

PETUNJUK TEKNIS

INVENTARISASI

HUTAN

NASIONAL 2.0



Kementerian Lingkungan Hidup dan Kehutanan
Direktorat Jenderal Planologi Kehutanan dan Tata Lingkungan
Direktorat Inventarisasi dan Pemantauan Sumber Daya Hutan
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MINISTRY OF ENVIRONMENT AND FORESTRY
DIRECTORATE GENERAL OF FORESTRY PLANOLOGY AND ENVIRONMENTAL MANAGEMENT
DIRECTORATE OF FOREST RESOURCES INVENTORY AND MONITORING

STANDARD OPERATING PROCEDURE NUMBER:
SOP.1/IPSDH/PSDH/PLA.1/B/10/2024

ON TECHNICAL
GUIDELINES FOR INVENTORY OF FOREST STANDINGS AND NON-TIMBER PLANTS IN THE FRAMEWORK
OF NATIONAL FOREST INVENTORY 2.0 (IHN 2.0)

PIG
INTRODUCTION

1. General

Indonesia is blessed with tropical forests that are among the largest in the world, along with Brazil and Congo. For decades, Indonesian forests have played a role as a major producer of wood and non-wood. The use of forests for wood production is regulated based on the principle of sustainability. A sustainable forest management system requires accurate data on the potential of forest stands that can be utilized. The information on forest potential that is needed is also related to data on the quantity and quality of stands or trees, which are obtained from the results of forest inventory.

In addition to being a provider of wood, tropical natural forests are also closely related to the issue of climate change, both as a source of emissions and as a natural carbon absorber. For this reason, a forest potential measurement system is needed that also considers the data needs for climate change. Through forest inventory, it is hoped that information on forest potential, both wood and non-wood potential, can be known accurately using methods that can be quickly accounted for and in accordance with reporting needs, resources and available capacity.

Indonesia began implementing the National Forest Inventory (NFI) in 1989–1996 with the main objective of estimating the timber potential in state forest areas. However, currently the need for forest resource information is increasing and is not limited to timber potential. For example, reporting emission reductions at the national and global levels requires information on biomass and carbon stocks in various types of land cover. In addition, Government Regulation No. 23 of 2021 concerning Forestry Implementation has given the Ministry of Environment and Forestry a mandate to implement the IF not only in state forest areas but also in private forest areas and customary forests.

For this reason, in 2022–2023, the Ministry of Environment and Forestry (cq. Directorate of Forest Resources Inventory and Monitoring) in collaboration with the Food and Agriculture Organization (FAO) has developed a new IHN system (called IHN 2.0) to be implemented starting in 2025.

2. The purpose and

objectives of the Technical Instructions for the Implementation of the National Forest Inventory 2.0 (JUKNIS IHN 2.0) are intended as a guideline for the implementation of IHN. The preparation of these technical instructions aims to ensure that the implementation of IHN can be carried out correctly so that the data and information produced have the expected level of accuracy.

3. Scope

IHN aims to record and assess the extent and quality of potential forest resources, especially at the national level, accurately, timely and reproducibly. The focus of IHN is at the national level, but can be applied at lower monitoring levels, such as provincial or management unit (KPH) levels. The objectives of implementing IHN can also be adjusted to monitoring needs, for example for carbon measurement as an additional option. Based on the mandate of the Regulation of the Minister of Environment and Forestry No. 7 of 2021 concerning Forestry Planning, Changes in Forest Area Designation and Changes in Forest Area Functions, and Use of Forest Areas, the scope of IHN is:

- IHN is part of national forest planning, which aims to obtain information at least related to: types and potential of forest stands, types, potential and distribution of non-timber plants.**
- IHN is carried out in state forest areas, customary forests, and private forests at the national level.**
- IHN is carried out by work units within the scope of the ministry or other agencies that have the competence and/or through the principle of data sharing.**
- IHN is carried out at least once every 5 years.**

4. Basis of

the Ministry of Environment and Forestry (KLHK) organize IHN based on the following regulations: 1) Law Number 41 of 1999 concerning Forestry, as amended by Law Number 19 of 2004 concerning the Stipulation of Government Regulation in Lieu of Law Number 1 of 2004 concerning Amendments to Law Number 41 of 1999 concerning Forestry into Law.

2) Law Number 6 of 2023 concerning the Stipulation of Government Regulation in Lieu of Law Number 2 of 2022 concerning Job Creation into Law.

3) Government Regulation Number 23 of 2021 concerning the Implementation of Forestry.

4) Regulation of the Minister of Environment and Forestry Number 7 of 2021 concerning Forestry Planning, Changes in Forest Area Designation and Changes in Forest Area Functions, and Use of Forest Areas.

CHAPTER II PROCEDURE

1. SAMPLING DESIGN

1.1. Sampling Method

In 2023–2024, the Indonesian Ministry of Environment and Forestry (MoEF) supported by FAO conducted a study to create a new design for the National Forest Inventory (NIF) that takes into account national-level forest resource data and information needs and adapts to national resource capacity. The study was conducted to determine the target population, especially related to forest structure and landscape patterns, using previous IFN data.

The new design of IHN (called IHN 2.0) uses the “*Stratified Systematic Sampling*” method. In this sampling method, the forest population in Indonesia is grouped into three strata, namely: 1) Dryland forest, swamp, and plantation. This stratum

includes five land cover classes : primary dryland forest (Hp/2001), secondary dryland forest (Hs/2002), primary swamp forest (hrp/2005), secondary swamp forest (Hrs/20051), and plantation forest (Ht/2006).

2) Trees Outside Forest (TOF).

These strata include four land cover classes: scrub (B/2007), swamp scrub (Br/20071), dryland agriculture (Pt/20091), and mixed dryland agriculture (Pc/20092).

3) Mangrove forests. This stratum includes two land cover classes: primary mangrove forests (Hmp/2004) and secondary mangrove forests (Hms/20041).

The sample units (clusters) are distributed systematically with a sampling framework in the form of a hexagonal grid *with* different distances/intervals in each strata and island group (Sumatra, Java, Bali Nusa, Kalimantan, Sulawesi, Maluku, and Papua) according to the calculation of the sample size (number of clusters) required to achieve the expected level of population estimation accuracy.

In each hexagonal grid, the cluster location is set at the center point of each hexagon (Figure 1). The use of the hexagonal grid is intended to provide a consistent sampling framework when sample intensification is needed for forest inventory at the provincial level. The number of clusters and their distribution maps are explained in another document separate from this JUKNIS.

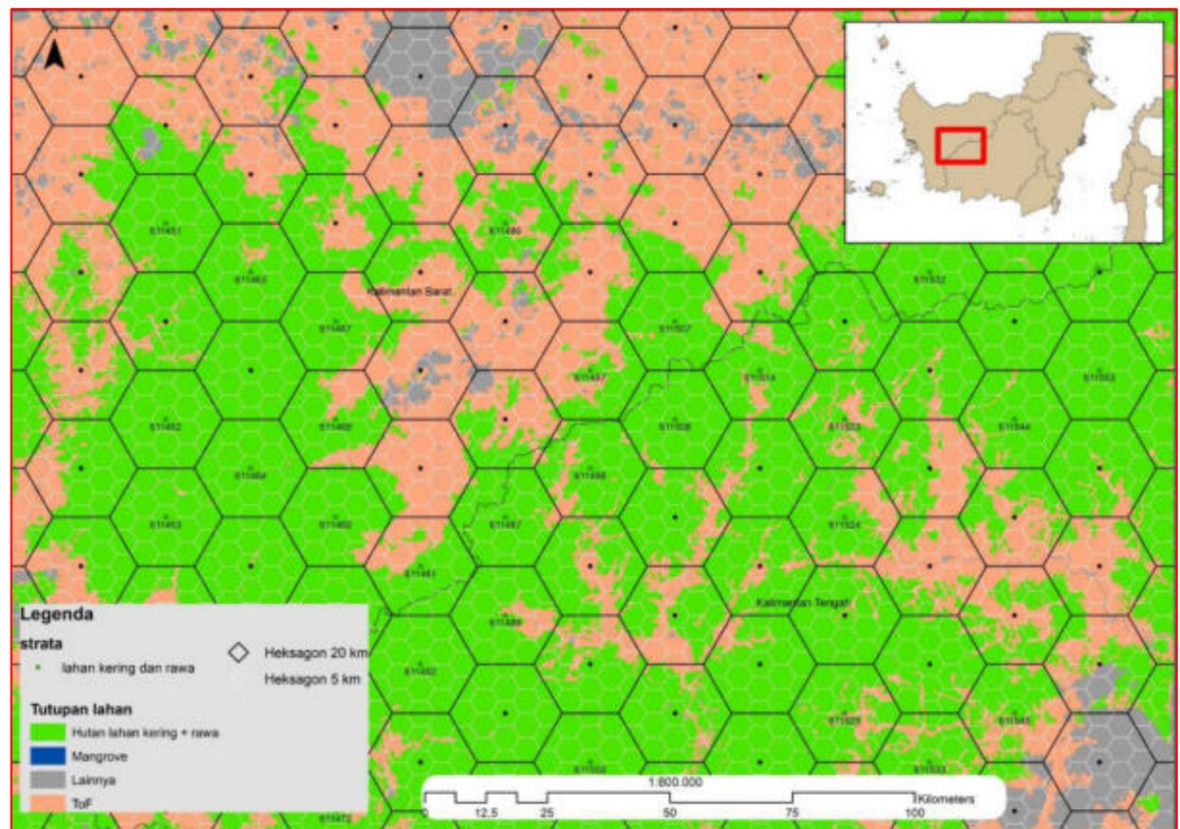


Figure 1. Example of IHN cluster distribution on a hexagonal grid with a distance of 20 km.

1.2. Design, Size, and Type of Cluster IHN uses

different designs and clusters for the dryland, swamp, and plantation forest (HLKRT) strata, the Trees Outside Forest (PDLH/TOF) strata, and the mangrove forest (HM) strata. However, the basic design is the same where the cluster is L-shaped consisting of 3 circular plots, namely Plot P (in the center of the cluster), Plot U (in the north of the cluster), and Plot T (in the east of the cluster), with a distance (k) between plots of 100 m for the HLKRT strata and a distance between plots of 50 m for the PDLH/TOF and HM strata.

Each plot consists of 4 circular subplots as follows (Figure 2): • Subplot A: in the HLKRT, PDLH/TOF, and HM

strata has a radius of

1 m for regeneration observation (DBH < 5 cm).

- Subplot B: in the HLKRT or PDLH/TOF strata, the radius is 5 m for measuring trees with a diameter of 5 cm to <20 cm, while in the HM strata, the radius is 5 m for measuring trees with a diameter of 5 cm to <10 cm.
- Subplot C: in the HLKRT or PDLH/TOF strata, the radius is 15 m for measuring trees with a diameter of 20 cm to <40 cm, while in the HM strata, the radius is 8 m for measuring trees with a diameter of 10 cm to <20 cm.
- Subplot D: in the HLKRT or PDLH/TOF strata has a radius of 25 m for measuring trees with a diameter of ≥ 40 cm, while in the HM strata it has a radius of 12 m for measuring trees with a diameter of ≥ 20 cm.

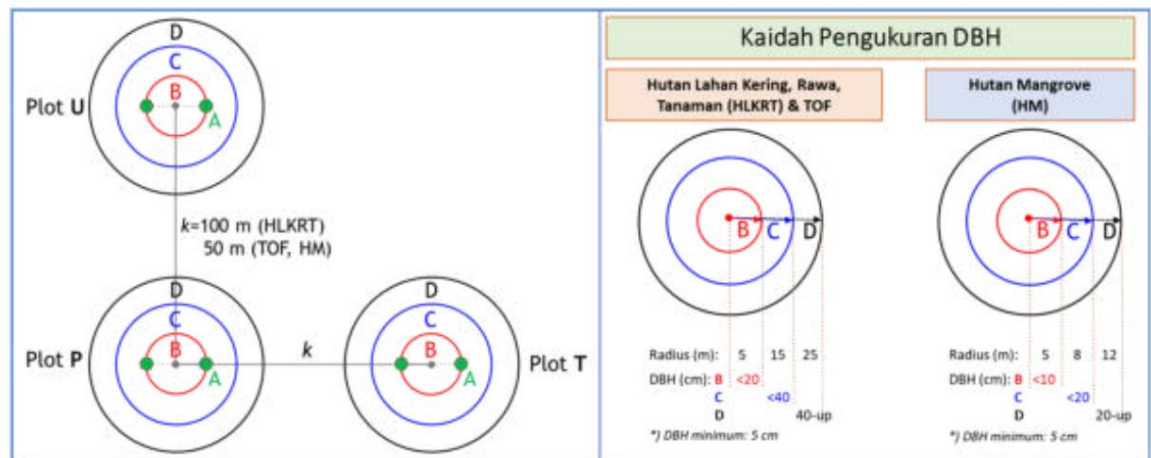


Figure 2. IHN cluster design and size

To obtain data on forest resource growth over time, IHN clusters are created permanently and measured periodically (every 5 years), so that a cluster is a permanent *sample plot*. In an IHN cluster, each plot center and all trees are marked and mapped permanently to facilitate re-measurement of the cluster in the next IHN period.

2. FIELD PLANNING AND PREPARATION

2.1. Identification of Cluster-plot Locations

- Step 1: The coordinates of the distribution of IHN clusters to be measured in the field are determined by KLHK cq IPSDH. IPSDH performs *overlay* Coordinates of the distribution of IHN clusters with BPKHTL boundaries to determine the IHN plots to be measured by each BPKHTL.
- Step 2: IPSDH determines the plan for the number and distribution of clusters to be measured each year by considering the representativeness of the distribution of clusters in each stratum. This is done to ensure that the clusters measured each year can represent the distribution of forest potential in each region.
- Step 3: BPKHTL determines the assignment of the survey team based on the planned cluster distribution to carry out field measurements, including if other institutions are involved in the field measurement activities.
- Step 4: Use GIS *software* to create a map of the distribution of IHN clusters that will be used by other teams or agencies.
- Step 5: *Overlay* the cluster distribution points with the base map (road network, rivers, settlements, etc.) required for compiling the working map.

2.2. Preparation of Tools and Logistics

The equipment needed during the activity includes equipment for searching for clusters, building clusters, measuring in clusters, and building tents if necessary.

To find and build clusters: 1. Work map 2. GPS 3.

Compass 4.

Machete

5. 25 m or 50

m measuring

tape 6. Mark with bright paint as

boundary markers at the center point of the plot 7. Cement and 2.5 *inch* diameter PVC pipe

8. Zinc plate measuring 40 x 30 cm in yellow color

For measurement and recording: 1. A

tablet with a memory card with the *Collect Mobile application*, or field forms for a number of clusters to be measured as a backup 2. Batteries for the measuring

equipment and a *power bank* for

tablet device to fill out the form 3. Tree labels

to mark individual trees that have been measured 4. Permanent marker

to write on the tree labels 5. Nails and hammer or other

tools (e.g. *stapler*) to attach the labels

6. *Phi*

band tree (minimum 2 pieces)

7. *Vertex and transponder* to determine the distance and height of the tree 8.

Compass to measure the direction or azimuth of the tree position

9. Protractor *to measure the angle of inclination of the wood dead*
10. Caliper to measure the diameter of rattan/liana
11. *Laser distance meter to measure distance quickly (optional)*
12. Canopy cover measuring tool (optional)
13. Other measuring instruments (optional), which can be used when the main measuring instrument is damaged in the field. For example, a *haga hypsometer* for measuring tree height and a *Suunto clinometer* for slope measurement.

For litter and understory measurements: 1. Digital hanging scale

with a minimum accuracy of 1 gram 2. Plastic bag for weighing 3. Plastic bag 4. Plot frame (*clip-plot*)

Other equipment that needs to be prepared: 1.

Personal use, such as gloves, hats, etc.

2. Medicines 3. Food

supplies 4. Tent equipment

(if needed)

5. Climbing equipment (if necessary)

6. Cooking equipment (if needed)

2.3. Inventory Team Requirements To complete

the task of measuring forest inventory clusters, the composition of members in one team consists of at least a core team and an interim team. The core team consists of: • 1 team leader • 2 assistant team leaders While the interim team consists of measurers, pioneers and cluster location seekers, and species identifiers with a total of 6 people.

Local surveyors, pioneers, and species identifiers are local laborers. If the terrain is difficult, additional pioneers are needed so that they can take turns. Pioneers also play a role in measurement activities. Species identifiers and measurers are usually local workers from surrounding villages who understand the types of trees.

If the cluster location is very far and requires staying at the location to be closer to the cluster, then the team needs to build a tent to stay overnight. For this reason, the Kerjantar team also acts as a logistics team and cook. The duties of each member can be seen in Table 1.

Table 1. Composition and duties of forest inventory team members

Position in the team	Task
Team Leader	• Responsible for all measurement activities in the field, including coordinating transportation, logistics, accommodation, and measurements within the plot. • During the pioneering towards the plot, the team leader usually operates the GPS, unless there is a pioneer team that understands how to operate the GPS. • Determine the location of the starting point of the plot and ensure plot development is done properly. • Record the results of plot monitoring and parameter measurements in the plot.
Assistant squad leader	• Conducting measurements of distance, direction and height of trees • Preparing and operating measuring instruments, especially <i>Vertex</i>, compass, and <i>laser distance meter</i>. • Assisting with measurements in small plots if necessary.
Pioneer	• Conduct pioneering or search for a path from the access road lastly towards the plot. • Constructing a plot that includes setting up boundary stakes or poles, measuring distances and azimuths for plot boundary locations and installing stakes or poles that can be seen by the measuring team. • Assisting in measurements within the plot
Type identifier	• Identify bamboo and other vegetation species • Assist with pioneering if necessary • Assist with measurements within the plot
Measuring	• Performing measurements of parameters in the plot • Assist with pioneering if necessary
Logistics personnel	• Help provide the necessary materials and tools • Bring materials and tools during activities • Set up tents if you have to stay overnight in the field • Help prepare food
Cook	• Coordinating the provision of food ingredients • Cooking for all members

The team leader can come from BPKHTL, KPH, Provincial Office in charge of forestry or other implementing agencies that have the competence to carry out national forest inventory activities as proven by work experience in the field of forest inventory and have attended IHN 2.0 training.

2.4. Data recording form

The survey team filled out the field form (Attachment 1) via the *Collect Mobile* application or the printed version (if necessary as a backup) according to the activity stages as listed in Table 2.

Table 2. Field forms at each stage of the survey team's activities

No.	Stages of survey team activities	Form
1.	Departure from the accommodation (<i>basecamp</i>) to the cluster location. Then, observation and measurement of the general condition of the cluster when the survey team arrives at the center point of the Plot (P/U/T).	F1
2.	Observation and measurement of general conditions in the center of Plot P, Plot U, and Plot T.	F2
3.	In each sample plot (Plot P, Plot U, or Plot T), the survey team first created 2 subplots A (A1, A2) and conducted regeneration observations (DBH <5 cm). Subplot A is a circular plot with a radius of 1 m placed in the West-East or North-South direction.	F3
4.	In each subplot A (A1, A2), the survey team cut the undergrowth, collected litter, and weighed the wet weight of the undergrowth and litter in the 0.5 x 0.5 m ² <i>clip-plot</i> . In addition, in certain clusters the survey team took samples of undergrowth and litter of approximately 300 grams for further analysis in the laboratory.	F4, F5
5.	In certain previously determined clusters, the survey team conducted soil carbon measurements on subplot A.	F6
6.	In subplot B, the survey team measured dead wood, including determining the level of decay by slashing with a machete.	F7
7.	In subplot C, the survey team measured rattan/liana, bamboo, or palm.	F8, F9, F10
8.	In subplots B, C, and D, the survey team measured live and dead trees (DBH ≥5 cm). Tree height measurements were only carried out on 6 sample trees, representing small, medium, and large diameter classes. In PSP, flat and azimuthal distance measurements were carried out from the center point of the subplot to	F11

No.	The stages of the survey team's	Form
	activities for each tree being measured. For trees of unknown species, the survey team needs to take photos of parts of the tree (e.g. leaves, trunks, and fruits) and/or make herbarium specimens for species identification purposes.	
9.	The survey team fills in their personal details at the end of the activity. survey.	F12

3. CLUSTER DEVELOPMENT

3.1. Coordination and Preparation of Cluster Development Coordination

with related parties at the district level needs to be carried out so that implementation activities in the field are known to related parties and receive the necessary support. In addition, during coordination activities, additional initial data collection activities, logistics preparation and labor can be carried out. Coordination is carried out with related parties including: • Forest area managers and/or forest utilization permit holders to obtain additional information related to accessibility to the cluster and obtain additional data and information. • Village/hamlet officials to inform activity plans, obtain local labor, as well as obtain additional information related to access to the location, and provision of logistics.

