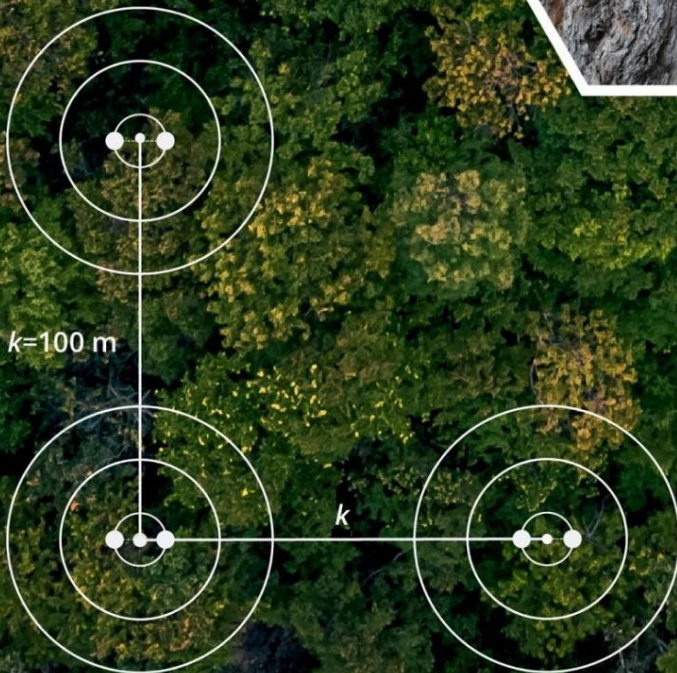




DIREKTORAT JENDERAL
PLANOLOGI KEHUTANAN

KEMENTERIAN KEHUTANAN
REPUBLIK INDONESIA



PETUNJUK
TEKNIS

INVENTARISASI HUTAN NASIONAL 2.0

INVENTARISASI TEGAKAN HUTAN DAN TUMBUHAN NON KAYU
DALAM RANGKA INVENTARISASI HUTAN TINGKAT NASIONAL



MINISTRY OF FORESTRY

DIRECTORATE GENERAL OF FORESTRY PLANOLOGY

DECISION OF THE DIRECTOR GENERAL OF FORESTRY PLANOLOGY

NUMBER 3 OF 2025

ABOUT

TECHNICAL GUIDELINES FOR INVENTORY OF FOREST STANDINGS AND NON-TIMBER PLANTS
IN THE FRAMEWORK OF NATIONAL LEVEL FOREST INVENTORY

BY THE GRACE OF GOD ALMIGHTY

DIRECTOR GENERAL OF FORESTRY PLANOLOGY,

Considering:

- a. that based on Article 19 paragraph (4) of the 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, as well as the Use of Forest Areas, the Implementation of Forest Inventories refers to the Forest Inventory guidelines; b. that the Forest Inventory guidelines as referred to in letter a require further detailing in the form of technical instructions;
- c. that based on the considerations as referred to in letters a and b, it is necessary to stipulate a Decree of the Director General of Forestry Planning concerning Technical Instructions for Inventory of Forest Stands and Non-Timber Plants in the Framework of National Level Forest Inventory;

Remember

- :
1. Law Number 41 of 1999 concerning Forestry (State Gazette of the Republic of Indonesia of 1999 Number 167, Supplement to the State Gazette of the Republic of Indonesia Number 3888), as amended several times, most recently by Law Number 6 of 2023 concerning the Stipulation of Government Regulation in Lieu of Law of the Republic of Indonesia Number 2 of 2022 concerning Job Creation to Become Law (State Gazette of the Republic of Indonesia of 2023 Number 41, Supplement to the State Gazette of the Republic of Indonesia Number 6856);
 2. Government Regulation Number 11 of 2018 concerning Procedures for Organizing Remote Sensing Activities (State Gazette of the Republic of Indonesia 2018 Number 56, Supplement to the State Gazette of the Republic of Indonesia Number 6196);
 3. Government Regulation Number 23 of 2021 concerning Forestry Implementation (State Gazette of the Republic of Indonesia 2021 Number 33, Supplement to the State Gazette of the Republic of Indonesia Number 6635);



4. Government Regulation Number 45 of 2021 concerning Implementation of Geospatial Information (State Gazette Republic of Indonesia 2021 Number 55, Supplement to the State Gazette of the Republic of Indonesia Number 6657);
5. Presidential Regulation Number 175 of 2024 concerning the Ministry of Forestry (State Gazette of the Republic of Indonesia 2024 Number 371);
6. Regulation of the Minister of Environment and Forestry Number 7 of 2021 concerning Forestry Planning, Changes in Designation and Changes in Area Function Forests, and the Use of Forest Areas (State Gazette of the Republic of Indonesia 2021 Number 322);
7. Regulation of the Minister of Environment and Forestry Number 24 of 2021 concerning the Implementation of Thematic Geospatial Information within the Scope of the Ministry of Environment and Forestry (State Gazette Republic of Indonesia 2021 Number 1387);
8. Regulation of the Minister of Environment and Forestry Number 18 of 2022 concerning the Organization and Work Procedures of the Forest Area and Environmental Management Center (State Gazette of the Republic of Indonesia 2022 Number 724);
9. Regulation of the Minister of Forestry 1 of 2024 concerning the Organization and Work Procedures of the Ministry of Forestry (State Gazette of the Republic of Indonesia 2024 Number 1002);
10. Regulation of the Minister of Forestry Number 1 of 2025 concerning the Official Documents of the Ministry of Forestry (State Gazette of the Republic of Indonesia of 2025 Number 84);

DECIDE:

- Set : DECISION OF THE DIRECTOR GENERAL OF FORESTRY PLANOLOGY CONCERNING TECHNICAL GUIDELINES FOR INVENTORY OF FOREST STANDINGS AND NON-TIMBER PLANTS IN THE FRAMEWORK OF NATIONAL LEVEL FOREST INVENTORY.
- FIRST : To establish Technical Instructions for Inventory of Forest Stands and Non-Timber Plants in the Framework of National Forest Inventory, hereinafter referred to as Technical Instructions for National Forest Inventory 2.0 (IHN 2.0), as stated in the Attachment which is an integral part of this Decree.
- SECOND : Technical Instructions for National Forest Inventory 2.0 (IHN 2.0) as referred to in the FIRST dictum contains, among others:
other:
a. Planning Stage includes Sampling Design; Planning; Field Preparation; and
b. The Implementation Stage includes Cluster Development; Field Data Collection; and/or
c. Implementation Reporting.



THIRD : Technical Instructions as referred to in the Dictum
FIRST is a reference for work units within the Ministry of Forestry, Provincial Governments or other agencies/institutions that have competence in the field
Forest Inventory.

FOURTH : With the stipulation of this Decision, then:
1. Activities related to the National Level Forest Inventory that have been or are being carried out before this Decree are declared to still be valid and will continue to be carried out.
comply with the provisions of this Decree; and
2. Technical Instructions for *Temporary Sample Enumeration Plot/ Permanent Sample Plot* (TSP – PSP) 2011 and Technical Instructions for Re-Enumeration of Permanent Sample Plots 2011, are declared invalid.

FIFTH : When these Technical Instructions come into force, their validity may end automatically upon the enactment of amendments to the Regulation of the Minister of Environment and Forestry Number 7 of 2021 concerning Forestry Planning, Changes in Designation and Changes in the Function of Forest Areas and Use of Forest Areas, and shall be subsequently adjusted to the provisions in the Ministerial Regulation in question.

SIXTH : This decision shall come into effect on the date of stipulation.

Established in Jakarta
on March 25, 2025

DIRECTOR GENERAL OF PLANNING
FORESTRY,

Copy true to the original
Head of Program, Evaluation
Law and Technical Cooperation

ALI MA'MUR
NIP. 19750519 200003 1 002

Signed.

ADE TRI AJIKUSUMAH
NIP. 19751026 199603 1 001

A copy of the Decision is submitted to:

1. Minister of Forestry;
2. Deputy Minister of Forestry;
3. Secretary General of the Ministry of Forestry;
4. Inspector General of the Ministry of Forestry;
5. Echelon I within the Ministry of Forestry.





**DIREKTORAT JENDERAL
PLANOLOGI KEHUTANAN**

**KEMENTERIAN KEHUTANAN
REPUBLIK INDONESIA**

Attachment
DECISION OF THE DIRECTOR GENERAL OF FORESTRY PLANOLOGY
NUMBER 3 OF 2025
ABOUT
TECHNICAL GUIDELINES FOR FOREST AND PLANT INVENTORY
NON-TIMBER IN THE FRAMEWORK OF NATIONAL FOREST INVENTORY



LIST OF CONTENTS

TABLE OF CONTENTS	vi
LIST OF TABLES	vii
LIST OF FIGURES	viii
LIST OF APPENDICES	ix
CHAPTER I	1
INTRODUCTION.....	1
1. General.....	1
2. Purpose and Objectives.....	1
3. Scope.....	1
4. Basics.....	2
5. Glossary of Terms and Abbreviations	2
CHAPTER II	5
PROCEDURE.....	5
1. SAMPLING DESIGN.....	5
2. FIELD PLANNING AND PREPARATION.....	9
3. CLUSTER DEVELOPMENT.....	13
4. FIELD DATA COLLECTION.....	16
5. REPORTING ON INVENTORY IMPLEMENTATION.....	51
BIBLIOGRAPHY	53



LIST OF TABLES

Table 1. Composition and duties of forest inventory team members.....	
11 Table 2. Field forms at each stage of the survey team's activities.....	12
Table 3. Summary of observation and measurement activities in each cluster.....	16
Table 4. Slope correction for distance measurement.....	75
Table 5. Slope correction for plot radius measurement.....	76



LIST OF FIGURES

Figure 1. Example of IHN cluster distribution on a hexagonal lattice with a distance of 20 km.....	6
Figure 2a. Design of IHN HLKRT cluster size.....	7
Figure 2b. Design and size of the IHN PDLH/TOF cluster.....	7
Figure 2c. Design of the IHN Mangrove cluster size.....	8
Figure 3. Cluster design (left) and permanent marking at the center of the plot (right)	14
Figure 4. Nameplates at each plot center in an IHN cluster.....	15
Figure 5. Regeneration subplots (A1 and A2) with West–East or North–South on each plot.....	35
Figure 6. Understory plot frames (A1 and A2) with East–West or North–South positions in each plot.....	36
Figure 7. Understory/litter sample labels for laboratory analysis.....	37
Figure 8. Location of transect lines for dead wood measurements using the method <i>Line Intersect Sampling</i>	39
Figure 9. Deadwood measurement requirements using the LIS method.....	40
Figure 10. Rattan measurement requirements in subplot C.....	42
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 section (IPSDH, 2021).....	43
Figure 12. Characteristics of young (a), medium (b), and old (c) bamboo based on the presence lichen on the stem (IPSDH, 2021).....	43
Figure 13. Possible positions of solitary bamboo (S1, S2, S3, S4) and clumped bamboo (R1, R2, ..., R7) in subplot C.....	44
Figure 14. The radius and diameter limit (DBH) of trees measured in subplots B, C, and D in dryland forests, swamps, plants, TOF, and mangroves	45
Figure 15. Sequence of tree measurements, determination of measured and unmeasured trees, and Determining the distance and azimuth of trees	46
Figure 16. Diameter measurement points for various tree conditions.....	48
Figure 17. Height of base of crown and total height of tree.....	49
Figure 18. Mechanism for reporting forest inventory activities by BPKH.....	51
Figure 19. Illustration of slope gradient (a) 10% and (b) 100%.....	72
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: adapted from DeYoung, 2016).....	73
Figure 21. Slope correction for distance measurement	73
Figure 22. Correction of plot radius on slope (source: adapted from Kleinn et al. (2002))	74
Figure 23. Measuring (a) tree diameter using a 1.3 m measuring stick and (b) stump diameter measurement	77
Figure 24. Difference in length and height of trees (a) and the principles of trigonometry in determining tree height (b) (adapted from Rusolono et al. (2015)).....	78



