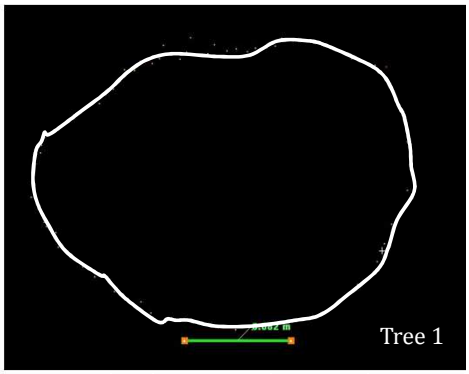




No	Parameter	Tree 1	Tree 2
1	TTH	8,685 m	7,507 m
2	CBH	1,643 m	2,591 m
3	CH	7,042 m	4,916 m

Diameter at breast height (DBH)





No	Parameter	Tree 1	Tree 2
1	DBH	0,249 m	0,176 m

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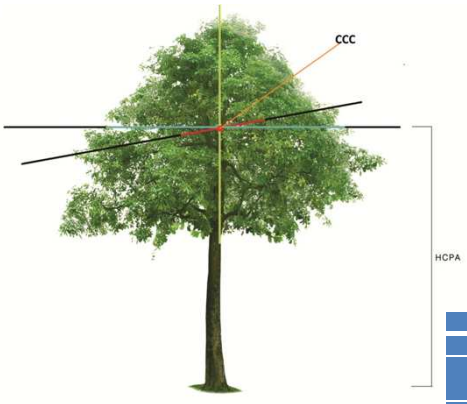
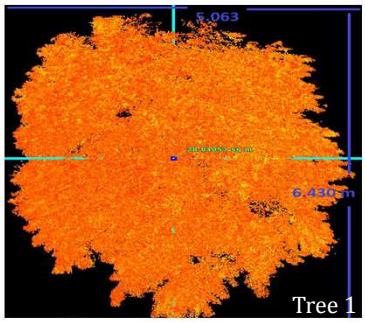
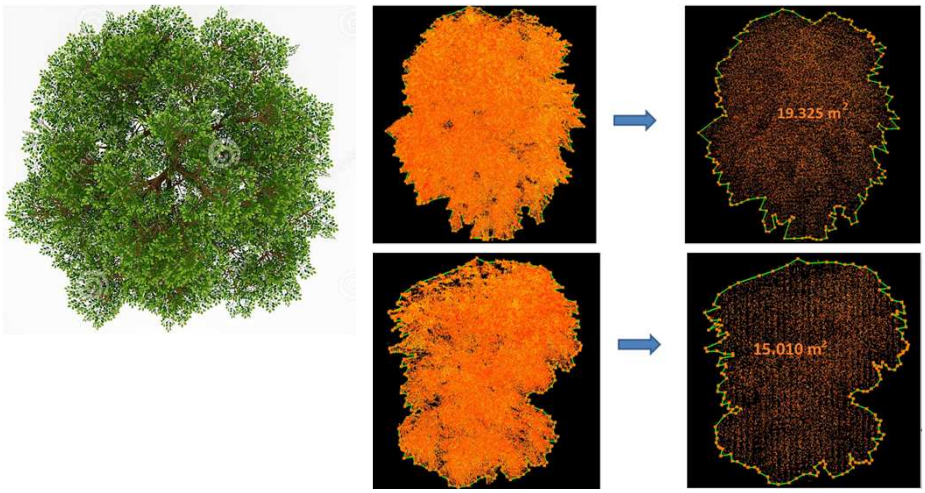
Height of maximum crown projection area (HCPA) dan *Center of the crown at the height of maximum crown projection area* (CCC)





No	Parameter	Tree 1	Tree 2
1	HCPA	5,631 m	4,615 m
2	CCC	X: -7,087m	X: -6,283m
		Y: -2,861m	Y: 2,045 m
		Z: 5,137 m	Z : 4,538 m

Maximum crown projection area (CPA)