3.2. Access to the Plot Step 1:

Use the working map created based on the cluster distribution map obtained from Sub Chapter 3.1.

Step 2: Enter the name and coordinates of the cluster midpoint.
will be measured into GPS.

Step 3: Use GPS to find the center point of the cluster. The coordinates of the cluster to be measured are previously entered into the GPS. To avoid bias, the determination of the center point of the cluster must be in accordance with the GPS point (with an error of ± 10 m). Unless the cluster is really inaccessible because it is dangerous, for example on the edge of a cliff, submerged in water, etc. If the cluster is inaccessible, it can be abandoned. If some plots in the cluster are accessible, then some of those plots are measured.

3.3. Determining the Plot Center Point

Step 1: Determine the cluster center point in the field according to GPS. The cluster center point is the center point of Plot P (see Figure 3).

Step 2: Install cluster center markers and cluster identification signs. The markers installed should be those with a high level of durability.

Step 3: After measuring Plot P, take measurements on Plot U which is 100 m north of the cluster center point. For mangrove and TOF, the distance between plots is 50 m.

Step 4: After the measurement on Plot U is complete, take measurements on Plot T which is 100 m to the East from the center point of the cluster. For mangrove and TOF, the distance between plots is 50 m.

The order of plot measurements can be adjusted to field accessibility, for example by first measuring easily accessible plots while maintaining consistency in writing the plot numbers.

The location of the plot center must be in accordance with the coordinates of each plot that has been determined in the cluster distribution with a GPS error tolerance of ± 10 m and no shifting of the plot location is permitted.

If the GPS signal at the center of the plot is weak (error >10 m), the survey team can determine the center of the plot in the following way: 1) Look for a location around the center of the plot where the GPS

signal reception is strong (error <10 m) and set it as an auxiliary point.

2) Measure the flat distance from the auxiliary point to the center of the plot (according to the distance from the GPS reading).

3) Measure the azimuth from the auxiliary point to the center of the plot.

If the plot center cannot be reached, for example if it is in a ravine or dangerous area, then the survey team does not need to create the plot and does not need to move it to another location nearby.

However, the survey team must record the coordinates of the last location that can be visited and conduct visual observations and record general conditions according to form F2 (see explanation in Sub-chapter 5.2).

The center of each plot must be marked permanently using a PVC pipe filled with concrete with a diameter of 2.5 inches and a total length of 1.0 m (where the planted part is around 0.6 m) and the top is painted red, with a cluster number, and metal/iron (for metal detectors) to facilitate tracking the center of the plot in the next IHN activity (Figure 3). Permanent marking using the concrete PVC pipe is carried out on the HLKRT and PDLH/TOF strata in the forest area. For the PDLH/TOF strata outside the forest area and the mangrove forest strata, marking using the concrete PVC pipe is not necessary.

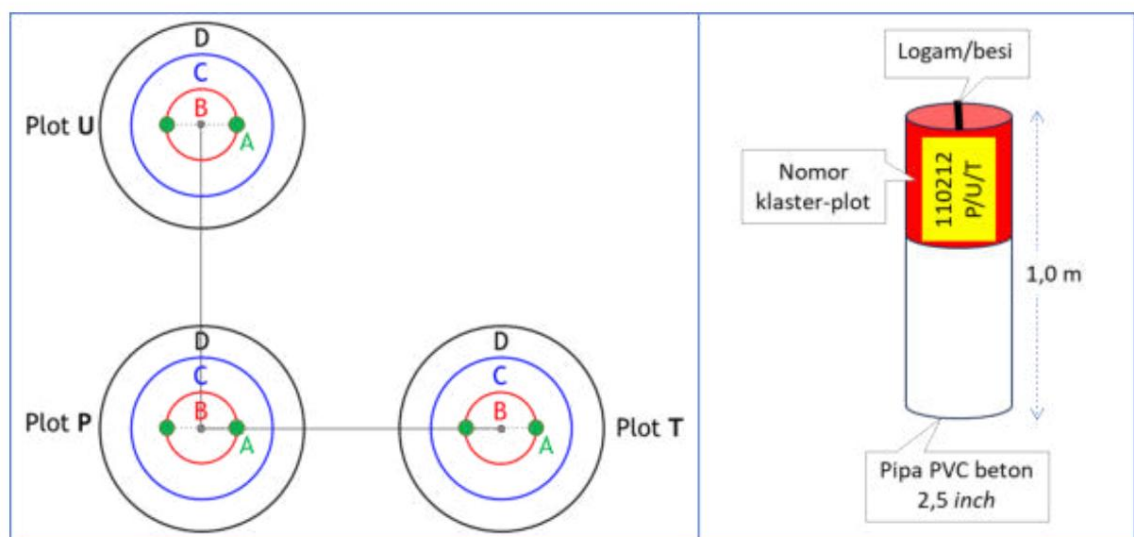


Figure 3. Cluster design (left) and permanent mark at the center of the plot (right)

In addition to marking the plot center point using the concrete PVC pipe, the location of each plot center is also marked using a nameplate attached to the tree closest to the plot center point. The nameplate measures 40 x 30 cm and is painted yellow and contains the following information: cluster number, plot number (P, U, or T), BPKHTL area, province and district, sub-district and village, field coordinates, and time the plot was created (in the format: date/month/year) (Figure 4). Marking the plot center using the nameplate is carried out in clusters in the HLKRT, PDLH/TOF strata in forest areas, and mangrove forests.



Figure 4. Nameplate at each plot center in an IHN cluster.

3.4. Identification of *Witness Points*

Witness points are needed to trace the center point of the plot during cluster re-measurement. Therefore, after marking the center point of the plot using concrete PVC pipes, the survey team must determine at least two witness points inside and/or outside the plot. Witness points are natural objects that are easy to observe, such as large rocks, coral, or trees that are relatively large in size. The work stages are as follows: Step 1: Determine 2 or more witness points inside or outside the plot.

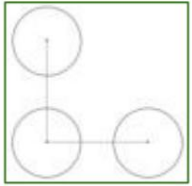
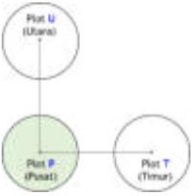
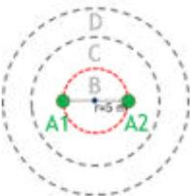
Record in the field form.

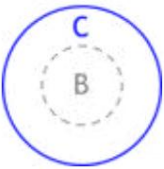
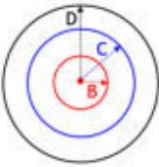
Step 2: Record the distance and azimuth of each witness point from the center point of the plot.

4. FIELD DATA COLLECTION

In each cluster, the survey team conducted observations, measurements, and records on cluster information, plot information, regeneration, undergrowth, litter, trees (living and dead), stumps, dead wood, rattan/liana, bamboo, and soil carbon. Table 3 presents a summary of data collection activities in each cluster, which are further explained in the sub-chapters below.

Table 3. Summary of observation and measurement activities in each cluster

Location		Observation and measurement	Field form
Cluster		Cluster information: - Cluster number, location and type; - Survey team; Survey time; - Accessibility	F1
Plot		Plot information: - Plot number and location; Measurement time; Accessibility; - Elevation and slope gradient; - Photo of plot condition; Land cover class; - Forest type; Land use; - Manager; Stand condition; Indications of human disturbance	F2
Subplot A		Regeneration: Species and number of individuals	F3
		Understory plants: Total wet weight & sample	F4
		Litter: Total wet weight & sample	F5
		Soil carbon: Soil type; Depth; Sample volume	F6
Transect in subplot B		Dead wood: Diameter; Weathering class	F7
Subplot C		Rattan and lianas: Category; Species; Number of clumps; Diameter; Length; Commerciality	F8

Location		Observation and measurement	Form field
		Bamboo: • Category; Species; Age class, Number of stems; Diameter; High; Commerciality	F9
		Palm: • Type; Species; Diameter; Height	F10
Subplot B+C+D		Trees (living and dead): • DBH; DBH Height; Distance; Azimuth; Species code; Species (local/latin name); Status; Wood quality; Specific gravity class; Height of crown base; Total height; Photo or herbarium (for unknown species)	F11
Cluster		Survey team identity: • Name; Position; number - Mobile Phone; Email	F12

4.1. Cluster Information

When the survey team has arrived at the cluster location specified on the map, the survey team conducts observations, measurements, and records the general conditions of the cluster using the F1 form with the following activity stages:

1) Select the island name code on the F1-1 form according to the following list:

F1-1 Island Code	
1	Sumatra
3	Java
5	Bali & Southeast
6	Kalimantan
7	Sulawesi
8	Maluku
9	Papua

2) Note the cluster number on the F1-2 form according to the numbering system specified on the map or *Collect Mobile (CM)* application.

The cluster number consists of 6 digits which indicate: •

1st digit: island code (see code F1-1).

- 2nd digit: inventory level, where code 1 is for IHN, code 2 is for provincial level, code 3 is for Forest Management Unit (KPH), and code 4 is for specific projects or purposes.
- 3rd to 6th digit: cluster sequence number on all islands, starting numbers 0001 to 9999.

Example of cluster number: 110007, which means the cluster is on Sumatra Island (1) for IHN activities (1) with cluster sequence number 7 (0007).

3) Record the year of cluster measurement on form F1-3, for example: 2024 if the cluster was measured in 2024.

- 4) Note down the province name code on the F1-4 form according to the following list (Note: the *Collect Mobile* application will provide a list of province codes/names according to the island code selected on F1-1): Province

Code F1-4	Province	Code F1-4	
11 Aceh		61 West Kalimantan	
12 North Sumatra		62 Central Kalimantan	
13 West Sumatra		63 South Kalimantan	
14. Riau		64 East Kalimantan	
15. Jambi		65 North Kalimantan	
16 South Sumatra		71 North Sulawesi	
17. Bengkulu		72 Central Sulawesi	
18 Lampung		73 South Sulawesi	
19 Bangka Belitung Islands		74 Southeast Sulawesi	
21 Riau Islands		75 Gorontalo	
31 Jakarta		76 West Sulawesi	
32 West Java		81 Maluku	
33 Central Java		82 North Maluku	
34 IN Yogyakarta		91 Papua	
35 East Java		92 West Papua	
36 Banten		93 South Papua	
51 Bali		94 Central Papua	
52 West Nusa Tenggara		95 Papua Mountains	
53 East Nusa Tenggara		96 Southwest Papua	

- 5) Select the land type (as a strata) that corresponds to the cluster location on form F1-5 with the following explanation:

Code F1-5	Land type
1	Dryland forests, swamps, and plants (inside or outside forest areas)

Code F1-5 Land type	
2	Trees Outside the Forest (PDLH) or <i>Trees Outside Forest (TOF)</i>
3	Mangrove forests (inside or outside forest areas)

6) Select the type of cluster measurement on form F1-6.

Planned , Unplanned, or Guaranteed

Quality (*Quality Assurance/ Control*) with the following explanation:

Code F1-6 Cluster data type	
1	Planned , if cluster measurements are carried out on the main coordinates/grid according to the IHN sampling design.
2	Unplanned , if the cluster measurement is conducted at locations outside the main coordinates/grid of the IHN, especially for the intensification of the number of samples on certain land cover types (e.g. primary swamp forest). The data from unplanned cluster measurements must be treated differently from planned cluster measurements when calculating the statistical values of forest resources from the IHN.
3	Quality assurance (QA/QC) if cluster measurements are carried out for the purpose of monitoring and evaluating the results of cluster measurements by the previous survey team. This activity is usually carried out by a special team with more experience.

7) Record the identity of the survey team on form F1-7 according to the explanation.
the following:

Code Modifier	F1-7	Description
Unit executor	1	BPKHTL unit/name, if the survey is carried out by BPKHTL staff.
	2	QA/QC team, if the survey is conducted by a special team for quality assurance (QA/QC).
	3	Other parties, if the survey is conducted independently by another agency/party, for example by a forestry company. Write the name of the survey team.
Team Leader	- Name of survey team leader.	

For BPKHTL units/names, the list is as follows:

BPKHTL Name Unit	Working area
1 BPKHTL Region I Medan	North Sumatra Province and West Sumatra
2 BPKHTL Region II Palembang, South Sumatra Province	
3 BPKHTL Region III Pontianak, West Kalimantan Province	
4 BPKHTL Region IV Samarinda, East Kalimantan Province and North Kalimantan	
5 BPKHTL Region V Banjarbaru, South Kalimantan Province	
6 BPKHTL Region VI Manado, North Sulawesi Province and North Maluku	
7 BPKHTL Region VII Makassar, South Sulawesi Province and West Sulawesi	
8 BPKHTL Region VIII Denpasar Province of Bali and Nusa Tenggara West	
9 BPKHTL Region IX Ambon 10 BPKHTL	Maluku Province
Region X Jayapura Papua Province 11 BPKHTL Region XI Yogyakarta	
Banten Province, Jakarta, West Java, Central Java, DI	DKI
	Yogyakarta, and East Java, Riau
12 BPKHTL Region XII Tanjung Pinang	Islands Province
13 BPKHTL Region XIII Pangkalpinang	Bangka Islands Province Belitung and Jambi
14 BPKHTL Region XIV Kupang Province of Nusa Tenggara East	
15 BPKHTL Region XV Gorontalo Province of Gorontalo	
16 BPKHTL Region XVI Palu	Central Sulawesi Province
17 BPKHTL Region XVII Manokwari	West Papua Province
18 BPKHTL Region XVIII Banda Aceh	Aceh Province
19 BPKHTL Region XIX New York	Riau Province
20 BPKHTL Region XX Bandar Lampung	Lampung Province and Bengkulu
21 BPKHTL Region XXI Palangka Raya	Central Kalimantan Province
22 BPKHTL Region XXII Kendari, Southeast Sulawesi Province	

- 8) Note down the name and coordinates of the survey team's accommodation. form F1-8.

Variable	Description
Name	The name of the survey team's accommodation, for example: <i>base camp</i> in the forest or accommodation in the community.
X Coordinate	Longitude (<i>Easting</i>) coordinates of GPS in decimal degrees.
Y Coordinate	Latitude (<i>Northing</i>) coordinates of GPS in decimal degrees.

- 9) If the survey team can visit the cluster location (see form F1-8), then record the survey time (date and time) on form F1-9.

when the survey team leaves for and returns from the parking location or cluster location:

- The starting point can be the nearest accommodation (*basecamp*) to the cluster location, for example in a village or in the forest). • The parking location is a place that can be accessed by vehicles before the survey team walks to the cluster location.

- The cluster location can be the center point of Plot P or any other plot. more accessible.

At each stage of the survey team's journey, the following time (date and time) was recorded: • Departure from the starting point to the parking location or cluster. The starting date and time were recorded when the team departed from the nearest lodging, while the ending date and time were recorded when the team arrived at the parking location (if using a vehicle) or directly to the cluster location. Thus, the time difference indicates the length of the journey from the lodging to the parking location or cluster.

- Departure from parking location to cluster location. The start date and time are recorded when the team will depart from the parking location, while the end date and time are recorded when the team arrives at the cluster location. This time recording is only done if the survey team uses a vehicle from the starting point. If the cluster location can be accessed on foot from the starting point (for example a *basecamp* in the forest), then time recording from the parking location is not necessary.
- Return from the cluster location to the parking location or starting point. The initial date and time are recorded when the team will return from the cluster location (the last plot measured) to the parking location (if using a vehicle) or directly to the starting point (lodging/basecamp), while the final time is recorded when the team arrives back at the parking location or starting point. Thus, the difference

the time indicates the length of the return journey from the cluster location to the parking location or starting point.

- 10) Observe and record the level of cluster accessibility on form F1-10 according to the following code:

Code F1-10	Description
1	Cluster is accessible
2	Clusters are inaccessible due to difficult and/or dangerous topography.
3	The cluster cannot be accessed because it is not permitted by the administrator/community
4	The cluster is not accessible for other reasons (please specify the reason)

- 11) If the cluster cannot be accessed (code options 2, 3, or 4 on the F1-10 form), include it (upload it to the *Collect* application).

Mobile) on form F1-11 the following physical evidence:

- Photos (3 pieces) showing the conditions around the cluster
- Coordinates (X, Y) of the last accessible access point
- Minutes confirming that cluster measurements could not be carried out and authorized by the relevant party (e.g. village head).

- 12) Record on form F1-12 several types of main/priority Non-Timber Forest Products (NTFPs), both flora and fauna, found around the cluster location or from information from the surrounding community. The types of NTFPs can be seen in the Regulation of the Minister of Forestry Number P.35/Menhut-II/2007 concerning Non-Timber Forest Products.

- 13) Record on form F1-13 the forest/land management party in accordance the following code:

Code F1-13	Description
1	Government
2	Private
3	Community (individual or group/cooperative)

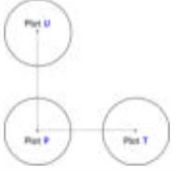
- 14) Provide important notes (*remarks*) if there are things that need to be noted. reported regarding cluster conditions on form F1-14.

4.2. Sample Plot Information

After observing and recording cluster information, the survey team conducted observations and recording on each sample plot (Plot,

Plot U, and Plot T) with the following activity stages: 1) Record the cluster number again on form F2-1 according to the numbering system that has been determined on the map or *Collect Mobile* (CM) application.

2) Record the plot code according to the plot number measured on form F2-2.

Code F2-2	Description	Illustration
1	Plot P (middle)	
2	Plot U (north)	
3	Plot T (east)	

3) Observe and record the level of plot accessibility on form F2-3. according to the following code:

Code F2-3	Description
1	Plot is accessible
2	Plot is inaccessible due to difficult and/or dangerous topography
3	Plot is not accessible as it is located in waters
4	Plots are inaccessible but visible, where the survey team can see land cover type, forest type, land use, and forest/land disturbance type, but cannot take measurements at the plot location.

If the plot cannot be accessed (code 2, 3, or 4) then measurements on that plot do not need to be continued, so the survey team does not need to continue filling out the form for that plot.

- 4) Record the measurement time of a plot on form F2-4, including the date, start time, and end time of the plot measurement.
- 5) Determine the center of the plot and record its coordinates according to the position specified on the map or *Collect Mobile* application on form F2-5. Use high-precision GPS to determine the center point of the plot, so that the error/shift in the coordinates is no more than 10 m. If the GPS signal is weak or the center of the plot is in a large tree, record the coordinates of the auxiliary point that is close to the center point of the plot, and measure the flat and azimuth distance from the auxiliary point to the supposed center point of the plot.

Variable F2-5	Description
X Coordinate	The <i>longitude (Easting)</i> coordinate of the GPS (in decimal degrees) at the center point of the plot or an auxiliary point close to the center of the plot.
Y Coordinate	The <i>latitude (Northing)</i> coordinate of the GPS (in decimal degrees) at the center point of the plot or an auxiliary point close to the center of the plot.

Variable F2-5	Description
GPS Accuracy Error	/shift of plot center coordinates from the actual location (specified on the map) with a tolerance of 10 m.
Distance	Distance (m) flat from the auxiliary point position to the plot center point.
Azimuth	Azimuth (°) from the auxiliary point position to the plot center point.

- 6) Record on form F2-6 whether the plot center is permanently marked or not according to the following code:

Code F2-6	Description
1	Yes, if permanent plot center marking is done using concrete PVC pipe (see subsection 4.3)
2	No, if the plot center is not marked permanently, or is only marked temporarily (for example using wooden/bamboo stakes/stakes)

If plot center marking is performed, determine 2 witness points *inside* and/or outside the plot and record the following:

Variable F2-6	Description
X Coordinate	The <i>longitude (Easting)</i> coordinates of the GPS (in decimal degrees) at each witness point.
Y Coordinate	The <i>latitude (Northing)</i> coordinates of the GPS (in decimal degrees) at each witness point.
GPS Accuracy Error	/shift of coordinates of each witness point from its supposed location (with a tolerance of 10 m).
Distance	Distance (m) flat from the center point of the plot to each witness point.
Azimuth	Azimuth (°) from the plot center point position to each witness point.

- 7) Use GPS or altimeter to find the elevation (asl) of the plot center and record the data on form F2-7.
- 8) Measure the slope (*slope, %*) of the plot and record the data on form F2-8. The slope of the plot is the average of the slope direction between two opposite points along the radius of the plot. Detailed explanations on how to measure the slope can be seen in Appendix 2A and 2B.