APPENDIX LIST

Appendix 1. Field Form.....	55
Appendix 2. Field Measurement Techniques.....	72
Appendix 3. Field Herbarium Creation	79
Appendix 4. List of Tree Species Identification Institutions/Laboratories.....	80
Appendix 5. Instructions for Using Vertex Laser Geo for Measuring Tree Distance and Height.....	82
Appendix 6. Format of Statement Letter for Implementation of IHN 2.0 Activities.....	88
Appendix 7. Format of Minutes of IHN 2.0 Cannot Be Implemented	89
Appendix 8. Procedure for Updating Collect Mobile.....	90
Appendix 9. Procedure for Uploading Collect Mobile Data to the Server.....	94
Appendix 10. Procedure for Backing Up Collect Mobile Data.....	



BAB I PENDAHULUAN



**DIREKTORAT JENDERAL
PLANOLOGI KEHUTANAN**

**KEMENTERIAN KEHUTANAN
REPUBLIK INDONESIA**

PIG INTRODUCTION

1. General

Indonesia is blessed with tropical forests that are among the largest in the world, alongside Brazil and the Congo. For decades, Indonesian forests have served as a major producer of timber and non-timber products. Forest utilization for timber production is regulated based on the principle of sustainability. A sustainable forest management system requires accurate data on the potential of exploitable forest stands.

The required forest potential information is also related to data on the quantity and quality of stands or trees, which is obtained from the results of forest inventories.

Besides providing timber, tropical natural forests are also closely linked to climate change issues, both as a source of emissions and as a natural carbon sink. Therefore, a forest potential measurement system is needed that also takes into account the data needs for climate change. Through forest inventories, it is hoped that information on forest potential, both timber and non-timber, can be quickly and accurately identified using accountable methods that align with reporting needs, available resources, and capacity.

Indonesia began implementing the National Forest Inventory (NFI) in 1989–1996, primarily to estimate timber potential in state forest areas. However, the need for forest resource information is increasing and extends beyond timber potential. For example, reporting emissions reductions at the national and global levels requires information on biomass and carbon stocks across various land cover types. Furthermore, Government Regulation No. 23 of 2021 concerning Forestry Implementation mandates the implementation of the NFI not only in state forest areas but also in privately owned and customary forests. Therefore, a new NFI system was developed in 2022–2023, to be implemented starting in 2025.

2. Purpose and Objectives

The Technical Guidelines for the Inventory of Forest Standing and Non-Timber Plants within the Framework of the National Forest Inventory, hereinafter referred to as the Technical Guidelines for the National Forest Inventory 2.0 (IHN 2.0), are intended as guidelines for the implementation of IHN in Indonesia. The preparation of these technical guidelines 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

The IHN aims to accurately, timely, and reproducibly record and assess the extent and quality of potential forest resources, particularly at the national level. The IHN focuses on the national level, but it can be applied to lower monitoring levels, such as the provincial or management unit (KPH) level.

The objectives of IHN implementation can also be adjusted to meet monitoring needs, for example, carbon measurement as an additional option. Based on the mandate of the Minister of Environment and Forestry Regulation No. 7 of 2021 concerning Forestry Planning, Changes in Forest Area Designation, and Changes in Area Functions,



Forests, as well as the use of forest areas within the scope of IHN are:

- 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 level national.
- IHN is carried out by work units within 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. Basics

The Ministry of Forestry organizes IHN based on regulations-
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 to Become Law.
- 3) Government Regulation Number 23 of 2021 concerning Forestry Management.
- 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 Function, and Use of Forest Areas.
- 5) Regulation of the Minister of Forestry Number 1 of 2024 concerning Organization and Governance Ministry of Forestry's work.
- 6) Regulation of the Minister of Forestry Number 3 of 2025 concerning the Organization and Work Procedures of the Forest Area Consolidation Center.

5. Glossary of Terms and Abbreviations

<i>Azimuth</i>	Direction
BBS	Wet Weight of Sample
BJ	Specific gravity
<i>Bole height</i>	Height of base of crown
BPKH	Forest Area Stabilization Center
<i>Clip plot</i>	A square frame measuring 0.5m x 0.5m is used to determine the subplots of litter and plants. lower
<i>Collect Mobile</i>	Application used for recording inventory data forest using tablets
DBH	<i>Diameter at breast height</i> or diameter at chest height which usually uses a standard of 1.3 m
GIS	<i>Geographic Information System</i>
GPS	<i>Global Positioning System</i>
Herbarium	Preserved plant specimen samples used for species identification
HLKRT	Dryland Forests, Swamps, and Plants
HM	Mangrove Forest



IHN	National Forest Inventory
IPCC	<i>Intergovernmental Panel of Climate Change</i>
IPSDH	Forest Resource Inventory and Monitoring
Cluster-plot	A collection of several measuring plots that form one sample unit
KPH	Forest Management Unit
LIS	<i>Line Intersect Sampling</i>
PDLH	Trees Outside the Forest
<i>Phi-band</i>	Measuring tape with diameter units
PSP	<i>Permanent Sample Plot</i>
SOC	<i>Soil Organic Carbon</i>
<i>Stratified Systematic Sampling</i>	Systematic stratified sampling based on a hexagonal <i>grid</i> , where sample units (plot clusters) are placed at the center of each hexagon at a certain distance. in each stratum
TBB	Total Wet Weight
TOF	<i>Trees Outside Forests</i>
<i>Transponder</i>	Tools used to determine flat distances using ultrasound technology, usually combined with a hypsometer range finder
QA/QC	<i>Quality Assurance/Quality Control</i> or quality assurance and quality control
<i>Ultrasonic laser hypsometer</i>	Distance and height measuring tool that uses technology laser and <i>ultrasound</i> , some brands that are often used include Vertex Haglof
<i>Witness point</i>	Witness points in the field used as reference points for the center of the plot



BAB II PROSEDUR



**DIREKTORAT JENDERAL
PLANOLOGI KEHUTANAN**

KEMENTERIAN KEHUTANAN
REPUBLIK INDONESIA

CHAPTER II PROCEDURE

1. SAMPLING DESIGN

1.1. Sampling Method

In 2023–2024, the Government of the Republic of Indonesia, supported by the FAO, conducted a study to design a new National Forest Inventory (NIHN) that takes into account national-level forest resource data and information needs and aligns with national resource capacity. The study aimed to identify target populations, particularly those related to forest structure and landscape patterns, using previous IHN data.

The new IHN design (called IHN 2.0) uses the *Stratified Systematic Sampling* method . In this sampling method, forest populations in Indonesia are grouped into three strata, namely:

- 1) Dryland, swamp, and plantation forests. 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). This stratum includes 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: mangrove forests primary (Hmp/2004) and secondary mangrove forests (Hms/20041).

The sample units (clusters) were systematically distributed using a hexagonal grid sampling frame *with* varying distances/intervals in each stratum and island group (Sumatra, Java, Bali Nusa, Kalimantan, Sulawesi, Maluku, and Papua) according to the sample size calculation (number of clusters) required to achieve the expected level of population estimation accuracy. In each hexagonal grid, the cluster location was determined at the center point of each hexagon (**Figure 1**). The use of the hexagonal grid was intended to provide a consistent sampling frame when sample intensification was required for forest inventory at the provincial level.



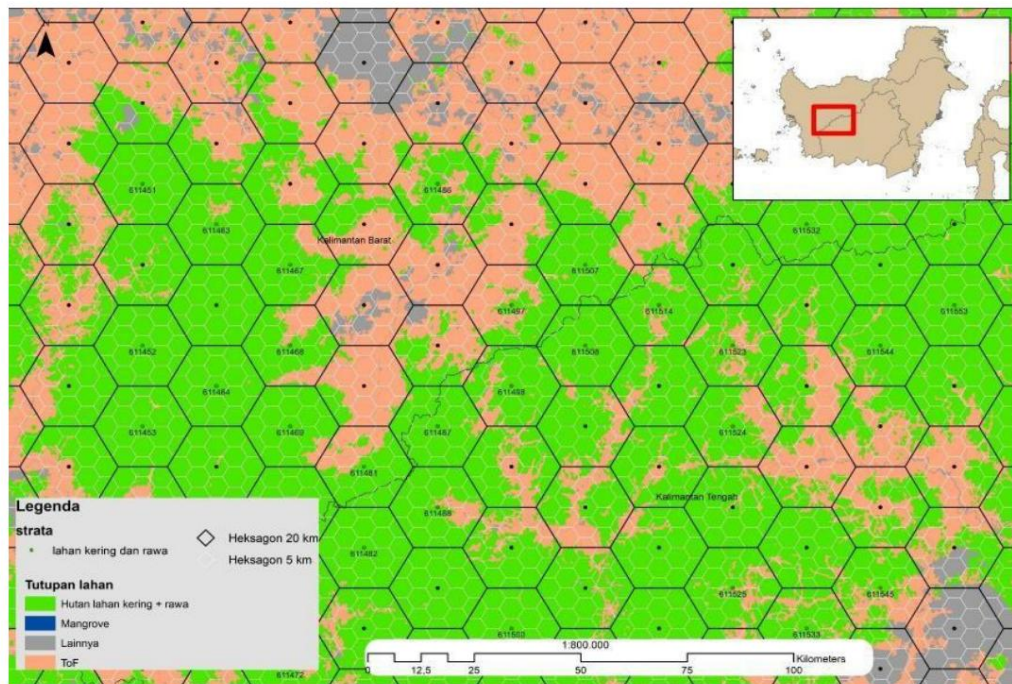


Figure 1. Example of the distribution of IHN clusters on a hexagonal grid with a distance of 20 km