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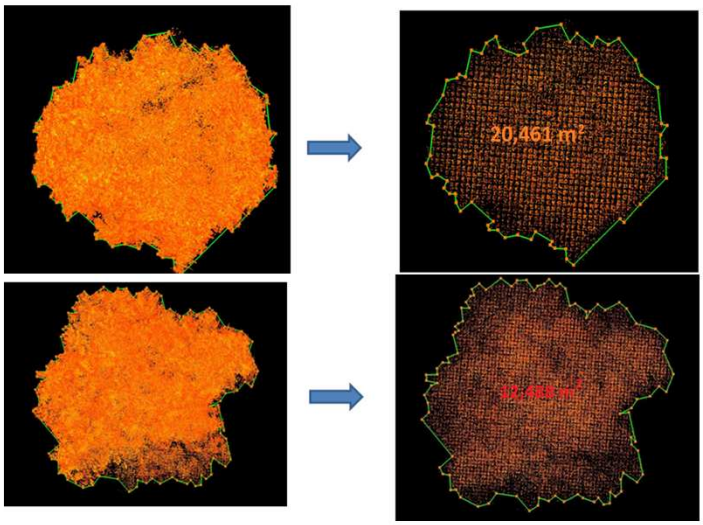
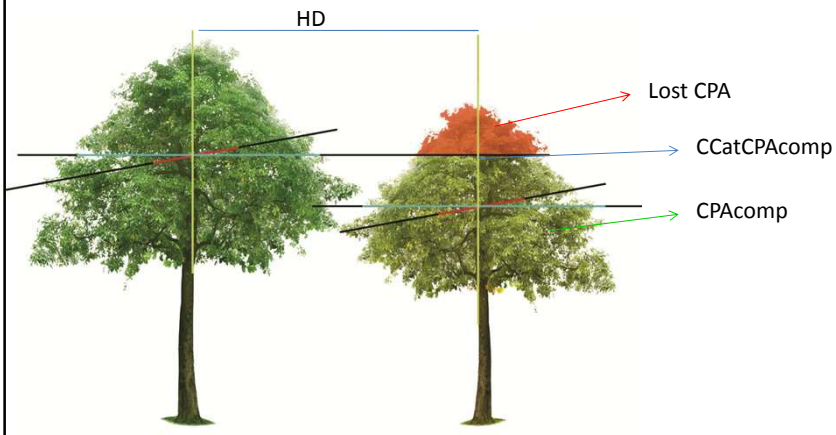
Leaf Area



Crown projection area at the height of maximum crown projection area of focal tree (CPAcomp) and Center of the crown at the height of the CCatCPAcomp and *horizontal distance between* CCC and CCatCPAcomp (HD)



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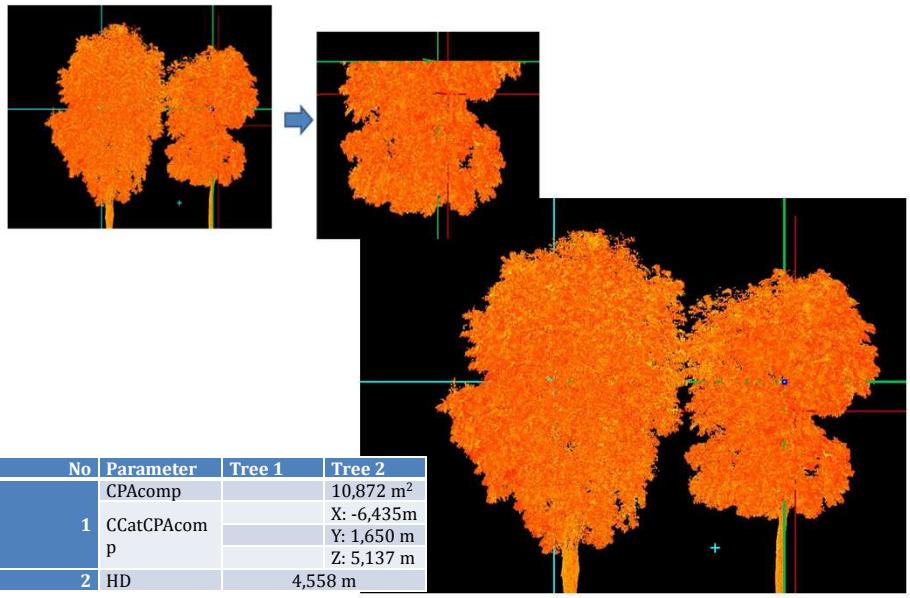

No	Parameter	Tree 1	Tree 2
1	CPAcomp		10,872 m²
	CCatCPAcomp		X: -6,435m
			Y: 1,650 m
			Z: 5,137 m
2	HD	4,558 m	

Coordinate of the center of the stem at ground level (CCG) and Horizontal distance between the CCG of the focal tree and CCG of the neighbour tree (DCGG)

No	Parameter	Tree 1	Tree 2
1	CCG	X: -6,867m	X: -6,629m
		Y: -2,506m	Y: 1,730 m
2	DCCG	4,243 m	

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Validation

The validity of these measurements indicates the accuracy of the measurement results as obtained from the model in software Cyclone 7.1.1. The validation was done by comparing the TLS results with the measurements from measuring tapes. Due to the limitation of the measuring tapes, only DBH, CBH, and DCCG can be compared.

Parameter	TLS	Tapes	Difference
DCCG	424,3cm	431 cm	-7,7cm
First tree			
DBH	24,9 cm	25,6 cm	0,7 cm
CBH	164,3cm	169,3cm	-5,0cm
Second tree			
DBH	17,6 cm	17,6 cm	-0,1cm
CBH	259,1cm	264,7cm	-5,6cm

CONCLUSION

1. From this research, it can be concluded that the TLS can be applied in forestry to measure the 12 biomass and interaction between a tree parameters which are related to the interaction between trees.

2. TLS can create 3-dimensional model of the tree crown with unique coordinates for each point, making the model unique for each tree with resolution that can reach up mm level. The measurement results using the TLS can be used because the difference between the TLS measurements and conventional method using measuring tapes is 1 mm – 7,7 cm

Thank You