- 9) Perform an 'aspect' observation if the slope is >8% (equivalent to 5). Aspect is the direction (*azimuth*) of the slope measured using a compass in degrees. Record the slope aspect on form F2-9 according to the following code:

Code F2-9	Description
1	North (<i>North</i> , azimuth 0 – 22.5 or 337.5 – 360)
2	North- east (<i>azimuth</i> 22.5 – 67.5)
3	East (<i>Azimuth</i> 67.5 – 112.5)
4	Southeast (<i>South-east</i> , azimuth 112.5 – 157.5)
5	South (<i>South</i> , azimuth 157.5 – 202.5)
6	Southwest (<i>South-west</i> , azimuth 202.5 – 247.5)
7	West (<i>West</i> , azimuth 247.5 – 292.5)
8	Northwest (<i>North-west</i> , 292.5 – 337.5)
9	Flat

- 10) Observe and record on form F2-10 whether the land cover type *in* the plot is included in the 'forest' or 'non-forest' category.
(*Trees Outside Forest, TOF*):

Code F2-10	Description
1	Forest , if the land cover is included in the forest category according to the KLHK definition. See 'forest' classes on form F2-11
2	Non-forest (TOF), if the land cover is not included in the forest category according to the KLHK definition. See 'non-forest/TOF' classes on form F2-11

- 11) Determine and record on form F2-11 the land cover class *according to the* category 'forest or non-forest' on form F2-10 previous:

Code F2-11	Code F2-12	Description *)
1/Forest	2001/Hp	Primary dryland forest
	2002/Hs	Secondary dryland forest
	2004/Hmp	Primary mangrove forest
	20041/Hms	Secondary mangrove forest
	2005/Hrp	Primary swamp forest
	20051/Hrs	Secondary swamp forest
	2006/Ht	Plantation forest
2/Non-forest	2007/B	Shrubs
	20071/Br	Swamp scrub

Code F2-11	Code F2-12	Description *)
	2010/Pk	Plantation
	2012/Pm	Settlement
	2014/T	Open land
	3000/S	Savannah
	20091/Pt	Dry land farming
	20092/Pc	Mixed dry land farming
	20093/Sw	Ricefield
	20094/Tm	Pond
	20121/Bdr/Plb	Airport/port
	20122/Tr	Transmigration settlement
	20141/Tb	Mining
	50011/Rw	Swamp
	5001/A	Body of water

The operational definition and further explanation for each of these land cover classes are as follows: *Layer code/*

No.	Class	toponymy	Operational definition (Working definition)	Notes
1.	Primary dryland forest	Hp/2001 All appearances of lowland forests, hill forests, mountain forests (highlands and subalpine), dwarf forests, heath forests, forests on limestone, forests on ultrabasic rocks, coniferous forests, deciduous forests and moss forests (natural ecosystems) that do not show human disturbance (logging sites, fire sites, road networks, etc.), excluding natural disturbances (floods, landslides, earthquakes, etc.)	Natural ecosystems that follow local knowledge	• Primary Forest that experiences human disturbance (eg: road network) is classified as secondary forest up to 1 km from disturbance. • Natural ecosystems that follow local knowledge as forests, remain classified as forests (not thickets) as an example of the Natural Forest Type on Flores Island, Sumbawa,

No.	Class	Layer code / toponymy	Operational definition (Working definition)	Notes
			as a forest, it remains classified as a forest (not a thicket) for example the Natural Forest Type on the islands of Flores, Sumbawa, Rote, Southeast Maluku and other islands in the <i>Wallacea</i> and <i>Webber lines</i> ; karst forests in Maros, Muna, and East Kalimantan; and low density natural forests.	Rote, Southeast Maluku and other islands in the <i>Wallacea</i> and <i>Webber lines</i> ; karst forests in Maros, Muna, and East Kalimantan; and low-density natural forests.
2.	Secondary dry land forest	Hs/2002 Primary	dryland forests that have experienced human disturbance (logging sites, burnt areas, road networks, etc.), including those regrowing from degraded land.	Primary forests that experience human disturbance (for example: road networks) are classified as secondary forests up to 1 km from disturbance.
3.	Forest swamp primary	Hrp/2005 All for	est features located in freshwater inundated areas and behind brackish water forests that do not show human disturbance (logging sites, fire sites, road networks, etc.), excluding natural disturbances (floods, landslides, earthquakes, etc.), including sago forests.	- Swamp forest what is meant is that which is included in the mineral swamp and peat swamp areas, usually has alluvial soil type. - Sago forests are included in the swamp forest class. - In the condition In certain areas, swamp forests can be found in the highlands, for example on Mount Gede Pangrango.

No.	Class	Layer code / toponymy	Operational definition (Working definition)	Notes
4. Forest	swamp secondary	Hrs/ 20051	Primary swamp forest that has experienced human disturbance (logging, fire, road networks, etc.). Severely logged areas if they do not show signs of permanent inundation (water coverage) are classified as open land, whereas if they show signs of inundation or are temporarily flooded they are classified as swamps.	- Severe logging scars if not visible - n sign - puddle (water cover) - in a way - permanently classified as open land. - Appearance - Open land that has been - inundated or temporarily flooded is classified as a swamp.
5. Forest	primary mangrove	Hmp/ 2004	All forest features (mangroves, nipah and nibung) located in brackish water environments that do not show human disturbance (logging sites, fire sites, road networks, etc.), excluding natural disturbances (floods, landslides, earthquakes, etc.).	Coastal forest ecosystems that are outside brackish water environments and are not affected by the ebb and flow of sea water are not included in forests. mangroves.
6. Forest	secondary mangrove	Hms/ 20041	Primary mangrove forests that have experienced human disturbance (logging sites, fire sites, road networks, etc.), including those growing/planted on sedimentary soil.	
7. Plantation	forests	Ht/2006 All uniform	forest appearances (monoculture) which can originate from forest activities	- Plant - Rubber - inside/outside the PBPH-HT area is classified

No.	Class	Layer code / toponymy	Operational definition (Working definition)	Notes
			reforestation/reclamation/ greening/industry.	as a Plantation class. Open land in the Plantation Forest class due to temporal harvest and planting rotation remains classified as a Plantation Forest class.
8. Plantation-	an	Pk/2010 All appearances of cultivated hard plants included in the plantation group, including oil palm, rubber, coconut, chocolate, coffee, tea.	Note: Plantations with perennial plant types that can be distinguished homogeneously; Block size classified as plantation (oil palm) is around 30 ha (300 m x 1000 m); Open land in the Plantation class due to rejuvenation/ replacement n commodities are temporarily still classified as Plantations.	- Plantations with distinguishable types of perennial plants in a way homogeneous. - Block size which is classified as a plantation (oil palm) is around 30 ha (300 m x 1000 m). - Open land in the Plantation class due to rejuvenation/pe - Temporary commodity changes are still classified as Plantations.
9. Bushes		B/2007 All appearances of areas/regions dominated by low vegetation		Shrubs dominated by low vegetation (in

No.	Class	Layer code / toponymy	Operational definition (Working definition)	Notes
			is on dry land.	below 5 m), has the potential to regenerate into forest.
10. Bushes	swamp	Br/20071 All appearances of areas/regions dominated by low vegetation and located in freshwater inundated areas and behind brackish water forests.		Water hyacinth is classified as a swamp (example: Rawa Pening in Semarang, Central Java).
11. Savanna/ Grassland		S/3000 All natural and permanent low vegetation features in the form of grasslands. This feature is a natural feature in parts of Southeast Sulawesi, East Nusa Tenggara and the southern part of Papua, and can also be found in Java. In some savannas there are a few bushes or trees. Savannas can be found on dry land or swamps (swamp grass, for example swamp grass in Wasur).		• Appearance This is a natural phenomenon in parts of Southeast Sulawesi, East Nusa Tenggara and the southern part of Papua, and can also be found in Java. • In some savanna There are few bushes or trees. • Savanna can found on dry land or swamps (swamp grass, for example swamp grass in Wasur).
12. Dry land farming		Pt/20091 All agricultural activities on dry land such as dry fields, mixed gardens and fields		
13. Mixed dry land farming		Pc/20092 All features that are a mixture of agricultural areas,		• This class often appears in farming areas

No.	Class	Layer code / toponymy	Operational definition (Working definition)	Notes
			plantations, bushes and shrubs. This class often appears in shifting cultivation areas, karst land crop rotations, and includes classes understood as mixed gardens, community forests, or agroforestry.	moving, and rotating karst land crops. This class also includes classes understood as mixed gardens, community forests or agroforestry.
14. Rice fields		Sw/ 20093	All appearances of the results of cultivating annual crops in wetlands characterized by embankment patterns. Wetland farming is classified as rice fields, including agricultural areas that were initially used as rice fields and in the dry season planted with annual crops are still classified as rice fields. What needs to be considered by the interpreter is the crop rotation phase consisting of the flooding phase, young plant phase, old plant phase, and fallow phase. This class also includes seasonal rice fields, rainfed rice fields, irrigated rice fields. Especially for seasonal rice fields in swampy areas, additional information from the field is needed.	- Agriculture Wetlands are classified as rice fields, including agricultural areas under use Initially it was rice fields and in the dry season it was planted with crops plant annuals are still classified as rice fields. • What the interpreter needs to pay attention to is the cropping rotation phase which consists of phases flooding, young plant phase, old plant phase and fallow phase. - This class also includes seasonal rice fields, rain-fed rice fields, rice fields

No.	Class	Layer code / toponymy	Operational definition (Working definition)	Notes
				irrigation. Especially for seasonal rice fields in swampy areas, additional information from the field is needed.
15. Tambak Tm/		20094	All the appearance of inland fisheries (fish/shrimp) or salting that appears with a dike pattern, usually located around the coast. In some locations it can come from swamp forests, swamps or swamp thickets.	In some locations it can originate from swamp forests, marshes or swamp thickets.
16. Settlements		Pm/2012 Residential	Residential areas, both urban, rural, industrial etc.	
17. Settlement an Transmigr	breast milk	Tr/20122 Residential	Residential areas in transmigration areas and located within transmigration permit areas. Cultivated land is separated from residential areas.	• Located in the transmigration permit area. • Transmigration Class is adjusted to become Transmigration Settlement. Cultivated land is separated from residential areas.
18. Open land		T/2014 All open	land features without vegetation, whether occurring naturally or as a result of human activity (rock outcrops, mountain peaks, snowy peaks, volcanic craters, sandbars, beach sand, river deposits, land clearing).	• Open land in the plantation forest class after harvesting that will be replanted is classified as plantation forest.

No.	Class	Layer code / toponymy	Operational definition (Working definition)	Notes
			and former fire areas). The appearance of open land for mining is classified as mining, while open land is used for land <i>clearing</i> classified as open land. Open land for the purpose of rice field/pond crop rotation is still classified as rice field/pond.	• Open land during the first land clearing indicated as being in a plantation forest/forestry area - Bunan is classified as open land. • The appearance of open land for mining is classified as mining, while open land is used for land <i>clearing</i> - classified as open land. - Open land within the framework of paddy/pond crop rotation remains classified as paddy/pond.
19. Mining	bro	Tb/20141 Open land	land used for open <i>pit</i> mining activities (eg: coal, tin, copper etc.), as well as large-scale closed mining areas that can be identified from imagery based on appearance associations.	Small-scale or unidentified closed mining areas are classified according to surface appearance.

No.	Class	Layer code / toponymy	Operational definition (Working definition)	Notes
			its objects, including <i>tailing ground</i> (mining waste dumps). Small-scale or unidentified closed mining areas are classified according to their surface appearance.	
20.	Water bodies A/5001	All water features	, including seas, rivers, lakes, reservoirs, coral reefs, seagrass beds, etc. The features of ponds, rice fields, and swamps have been classified separately.	
21.	Swamp	Rw/ 50011	The appearance of swamp land (flooded with fresh water and behind brackish water forests) that is no longer forested. Swamps are usually located in depressions or plains that are lower than the surrounding areas.	Swamps are usually located in depressions or lowlands compared to the surrounding areas.
22.	Clouds	Aw/2500 Cloud	appearance covering the land of an area with a size of more than 4 cm ² on the presentation scale. If the thin cloud coverage still shows the appearance below and allows for interpretation, it is still delineated.	
23.	Airport/ Harbor	Bdr/Plb/ 20121	The appearance of a large airport and port	

No.	Class	Layer code / toponymy	Operational definition (Working definition)	Notes
			allows for separate delineation.	

12) If the land cover is included in the 'forest' category, observe and record the forest type on form F2-12 according to the following code:

Code F2-12	Description
1	Mangrove forest
2	Nipah forest
3	Coastal forest
4	Freshwater swamp forest (<i>riparian</i>)
5	Peat swamp forest
6	Heathland forest
7	Monsoon mountain forests
8	Monsoon Savanna
9	Plantation forest
10	Sago forest
11	Bamboo forest
12	Others (write according to forest type)

Explanation of several types of forests based on the Vademecum Kehutanan book (KLHK 2020): •

Mangrove forests (also called mangrove/brackish water forests): grow in wet and salty habitats along the coast, especially muddy beaches at the mouths of large rivers, and can stretch along large rivers far inland (Kartawinata, 2013). Mangrove forests are influenced by the ebb and flow of sea water, which are overgrown with mangrove species such as *Avicennia alba*, *Sonneratia alba*, *Rhizophora* spp, etc. (Noor et al. 1999).

• **Coastal forest:** grows along the coast which is generally characterized by the presence of keben tree species (*Barringtonia asiatica*). • **Freshwater swamp forest:** found in large river basins (in Sumatra, Kalimantan, and Papua), the species composition is diverse, usually overgrown with *Alstonia* spp., *Barringtonia* spp., *Camphosperma* spp., *Dillenia* spp., *Eugenia* spp., *Neesia* spp., *Pholidocarpus* spp., and *Shorea* spp. (Kartawinata 2013).

• **Heath forest:** found in lowland rainforest areas (with elevations of 0–800 meters above sea level) in Kalimantan, Sumatra and Papua, the soil is very poor in nutrients and acidic, the water flowing from the heath forest is the color of tea, generally overgrown with the types of trees *Casuarina nobilis*, *Cotylelobium burckii*,

Cratoxylum spp., *Combretocarpus rotundatus*, and *Dacrydium elatum* (Kartawinata 2013). •

Monsoon savanna: a typical

ecosystem in areas with low rainfall intensity, for example in East Java, West Bali, East Nusa Tenggara, West Nusa Tenggara, Southeast Sulawesi, and Southeast Papua; dominated by grasslands (generally with the grass species *Heteropogon contortus*) or short shrubs with scattered and sparse trees (Kartawinata 2023).

- 13) Observe and record the type of land use *for non-forest areas* (PDLH/TOF) on form F2-13 according to the following codes:

Code F2-13	Description
1	Monoculture community forest
2	Mixed community forest
3	Agroforestry garden
4	Agriculture
5	Plantation
6	Pond
7	Others (write according to land use)

- 14) Estimate the proportion/percentage of the plot area that lies within the land cover class or forest type observed on form F2-11 or F2-12, and record the data on form F2-14:

Code F2-14	Description	Illustration
1	The entire (100%) plot area is located within the observed land cover class area.	
2	75–99% of the plot area lies within the observed land cover class area.	
3	50–74% of the plot area lies within the observed land cover class area.	
4	25–49% of the plot area lies within the observed land cover class area.	
5	<25% of the plot area lies within the observed land cover class area	

15) Observe and record the level of canopy density on form F2-15.

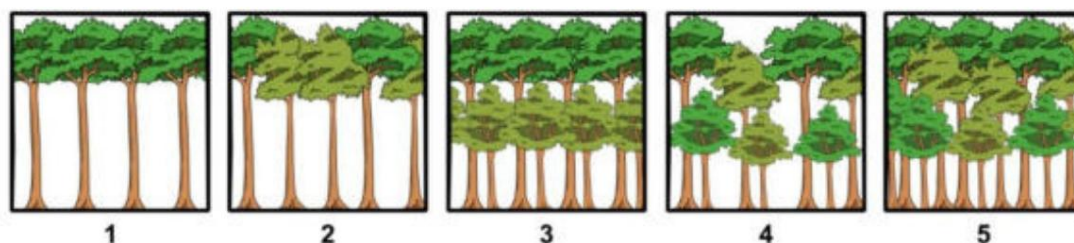
according to the following code:

Code F2-15	Description
1	Dense (>60%), if the majority of the tree canopies overlap
2	Moderate (30–60%), if the majority of the tree canopies touch each other
3	Rare (10–29%), when the majority of tree canopies are separated by relatively narrow gaps (<i>compared to the average crown diameter</i>)
4	Open (<10%), if the majority of the tree crowns are separated by wide gaps (<i>compared to the average diameter of the crown</i>)

16) Observe and record the vertical structure of the stand (crown layer of the stand) on form F2-16 according to the following code and illustration:

Code F2-16	Description
1	One canopy layer that is relatively the same height
2	One layer of canopy but tends to be different in height
3	Multi-layer canopy with clearly visible height differences
4	The vertical structure is diverse and gapped.
5	Vertical structures are very diverse

Illustration:

Source: adaptation of Otto (1994) in Fehrmann *et al.* (2017)**17) Observe and record indications of forest/land fires.**

form F2-17 according to the following code:

Code F2-17	Description
1	There was no fire incident
2	There was a fire not long ago, which can be seen from the burn marks on the forest floor and undergrowth.
3	There has been a fire for a long time, which can be seen from the burn marks on the tree trunks.

- 18) Observe and record the types of forest disturbances (which can cause biophysical changes) on form F2-18 according to the following codes:

Code F2-18	Description
1	No disturbance
2	Road construction
3	Logging
4	Shifting cultivation
5	Pests and diseases
6	Others (write according to the facts)

- 19) Take photos of the plot conditions (vegetation or landscape) taken from the center of the plot to the four cardinal directions (North, East, South, or West). All photos are taken in landscape orientation at the height of the photographer's eyes. Include the photo number on form F2-19:

Code F2-19	Description
1	Photo taken from the center of the plot towards the north
2	Photo taken from the center of the plot towards the east
3	Photo taken from the center of the plot towards the south
4	Photo taken from the center of the plot towards the west

4.3. Regeneration

After recording the plot information, the survey team conducted observations and recording of regeneration, namely individual plants/vegetation with a diameter/DBH <5 cm and a minimum height of 10 cm (including seedlings). In each plot, regeneration was observed in 2 small subplots (A1 and A2) with a radius of 1 m (area 3.14 m²), which were placed at a distance of 5 m (the same as the radius of subplot B) from the center of the plot in the West-East direction or if not possible can be made in the North-South direction (Figure 5). In the permanent cluster, the direction of the two subplots A1 and A2 must be made fixed/consistent to avoid bias/errors in regeneration observations.

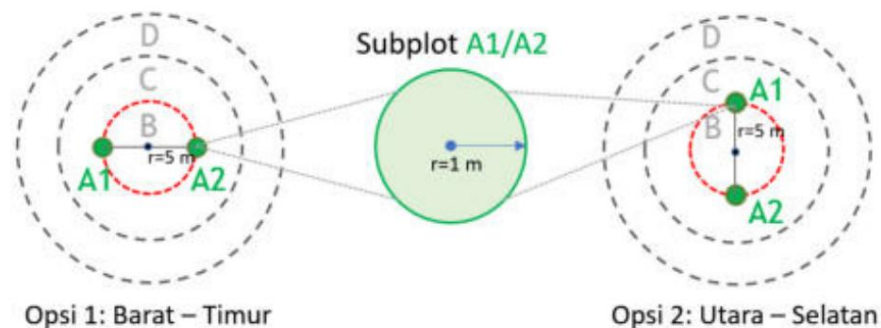


Figure 5. Regeneration subplots (A1 and A2) with **West–East** or North–South positions on each plot.

Observation and recording of regeneration (on form F3) is carried out by the survey team before other measurement activities to avoid damage to regeneration due to the mobility of the survey team in the plot. The stages of observation and recording of regeneration are as follows:

- 1) Record the information on the cluster number, plot number, and position of subplot A

(West – East or North – South) on form F3.

- 2) In each subplot (A1 or A2), observe and record (on form F3) the species code, species name (Latin or local name), and number of stems/ individuals for each species.
- 3) If necessary, make important notes about regeneration at each stage subplot.

4.4. Lower Plants

After completing the regeneration recording, at the subplot locations A1 and A2 at a distance of 6 m from the center of the plot, the survey team measured the undergrowth, namely all living vegetation (including seedlings) growing above the ground with a height of less than 1.5 m. The measurement of undergrowth was carried out by trimming and weighing all undergrowth in the A1 and A2 *clip-plot* frames (Figure 6). Each *clip-plot* measures 0.5 m x 0.5 m and is made of PVC pipes that can be disassembled and reassembled for easy carrying and use.