1.2. Cluster Design, Size, and Type

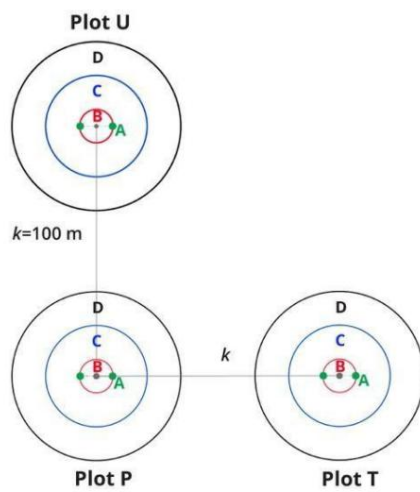
IHN uses different designs and clusters for the dryland, swamp, and plantation forest (HLKRT), the Trees Outside Forest (PDLH/TOF), and the mangrove forest (HM) strata. However, the basic design is the same, with an L-shaped cluster **consisting** of three circular plots: **Plot P** (at the center of the cluster), **Plot U** (north of the cluster), and **Plot T** (east of the cluster), with a distance (k) between plots of 100 m for the HLKRT strata and a distance of 50 m between plots for the PDLH/TOF and HM strata. Each plot consists of four circular subplots as follows (**Figures 2a, 2b, and 2c**):

- **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 (from the center of the plot) for measuring trees with a diameter of 5 cm to <20 cm, while in the HM strata, the radius is 5 m (from the center of the plot) 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 (from the center of the plot) for measuring trees with a diameter of 20 cm to <40 cm (because trees with a diameter of 5 cm to <20 cm have been measured in subplot B), while in the HM strata, the radius is 8 m (from the center of the plot) for measuring trees with a diameter of 10 cm to <20 cm (because trees with a diameter of 5 cm to <10 cm have been measured in subplot B).
- **Subplot D:** in the HLKRT or PDLH/TOF strata, the radius is 25 m (from the center of the plot) for measuring trees with a diameter of ≥ 40 cm (because trees with a diameter of <40 cm have been measured in subplots B and C), while in the HM strata, the radius is 12 m (from the center of the plot) for measuring trees with a diameter of ≥ 20 cm (because trees with a diameter of <20 cm have been measured in subplots B and C).

The distance between plots and the radius of the subplots are flat distances.



HLKRT



KAIDAH PENGUKURAN DBH

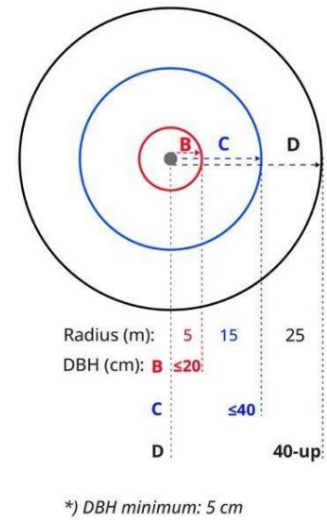
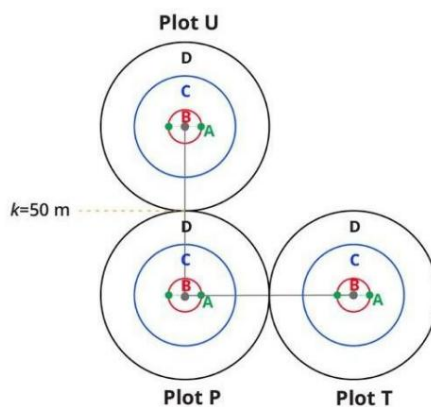


Figure 2a. Design of the IHN HLKRT cluster size

PDLH/TOF



KAIDAH PENGUKURAN DBH

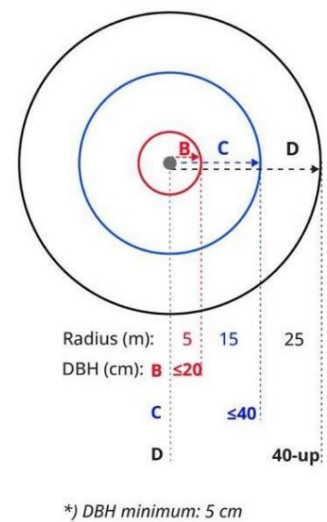
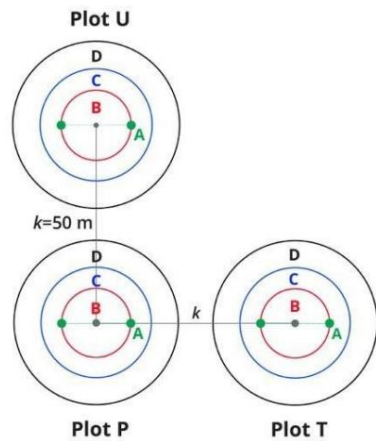


Figure 2b. Design and size of the IHN PDLH/ TOF cluster



MANGROVE



KAIDAH PENGUKURAN DBH

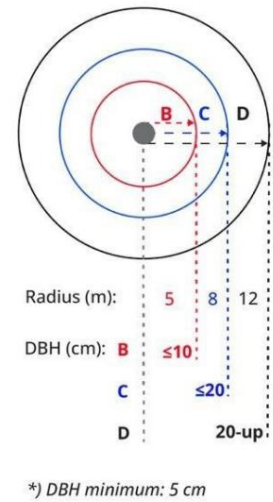


Figure 2c. Design of the IHN Mangrove cluster size

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 Cluster-plot Location Identification

Step 1: The coordinates of the distribution of IHN clusters to be measured in the field are determined by the Ministry of Forestry cq IPSDH Directorate. The IPSDH Directorate *overlays* the coordinates of the distribution of IHN clusters with the BPKH boundaries to determine the IHN plots to be measured by each BPKH.

Step 2: The IPSDH Directorate determines the number and distribution of clusters to be measured each year, taking into account the representativeness of the cluster distribution at each stratum. This is done to ensure that the clusters measured each year represent the distribution of forest potential in their respective regions.

Step 3: BPKH determines the assignment of the survey team based on the distribution of the planned clusters to carry out field measurements, including if other institutions are involved in the field measurement activities.

Step 4: Use GIS *software* to create a working map by *overlaying* the clusters with the base map (road network, rivers, settlements, etc.) that will be used by the survey team.

2.2 Preparation of Equipment and Logistics

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

To find and build a cluster:

1. Work map
2. GPS
3. Compass
4. Machete
5. Meter 25 m or 50 m
6. Mark the boundary with bright paint at the center point of the plot.
7. Cement and PVC pipe with a diameter of 2.5 *inches*
8. Zinc plate measuring 40 x 30 cm in yellow color
9. Zinc nails measuring at least 10 cm

For measurement and recording:

1. A tablet that has a memory card with the *Collect Mobile application*, or a field form for the number of clusters to be measured as a backup
2. Batteries for measuring equipment and *power-banks* for tablet devices for filling out forms
3. Tree labels for individual tree markers that have been measured.
4. Permanent marker for writing on tree labels
5. Nails and hammer for attaching tree labels
6. *Phi band* (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 *or Clinometer or* other measuring tool to measure the angle of inclination of dead wood
10. Calipers for measuring 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* or *Spiegel relascope* for measuring tree height and a *clinometer* for measuring slope inclination.

For measurements of litter and undergrowth:

1. Digital hanging scale with minimum accuracy of ± 1 gram
2. Plastic bags for weighing
3. Frame-plot (*clip-plot*)

Other equipment that needs to be prepared:

1. *Personal use*, such as gloves, hats, etc.
2. Medicines
3. Food ingredients
4. Tent equipment (if needed)
5. Climbing equipment (if needed)
6. Cooking equipment (if needed)

2.3 Inventory Team Requirements

To complete the forest inventory cluster measurement task, a team must consist of at least a core team and an interim team. The core team consists of:

- 1 team leader
- 2 assistant squad leaders

The intermediary team consists of six surveyors, pioneers, and cluster locators, as well as species identifiers. The surveyors, pioneers, and species identifiers are local laborers. If the terrain is difficult, additional pioneers may be needed to rotate. Pioneers also play a role in the measurement activities. Species identifiers and measurers are usually local laborers from surrounding villages who are familiar with tree species.

If the cluster location is very remote and requires staying on-site to be closer to the cluster, the team will need to set up tents for overnight stays. Therefore, the intermediary team also acts as a logistics team and cook. The duties of each member are shown in **Table 1**.



Table 1. *Composition and duties of forest inventory team members*

Position in the team	Task	Amount
Squad leader	- Responsible for all field measurement activities, including coordinating transportation, logistics, accommodation, and measurements within the plot. - During the pioneering journey to the plot, the team leader usually operates the GPS, unless there is a pioneering team that understands how to operate the GPS. - Determine the location of the starting point of the plot and ensure that the plot construction is carried out correctly. - Record the results of plot monitoring and parameter measurements in the plot.	1 person
Assistant chairman team	- Measuring the distance, direction and height of trees - Prepare and operate measuring instruments, especially <i>Vertex</i>, compass, and <i>laser distance meter</i>. - Assist with measurements on small plots if needed.	2 persons
Pioneer	- Pioneering or finding a way from the last access road to the plot. - Establishing a plot which includes preparing boundary stakes or poles, measuring distances and azimuths for plot boundary locations and installing stakes or poles that are visible to the surveying team. - Helps with measurements within the plot	2 persons
Type identifier	- Identifying types of bamboo and other vegetation - Assist with pioneering if needed - Helps with measurements within the plot	2 persons
Gauge	- Measure the parameters in the plot - Assist with pioneering if needed	2 persons

The team leader can come from BPKH, 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 participated in 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 needed 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, observe and measure the general condition of the cluster when the survey team arrives at the central 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 was a circular plot with radius of 1 m placed in the West-East or North-South.	F3
4.	In each subplot A (A1, A2), the survey team carried out cutting of undergrowth, collecting litter, and weighing. wet undergrowth and litter contained in a 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 around 300 grams for further analysis in the laboratory.	F4, F5
5.	In certain previously determined clusters, the survey team carried out soil carbon measurements on subplot A.	F6
6.	In subplot B, the survey team took measurements of dead wood, including determining the level of weathering by slashing with a machete/parang.	F7
7.	In subplot C, the survey team measured rattan/liana, bamboo, or palm trees.	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 taken on a minimum of 6 sample trees, representing small, medium, and large diameter classes. In the PSP, horizontal and azimuth distances were measured from the center of the subplot to each measured tree. For trees of unknown species, the survey team needed to take photos of parts of the tree (e.g. leaves, trunk, and fruit) and/or make herbarium specimens for species identification purposes.	F11
9.	The survey team fills in their personal details at the end of the survey activity.	F12



3. CLUSTER DEVELOPMENT

3.1 Coordination and Preparation for Cluster Development

Coordination with relevant parties at the district level is necessary to ensure that field implementation activities are known to them and receive the necessary support. Additionally, during coordination activities, additional initial data collection, logistics preparation, and labor recruitment can be conducted. Coordination with relevant parties includes:

- Forest area managers and/or forest utilization permit holders to obtain additional information related to accessibility to clusters and obtain additional data and information.
- Village/hamlet officials to inform activity plans, obtain local labor, as well as obtain additional information regarding 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 in **the sub-chapter** on field planning and preparation.

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

Step 3: Use GPS to find the cluster center point. The coordinates of the cluster to be measured are entered into the GPS beforehand. To avoid bias, the determination of the cluster center point must match the GPS point (with an accuracy of $\pm 10\text{m}$). Unless the cluster is truly inaccessible due to danger, for example, being 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. Cluster center point is the center point of Plot P (see **Figure 3**).

Step 2: Install cluster center point markers and cluster identification signs.

The stakes installed should have a high level of durability.

Step 3: After measuring Plot P, measure Plot U, which is 100 m north of the cluster center. For mangroves and TOF, the distance between plots is 50 m.

Step 4: After completing the measurements on Plot U, perform measurements on Plot T, which is 100 m east of the cluster center point. For mangroves and TOF, the distance between plots is 50 m.

The order of plot measurements can be adjusted to suit field accessibility, for example, by first measuring easily accessible plots while maintaining consistency in plot numbering. The plot center location must correspond to the coordinates of each plot defined in the cluster distribution, with a GPS accuracy tolerance of $\pm 10\text{ m}$, and no shifts in plot locations are permitted.

If the GPS signal at the plot center location is weak (accuracy $>10\text{ m}$), the survey team can determine the plot center in the following way:



- 1) Find a location around the center of the plot where the GPS signal reception is strong (accuracy <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 is inaccessible, for example, in a ravine or dangerous area, the survey team does not need to create the plot and does not need to move it to another nearby location. However, the survey team must record the coordinates of the last accessible location and conduct visual observations and general condition records according to Form **F2** (see explanation in **Subsection 4.2**).

The center of each plot must be permanently marked using a 2.5 inch diameter PVC pipe filled with concrete and a total length of 1.0 m (where the buried part is approximately 0.6 m) and the top is painted red, with a cluster number, and metal/iron (for *metal detectors*) to facilitate tracking of the plot center during subsequent IHN activities (**Figure 3**). Permanent marking using the concrete PVC pipe is carried out on the HLKRT and PDLH/TOF strata within 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.

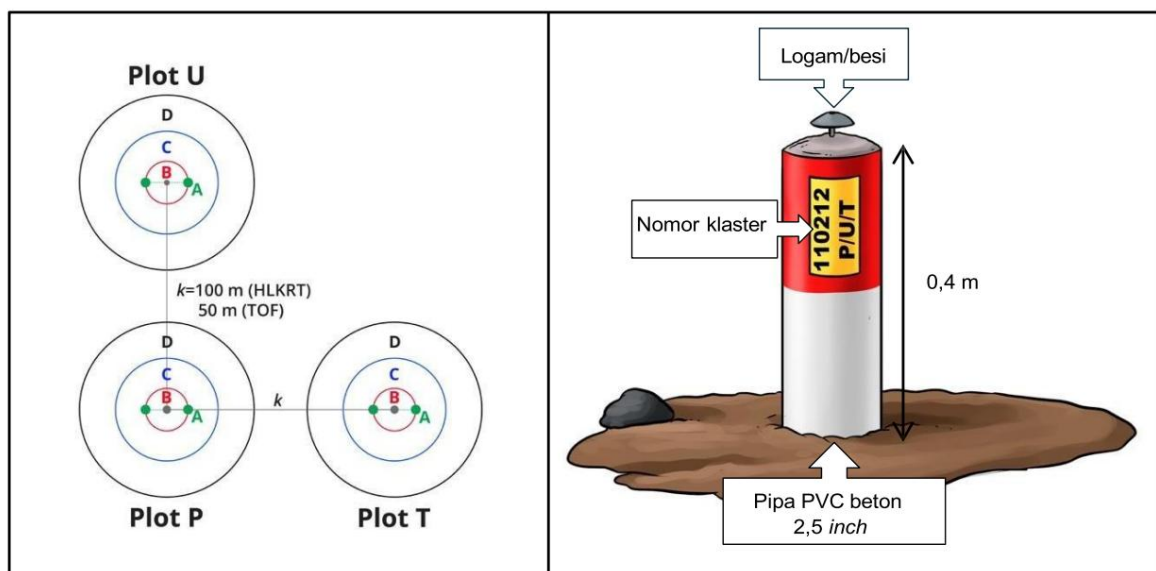


Figure 3. Cluster design (left) and permanent mark at the center of the plot (right)

In addition to marking the plot center points using concrete PVC pipes, the location of each plot center was also marked using nameplates attached to the tree closest to the plot center point. The nameplates were 40 x 30 cm in size and painted yellow and contained the following information: cluster number, plot number (P, U, or T), BPKH area, province and district, sub-district and village, field coordinates, and time of plot creation (in the format: date/month/year) (Figure 4). Marking of plot centers using these nameplates was carried out in clusters in the HLKRT, PDLH/TOF strata within 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 plot center point during cluster re-measurement. Therefore, after marking the plot center point using concrete PVC pipe, the survey team must establish at least two witness points inside and/or outside the plot. Witness points are easily observed natural objects, such as large rocks, coral, or relatively large trees. The work steps are as follows:

Step 1: Determine 2 or more witness points inside or outside the plot. Note them in field form.

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

Step 3: Document each witness point.

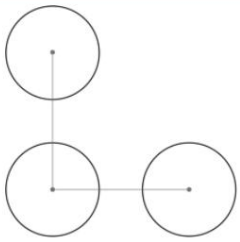
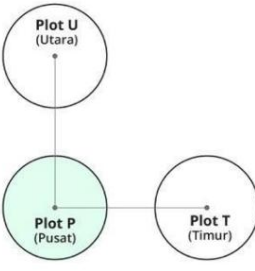
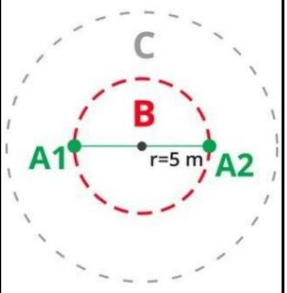
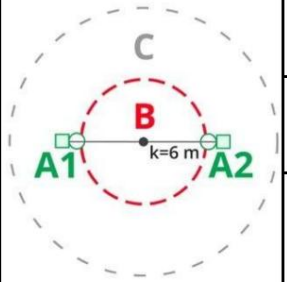
Step 4: Note the type of each witness point.



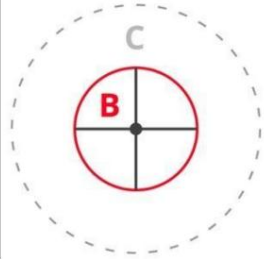
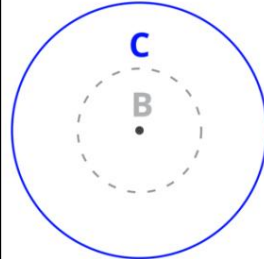
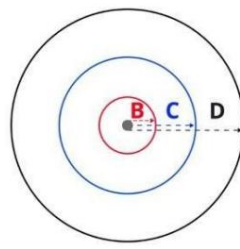
4. FIELD DATA COLLECTION

In each cluster, the survey team observed, measured, and recorded cluster information, plot information, regeneration, understory vegetation, litter, trees (living and dead), dead wood, rattan/liana, bamboo, palms, and soil carbon. **Table 3** presents a summary of data collection activities in each cluster, which are further explained in the subsections below.

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

Location		Observation and measurement	Field form
Cluster		Cluster information: • Number, location, and type of clusters; Survey team leader; Survey time; Accessibility	F1
Plot		Plot information: • Plot number and location; Measurement time; Accessibility; Elevation and slope gradient; Photos of plot conditions; Land cover class; Forest type; Land use; Management; Standing condition; Indications of human interference	F2
Subplot A		Regeneration: • Species and number of individuals	F3
Clip-plot in Sub Plot A		Understory plants: • Total wet weight & sample	F4
		Litter: • Total wet weight & sample	F5
		Soil carbon: • Soil type; Depth; Sample volume	F6



Location		Observation and measurement	Field form
Transect in subplot B		Dead wood: • Diameter; Weathering class; Tilt angle	F7
Subplot C		Rattan and lianas: • Category; Species; Amount stem; Diameter; Long; Commerciality	F8
		Bamboo: • Category; Species; Age class; Number of stems; Diameter; Height; 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; Quality wood; Specific gravity class; Height of crown base; Total height; Photo or herbarium (for species unknown)	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 work 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:

Code F1-1	Island
1	Sumatra
3	Java



Code F1-1	Island
5	Bali & Nusa Tenggara
6	Kalimantan
7	Sulawesi
8	Maluku
9	Papua

2) Record the cluster number on form **F1-2** according to the numbering system specified on the work 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 digits: cluster serial number on all islands, starting from number 0001 up 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 is measured 2024.

4) Note down the province name code on form **F1-4** 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**):

Code F1-4	Province	Code F1-4	Province
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	DKI Jakarta	76	West Sulawesi
32	West Java	81	Maluku
33	Central Java	82	North Maluku
34	DI Yogyakarta	91	Papua
35	East Java	92	West Papua
36	Banten	93	South Papua



Code F1-4	Province	Code F1-4	Province
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 the **F1-** form.

5 with the following explanation:

Code F1-5	Land type
1	Dryland forests, swamps, and plantations (inside or outside forest areas)
2	Mangrove forests (inside or outside forest areas)
3	Trees Outside Forest (PDLH) or <i>Trees Outside Forest</i> (TOF)

6) Select the type of cluster measurement on form **F1-6**, whether Planned ,
Unplanned , or *Quality Assurance/Control* with the following explanation:

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

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

Variable	Code F1-7	Description
Unit implementer	1	BPKH unit/name, if the survey is conducted by BPKH 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 the survey team leader.



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

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



8) Record the name and coordinates of the survey team's accommodation on 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	<i>Longitude (Easting)</i> coordinates from GPS in decimal degrees.
Y Coordinate	The <i>latitude (Northing)</i> coordinates of the 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 villages or in the forest.
- Parking location is a place that can be accessed by vehicles before then the survey team walked to the cluster location.
- The cluster location can be the center point of Plot P or another plot that is easier accessible.

At each stage of the survey team's journey, the time (date and time) was recorded as follows:

- Departure from the starting point to the parking location or cluster. The starting date and time are recorded when the team departs from the nearest accommodation, while the ending date and time are recorded when the team arrives at the parking location (if using a vehicle) or directly at the cluster location. Thus, the time difference indicates the travel time from the accommodation to the parking location or cluster.
- Departure from the parking lot to the cluster location. The starting date and time are recorded when the team departs from the parking lot, while the ending 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 recording the time from the parking lot is not necessary.
- Return from the cluster location to the parking location or starting point. The starting 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 ending time is recorded when the team arrives back at the parking location or starting point. Thus, the time difference indicates the length of the return trip 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 code. the following:

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 inaccessible for other reasons (please specify the reason)

11) If the cluster cannot be accessed (choice code 2, 3, or 4 on form **F1-10**), include (upload to the *Collect Mobile application*) the following physical evidence on form **F1-11** :

- Photos (3 pieces) showing the conditions around the cluster
- Coordinates (X, Y) of the last accessible access point
- Minutes of the National Forest Inventory Activity Cannot Be Implemented which confirms that cluster measurements cannot be carried out and is authorized by the relevant parties (village head/head of regional stakeholders).