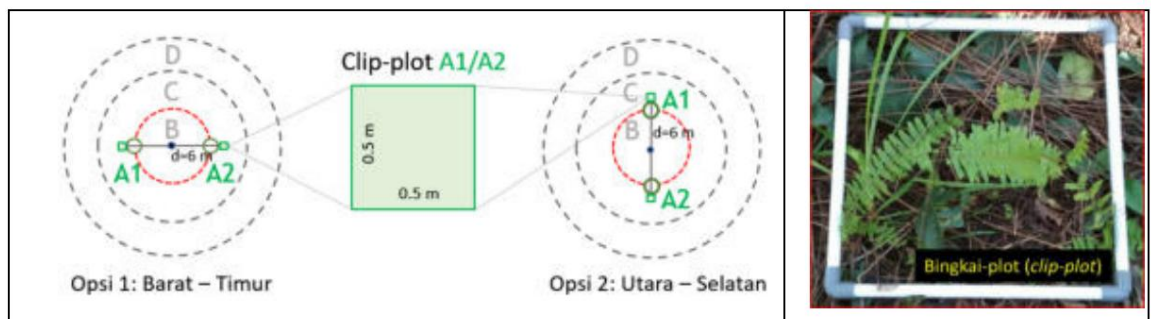


Figure 6. Frame-plot (*clip-plot*) of understory plants (A1 and A2) with **West–East or North–South** positions on each plot.

The stages of measuring understory plants in subplots A1 and A2 in each sample plot (Plot P, Plot U, and Plot T) are as follows: 1) Place the plot frame (*plot clip*) in subplots A1 and A2, namely at a distance of 6 m from the center of the plot in a West-East direction (Figure 6).

If it is not possible to make it in the West–East direction, it can be made in the North–South direction.

- 2) Identify and cut (using cutting shears or other tools) all undergrowth (including seedlings) within the plot frame. Collect, mix, and contain all undergrowth from both subplots (A1 and A2) in a large plastic bag.

Then, weigh the total wet weight (TBB, grams) of the undergrowth and record the results (after subtracting the weight of the bag) on form F4.

- 3) In certain clusters that have been determined, take samples of undergrowth for laboratory analysis.

For this, stir the undergrowth in a large plastic bag (from step 2 above) until all parts are mixed. Then take a sample of about 300 grams of undergrowth (or all if the TBB is less than 300 grams), put it in a small plastic bag and weigh the wet weight of the sample (BBS, grams) of the undergrowth. Record the results (after subtracting the weight of the bag) on form F4. Label the small plastic bag (Figure 7), and store the undergrowth sample bag in a large sack/bag to be taken to the laboratory to determine the dry weight of the sample (BKS, grams) of the undergrowth. The remaining undergrowth in the large bag can be thrown back onto the forest floor.

Sampel Tumbuhan Bawah / Seresah *)	
Nomor klaster:	Total berat basah (TBB, gram): **)
Nomor Plot:	Berat basah sampel (BBS, gram): **)
*) Coret yang tidak perlu, **) Setelah dikurangi berat kantong	

Figure 7. Understory/litter sample labels for laboratory analysis.

4.5. Litter

After measuring the understory, the survey team measured litter in subplots A1 and A2 (Figure 6). The litter measured includes all organic materials on the forest floor that have not been completely decomposed, such as leaves, fine tree roots, and small diameter tree branches (<10 cm). The stages of measuring litter are as follows: 1) Collect litter in the A1 and A2 plot frames after pruning and collecting understory. If necessary, dredge up litter that sticks to the soil surface.

- 2) Combine and mix all the litter from both plot frames (A1 and A2), and collect it in a large plastic bag.

Weigh the total wet weight (TBB, grams) of the litter and record the data (after deducting the weight of the bag) on form F5.

- 3) In certain clusters that have been determined, take samples of undergrowth for laboratory analysis.

For that, take a litter sample of about 300 grams (or all of it if the TBB is less than 300 grams) from the large plastic bag, then put it in a small plastic bag that has been labeled (Figure 7). Then, weigh the litter sample and record the results on the F5 form and label the sample bag to be taken to the laboratory.

to determine the dry weight of the sample (BKS, grams) of the litter.
Return the remaining unused litter to the forest floor.

4.6. Soil Carbon

Soil carbon or *soil organic carbon* (SOC) according to the IPCC Guidelines 2006 is all organic matter in the soil at a certain depth (30 cm for mineral soil), including roots and fine litter with a diameter of less than 2 mm, because it is difficult to distinguish. The method of measuring soil carbon must be adjusted to the needs. For IHN and also the calculation of greenhouse gas emissions, measurement of soil carbon stocks does not have to be done. This is because the measurement of emissions from soil carbon is based on emission factor data obtained from specific research related to land cover changes. Therefore, it is better to use a more appropriate sampling design.

If soil carbon is a parameter that must be measured, the soil carbon measurement method is divided into three methods, namely, (1) for mineral soil or dry land, (2) for peat soil, and (3) for mangroves. For IHN, soil measurements are carried out at the center point of Plot P. However, if more detail is needed, it can be carried out at all center points of the plot.

Soil Mineral Carbon Measurement

Soil carbon measurements on mineral land were carried out to determine the soil carbon content to a depth of 30 cm (SNI 2019). Soil samples at depths of 0–5 cm; 5–10 cm, 10–20 cm, and 20–30 cm were taken to be taken to the laboratory. Sampling was carried out using a *soil ring*. Each sample was put into plastic (it is better if the soil remains intact in the soil ring) and then labeled, indicating the name of the cluster, plot, depth. The samples were then taken to the laboratory to be tested for organic content and carbon content.

Peat Soil Carbon Measurement

For peatlands, in addition to knowing the carbon content in each layer, information on peat depth is also needed. This is possible because there is a clear and easily observed difference between peatlands and the organic soil layer beneath. Peat depth data can be used to estimate the volume of peat domes and overall carbon reserves.

To measure the depth of peat, a peat drill is needed that can reach the deepest limit of peat. Therefore, a peat depth reference is needed based on the results of previous peat research and surveys. Drilling is carried out at the point that has been planned to be drilled. Drilling is carried out in stages, according to the length of the connecting iron (*extension rod*) which is usually 1 m long.

Every time the depth is increased by 1 meter, the drill is pulled out to find out

the presence of mineral soil in the form of clay or loam. If it has not reached the mineral soil, add more connecting iron, until it reaches the mineral soil limit. Record the total peat depth in form F6. Use a meter to measure the length of the organic soil to the mineral soil limit. This length is then added to the total length of the previous drilling at the same point, so that the total peat depth value is obtained.

Peat soil sampling is carried out at each representative depth, around 3-5 samples that represent at least shallow, medium and deep depths. For example, the total peat depth is around 5 meters, then samples can be taken at depths of 1, 3 and 5 meters. Samples are taken using a *peat sampler* with a known volume (eg *Eijkelpomp*), or peat coring with a known tube diameter. For sampling with *peat coring*, measure the length of the soil sample to be taken, to determine the sample volume. Put the sample in a plastic bag, then label it to indicate the cluster number, plot, depth and sample volume.

Next, the samples were taken to the laboratory to be tested for organic content and carbon content.

Mangrove Soil Carbon Measurement

For mangrove soil, you can use the same soil drill as in peatland. Unlike in peatland, mangrove soil is difficult to distinguish from mineral soil layers. Usually soil samples are taken to a depth of 3–5 m. If the soil depth to be measured only reaches a maximum of 3 meters, then the samples taken should represent a depth of 1, 2 and 3 meters. The samples are then taken to the laboratory to be tested for organic content and carbon content.

4.7. Dead Wood

Deadwood is the dead woody plant parts found above the ground surface (also called *lying/fallen/down deadwood*), for example trunks and branches, with a minimum size of 10 cm. Deadwood measurements use the Line Intersect Sampling (LIS; Marshall *et al.* (2000), Walker *et al.* (2012)) method with 4 transect lines each 5 m long forming a '+' sign on subplot B (Figure 8).

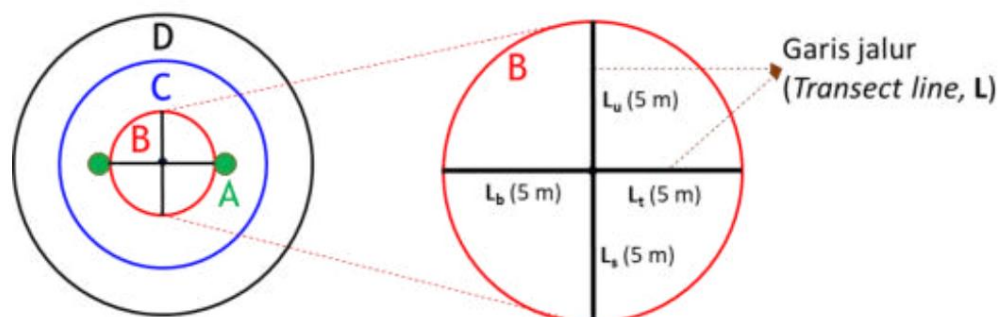


Figure 8. Location of dead wood measurements using the Line Intersect Sampling method.

Deadwood measurements using the LIS method can be carried out by the survey team after measuring trees (dead and alive) or in parallel with other activities by several team members.

The stages of measuring dead wood are as follows: 1)

Record the cluster number and plot number on form F7.

- 2) From the center point of subplot B, make 4 *transect* lines by stretching a measuring tape or rope to the east (called Lt), to the west (called Lb), to the north (called Lu), and to the south (called Ls) each with a flat distance of 5 m.
- 3) Identify and measure the diameter and angle of inclination of dead wood (with a diameter of ≥ 10 cm) that intersects the line (measuring tape or rope) with the following provisions:
 - The diameter of dead wood is measured at the point where the dead wood part (e.g. fallen trunk or branch) intersects the path line (Figure 9a), and is measured perpendicularly to the center axis of the dead wood trunk.
 - The angle of inclination of dead wood is measured (using a protractor or other relevant tool) between the path line and the center axis of the dead wood trunk (Figure 9a).

- Dead wood is measured if the majority (>50%) of its diameter is above ground level (Figure 9b).

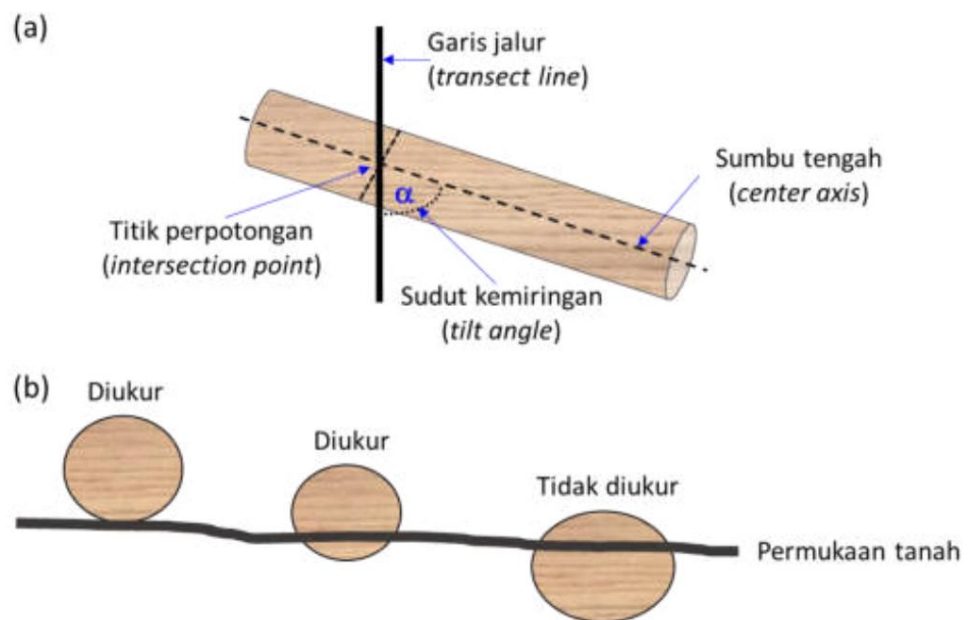


Figure 9. Deadwood measurement provisions using the LIS method

- 4) Estimate the level of decay of each dead wood by striking or slashing a machete/parang at a part that represents the condition of the dead wood (for example in the middle of the trunk), and categorize it into three classes:
 - Class 1: not/not yet decayed, if the machete that is slashed has difficulty penetrating the dead wood or the machete tends to bounce back.

- Class 2: slightly weathered, if the machete that was cut is slightly damaged easily penetrates dead wood.

- **Class 3: weathered**, if the machete that is slashed very easily penetrates the dead wood.

5) Record the dead wood measurement results on the four path lines (Lt, Lb, Lu, and Ls) on form F7.

4.8. Rattan and Liana

Measurements of rattan, lianas, and bamboo were carried out in all plots in subplot C. All types and sizes of rattan, lianas, and bamboo included in subplot C were measured and recorded on form F8.

Rattan Measurement

Rattan measurements in subplot C were carried out on young and adult rattan. Young rattan is rattan that has a length of <3 m, while adult rattan has a length of ≥ 3 m. The stages of measuring young and adult rattan are as follows: 1) Observe the presence of all young

rattan (length <3 m) and adult rattan (length >3 m) in subplot C. Use a

distance measuring tool (eg *Vertex*) to determine whether the rattan (in the form of individuals, clumps, or stem parts) is within the radius of subplot C.

- 2) If young rattan is found, record it on form F8: stem number (if solitary) or clump (if in clumps), species name, and number of stems in each clump.
- 3) If adult rattan is found, then record on form F8: species name, sales value information (commercial, non-commercial, or unknown), stem diameter (in centimeters), and stem length (in meters). Diameter measurements are carried out on adult rattan with a minimum diameter of 1.0 cm with a diameter measurement point at a length of 1.3 m from the top of the roots.

Rattan measurements are carried out

if: • Rattan has roots in subplot C and all or part of its stems are in subplot C (Figure 10 #1, Figure 10 #2, and Figure 10 #4). If the rattan spreads far outside subplot C and does not return to subplot C, then the part of the stem that is measured is only the part located in subplot C. Rattan that spreads/crosses subplot C is not measured if it does not have roots in subplot C (Figure 10 #3).

- Rattan has roots inside subplot C, spreads outside the boundaries of subplot C, and then spreads back in or up the trees in subplot C (Figure 10 #5). For such cases, stem length measurements are taken for the entire stem, including the part of the stem that is outside subplot C.

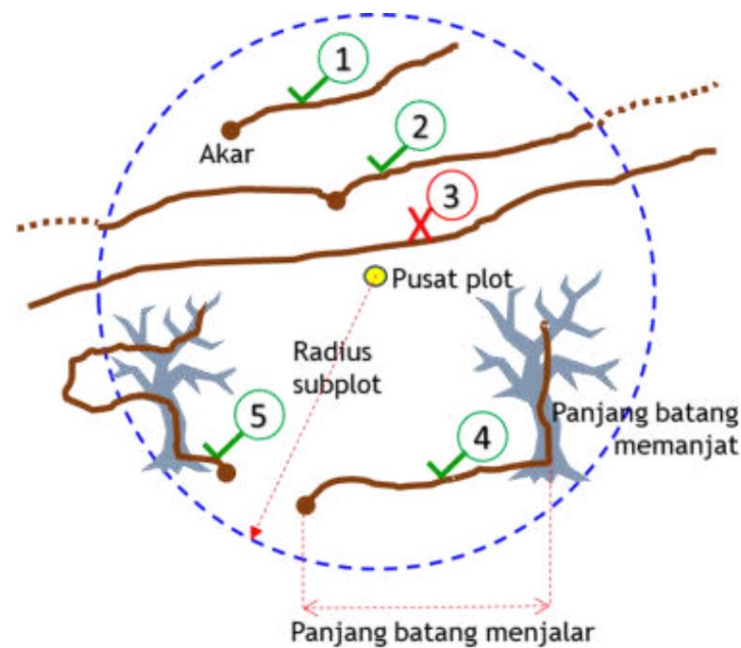


Figure 10. Rattan measurement provisions in subplot C

Liana Measurements

In addition to rattan, in subplot C, measurements were also carried out on lianas, namely "woody plants (having *xylem*) that creep or climb the canopy of other plants/trees (Gerwing *et al.* 2006)" with the following procedure: 1)

Observe the presence of small lianas (<5 cm in diameter) and large lianas. (≥5 cm in diameter) found in subplot C.

2) If small lianas are found, record them on form F8: species name and sales value information (commercial, non-commercial, or unknown).

3) If large lianas are found, record them on form F8: species name, stem diameter (in centimeters), stem length (in meters), and sales value information (commercial, non-commercial, or unknown). Stem diameter is measured at a height of 1.3 m from the top of the roots. The provisions for measuring lianas in subplot C are the same as for measuring rattan (Figure 10).

4.9. Bamboo

As with rattan/liana, bamboo measurements are also carried out by survey team in subplot C with the following procedure: 1)

Observe the presence of bamboo, both solitary and clumped, in subplot C.

2) If solitary bamboo is found, then measure and record on form F9: species name, age class, stem diameter, and total stem height. Stem diameter measurements are taken at a height of 1.3 m above ground level or shifted slightly in the middle of the segment if the height of 1.3 m is located right on the stem space line (Figure 11).

Age classes are divided into 3 classes, namely young, medium, and old, with the following characteristics (IPSDH 2021):

- Young age: the stem is clean (no lichen) and has petals (Figure 12a).
- Medium age: the stem is covered with slightly piled lichen (Figure 12b).
- Old age: the stem is covered with a lot of piled lichen (Figure 12c).

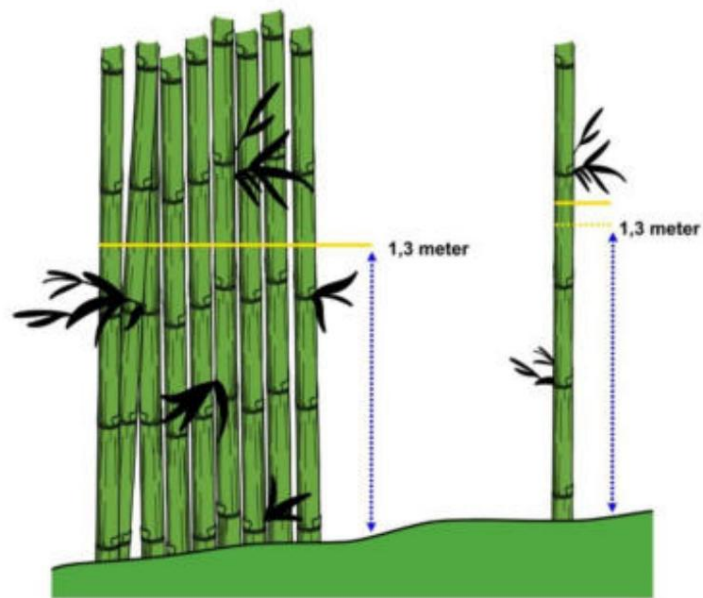


Figure 11. Measurement of bamboo stem diameter at a height of 1.3 m or slightly shifted above it in the middle of the bamboo segment (IPSDH 2021)

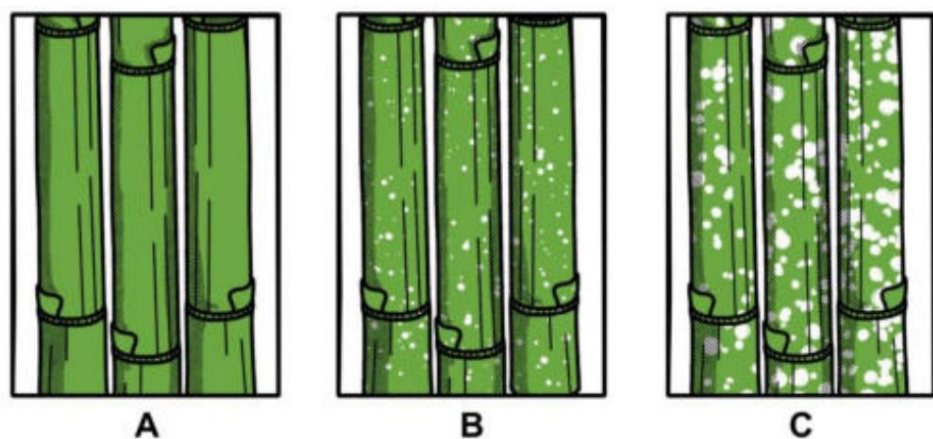


Figure 12. Characteristics of young (A), medium (B), and old (C) bamboo based on the presence of lichen on the stem (IPSDH 2021)

3) If a clump of bamboo is found, identify whether the center point of the clump is inside or outside subplot C.