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 local community. The types of NTFPs can be seen in **the Regulation of the Minister of Forestry Number P.35/Menhut-III/2007 concerning Non-Timber Forest Products**.

13) Record the forest/land management party according to the following code on form **F1-13** :

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

14) Provide important *remarks* if there are things that need to be 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 P, Plot U, and Plot T) with the following activity stages:

1) Record the cluster number again on the **F2-1** form according to the numbering system.

has been determined on the work map or *Collect Mobile* (CM) application .

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

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



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

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

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

Variables F2-5	Description
X coordinate	Longitude (<i>Easting</i>) coordinates from GPS (in units) 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> coordinates from the GPS (in decimal degrees) at the center point of the plot or an auxiliary point that is close to it. plot center.
GPS Accuracy	The error/shift of the plot center coordinates from the supposed location (specified on the map) with a tolerance of 10 m.
Distance	The flat distance (m) from the auxiliary point position to the center point of the plot.
Azimuth	Azimuth (°) from the auxiliary point position to the center point of the plot.

- 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 pipes
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 done, determine 2 witness points *inside* and/or outside the plot and note the following:

Variables F2-6	Description
X coordinate	Longitude (<i>Easting</i>) coordinates from GPS (in decimal degrees) at each witness point.
Y Coordinate	The latitude (<i>Northing</i>) coordinates from GPS (in decimal degrees) at each witness point.
GPS Accuracy	Error/shift in the coordinates of each witness point from its proper location (with a tolerance of 10 m).
Distance	The distance (m) is the horizontal distance from the center point of the plot to each witness point.
Azimuth	Azimuth ($^{\circ}$) from the plot center point position to each witness point.
Photo	Document each witness point.
Type	Note the type of each witness point.

7) Use a GPS or altimeter to find out the elevation (masl) of the center of the plot and note it down. the data on form **F2-7**.

8) Measure the slope (%) of the plot and record the data on form **F2-8**. The slope of the plot is the average slope direction between two opposite points along the plot radius. A detailed explanation of how to measure the slope can be seen in **Appendices 2A** and **2B**.

9) Carry out ' *aspect*' observations if the slope gradient is $>8\%$ (equivalent to 5°).

Aspect is the direction (*azimuth*) of the slope gradient measured using a compass in degrees. Record the slope aspect on form **F2-9** using the following code:

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

10) Observe and record on form **F2-10** whether the land cover type *in* the plot is 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 definition of the Ministry of Forestry. See the classes of 'forest' on



	form F2-11
2	Non-forest (TOF), if the land cover does not fall into the forest category according to the Ministry of Forestry's definition. See 'non-forest' classes. forest/TOF' on form F2-11

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

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 forests
2/Non-forest	2007/B	Shrubs
	20071/Br	Swamp scrub
	2010/Pk	Plantation
	2012/Pm	Settlement
	2014/T	Open land
	3000/S	Savannah
	20091/Pt	Dryland farming
	20092/Pc	Mixed dry land farming
	20093/Sw	Ricefield
	20094/Tm	Fishpond
	20121/Bdr/Plb	Airport/port
	20122/Tr	Transmigration settlements
	20141/Tb	Mining
	50011/Rw	Swamp
	5001/A	Body of water

The operational definitions and further explanations for each land cover class are as follows:

No.	Class	Layer code / toponymy	Operational definition (Working definition)	Notes
1.	Primary dryland forest	Hp/2001	The entire appearance of lowland forests, forests hills, forest mountains (highlands and subalpine), dwarf forests, heath forests, forests on limestone, forests on ultrabasic rocks, coniferous forests, deciduous forests leaves and moss forest	Forest The primary that experiences human disturbance (e.g. road network) is graded become secondary forest until with 1 km from the disturbance.



No.	Class	Layer code / toponymy	Operational definition (Working definition)	Notes
			(natural ecosystem) that does not show human disturbance (logging scars, fire scars, road networks, etc.), excluding natural disturbances (floods, landslides, earthquakes, etc.) Natural ecosystems that knowledge following the local as forest, still classified as forest (not thicket) as an example of Natural Forest Type in Flores Island, Sumbawa, Rote, Southeast Maluku and other islands in the line <i>Wallacea</i> and <i>Webber</i>; karst forests in Maros, Muna, and East Kalimantan; and dense natural forests low.	Natural ecosystems that follow local knowledge as forests, are still classified as forests (not thickets) as an example of Forest Type. Nature on the Island Flores, Sumbawa, Rote, Maluku Southeast and of the others inner island line <i>Wallacea</i> and <i>Webber</i>; karst forests in Maros and Muna, Kalimantan East; and low density natural forest.
2.	Forest land dry secondary	Hs/2002	Primary dryland forests that have experienced human disturbance (logging sites, fire sites, road networks, etc.), including those that have regrown from degraded land.	Primary Forest that is experiencing human disturbance (eg: road network) is classified as secondary forest up to 1 km from disturbance.
3.	Primary swamp forest	Hrp/2005	All forest features located in freshwater inundated areas and behind brackish water forests that do not show human disturbance (logging sites, fire sites, road networks) etc.), not included natural disturbances (floods, landslides, earthquakes, etc.) including sago forests.	- The swamp forests referred to are those in mineral and peat swamp areas, usually swamp having alluvial soil types. - Sago forests are included in swamp forest class. - On condition forests, certain swamps can be in the highlands, for example in Mount Big Pangrango.



No.	Class	Layer code / toponymy	Operational definition (Working definition)	Notes
4.	Secondary swamp forest	Hrs/ 20051	Primary swamp forest that has experienced human disturbance (logging scars, fire scars, road networks, etc.). Severe logging scars if not show (water coverage) sign permanent puddles are classified as open land, whereas if showing traces of puddles or being temporarily inundated is classified as a swamp.	- Severe logging scars if they do not show signs of puddles (water spots) permanently classified as open. land - Appearance open land that has been inundated or temporarily flooded is classified as a swamp.
5.	Forest primary mangroves	Hmp/ 2004	All forest features (mangroves, nipah and nibung) located in brackish water environments that do not show human disturbance (logging scars, fire scars, road networks, etc.), excluding natural disturbances (floods, landslides). landslides, earthquakes, etc.).	The coastal forest ecosystem is located outside the brackish environment and not affected by tides sea is not included mangrove forests.
6.	Forest secondary mangroves	Hms/ 20041	Primary mangrove forest which have experienced human disturbance (logging sites, fire sites, road networks, etc.), including those growing/planted on the ground sedimentation.	
7.	Forest plant	Ht/2006	The entire appearance of a uniform forest (monoculture) that can originate from activities reforestation/reclamation/ greening/industry.	Rubber Plants inside/ outside the PBPH-HT area classified as Plantation class. - Open land in the Plantation Forest class due to the temporal rotation of harvests and planting remains classified as a class Plantation Forest.
8.	Plantation	Pk/2010	The entire appearance of the results of cultivating perennial plants which includes the group	Plantation with plants type



No.	Class	Layer code / toponymy	Operational definition (Working definition)	Notes
			plantations, among others palm oil, rubber, coconut, chocolate, coffee, tea. Note: Plantations with homogeneously distinguishable perennial crops; The block size classified as a plantation (oil palm) is approximately 30 ha (300 m x 1000 m); Open land in the Plantation class because Temporary rejuvenation/ replacement of commodities remains classified as Plantations.	annual that can be distinguished homogeneously. - Classified block size as a plantation (palm) around 30 ha (300 m x 1000 m). - Land on open class Plantations because the rejuvenation/ change of commodities is still classified as temporary Plantation.
9. Bushes	B/2007		All areas/ appearance regions dominated by low vegetation located on dry land.	Shrubs dominated by low vegetation (below 5 m), have the potential to regeneration into forest.
10. Bushes swamp		Br/20071	All over appearance areas/regions dominated by low vegetation and located in areas inundated with fresh water and behind the forest brackish.	Water hyacinth is classified as (example: Rawa Pening swamp in Semarang, Central Java).
11. Savanna/ Grassland		S/3000	All natural and permanent low vegetation features in the form of grasslands. This appearance is a natural appearance 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 few bushes or trees. Savanna is found on dry land or swamps (swamp grass, for example swamp grass in Wasur).	- This appearance is an appearance natural in some Sulawesi Southeast, Nusa Southeast and parts of South Papua, also can be found in Java. - In some savannas there are few bushes or trees.



No.	Class	Layer code / toponymy	Operational definition (Working definition)	Notes
				Savanna Can contains on land or dry (grass, for swamp example swamp, 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. Agriculture	mixed dry land	Pc/20092	All features that are a mixture of agricultural areas, plantations, bushes and shrubs. This class often appears in shifting cultivation areas, karst land crop rotation, and enter the class which is understood as mixed gardens, community forests, or agroforestry.	- This class often appears in shifting cultivation areas, rotation - And plant karst land. - This class also includes classes understood as mixed gardens, community forests or agroforestry.
14. Rice fields		Sw/ 20093	The entire appearance of the results of cultivating annual plants in wetlands characterized by embankment patterns. Agricultural wetlands are classified as rice fields, including agricultural areas which was originally used as a rice field and in the dry season was planted with crops Annual crops are still classified as rice fields. What the interpreter needs to pay attention to is the crop rotation phase, which consists of the flooding phase, the young plant phase, the old plant phase, and the fallow phase. This class also includes seasonal rice fields and dry rice fields. rain, irrigated rice fields. Especially for seasonal rice fields in swampy areas, additional information is needed from field.	Wetland farming is graded as rice fields, including areas agriculture which was originally used for rice fields and in the dry season planted Annual crops are still classified as rice fields. - necessary - What the interpreter pays attention to is the crop rotation phase which consists of the phase inundation, plant phase young, old plant phase and fallow phase. - This class also includes seasonal rice fields, cistern rice fields - rain, rice fields



No.	Class	Layer code / toponymy	Operational definition (Working definition)	Notes
				irrigation. Special for ricefield seasonal in areas swamp require additional field information. from
15. Fish pond		Tm/ 20094	All over land features Salted fisheries (fish/ or shrimp) are visible in the form of embankments, usually located around the coast. In some locations, they can originate from the forest swamp, marsh or thicket swamp.	In some locations it can originate from swamp forests, marshes or swamp thickets.
16. Settlements		PM/2012	Residential areas, both urban, rural, industrial etc.	
17. Transmigration Settlement		Tr/20122	Residential areas in transmigration areas and within transmigration permit areas. Cultivated land is separated from residential areas.	- Located within the permit area transmigration. - Class Transmigration adjusted become Settlement transmigration. 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, snow- capped peaks, volcanic craters, sandbars, beach sand, river deposits, land clearing and former mining areas). fire). Appearance of open land for mining mining, classified while open land used Land clearing is classified as open land.	Open land in the forest plantation class after harvesting that will be replanted is classified as forest plant. Open land during the first land clearing which is indicated into the forest plants/plantations Nan classified