Measurements of bamboo clumps are only carried out if the center point of the clump is located in subplot C (see R1, R2, R4, R5, and R7)

in Figure 12). If there are 2 or more bamboo clumps whose center point is right at the subplot boundary (for example R5, R6 and R7 in Figure 13), then measurements of the bamboo clumps are carried out alternately, for example clump R5 is measured, clump R6

not measured, and the R7 cluster was measured as shown in Figure 13.

- 4) In the bamboo clump that has been determined to be measured, measure and record on form F9: species name, average stem diameter, clump height, and number of stems per clump. The average stem diameter is obtained from the results of measuring the diameter of 3 stems representing young bamboo, medium bamboo, and old bamboo (Figure 12). The average height of the clump is obtained from the results of measuring the total height of the bamboo stems representing the average height of the stems in the clump.

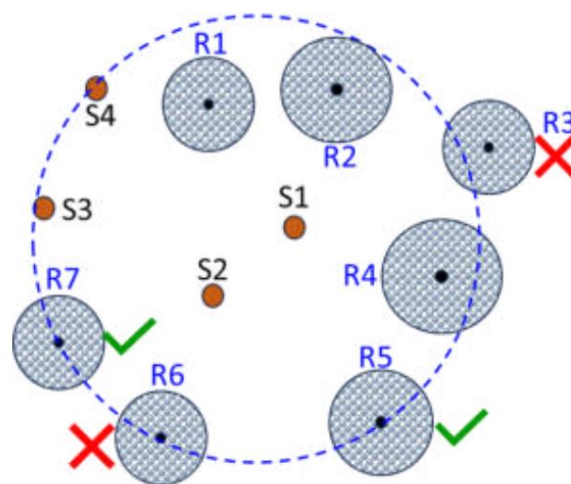


Figure 13. Possible positions of solitary bamboo (S1, S2, S3, S4) and clumping bamboo (R1, R2, ..., R7) in subplot C.

4.10. Palm

Palm is one of the forms of vegetation that is often found in tropical areas that are included in the *Arecaceae/Palmae* family. Palm has the characteristics of a single stem without branches with leaves with sheaths and resemble the shape of bird feathers. Palm measurements were carried out in each plot in subplot C with the following procedures: 1) Identification of palm species (including nipah if in coastal areas) found in subplot C.

- 2) For each individual palm (with a diameter of ≥ 5 cm), measure and record on the F10 form: species name, palm type, stem diameter, and total height. Palms are divided into three categories, namely: (1) Tall and thin (such as betel nut), (2) Short and fat (such as young oil palm, nipah), and (3) Medium height (such as coconut, sago, etc.). Diameter measurements are taken at a height of 1.3 m above ground level.
- 3) Attach a serial number label to each palm that has been measured.

4.11. Trees and Dead Trees

Measurements of living and dead trees were carried out in subplots B, C, and D with the provisions of the subplot radius and tree diameter limit (DBH) for the HLKRT strata (dryland forest, swamp, and plants), PDLH/TOF strata, and mangrove forest strata as in Figure 14. Subplot boundaries do not need to be physically created in the field, because in practice the survey team will measure trees based on the distance from the center of the plot. In measuring trees using the three subplots, the survey team can measure all trees with a diameter of ≥ 5 cm continuously starting from subplots B, C, to D, but does not measure trees with a diameter smaller than the upper limit of DBH in a particular subplot. For example, if there is a tree with a diameter of 10 cm in subplot C in dryland forest, then the tree is not measured. However, if there is a tree with a diameter of 50 cm in subplot B, then the tree is still measured.

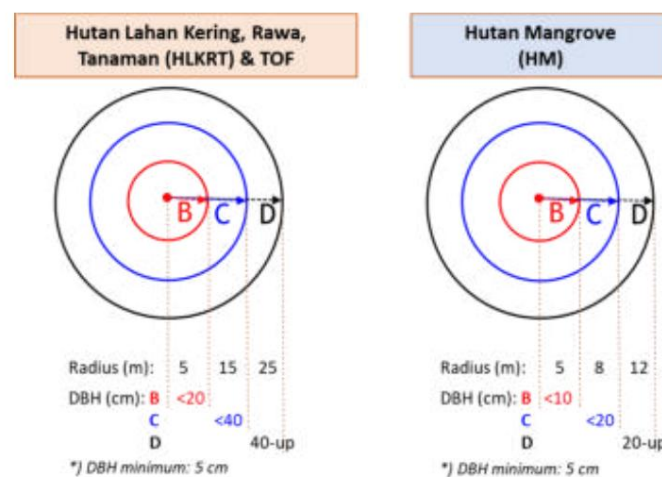


Figure 14. Tree radius and diameter limit (DBH) sizes measured in subplots B, C, and D in dryland forest, swamp, plantation, TOF, and mangrove.

Measurement and recording of living and dead trees in the three Subplots are carried out by the survey team with the following stages:

- 1) Fill in the cluster number and plot number information on form F11.
- 2) Starting from the center of the plot, the survey team moves north to measure trees in subplots B, C, and D, and then moves clockwise so that all trees in a plot are measured (Figure 15). A tree is measured if:
 - The estimated center point of the basal plane of the trunk is located within the subplot or most (>50%) of the trunk is located within the subplot, for example trees 2, 3, 4, 5 and 6 in Figure 15.

For tree 4 with a diameter of 50 cm, it is still measured in subplot D, even though the center point of its trunk is outside the boundary of subplot B. Conversely, for tree 'd' with a diameter of 9 cm, it is not measured in subplot B because the center point of its trunk is outside the boundary of subplot B. If the estimated center point of the basal plane of the trunk is exactly on the boundary of the subplot, then the trees are measured alternately, for example trees 5 and 6 are measured but tree 'c' is not measured in Figure 15.

- Have a diameter not more than the upper limit of the DBH class of a particular subplot (Figure 15). For example, if tree 2 (in Figure 15) has a diameter of 9 cm, then the tree is measured in subplot B because its diameter is less than the upper limit of the DBH class of subplot B (<20 cm for dry land or <10 cm for mangrove). This means that if there is a small diameter tree in a larger subplot (C or D), then the tree is not measured, for example tree 'a' with a diameter of 9 cm is in subplot D.

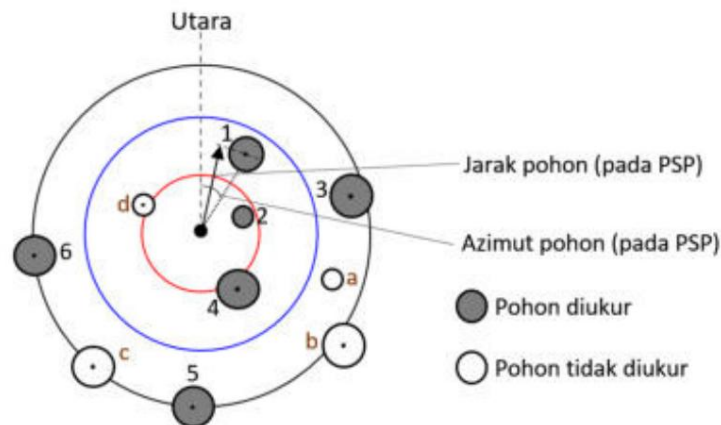
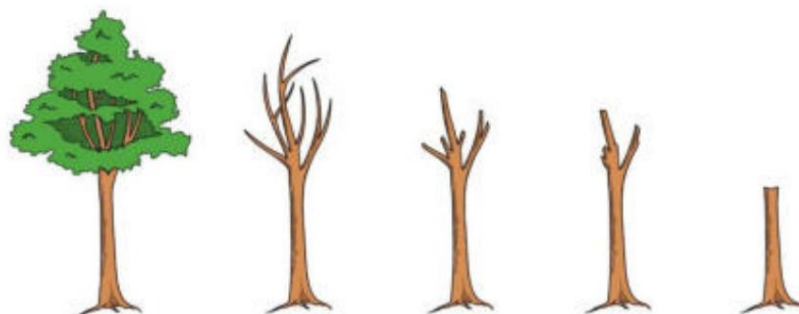


Figure 15. Sequence of tree measurements, determination of measured and unmeasured trees, and determination of tree distance and azimuth.

- 3) All trees and dead trees are labeled indicating the tree's serial number in the plot. Tree labels can be made of durable yellow/red plastic.
- 4) For each 'measured tree', observe and record the tree status on form F11 with the following code:

F10 Code (Status)	Description
1	Life
2	Dead with branches and twigs without leaves
3	Dead with large branches without twigs and leaves
4	Dead with almost no branches, twigs, and leaves
5	Dead in the form of stumps of varying heights

Illustration:



Source: adaptation from Manuri *et al.* (2011), BSN (2011)

- 5) Identify and record the code and species name of each tree measured on the F11 form. Known tree species can be selected from the tree list in the *Collect Mobile (CM)* application.

For trees whose species name is unknown, recording can use the local name accompanied by photos (leaf, stem, fruit, etc.) and/or herbarium for further species identification purposes. How to make a herbarium refers to appendix 3 of this guide. Include the photo and/or herbarium number on form F11 with the format: cluster number, plot number, and tree number, for example: K7-P1-PH5, which means the 7th cluster, 1st plot, and 5th tree.

- 6) Measure the tree diameter using a diameter tape (*phi-band*) at a height of 1.3 m above the ground (*called diameter at breast height, DBH*), and record it with an accuracy of 0.1 cm (for example 20.3 cm, not 20 cm). To maintain consistency in diameter measurements, use a 1.3 m stick as an aid when measuring. To avoid errors in diameter measurement, the diameter tape must be wrapped (without twisting) perpendicular to the axis of the trunk that has been cleared of climbing plants (if any). In the field, the diameter measurement point is adjusted to the condition of the tree as illustrated in Figure 16 (FAO (2012), Fehrmann *et al.* (2017), Manuri *et al.* (2011), Rusolono *et al.* (2015), van Laar & Akca (2007)): • Tree standing upright (normal) on flat ground: DBH is measured at 1.3 m

from the ground surface (Figure 16a).

- Leaning trees on flat ground: DBH is measured 1.3 m from the nearest ground surface or in the direction of the trunk slope (Figure 16b).
- Upright trees on sloping ground:

DBH is measured 1.3 m from the nearest ground surface or in the direction of the trunk slope highest ground surface/top side (Figure 16c).

- Deformed (bloated) trees exactly at 1.3 m: DBH is measured at the boundary of the normal part at the top or bottom of the mark, whichever is closest (Figure 16d).
- Branched trees >1.3

m: DBH is measured 1.3 m from the ground and considered as one tree (Figure 16e).

- Branched trees <1.3 m: DBH is measured

1.3 m from the ground on each branch and considered as a separate tree (Figure 16f).

- Trees with supporting roots (eg *Rhizophora* spp.): if the height of the supporting roots is $\leq$ 1.3 m then the DBH is measured 1.3 m from the ground surface, or if the height of the supporting roots is >1.3 m then the DBH is measured 20 cm from the top of the supporting roots

(Figure 16g).

- Trees with buttresses >1.3 m: DBH is measured 20 cm

above the buttress at the part of the trunk that begins to normalize (Figure 16h)

In detail, the method of measuring tree diameter is explained in Appendix 2C.

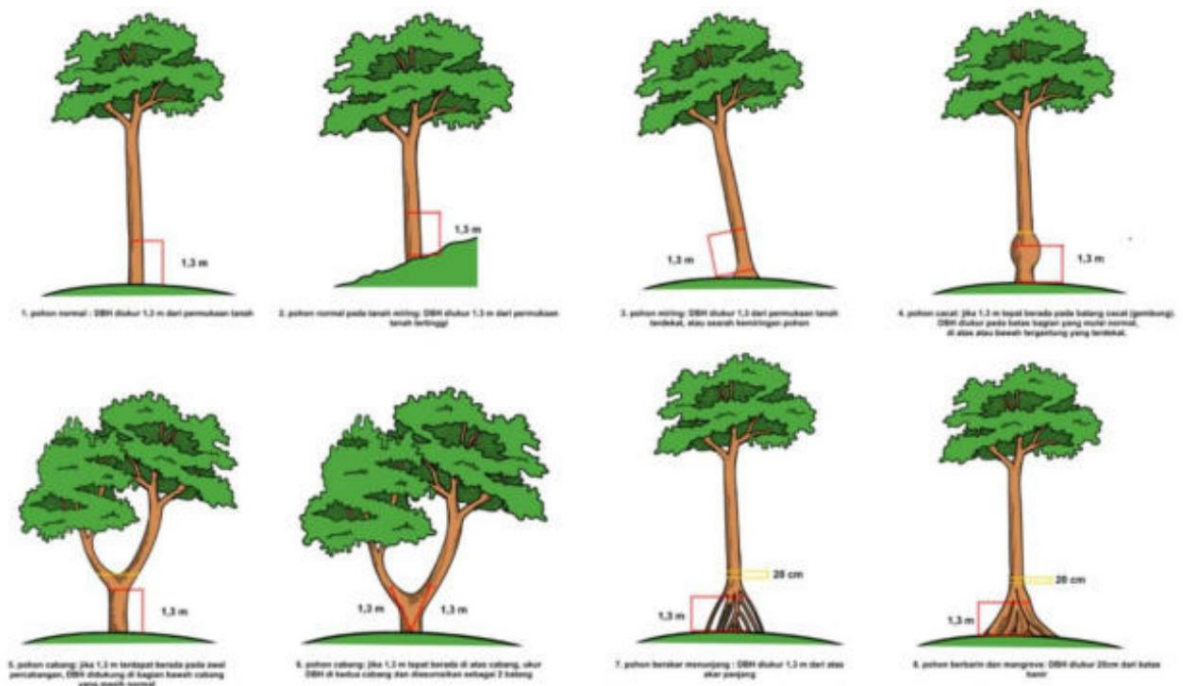


Figure 16. Diameter measurement points in various tree conditions.

- 7) Measure the flat distance and azimuth from the center of the plot to each measured tree (Figure 15). For ease and speed of measurement, the flat distance should be measured using an electronic distance meter, such as Vertex, which already takes into account the slope. Azimuth is the angle from the north to the position of the tree (0–360), which can be measured using a compass or a direction indicator application on a *smartphone*. This data is needed to create a map of the distribution of trees in each plot to facilitate re-measuring the cluster in the future.

- 8) After measuring all tree diameters, select 6 sample trees to measure their height. If the number of trees in the plot is less than 6 trees, then the height measurement is carried out on all trees in the plot. The sample trees must represent the diameter range in the plot and grow normally (e.g., no broken crowns or irregular shapes). For this reason, the survey team can select 2 sample trees that represent small, medium, and large diameter classes. On each sample tree, measure the height of the crown base (*bole height*) and total height (*total height*), which are recorded to 1 decimal place, with the following limitations (Husch *et al.*, 2003; Figure 17):
 - Height of the crown base (T-pt, m), which is the vertical distance from the base of the tree to the base of the crown.
 - Total height (T-total, m), which is the vertical distance from the base of the tree to the top of the tree.

In detail, the method of measuring tree height is explained in Appendix 2C.

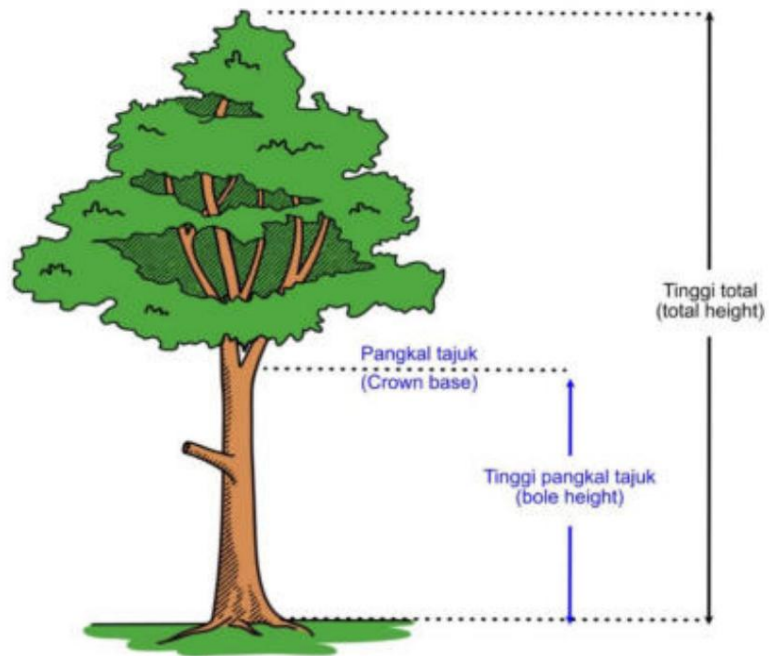


Figure 17. Height of crown base and total height of tree

- 9) For each dead tree in the form of a stump (status 5), measure the height of the stump (in addition to its diameter) and record it (up to 1 decimal place) in the “T-total” column in form F11.
- 10) On living trees with a diameter of ≥ 20 cm, observe and record the level of wood quality (*timber quality*) according to the following code:

F11 Code (Wood quality)	Description
1	The stem is straight and free from damage.
2	Same as 1, but up to 50% of the stem section has edges or the cross section of the stem is irregular and slightly twisted.
3	Rotted and knurled logs or those with other defects that can reduce the wood volume by up to 25%, such as rot, burnt, branched, or bent.
4	The trunk has many knots and is curved or has other defects that can reduce the wood volume by 25–50%.
5	Rejected due to >50% defective stems.

- 11) For each tree species (living or dead) whose Latin name is not yet known, ask local people to estimate the specific gravity class (hardness level) of the tree according to the following code:

F11 Code (BJ Class)	Description
1	The specific gravity of the tree is low, if the wood floats in water
2	The specific gravity of the tree is medium, if the wood floats in water
3	The specific gravity of the tree is high, if the wood sinks in water

4.12. Survey Team Identity

After completing the measurement of a cluster, record the identity of the survey team on the F12 form with the following information: • Name: filled with the full name of the team leader and members. • Position: filled with the position in the team whether as leader, member, or local worker. • *Mobile phone*: filled with the *telephone/mobile phone* number for

further communication.

- Email: filled with email address (if any).

Information about the identity of the survey team is needed for further communication, for example if verification of survey data is required.

5. REPORTING ON INVENTORY IMPLEMENTATION

5.1. Reporting Mechanism

After the cluster measurement in the field, the survey team coordinated by the head of the inventory implementation team carries out the following post-survey activities: 1) Re-checking the accuracy and completeness of the inventory data recorded through the *Collect Mobile* application or its printed form (if used).

2) Complete the scientific names of tree species that are not identified in the field. If the survey team takes herbarium samples, the herbarium samples must be sent to a laboratory or competent expert for the tree species identification process.

3) Handle the inventory data flow process, starting from sending data from *Collect Mobile* to the IHN database server at the IPSDH Directorate to archiving the data (in file format). *Excel*) in BPKHTL.

4) Prepare a report on the implementation of inventory activities submitted to the section head or person in charge of inventory activities. Data analysis and preparation of the IHN annual report are handled by the IPSDH Directorate.

The inventory report is submitted to the leadership (Head of BPKHTL or implementing agency) for evaluation and approval. Furthermore, the inventory implementation report is submitted to the Director of IPSDH. Schematically, the reporting mechanism is presented in Figure 18.

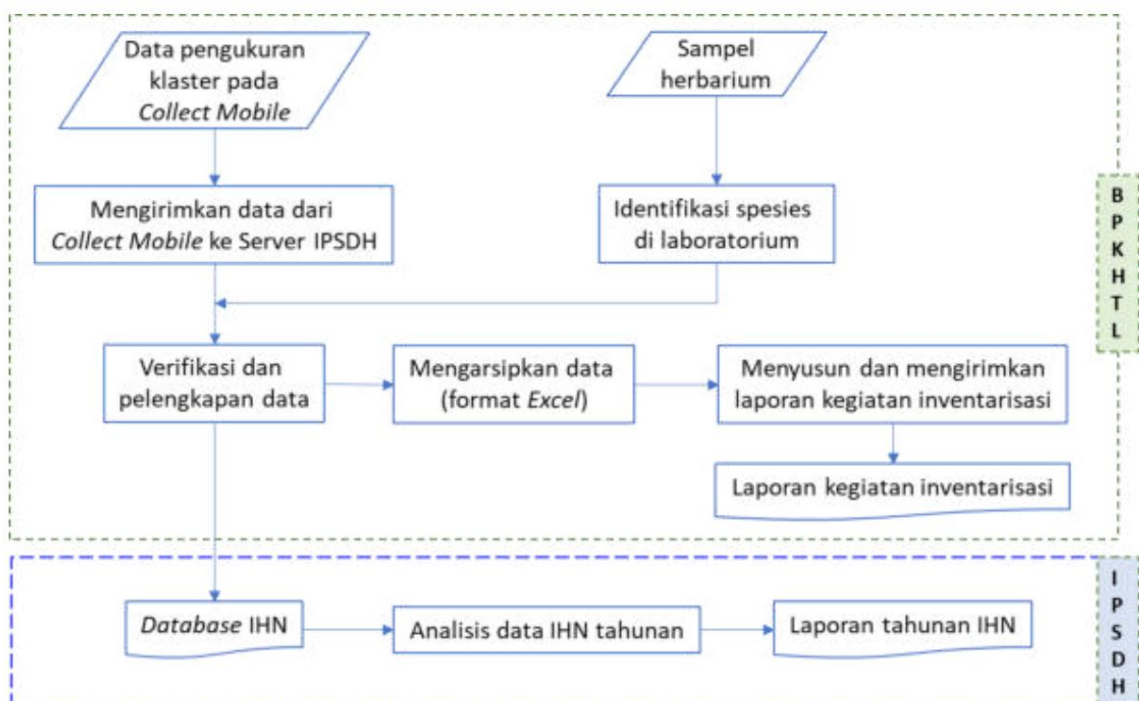


Figure 18. Reporting mechanism for forest inventory activities by BPKHTL

5.2. Table of Contents of the Report

The report on the implementation of inventory activities is prepared briefly. with the following systematics:

A. Composition of the

implementing team Contains information on the head and members of the implementing team and the person responsible for forest inventory activities, including contact details.

B. Time of implementation

Contains information on the date/time of forest inventory activities according to the previously determined cluster measurement activity schedule in the field.

C. Activity location

Contains information on the locations of cluster measurement activities in the field, which can be grouped according to administrative areas (e.g. province, district, sub-district, and village) as well as geographical coordinates according to the cluster locations determined on the IHN cluster distribution map.

D. Statement letter regarding implementation of activities

Contains a statement from the Head of BPKHTL or the person in charge of the inventory activity stating that the forest inventory activity has been carried out according to the previously prepared activity plan. In addition, it also needs to be explained that the field measurement data has been uploaded to the IHN *database system* determined by the IPSDH Directorate. The letter needs to include an explanation if the realization of the activity is not in accordance with the target or previous plan.

E. Summary of forest inventory activities

Contains information about the targets and realization of cluster measurements, explanations of inaccessible clusters (if any), species identification results (including herbarium sample analysis results), measurement data verification results, and other relevant matters.

Established in Jakarta on
17 October 2024

DIRECTOR,



ERIK TEGUH PRIMANTORO NIP.
19690114 199603 1 001

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Attachment 1. Field Form

Form 1: Cluster Information

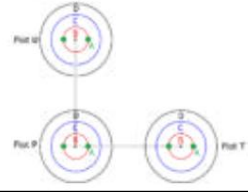
F1-1 Island		ý1/SM ý3/JW ý7/SL ý8/ML ý5/BN ý9/PP ý6/KL
F1-2 Cluster number ...		
F1-3 Years of measurement		...
F1-4 Province		ý11-Aceh ý12-North Sumatra ý13-West Sumatra ý14-Riau ý15-Jambi ý16-South Sumatra ý17-Bengkulu ý18-Lampung ý19-Bangka Belitung Islands ý21-Riau Islands ý31-DKI Jakarta ý32-West Java ý33-Central Java ý34-DI Yogyakarta ý35-East Java ý36-Banten ý51-Bali ý52-West Nusa Tenggara ý53-East Nusa Tenggara ý61-West Kalimantan ý62-Central Kalimantan ý63-South Kalimantan ý64-East Kalimantan ý65-North Kalimantan ý71-North Sulawesi ý72-Central Sulawesi ý73-South Sulawesi ý74-Southeast Sulawesi ý75-Gorontalo ý76-West Sulawesi ý81-Maluku ý82-North Maluku ý91-Papua ý92-West Papua ý93-South Papua ý94-Central Papua ý95-Papua Mountains ý96-Southwest Papua
F1-5 Land type		ý1/Dry land, swamps and peat ý2/Mangrove
F1-6 Cluster data types		ý1/Planned ý2/Unplanned ý3/Quality assurance (QA/QC)
F1-7 Survey team:		
	-Executing unit	ý1/BPKHTL Unit ... ý2/QA/QC Team ý3/Other parties
	- Team leader ...	
F1-8 Accommodation (base-camp)		Name: ... X coordinate: ... Y Coordinate: ...

Appendix 1 (continued)

F1-9 Survey time:		
	Departure from the starting point to location parking or cluster	Start date & time: End date & time:
	Departure from parking location to cluster location	Start date & time: End date & time:
	Return from the cluster location to the parking location or starting point	Start date & time: End date & time:
F1-10 Cluster accessibility		ý1/Accessible ý2/ Inaccessible due to difficult and/or dangerous topography ý3/ Inaccessible due to not being permitted by the management/community ý4/Inaccessible for other reasons....
F1-11 Physical evidence cluster cannot be accessed		ýPhoto 1 ýPhoto 2 ýPhoto 3 ýX (Easting) coordinate of the last access point ýY coordinate (Northing) of the last access point ýMinutes
F1-12 Type of HHBK main		
F1-13 Forest/land management		ý1/Government ý2/Private ý3/Community
F1-14 Important notes:		

Appendix 1 (continued)

Form 2: Plot Information

F2-1 Cluster number	...	
F2-2 Plot number	y1 y2 y3	
F2-3 Plot accessibility	y1/Accessible y2/Inaccessible due to difficult/dangerous topography y3/Not accessible due to being located in waters y4/Inaccessible but visible	
F2-4 Plot measurement time:		
-Date (dd/mm/yy)		
-Start time (hours:minutes)		
-Complete time (hours:minutes)		
F2-5 Plot location:		
-X coordinate (Easting)		
-Y coordinate (Northing)		
-GPS accuracy (m)		
-Distance to plot center (m)		
-Azimuth to plot center (°)		
-Photo of the signpost		
-Photo of PVC pipe		
F2-6 Plot center marking:	y1/Yes y2/No 1.1 Witness point 1: -X coordinate (Easting): -Y coordinate (Northing): -GPS accuracy (m): -Distance from plot center (m): -Azimuth from plot center (°): -Photo 1.2 Witness point 2: -X coordinate (Easting): -Y coordinate (Northing): -GPS accuracy (m): -Distance from plot center (m): -Azimuth from plot center (°): -Photo	

Appendix 1 (continued)

F2-7 Elevation (masl)				
F2-8 Slope gradient (%)				
F2-9 Slope gradient aspect		ÿ1/North ÿ2/Northeast ÿ3/East ÿ4/Southeast ÿ5/South ÿ7/ West ÿ1/ ÿ8/Northwest ÿ9/Flat		
F2-10 Land cover categories		Forest ÿ2/Non-forest/TOF		
F2-11 Land cover class in the field		ÿ2001/Hp ÿ2002/Hs ÿ2004Hmp ÿ20041/Hms ÿ2005/Hrp ÿ20051/Hrs ÿ2006/Ht ÿ2007/B	ÿ20071/Br ÿ2010/Pk ÿ2012/Pm ÿ2014/T ÿ3000/S ÿ20091/Pt ÿ20092/Pc ÿ20093/Sw	ÿ20094/Tm ÿ20121/Bdr/Plb ÿ20122/Tr ÿ20141/Tb ÿ50011/Rw ÿ5001/A
F2-12 Forest type		ÿ1/Ht-Mangrove ÿ2/Ht-Nipah ÿ3/Ht-Beach ÿ4/Ht-Freshwater swamp ÿ5/Ht-Peat swamp ÿ6/Ht-Kerangas	ÿ7/Ht-Monsoon Mountains ÿ8/Monsoon Savanna ÿ9/Ht-Plants ÿ10/Ht-Sago ÿ11/Ht-Bamboo ÿ12/Others...	
F2-13 Non-forest land use / TOF		ÿ1/Monoculture community forest ÿ2/People's forests mix ÿ3/ Agroforestry	ÿ4/Agriculture ÿ5/Farming ÿ6/Pond ÿ7/Others...	
F2-14 Proportion (%) of plot area located within class area observed land cover		ÿ1/100% ÿ3/50–74%	ÿ2/75–99% ÿ4/25–49%	ÿ5/0–24%
F2-15 Canopy density level		ÿ1/Meet (>60%) ÿ2/Medium (30–60%) ÿ3/Rarely (10 – 29%) ÿ4/Open (0–9%)		
F2-16 Structure vertical upright		ÿ1/One canopy layer of the same height ÿ2/One canopy layer of different height ÿ3/Multi-layer header is clearly visible ÿ4/Vertical structure is diverse and gapped ÿ5/The vertical structure is very diverse		

Appendix 1 (continued)

F2-17 Fire	forest/land	ý1/No fire occurred ý2/A fire recently occurred ý3/There has been a fire for a long time
F2-18 Types of forest disturbances		ý1/None ý2/Road construction ý3/Logging ý4/Moving cultivation ý5/Pests and diseases ý6/Others:
F2-19 Plot condition	photo:	ý1/North, Photo number: ý2/ East, Photo number: ý3/South, Photo number: ý4/West, Photo number:

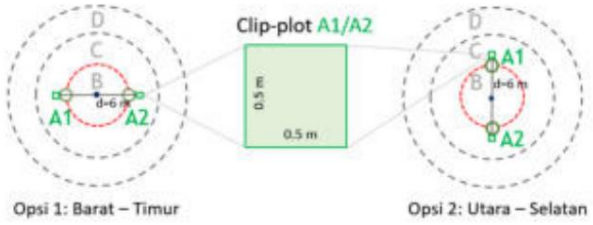
Appendix 1 (continued)

Form 3: Regeneration

General Plot Information					
Number cluster	...				
Plot number	y1	y2	y3		
Position of subplot A	y1/West – East y2/North – South		Subplot A1/A2 Opsi 1: Barat – Timur Opsi 2: Utara – Selatan		
Was regeneration found? y No y Yes (fill in the table below)					
Regeneration observation (DBH <5 cm, height y10 cm): Subplots A1 and A2					
Subplot	Species code	Name (Latin/local) of species	Number of stems		
Notes:					

Appendix 1 (continued)

Form 4: Lower Plants

General Information Sample Plot			
Cluster number ...			
Plot number	ŷ1	ŷ2	ŷ3
Subplot position A ŷ1/	West – East		
Are undergrowth found? ŷ No ŷ Yes (fill in the table below)			
Understory weighing: <i>clip-plots</i> A1 and A2			
TBB (grams)	BBS (grams)	Sample number	BKS (grams)
Notes:			

Description: 1)

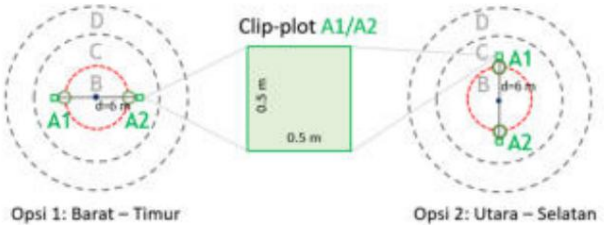
TBB = Total Wet Weight, BBS = Wet Weight of Sample, BKS = Dry Weight of Sample. TBB and BBS are measured directly in the field (after deducting the weight of the bag/container), while BKS is obtained from the results of laboratory analysis.

2) The understory plant sample number begins with the letters TB followed by the cluster and plot number, for example: TB-K7-P1, meaning the understory plant sample is in Cluster 7 and Plot P.

3) Sampling for laboratory analysis is only carried out on certain pre-defined clusters.

Appendix 1 (continued)

Form 5: Litter

General Information Sample Plot			
Cluster number ...			
Plot number	ŷ1	ŷ2	ŷ3
Subplot position A ŷ1/	West – East	 Opsi 1: Barat – Timur Opsi 2: Utara – Selatan	
	ŷ2/North – South		
Was litter found? ŷ No ŷ Yes (fill in the table below)			
Litter weighing: <i>clip-plots</i> A1 and A2			
TBB (grams)	BBS (grams)	Sample number	BKS (grams)
Notes:			

Description: 1)

TBB = Total Wet Weight, BBS = Wet Weight of Sample, BKS = Dry Weight of Sample. TBB and BBS are measured directly in the field (after deducting the weight of the bag/container), while BKS is obtained from the results of laboratory analysis.

2) The litter sample number begins with the letters SR followed by the cluster and plot number, for example: SR-K7-P1, meaning the understory plant sample is in Cluster 7 and Plot P.

3) Sampling for laboratory analysis is only carried out on certain pre-defined clusters.

Appendix 1 (continued)

Form 6: Soil Carbon

General Information Sample Plot			
Cluster number ...			
Plot number	ŷ1	ŷ2	ŷ3
Soil type	ŷ Mineral ŷ Peat ŷ Mangrove		
Depth (peat only)	 cm		

[illegible]

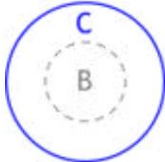
Appendix 1 (continued)

Form 7: Dead Wood

General Information Sample Plot			
Cluster number ...			
Plot number	ŷ1	ŷ2	ŷ3

[illegible]

Notes:	Measurement location:

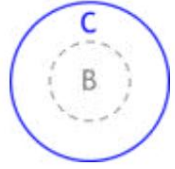
Information:	Measurement location:
Plant groups: [1] Rattan, [2] Liana Category: [1] Young (length <3 m), [2] Adult (length ≥3 m) The number of stems is only counted for clumped rattan/liana Diameter (cm) and length (m) are only measured on adult rattan/liana. Commerciality: [1] Yes, [2] No, [3] Don't know	

Appendix 1 (continued)

Form 9: Bamboo

General Information Sample Plot		
Cluster number ...		
Plot number ý1	ý2	ý3

Was bamboo found?							
ý No ý Yes (fill in the table below)							
Category	Code Sp.	Species	Class age	Amount stem	Height Diameter		Commerciality

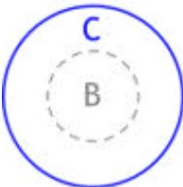
Information:	Measurement location:
Category: [1] Solitary, [2] Clumping Age classes: [1] Young, [2] Medium, [3] Old; only observed in solitary bamboos Number of stems: counted in each bamboo clump Diameter (cm) and height (m): for solitary bamboo, the average is taken for each stem, while for clumped bamboo, the average is taken. Commerciality: [1] Yes, [2] No, [3] Don't know	

Appendix 1 (continued)

Form 10: Palm

General Information Sample Plot			
Cluster number ...			
Plot number	$\hat{y}_1$	$\hat{y}_2$	$\hat{y}_3$

[illegible]

Information:	Measurement location:
Palm type: 1) Tall and thin (like a betel nut) 2) Short fat (such as young oil palm, nipah) 3) Medium high (such as coconut, sago, etc.)	

Appendix 1 (continued)

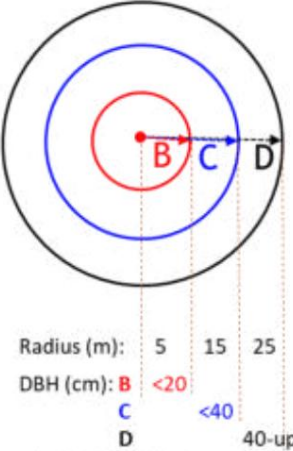
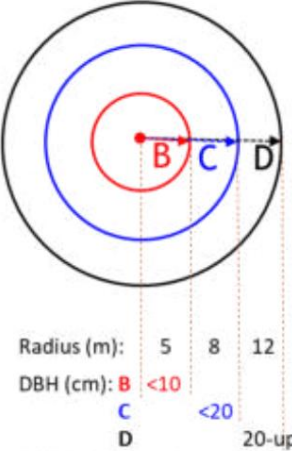
Form 11: Trees (Living and Dead)

General Information Sample Plot			
Cluster number ...			
Plot number	ŷ1	ŷ2	ŷ3

[illegible]

[illegible]

DBH	No.	Tall DBH	Azimuth	Distance	Code Sp.	Species (local/latin)	Status	Wood quality	BJ Class	T-pt	T-total		Photo/ her-barium number	Notes

Information:	Measurement location: Subplot B, C, D
DBH Height: Height (m) DBH measurement if not done at 1.3 m, for example buttressed trees Status: 1/Alive, 2/Dead with many branches without leaves, 3/Dead with large branches without twigs and leaves, 4/Dead with almost no branches-twigs-leaves, 5/Dead in the form of a stump with a certain height. Tree height (T-pt, T-total): Measured on 6 sample trees representing small, medium and large diameter classes. If the number of trees in the plot is less than 6 trees, then measure the height of all the trees in the plot. For other trees whose height is not measured, the value is given 0 (zero) or left blank. Photo/herbarium no.: Only for trees whose species name is not yet known	Kaidah Pengukuran DBH Hutan Lahan Kering, Rawa, Tanaman (HLKRT) & TOF  Radius (m): 5 15 25 DBH (cm): B <20 C <40 D 40-up *) DBH minimum: 5 cm Hutan Mangrove (HM)  Radius (m): 5 8 12 DBH (cm): B <10 C <20 D 20-up *) DBH minimum: 5 cm

Appendix 1 (continued)

Form 12: Survey Team List

No.	Name	Position *)	Mobile Phone	Email	

*) Fill in with the options: Chairman, member, or local staff

Appendix 2. Field Measurement Techniques

A. Slope Measurement

Slope measurements are made parallel to the field slope using an angle measuring instrument, such as a *Suunto clinometer*, *compass*, or *Vertex*. In forestry, slopes are more commonly expressed in percent (%) rather than degrees (°). Percent slope is the ratio of the field rise to the flat distance. For example, a slope of 10% indicates that the field elevation changes by 10 m for every 100 m of flat distance (Figure 19a). The slope can exceed 100% (equivalent to >45°) if the incline is steep (Figure 19b).

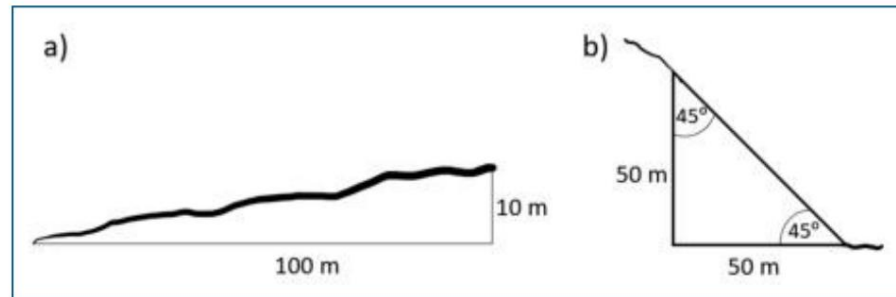


Figure 19. Illustration of slope gradient (a) 10% and (b) 100%

Slope measurement can be carried out by two team members who are relatively the same height with the following procedure (adapted from DeYoung, 2023): 1)

Determine the 0% slope point

which is parallel to the height of the measuring eye on a part of the coworker's body, for example the nose in Figure 20a.

Alternatively, both gauges use a stick that is the same height as the gauge's eye level.

- 2) Ask a coworker to walk up or down to a specific measurement point in the field (e.g. plot boundary).
- 3) Aim from the measuring tool to the 0% slope point on the coworker (Figure 20b). When aiming, use both eyes, where one eye is used to see the 0% slope point on the coworker and the other eye is used to read the scale on the measuring tool.
- 4) Record the results of the slope measurement on the field form in percentage (%) and/or use the slope value to determine the flat distance (for example when determining the subplot radius).