No.	Class	Layer code / toponymy	Operational definition (<i>Working definition</i>)	Notes
			open for the purpose of rotating rice fields/ponds are still classified as rice fields/ponds.	as open. land • Appearance open land for Mining is classified as mining, while open land is used land clearing classified <i>clearing</i> as open. land open Land in frame rotation plant rice fields/ ponds are still classified as rice fields/ponds.
19. Mining Tb/20141			Open land which is used for open <i>pit</i> mining activities (such as coal, tin, copper, etc.), as well as large-scale closed mining areas which can be identified from imagery based on associations. the appearance of the object, including <i>the tailing ground</i> (waste dump) mining). Land small-scale or unidentified closed mining is classified according to appearance its surface.	Land small-scale or unidentified closed mining classified according to their surface appearance.
20. Water body		A/5001	All the appearance of waters, including seas, rivers, lakes, reservoirs, coral reefs, seagrass beds, etc. The appearance of ponds, rice fields, and swamps has been classified alone.	
21. Swamp		Rw/ 50011	The appearance of swamp land (flooded with fresh water and in	Swamps are usually located in areas



No.	Class	Layer code / toponymy	Operational definition (Working definition)	Notes
			behind the brackish water forest) which is no longer forested. Swamps are usually found in depressions or lower plains than surrounding areas.	a lowland or basin that is lower than the surrounding area.
22. Clouds		Aw/2500	The appearance of clouds covering the area with a size something more than 4 cm ² on the presentation scale. If the thin cloud cover still shows the appearance below and allows interpretation to remain delineated.	
23. Airport/Port		Bdr/Plb/20121	The appearance of the airport and port which is large in size large and allows for separate delineation.	

12) If the land cover is 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 forests
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 forests
10	Sago forest
11	Bamboo forest
12	Others (write according to forest type)

Explanation of several forest types based on the Forestry Vademecum book (KLHK, 2020):

- Mangrove forests (also called mangrove/brackish water forests): grow in wet and salty habitats along the coast, especially muddy shores 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 covered by mangrove species such as *Avicennia alba*, *Sonneratia alba*, *Rhizophora* spp, etc. (Noor et al. 1999).
- Coastal forests: grow along the coast and are generally characterized by the presence of the keben tree (*Barringtonia asiatica*).



- Freshwater swamp forest: found in large river basins (in Sumatra, Kalimantan, and Papua), the species composition is diverse, usually covered with tree species such as *Alstonia* spp., *Barringtonia* spp., *Camptosperma* spp., *Dillenia* spp., *Eugenia* spp., *Neesia* spp., *Pholidocarpus* spp., and *Shorea* spp. (Kartawinata 2013).
- Heath forest: found in lowland rainforest areas (with elevations 0–800 masl) 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 water, generally covered 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 types of land use for non-forest areas .
(PDLH/TOF) on form **F2-13** according to the following code:

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

14) Estimate the proportion/percentage of 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 is located within the class area observed land cover	



15) Observe and record the level of canopy density on form **F2-15** according to the following code.

This:

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

16) Observe and record the vertical structure of the stand (tree canopy layers) 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	The vertical structure is very diverse

Illustration:



1 2 3 4 5

Source: adaptation of Otto (1994) in Fehrmann *et al.* (2017)

17) Observe and record indications of forest/land fires on form **F2-17** according to the following code:

Code F2-17	Description
1	There was no fire incident
2	There was a fire recently, 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 in the four cardinal directions (North, East, South, or West). All photos are taken in landscape orientation at the photographer's eye level. 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 observed and recorded 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.

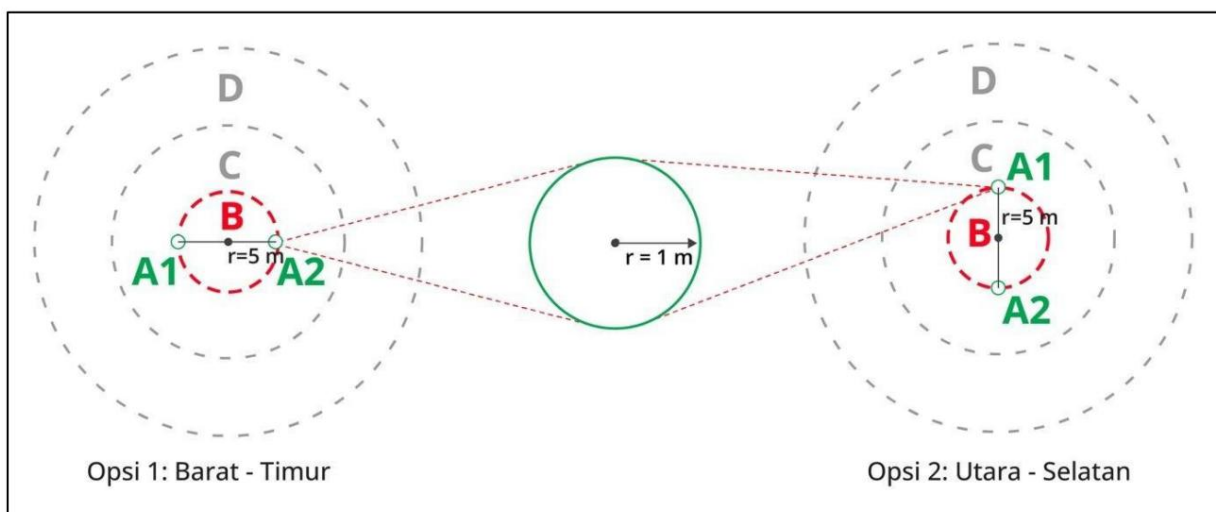


Figure 5. Regeneration subplots (A1 and A2) with West–East or North–South on each plot

Regeneration observations and recording (on form F3) are conducted by the survey team prior to any other measurement activities to avoid damage to regeneration due to the survey team's mobility within the plot. The stages of regeneration observation and recording 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 in each subplot.

4.4 Understory Plants

After completing the regeneration recording, at subplot locations A1 and A2 at a distance of 6 m from the center of the plot, the survey team measured undergrowth, namely all living vegetation (including seedlings) growing above ground with a height of less than 1.5 m.

Undergrowth measurements were carried out by trimming and weighing all undergrowth in the clip -plots A1 and A2 (**Figure 6**).

Each *clip-plot* measures 0.5 m x 0.5 m and is made from PVC pipes that can be disassembled for easy carrying and use.

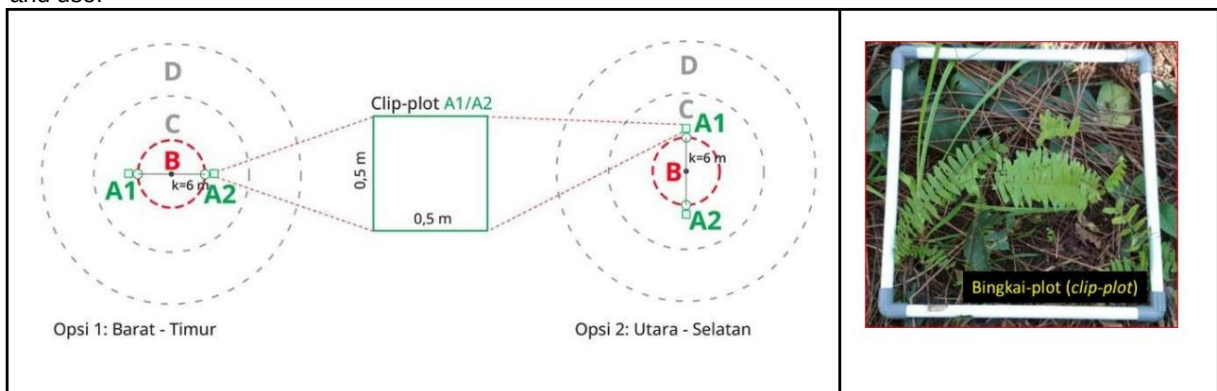


Figure 6. Frame-plot (*clip-plot*) of undergrowth (A1 and A2) with West-position East or North–South on each plot

The steps for measuring undergrowth in subplots A1 and A2 in each example plot (Plot P, Plot U, and Plot T) are as follows:

- 1) Place the plot-frame (*clip-plot*) in subplots A1 and A2, namely at a distance of 6 m from the center of the plot in the 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 pruning shears or other tools) all undergrowth (including seedlings) within the plot frame. Collect, mix, and store all undergrowth from both subplots (A1 and A2) in a large plastic bag. Then, weigh the total wet weight (WW, 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 the previous stage 2) until all parts are mixed. Then take a sample of about 300 grams of undergrowth (or all of it if the TBB is less than 300 grams), put it in a small plastic bag and weigh the wet weight of the undergrowth sample (BBS, grams).

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 undergrowth sample (BKS, grams).



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

Following the understory measurements, the survey team conducted litter measurements in subplots A1 and A2 (**Figure 6**). The litter measured included all organic material on the forest floor that had not yet fully decomposed, such as leaves, fine tree roots, and small-diameter tree branches (<10 cm). The litter measurement steps were as follows:

- 1) Collect the litter in the A1 and A2 plot frames after pruning and collecting the undergrowth. If necessary, rake up the litter attached 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 (WW, grams) of the litter and record the data (after deducting the weight of the bag) on form **F5**.
- 3) In the designated clusters, collect understory plant samples for laboratory analysis. To do this, take a litter sample of approximately 300 grams (or all of it if the TBB is less than 300 grams) from the large plastic bag, then place it into a small, labeled plastic bag (**Figure 7**). Then, weigh the litter sample and record the results on form **F5** 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 any unused litter to the forest floor.

4.6 Soil Carbon

According to the 2006 IPCC Guidelines, soil *organic carbon* (SOC) is all soil organic matter at a specific depth (30 cm for mineral soils), including roots and fine litter with a diameter of less than 2 mm, as these are difficult to distinguish. Soil carbon measurement methods must be tailored to the needs.

For the IHN and greenhouse gas emission calculations, soil carbon stock measurements are not necessary. This is because soil carbon emissions measurements are based on emission factor data obtained from specific studies related to land cover change. Therefore, a more appropriate sampling design is recommended.

If soil carbon is the 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



is done at the center point of Plot P. However, if more detail is needed, it can be done at all center points of the plot.

Mineral Soil Carbon Measurement

Soil carbon measurements on mineral soils were conducted to determine soil carbon content down to a depth of 30 cm (SNI 2019). Soil samples were taken at depths of 0–5 cm, 5–10 cm, 10–20 cm, and 20–30 cm and transported to the laboratory. Sampling was carried out using a *soil ring*. Each sample was placed in a plastic bag (preferably with the soil intact within the ring) and labeled with the cluster name, plot, and depth. The samples were then transported to the laboratory for testing of organic matter and carbon content.

Peat Soil Carbon Measurement

For peatlands, in addition to determining the carbon content in each layer, information on peat depth is also necessary. This is possible because there is a clear and easily observable distinction between peatland and the underlying organic soil layer. Peat depth data can be used to estimate peat dome volume and overall carbon stocks.