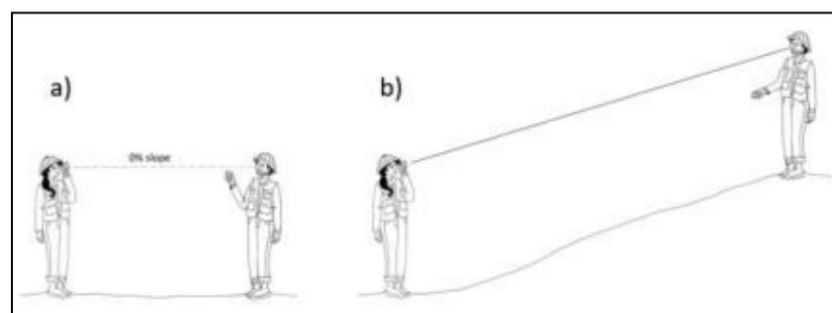


Figure 20. How to determine (a) the 0% slope point on the nose of a colleague and its use when (b) measuring the slope by two members of the survey team (source: DeYoung, 2016)

B. Slope Correction for Plot Distance and Radius

All distances *used* in field measurements are horizontal distances, for example the distance between plots or the distance from the center of a plot to each tree in the plot. If the land is flat, then distance measurements can be carried out directly because the distance measured is already a horizontal distance. However, if the land is not flat, then the field distance can be used which is calculated based on the horizontal distance and the slope as presented in Figure 21. For example, if the survey team wants a horizontal distance of 20 m on land with a slope of 20%, then the field distance measured on the land is 20.40 m. Table 4 presents the values of the field distance based on the desired horizontal distance (2, 5, 8, 12, 15, 25, and 50 m) at various slope values. If the desired horizontal distance is not available in Table 4, then the field distance at a certain slope can be calculated by multiplying the values in the 'Factor (f)' column by the desired horizontal distance. For example, on a slope of 40% and the desired level distance is 30 m, the field distance is: $1.077 \times 30 = 32.31$ m.

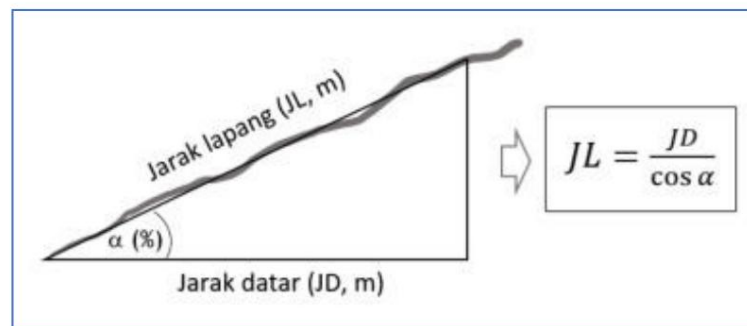


Figure 21. Slope correction for distance measurement

To create a circular plot on uneven land, the plot radius must also be corrected because the circular surface will become an elliptical surface *on* land with a certain slope. Therefore, the elliptical surface must be transformed so that its area matches the circular surface (Figure 22). This correction needs to be done if the plot radius measurement is done manually or does not use a modern measuring instrument that already considers the slope (eg *Vertex*). Table 5 presents the plot radius correction values at various desired slope angles and plot radii.

For example, if the survey team will make a plot with a radius of 15 m on land with a slope of 30%, then in the field the survey team must make a plot with a radius of 15.33 m.

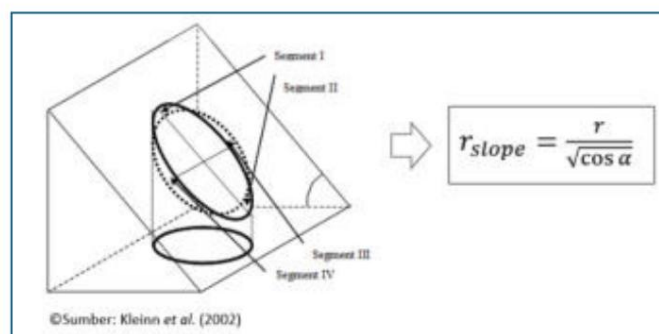


Figure 22. Correction of plot radius on slope

Table 4. Slope correction for distance measurement

Slope a(%) a) (f)	Factor	Distance					
		2	5	8	15	25	50
	2.00 5.00 8.00 12.00 15.00 25.00 50.00 1.1 1.000 2.00 5.00 8.00 12.00						
1 2	15.00 25.00 50.01						
3	1.7 1.000 2.00 5.00 8.00 12.01 15.01 25.01 50.02						
4	2.3 1.001 2.00 5.00 8.01 12.01 15.01 25.02 50.04						
5	2.9 1.001 2.00 5.01 8.01 12.01 15.02 25.03 50.06						
6	3.4 1.002 2.00 5.01 8.01 12.02 15.03 25.04 50.09 4.0 1.002 2.00 5.01						
7	8.02 12.03 15.04 25.06 50.12 4.6 1.003 2.01 5.02 8.03 12.04 15.05						
8	25.08 50.16 5.1 1.004 2.01 5.02 8.03 12.05 15.06 25.10 50.20						
9							
10	5.7 1.005 2.01 5.02 8.04 12.06 15.07 25.12 50.25						
11	6.3 1.006 2.01 5.03 8.05 12.07 15.09 25.15 50.30						
12	6.8 1.007 2.01 5.04 8.06 12.09 15.11 25.18 50.36						
13	7.4 1.008 2.02 5.04 8.07 12.10 15.13 25.21 50.42 14 8.0 1.010 2.02 5.05 8.08						
12.12	15.15 25.24 50.49 15 8.5 1.011 2.02 5.06 8.09 12.13 15.17 25.28 50.56						
16	9.1 1.013 2.03 5.06 8.10 12.15 15.19 25.32 50.64						
17	9.6 1.014 2.03 5.07 8.11 12.17 15.22 25.36 50.72						
18	10.2 1.016 2.03 5.08 8.13 12.19 15.24 25.40 50.80						
19	10.8 1.018 2.04 5.09 8.14 12.21 15.27 25.45 50.89						
20	11.3 1.020 2.04 5.10 8.16 12.24 15.30 25.50 50.99 21 11.9 1.022 2.04 5.11						
8.17	12.26 15.33 25.55 51.09 22 12.4 1.024 2.05 5.12 8.19 12.29 15.36 25.60						
51.20	23 13.0 1.026 2.05 5.13 8.21 12.31 15.39 25.65 51.31						
24	13.5 1.028 2.06 5.14 8.23 12.34 15.43 25.71 51.42						
25	14.0 1.031 2.06 5.15 8.25 12.37 15.46 25.77 51.54						
26	14.6 1.033 2.07 5.17 8.27 12.40 15.50 25.83 51.66						
27	15.1 1.036 2.07 5.18 8.29 12.43 15.54 25.90 51.79 28 15.6 1.038 2.08 5.19						
8.31	12.46 15.58 25.96 51.92 29 16.2 1.041 2.08 5.21 8.33 12.49 15.62 26.03						
52.06	30 16.7 1.044 2.09 5.22 8.35 12.53 15.66 26.10 52.20						
31	17.2 1.047 2.09 5.23 8.38 12.56 15.70 26.17 52.35						
32	17.7 1.050 2.10 5.25 8.40 12.60 15.75 26.25 52.50						
33	18.3 1.053 2.11 5.27 8.42 12.64 15.80 26.33 52.65						
34	18.8 1.056 2.11 5.28 8.45 12.67 15.84 26.41 52.81 35 19.3 1.059 2.12 5.30						
8.48	12.71 15.89 26.49 52.97 36 19.8 1.063 2.13 5.31 8.50 12.75 15.94 26.57						
53.14	37 20.3 1.066 2.13 5.33 8.53 12.80 15.99 26.66 53.31						
38	20.8 1.070 2.14 5.35 8.56 12.84 16.05 26.74 53.49						
39	21.3 1.073 2.15 5.37 8.59 12.88 16.10 26.83 53.67						
40	21.8 1.077 2.15 5.39 8.62 12.92 16.16 26.93 53.85						
41	22.3 1.081 2.16 5.40 8.65 12.97 16.21 27.02 54.04 42 22.8 1.085 2.17 5.42						
8.68	13.02 16.27 27.12 54.23 43 23.3 1.089 2.18 5.44 8.71 13.06 16.33 27.21						
54.43	44 23.7 1.093 2.19 5.46 8.74 13.11 16.39 27.31 54.63						
45	24.2 1.097 2.19 5.48 8.77 13.16 16.45 27.41 54.83						
46	24.7 1.101 2.20 5.50 8.81 13.21 16.51 27.52 55.04						
47	25.2 1.105 2.21 5.52 8.84 13.26 16.57 27.62 55.25						
48	25.6 1.109 2.22 5.55 8.87 13.31 16.64 27.73 55.46 49 26.1 1.114 2.23 5.57						
8.91	13.36 16.70 27.84 55.68 50 26.6 1.118 2.24 5.59 8.94 13.42 16.77 27.95						
55.90	51 27.0 1.123 2.25 5.61 8.98 13.47 16.84 28.06 56.13						
52	27.5 1.127 2.25 5.64 9.02 13.53 16.91 28.18 56.36						
53	27.9 1.132 2.26 5.66 9.05 13.58 16.98 28.29 56.59						
54	28.4 1.136 2.27 5.68 9.09 13.64 17.05 28.41 56.82						
55	28.8 1.141 2.28 5.71 9.13 13.70 17.12 28.53 57.06 56 29.2 1.146 2.29 5.73						
9.17	13.75 17.19 28.65 57.31 57 29.7 1.151 2.30 5.76 9.21 13.81 17.27 28.78						
57.55	58 30.1 1.156 2.31 5.78 9.25 13.87 17.34 28.90 57.80						
59	30.5 1.161 2.32 5.81 9.29 13.93 17.42 29.03 58.05						
60	31.0 1.166 2.33 5.83 9.33 13.99 17.49 29.15 58.31						
61	31.4 1.171 2.34 5.86 9.37 14.06 17.57 29.28 58.57						
62	31.8 1.177 2.35 5.88 9.41 14.12 17.65 29.42 58.83						
63	32.2 1.182 2.36 5.91 9.46 14.18 17.73 29.55 59.10 64 32.6 1.187 2.37 5.94						
9.50	14.25 17.81 29.68 59.36 65 33.0 1.193 2.39 5.96 9.54 14.31 17.89 29.82						
59.63							
Slope a(%) a)	Factor	Distance (m)					
(f) 66 33.4 1.198 2.40		2	5	8	12	15	25 50
	5.99 9.59 14.38 17.97 29.95 59.91						
67	33.8 1.204 2.41 6.02 9.63 14.44 18.06 30.09 60.19						
68	34.2 1.209 2.42 6.05 9.67 14.51 18.14 30.23 60.46						
69	34.6 1.215 2.43 6.07 9.72 14.58 18.22 30.37 60.75						
70	35.0 1.221 2.44 6.10 9.77 14.65 18.31 30.52 61.03						
71	35.4 1.226 2.45 6.13 9.81 14.72 18.40 30.66 61.32						
72	35.8 1.232 2.46 6.16 9.86 14.79 18.48 30.81 61.61						
73	36.1 1.238 2.48 6.19 9.90 14.86 18.57 30.95 61.91						
74	36.5 1.244 2.49 6.22 9.95 14.93 18.66 31.10 62.20						
75	36.9 1.250 2.50 6.25 10.00 15.00 18.75 31.25 62.50						
76	37.2 1.256 2.51 6.28 10.05 15.07 18.84 31.40 62.80						
77	37.6 1.262 2.52 6.31 10.10 15.15 18.93 31.55 63.11						
78	38.0 1.268 2.54 6.34 10.15 15.22 19.02 31.71 63.41						
79	38.3 1.274 2.55 6.37 10.20 15.29 19.12 31.86 63.72						
80	38.7 1.281 2.56 6.40 10.24 15.37 19.21 32.02 64.03						
81	39.0 1.287 2.57 6.43 10.30 15.44 19.30 32.17 64.34						
82	39.4 1.293 2.59 6.47 10.35 15.52 19.40 32.33 64.66						
83	39.7 1.300 2.60 6.50 10.40 15.59 19.49 32.49 64.98						
84	40.0 1.306 2.61 6.53 10.45 15.67 19.59 32.65 65.30						
85	40.4 1.312 2.62 6.56 10.50 15.75 19.69 32.81 65.62						
86	40.7 1.319 2.64 6.59 10.55 15.83 19.78 32.97 65.95						
87	41.0 1.325 2.65 6.63 10.60 15.91 19.88 33.14 66.27						
88	41.3 1.332 2.66 6.66 10.66 15.98 19.98 33.30 66.60						
89	41.7 1.339 2.68 6.69 10.71 16.06 20.08 33.47 66.93						
90	42.0 1.345 2.69 6.73 10.76 16.14 20.18 33.63 67.27						
91	42.3 1.352 2.70 6.76 10.82 16.22 20.28 33.80 67.60						
92	42.6 1.359 2.72 6.79 10.87 16.31 20.38 33.97 67.94						
93	42.9 1.366 2.73 6.83 10.92 16.39 20.48 34.14 68.28						
94	43.2 1.372 2.74 6.86 10.98 16.47 20.59 34.31 68.62						
95	43.5 1.379 2.76 6.90 11.03 16.55 20.69 34.48 68.97						
96	43.8 1.386 2.77 6.93 11.09 16.63 20.79 34.66 69.31						
97	44.1 1.393 2.79 6.97 11.15 16.72 20.90 34.83 69.66						
98	44.4 1.400 2.80 7.00 11.20 16.80 21.00 35.00 70.01						
99	44.7 1.407 2.81 7.04 11.26 16.89 21.11 35.18 70.36						
100	45.0 1.414 2.83 7.07 11.31 16.97 21.21 35.36 70.71						
101	45.3 1.421 2.84 7.11 11.37 17.06 21.32 35.53 71.07						
102	45.6 1.428 2.86 7.14 11.43 17.14 21.43 35.71 71.42						
103	45.8 1.436 2.87 7.18 11.48 17.23 21.53 35.89 71.78						
104	46.1 1.443 2.89 7.21 11.54 17.31 21.64 36.07 72.14						
105	46.4 1.450 2.90 7.25 11.60 17.40 21.75 36.25 72.50						
106	46.7 1.457 2.91 7.29 11.66 17.49 21.86 36.43 72.86						
107	46.9 1.465 2.93 7.32 11.72 17.57 21.97 36.61 73.23						
108	47.2 1.472 2.94 7.36 11.77 17.66 22.08 36.80 73.59						
109	47.5 1.479 2.96 7.40 11.83 17.75 22.19 36.98 73.96						
110	47.7 1.487 2.97 7.43 11.89 17.84 22.30 37.17 74.33						
111	48.0 1.494 2.99 7.47 11.95 17.93 22.41 37.35 74.70						
112	48.2 1.501 3.00 7.51 12.01 18.02 22.52 37.54 75.07						
113	48.5 1.509 3.02 7.54 12.07 18.11 22.63 37.72 75.45						
114	48.7 1.516 3.03 7.58 12.13 18.20 22.75 37.91 75.82						
115	49.0 1.524 3.05 7.62 12.19 18.29 22.86 38.10 76.20						
116	49.2 1.532 3.06 7.66 12.25 18.38 22.97 38.29 76.58						
117	49.5 1.539 3.08 7.70 12.31 18.47 23.09 38.48 76.96						
118	49.7 1.547 3.09 7.73 12.37 18.56 23.20 38.67 77.34						
119	50.0 1.554 3.11 7.77 12.44 18.65 23.32 38.86 77.72						
120	50.2 1.562 3.12 7.81 12.50 18.74 23.43 39.05 78.10						
121	50.4 1.570 3.14 7.85 12.56 18.84 23.55 39.24 78.49						
122	50.7 1.577 3.15 7.89 12.62 18.93 23.66 39.44 78.87						
123	50.9 1.585 3.17 7.93 12.68 19.02 23.78 39.63 79.26						
124	51.1 1.593 3.19 7.96 12.74 19.12 23.89 39.82 79.65						
125	51.3 1.601 3.20 8.00 12.81 19.21 24.01 40.02 80.04						
126	51.6 1.609 3.22 8.04 12.87 19.30 24.13 40.22 80.43						
127	51.8 1.616 3.23 8.08 12.93 19.40 24.25 40.41 80.82						
128	52.0 1.624 3.25 8.12 12.99 19.49 24.36 40.61 81.22						
129	52.2 1.632 3.26 8.16 13.06 19.59 24.48 40.81 81.61						
130	52.4 1.640 3.28 8.20 13.12 19.68 24.60 41.00 82.01						

Table 5. Slope correction for plot radius measurements

Slope a(%)													Factor													Plot radius (m) 8																																																																									
a\()													2													5													12 15 25																																																												
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66																																		

C. Measuring Tree Diameter and Height

In general, tree diameter measurements are carried out at a height of 1.3 m above ground level. However, the tree diameter measurement point may vary according to the condition of the tree in the field as illustrated in Figure 16 (see Chapter 5). For consistency of measurement results, the survey team is advised to use only *phi-band* (not circumference tape) because the use of different measuring instruments can cause errors in reading the measurement scale. In addition, the survey team is advised to use a 1.3 m measuring stick (Figure 23a) when measuring tree diameter. For stumps, the diameter can be measured in both perpendicular directions (i.e. the longest and shortest diameters) and then the average value is taken (Figure 23b).

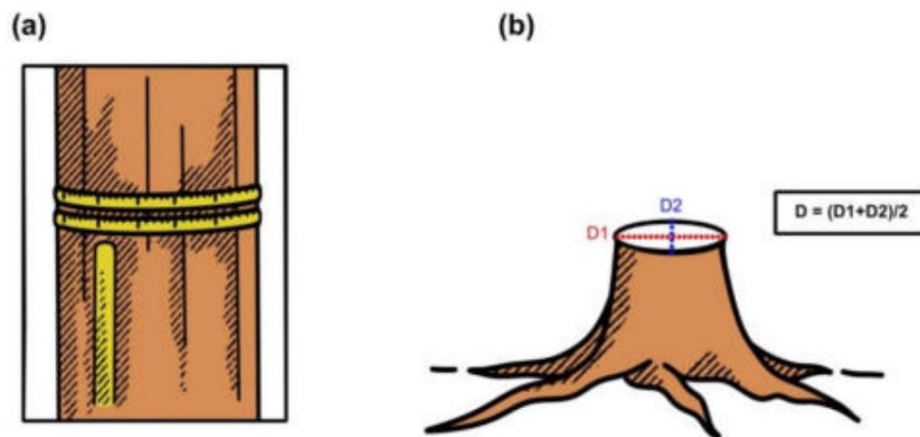


Figure 23. Measurement of (a) tree diameter using a 1.3 m measuring stick and (b) measurement of stump diameter.

To avoid errors in measuring diameter, the survey team needs to... pay attention to the following:

- 1) *Phi-band* is wrapped around the tree trunk in a horizontal or perpendicular position. rod axis.
- 2) *Phi-band* is wrapped around the tree trunk in an unfolded or unwrapped condition. twist.
- 3) The *Phi-band* used does not stretch the ribbon.
- 4) Clean the part of the stem to be measured if it is entangled in vines or obstructed by other things so that the measurement results are not *overestimated*.

Unlike diameter, tree height is quite difficult to measure in the field. It is recommended to use electronic height measuring instruments, such as *Vertex* or *laser hypsometer*, to measure tree height more accurately and efficiently (because it does not require a flat distance measurement first). In sloping trees, the height is not measured along the length of the trunk, but rather measured at the vertical distance between the crown peak (for total height) and its projection point on the ground surface (Figure 24a). Tree height is calculated based on trigonometric principles from the reading of the instrument scale to the top (A) and to the base (B) of the tree (Figure 24b). For example, if scale A shows 25 and B shows -2, then the tree height is 23 m.

The height of the tree will automatically appear on the electronic height measuring device screen.

To avoid errors in height measurement, the survey team needs to pay attention to the following: 1) If the land is not flat or rather steep, measure the height from a position perpendicular to the direction of the slope or from a position higher than the base of the tree. With such a position, the measurer can clearly see the top of the tree. Conversely, if the measuring position is much lower than the base of the tree, the measurer cannot see the top of the tree clearly, which can cause measurement errors.

- 2) For trees with dense/thick crowns, first observe the top of the tree from a close distance to avoid measurement errors because from a distance the top of the tree is not clearly visible due to being blocked by the thick crown.
- 3) For leaning trees, measure the height perpendicular to the slope of the tree (Figure 24a).
- 4) If the height measurement uses *Vertex*, place the *transponder* on the tree trunk at a height of 1.3 m above ground level. Also perform periodic calibration of the *Vertex* because its sensitivity is affected by temperature and humidity.