To measure peat depth, a peat drill is required that can reach the deepest peat boundary. Therefore, a peat depth reference is needed based on the results of previous peat research and surveys. Drilling is carried out at the planned drilling point. Drilling is carried out in stages, according to the length of the extension rod, which is usually 1 m. For each additional meter of depth, the drill is removed to detect the presence of mineral soil, either clay or loam. If the mineral soil has not yet been reached, add more extension rods until the mineral soil boundary is reached. Record the total peat depth on form **F6**. Use a tape measure to measure the length from the organic soil to the mineral soil boundary. This length is then added to the total length of previous drilling at the same point to obtain the total peat depth.

Peat soil sampling was carried out at each representative depth, around 3–5 samples representing at least shallow, medium and deep depths. For example, if the total peat depth is approximately 5 meters, samples can be taken at depths of 1, 3, and 5 meters. Samples are taken using a *peat sampler* with a known volume (e.g., an *Eijkelpomp*) or a peat corer with a known tube diameter. For *peat coring*, measure the length of the soil sample to be collected to determine the sample volume. Place the sample in a plastic bag and label it with 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 auger as for peatland. Unlike peatland, mangrove soil is difficult to distinguish from the mineral soil layer. Soil samples are typically taken to a depth of 3–5 m. If the soil depth to be measured is only 3 meters, samples should be taken at depths of 1, 2, and 3 meters. The samples are then taken to a laboratory for testing for organic matter 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 diameter 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 (at a flat distance) forming a '+' sign around subplot B (**Figure 8**).

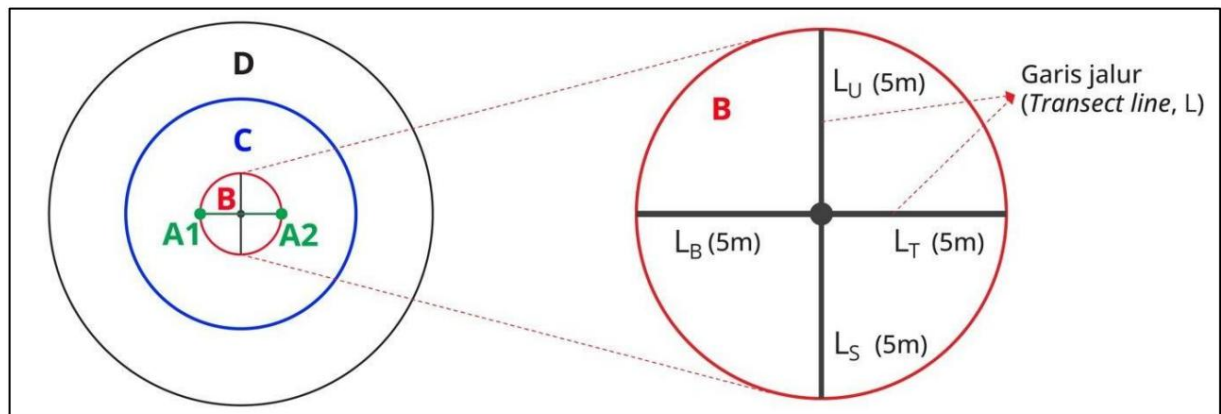


Figure 8. Location of transect lines for dead wood measurements using the Line Intersect Sampling method.

Deadwood measurements using the LIS method can be conducted by the survey team after tree measurements (dead and live) or in parallel with other activities by several team members. The stages of deadwood measurement 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 in the four cardinal directions: east (called L_T), west (called L_B), north (called L_U), and south (called L_S) each with a flat distance of 5 m.

On sloping ground, the length of each transect line must be corrected using the slope angle. If *Vertex* is used to determine the 5 m horizontal transect line distance, the slope angle correction is automatically calculated by *Vertex* (note: this is the preferred method). However, if the transect line distance is measured using a measuring tape or rope, the transect line distance must be corrected using the slope angle (see **Table 4** in **Appendix 2**).

In this case, the survey team must ensure that the transect line length is always exactly 5 m when projected onto a flat surface.

- 3) Identify and measure the diameter and angle of inclination of dead wood (with a diameter of ≥ 10 cm) that intersects the transect line (measuring tape or rope) with the following provisions:
 - The diameter of dead wood is measured at the point where the dead wood (e.g. a fallen trunk or branch) intersects the transect line (**Figure 9a**), and is measured perpendicular to the central axis of the dead wood.
 - After measuring the diameter of the dead wood, at the intersection point, measure the tilt angle of the dead wood, which is the angle between the center axis of the dead wood trunk and an imaginary horizontal line at the intersection point (the line



(dotted red in **Figure 9a**). Measuring the angle of inclination of dead wood (in degrees) can be done using *Vertex* or other tools, including a protractor, digital angle ruler, or an angle measuring app on a *smartphone*.

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

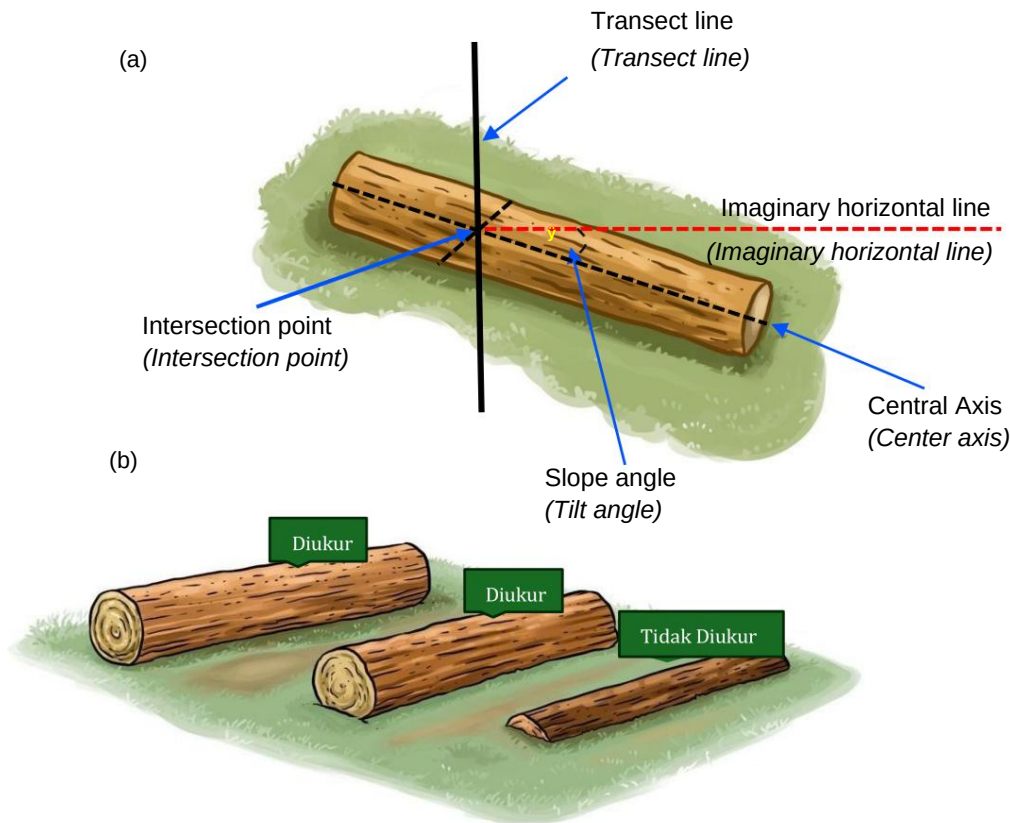


Figure 9. Deadwood measurement provisions using the LIS method

- 4) Estimate the level of decay of each dead wood by hitting or slashing a machete/cleaver on 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 rotten, if the machete that is slashed has difficulty penetrating the dead wood or the machete tends to bounce back.
 - Class 2: slightly rotten, if the machete that is slashed can easily penetrate the dead wood.
 - Class 3: rotten, if the machete that is slashed very easily penetrates the dead wood.
- 5) Record the results of the dead wood measurements on the four line lines (Lt, Lb, Lu, and Ls) on form **F7**.



4.8 Rattan and Liana

Rattan and liana measurements were carried out in all plots in subplot C. All types and sizes of rattan and liana 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 is <3 m long, while mature rattan is ≥3 m long. The stages of measuring young and mature rattan are as follows:

- 1) Observe the presence of all young rattan (length <3 m) and adult rattan (length ≥3 m) that are in subplot C. Use a distance measuring tool (e.g. *Vertex*) to determine whether the rattan (individual, clump, or stem section) 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 clumped), species name, and number of stems in each clump.
- 3) If adult rattan is found, 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 the diameter measurement point at a length of 1.3 m from the top of the root. Rattan measurements are carried out if:
 - Rattan has roots in subplot C and all or part of its stem is 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 length of the stem that is measured is only that which is 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 of the entire stem, including the part of the stem that is outside subplot C.

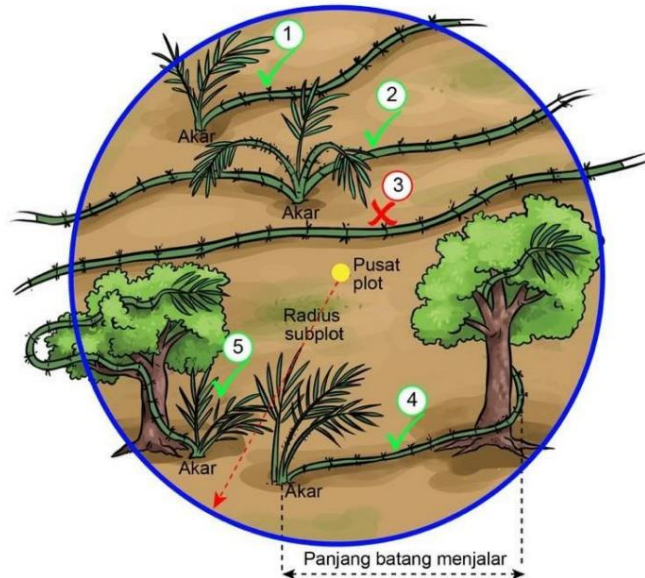


Figure 10. Rattan measurement provisions in subplot C

Liana Measurement

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 (diameter <5 cm) and large lianas (diameter $\geq$ 5 cm) contained 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 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 were also carried out by the survey team on subplot C with the following procedure:

- 1) Observe the presence of bamboo, both solitary and clumped, which is found in subplot C.
- 2) If a solitary bamboo is found, measure and record it on form **F9**: species name, age class, stem diameter, and total stem height.

Measurement of stem diameter was carried out at a height of 1.3 m from the surface.



The soil or shifted slightly in the middle of the segment if the 1.3 m height is located exactly 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-aged: the trunk is covered with slightly piled lichens (Fig **12b**).
- Old age: the trunk is covered with thick layers of lichen (**Figure 12c**).