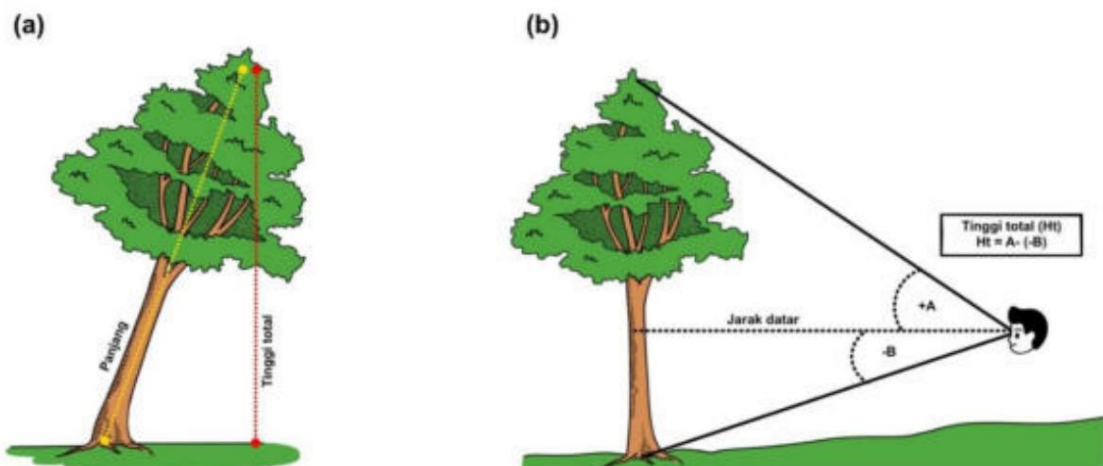


Figure 24. Differences in tree length and height (a) and trigonometric principles in determining tree height (b) (adapted from Rusolono et al. (2015))

Appendix 3. Making Herbarium in the Field

Herbarium is a preserved plant specimen for scientific research purposes. Herbarium specimens can use part or all of the dried plant parts and placed on a paper base or stored in a closed container filled with alcohol or formalin solution for wet herbarium. The method of making herbarium specimens for forestry tree species usually uses herbariums placed on paper using two methods, namely dry and wet herbariums. Dry herbariums require bamboo racks as clamps to ensure that the specimen remains flat. While dry herbariums require alcohol solution for specimen preservation. In forest inventory activities, herbariums are used to store specimens whose types are unknown, both local and Latin names. Furthermore, the herbarium specimens are sent to the laboratory to identify their Latin names. Wet herbariums are often used in forest inventory activities, because of the ease of managing specimens.

The tools and materials used to make a wet herbarium are: 1. A machete, knife or pruning shears to cut the branches from the plant.

tree

2. Alcohol solution with a concentration of 70% or formalin with a concentration of 0.04%.

3. Acid-free stiff paper such as newspaper, baking paper, flip chart paper 4. Paper tape to stick

the specimen on the paper 5. Labels to mark the specimen, can use cardboard

and string 6. Pencil to write the label code

7. String to tie the entire specimen, you can use a string similar to that used for labels.

8. Large plastic to store airtight herbarium 9. Insulating tape to close the plastic to make it airtight

The first step to be taken is to identify the target tree. The tree that will be taken as a specimen is the tree whose Latin name you want to know, you can choose a tree that is easy to climb or has shorter branches and twigs.

Next, pick the whole twigs including the main twigs and leaf veins. If there are flowers or fruits, they should also be taken. Store them in a safe place, to be taken to the tent or lodging location, where the herbarium will be made. Collect several other types of specimens at once. Arriving at the tent or lodging, the herbarium specimens must be processed immediately.

Prepare the materials. Place the plant specimen on a sheet of newspaper. Use tape to attach the specimen to the newspaper. Label it with the specimen identification code, which is tied to the branch. Record in a notebook, the specimen identification code as stated on the label, local name, place name, altitude, and type of ecosystem where the specimen was collected.

Cover the specimen with folded newspaper so that it is completely covered by newspaper. Do the same for the other specimens. Stack the specimens one by one until there are about 10-15 pieces of herbarium paper, then tie them with string. Next, the herbarium pile is put into a large plastic bag. Then pour alcohol evenly over all parts.

stack of herbarium in a plastic bag. Then tie and close the plastic tightly using tape. The herbarium is ready to be taken to the office in the provincial city or the nearest city to be sent to the laboratory to be identified by its Latin name. A list of institutions in each region in Indonesia that have laboratories or *taxonomists* for herbarium identification is available in the list below.

Appendix 4. List of Tree Species Identification Institutions/Laboratories

(update September 2023)

JAVA

1. Herbarium Bogoriense (BO), BRIN

Address: Jl. LIPI, Cibinong, District. Cibinong, Bogor Regency, West Java 16911

Contact Botanist or Taxonomist: Asih Perwita Dewi (+62 896-9416-2984),
Hariri (+62 856-2289-592), Seny Kurnia +1 (604) 783 – 9376

2. Forest Ecology Lab, Faculty of Forestry and Environment, Bogor Agricultural University, Bogor

Address: IPB Campus, Jl. Raya Dramaga, Babakan, Dramaga District, Bogor Regency,
West Java 16680 Contact Botanist/Taxonomy:
Zakaria Anshori (+62 812-1814-6117)

3. Bandungense Herbarium SITH ITB, Jatinangor Campus

Address: Jalan Let. Gen. Ret. Dr. (HC). Mashudi N0.1/ Jl.
Jatinangor Highway Km 20.75. Sumedang, West Java – Indonesia.
Contact Botanist/Taxonomy: Arifin Surya Dwipa Irsyam (+62 821-
1716-4085)

4. Plant Taxonomy Lab, Faculty of Biology, Padjajaran

University, Bandung Address:
Jl.
Jatinangor, Sumedang Regency, West Java 45363 Contact Botanist/
Taxonomy: Budi Irawan (+62 815-7190-043)

KALIMANTAN 1.

**Dendrology and Wildlife Lab, Faculty of Forestry, University of
Mulawarman, East Kalimantan**

Address: Jl. Kuaro, Gn. Kelua, Samarinda Ulu District, Samarinda City, East Kalimantan
75119 Contact Botanist /
Taxonomy's: Prof Paulus Matius and Team (+62 813-
4917-8548, Sarah Agustiorini (+62 812 555 67264), Medi Hendra (+62 813-4787-2504)

**2. Plant Taxonomy and Ecology Lab, Faculty of Mathematics and Natural Sciences,
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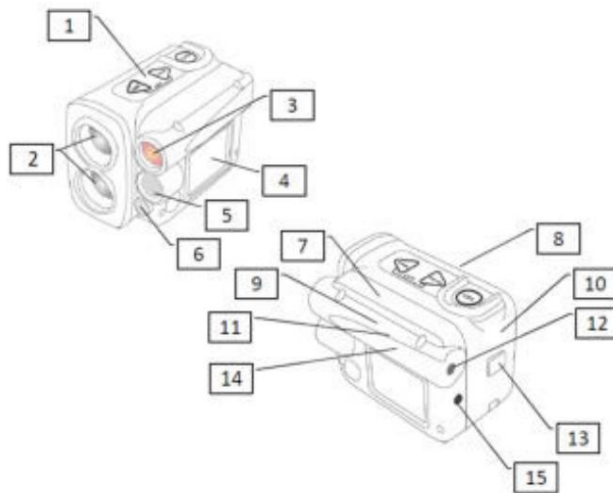
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Appendix 5. Instructions for Using Vertex Laser Geo for Measurements Measure Tree Distance and Height



Tool components:

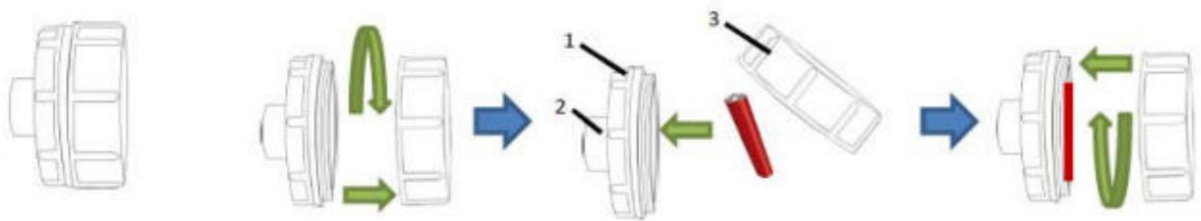


1. Buttons
2. Laser optics
3. Lens for Vision display
4. LCD screen
5. Ultrasonic receiver
(VERTEX LASER GEO)
6. Ultrasonic temperature sensor
(VERTEX LASER GEO)
7. Bluetooth Transmitter
8. Rechargeable Li-Ion
battery
9. GPS Receiver
10. SSD drive
11. Tilt sensor
12. Vision
Display
13. USB connection and
charging as well as
protective cover
14. Compass Sensor
15. IR (*Infra Red*) Transmitter

T3 Transponder •

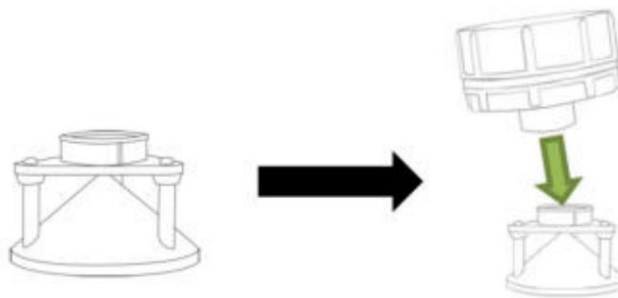
This transponder is equipped with an ultrasonic transmitter and receiver that communicate with the measuring instrument. • The T3 transponder is equipped with a beep signal, which indicates the status ON or OFF.

- T3 does not have a switch and VERTEX LASER GEO instrument on is basically used as a remote control to turn on and off. When turned on, the Transponder remains active until turned off or after approximately 20 minutes of inactivity.
 - The Transponder uses one 1.5-volt AA alkaline battery
1. Transponder housing 2. Ultrasonic transmitter-receiver 3. Battery cover



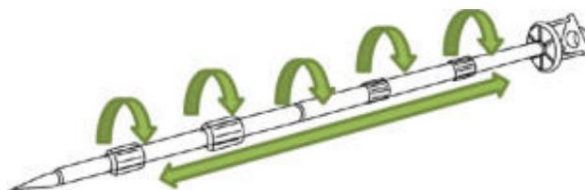
360 Adapter/Spreader •

The adapter allows the ultrasonic signal to spread in a circle. full 360 degrees for circular sample plot work.

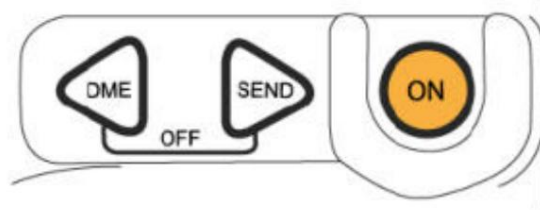


Monopod

- Monopod is useful for taking 360 degree measurements with using ultrasound.



Using Buttons on Vertex



ON Button -

Press On to activate Vertex - When you are using the laser function to measure distance, the ON button can be kept pressed to activate the scanning function. The laser will scan continuously until the target is acquired or the button is released.

Arrow Keys

- Use the arrow keys - DME and SEND - to select menus, and to change values and options.

SEND button

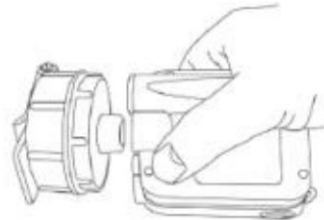
- With the SEND button, data can be sent by IR and Bluetooth to external device or stored in internal memory during measurement.

Disabling Vertex

- Press the DME and SEND buttons simultaneously to deactivate vertex.

Connecting Vertex and Transponder 1. Connect Vertex with Transponder:

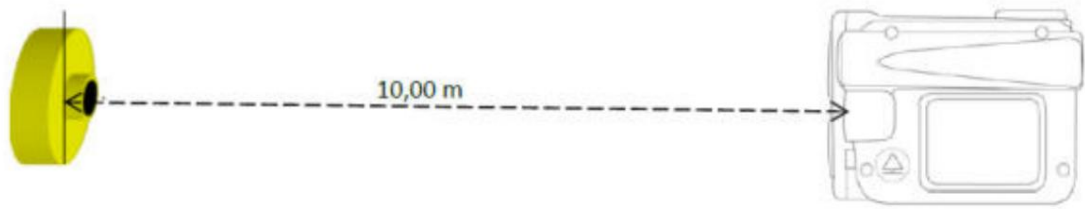
- Bring the Vertex and Transponder close together as shown in the picture (make sure the Vertex screen is off) b. Press the DME button until you hear a “beep” sound twice.
- Turn off the Vertex connection with the Transponder a. Bring the Vertex and Transponder close together as shown in the picture (make sure the Vertex screen is off) b. Press the DME button until you hear a “beep” sound 4 times



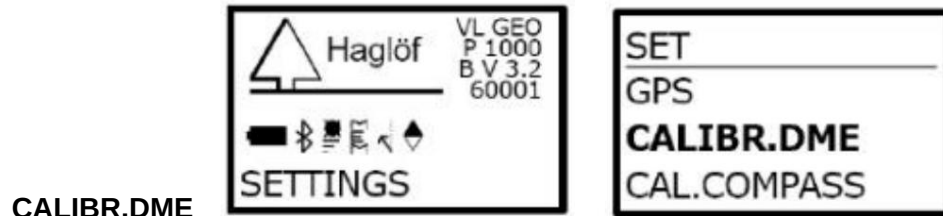
Vertex and Transponder Calibration 1. Connect the Vertex to the Transponder: 2. Place the Vertex and Transponder close together as shown (make sure the Vertex screen is off) a.

- Press the DME button until you hear 2 beeps b. Turn off the Vertex display (DME and SEND)

- Then after that, stretch the Vertex and Transponder as far as 10 meters, as shown in the image below:

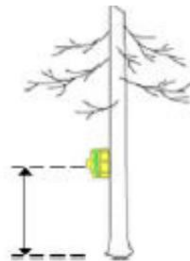


4. Press the ON button, then select **SETTINGS**, then select

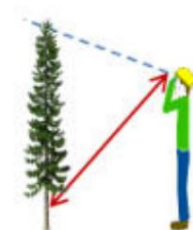
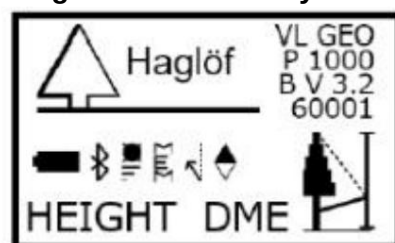


5. Wait until the number 10.00, when the number 10.00 is displayed on the screen. screen, VERTEX LASER GEO USG calibration is complete and ready to use

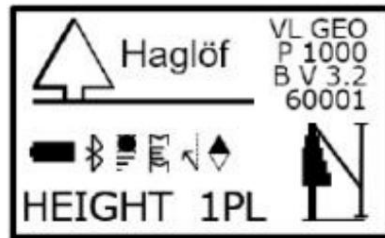
Using Vertex to Measure Distance and Height of Trees 1. Place the transponder on the tree whose distance and height will be measured, Place the transponder at a height of 1.3 meters.



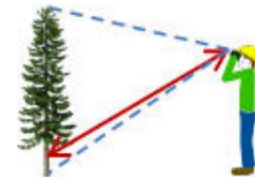
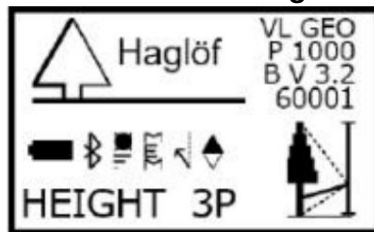
2. Press ON to activate Vertex There are 3 measurement modes in Vertex Laser Geo: a. Height DME – this mode uses ultrasound, this mode can measure the height of the base of the crown and the total height simultaneously.



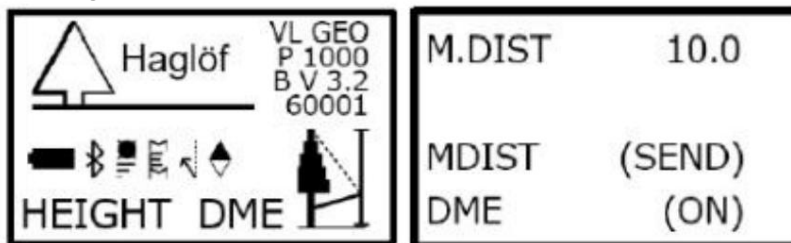
b. Height 1 PL – this mode uses Laser, this mode is recommended for use when the field conditions are flat and can only measure 1 time (cannot measure the height of the base of the crown and the total height simultaneously).



- c. Height 3P – this mode uses laser. Angle – tilt – measured at the base and the highest (top) part of the object.

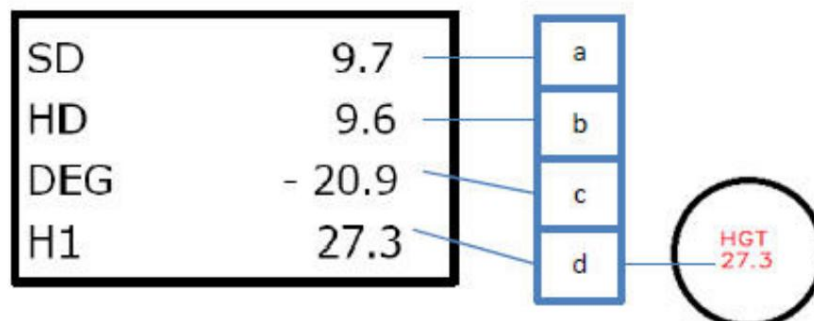


3. Select Height DME mode, then click ON.



4. Then click ON, point the Vertex at the transponder until you hear a “beep” sound once (this indicates that the Vertex and transponder are connected and ready to measure the height of the base of the crown and the total height).

5. The next step is to direct the center point on the observation screen to height of the base of the header and press the ON button until it beeps once and the display shows that “H1” is locked (does not change).

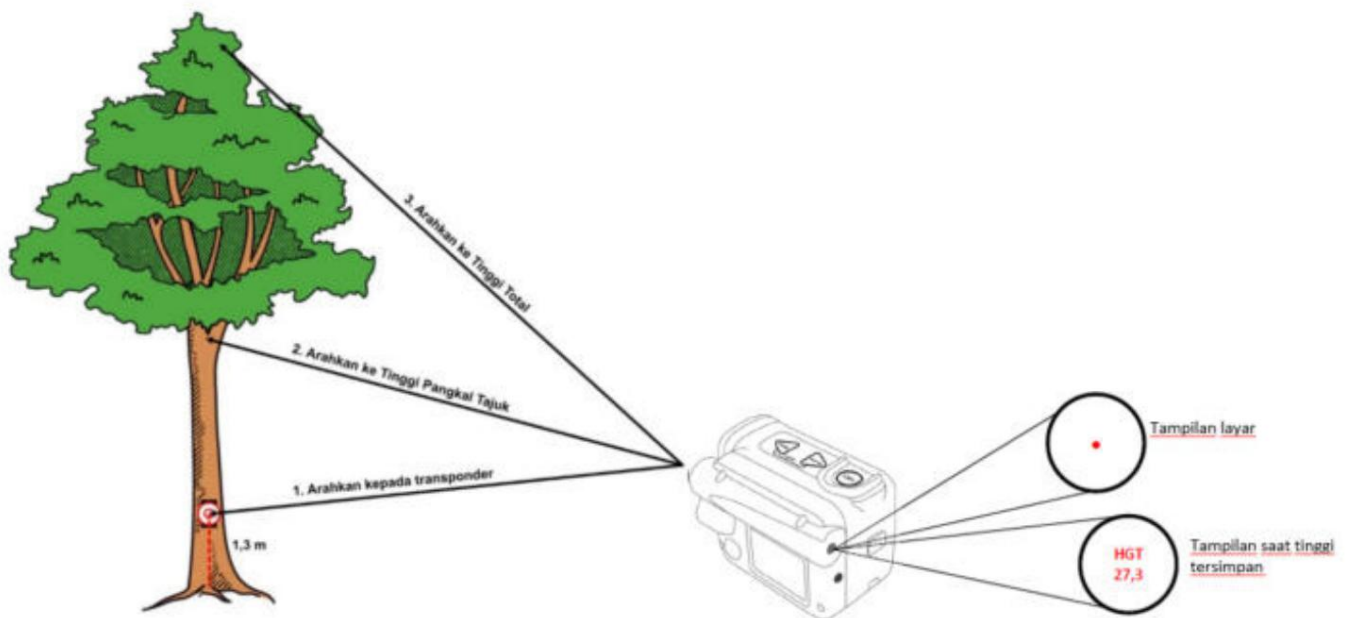


- a. SD – Slope distance (m or feet) b. HD - Horizontal Distance (m or feet) c. DEG - Angle (Degree, % or Grads) d. H1 – Head Height (m or feet)

6. To get the total height (H2), press the ON button 1 time, then point it to the total height point, press the ON button until the Vertex beeps 1 time to save the height data on the Vertex screen.



Illustration of height measurement using Vertex





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