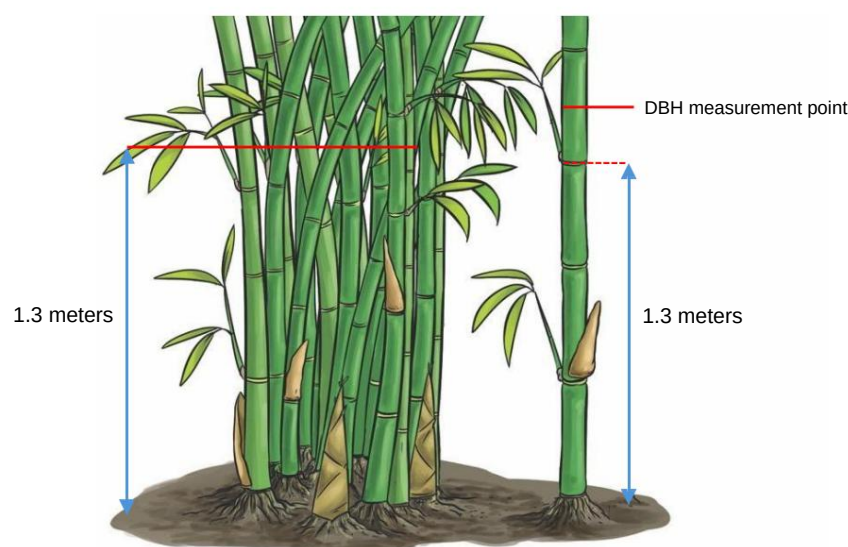


Figure 11. Measurement of the diameter of the bamboo stem at a height of 1.3 m or slightly shifted above it in the middle of the bamboo segment (IPSDH, 2021)

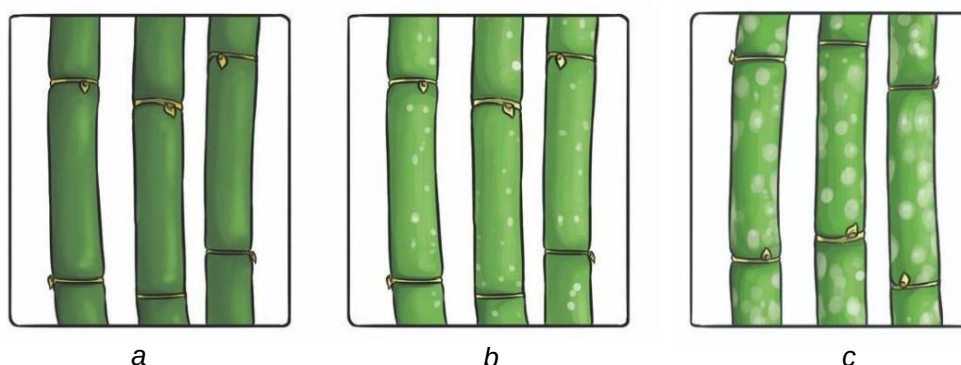


Figure 12. Characteristics of young (a), medium (b), and old (c) bamboo based on the presence of lichen on the stem (IPSDH, 2021)

- 3) If bamboo clusters are found, then identify whether the center point of the cluster is inside or outside subplot C. Measurements of bamboo clusters are only carried out if the center point of the cluster 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 exactly on 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** is not measured, and clump **R7** is measured as shown in **Figure 13**.

- 4) On 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 which represents the average height of the stems in the clump.

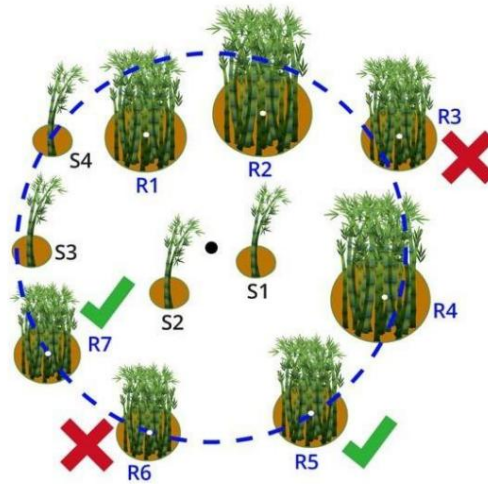


Figure 13. Possible positions of solitary bamboo (S1, S2, S3, S4) and clumped bamboo (R1, R2, ..., R7) in subplot C

4.10 Palm

Palm trees are a type of vegetation commonly found in tropical regions and belong to the *Arecaceae/ Palmae family*. Palm trees are characterized by a single, branchless trunk and leaves with sheaths that resemble bird feathers. Palm tree measurements were taken in each plot in subplot C using the following procedure:

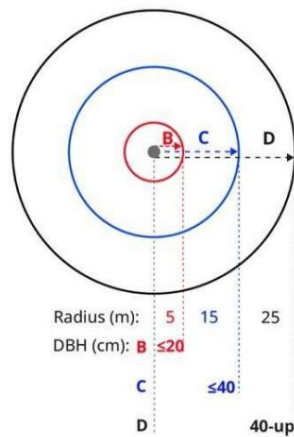
- 1) Identify the types of palm (including nipah palm if in coastal areas) found in subplot C.
- 2) For each individual palm (with a diameter of ≥ 5 cm), measure and record on form **F10**: species name, palm type, stem diameter, and total height. Palms are divided into three categories, namely: (1) Tall and thin (such as areca nut), (2) Short and fat (such as young oil palm, nipah), and (3) Medium height (such as coconut, sago, etc.). Diameter measurements are carried out at a height of 1.3 m above ground level.



4.11 Trees and Dead Trees

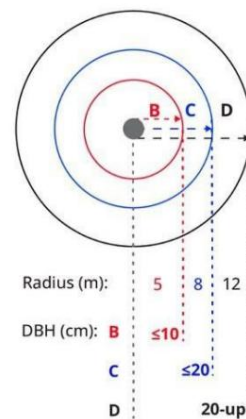
Measurements of live and dead trees were conducted in subplots B, C, and D with the provisions of the subplot radius and tree diameter limit (DBH) for the HLKRT strata (dryland forest, swamp, and plantations), PDLH/TOF strata, and mangrove forest strata as in **Figure 14**. Subplot boundaries do not need to be physically established 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 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.

Hutan Lahan Kering, Rawa, Tanaman (HLKRT) & TOF



*) DBH minimum: 5 cm

Hutan Mangrove (HM)



*) DBH minimum: 5 cm

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

Measurement and recording of live and dead trees in the three subplots was 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 the 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 base plane of the stem is located within the subplot or most (>50%) of the stem 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 the stem is outside the boundaries of subplot B.
- On the other hand, for tree 'd' with a diameter of 9 cm, it was not measured in subplot B because the center point of the trunk was outside the boundaries of subplot B. If the estimated point



the center of the base plane of the trunk is exactly on the subplot boundary, so 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 no 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.

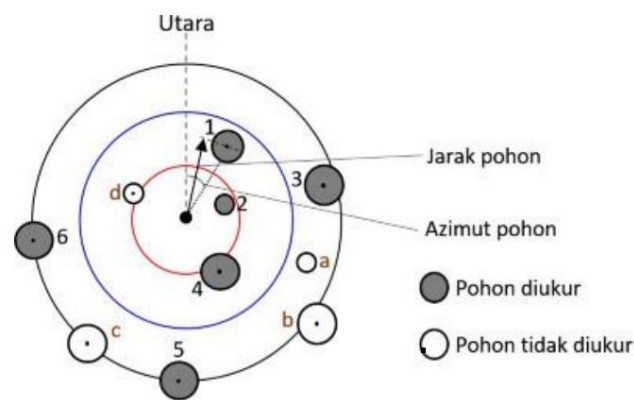


Figure 15. Sequence of tree measurements, determination of measured and unmeasured trees, and determination of tree distance and azimuth.

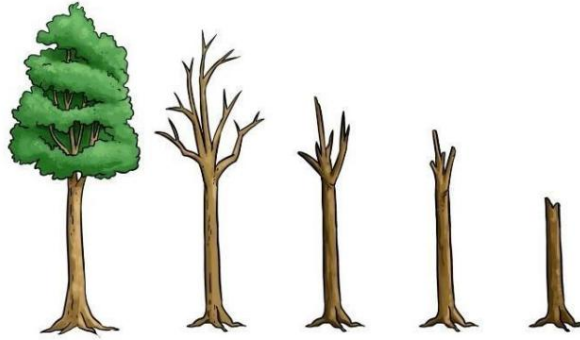
3) All trees and dead trees are labeled with the serial number of the tree in the plot. Tree labels can be made of durable yellow/red plastic.

4) For each '*measured tree*', observe and record the status of the tree 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 form **F11**.

Known tree species can be selected from the tree list in the *Collect Mobile* (CM) application. For trees with unknown species names, recording can be done using local names accompanied by photographs (leaf, stem, fruit, etc.) and/or a herbarium for further species identification purposes. Instructions for creating a herbarium refer to Appendix 3 of this guide.

Include the photo and/or herbarium number on the **F11** form in the format: cluster number, plot number, and tree number, for example: 110001-PP-PH5, which means cluster 110001, plot P, and tree 5.

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 to the nearest 0.1 cm (e.g., 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 measuring diameter, the diameter tape should be wound (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)):

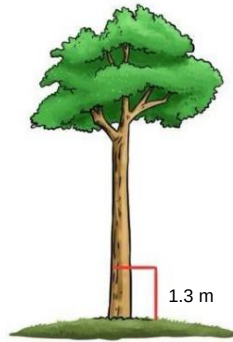
- Tree standing upright (normal) on flat ground: DBH is measured 1.3 m from the ground surface (**Figure 16a**).
- Leaning trees on flat ground: DBH is measured 1.3 m from the nearest ground surface or in the direction of the trunk slope (**Figure 16b**).
- Trees standing upright on sloping ground: DBH is measured 1.3 m from the surface highest ground/top side (**Figure 16c**).
- Deformed (bloated) tree at exactly 1.3 m: DBH is measured at the boundary of the part that begins to normalize at the top or bottom of the mark, whichever is closest (**Figure 16d**).
- Trees with branches >1.3 m: DBH is measured 1.3 m from the ground surface and considered as one tree (**Figure 16e**).
- Trees with branches <1.3 m: DBH is measured 1.3 m from the ground surface on each branch and is considered a different tree (**Figure 16f**).
- Trees with taproots (e.g. *Rhizophora* spp.): if the height of the roots support is ≥ 1.3 m, then the DBH is measured 1.3 m from the ground surface (**Fig**



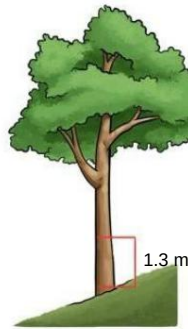
16g), or if the height of the supporting roots is >1.3 m then the DBH is measured 20 cm from the top of the supporting roots (**Figure 16h**).

- Trees with buttresses >1.3 m: DBH is measured 20 cm above the buttress on the trunk, which begins to return to normal (**Figure 16i**).

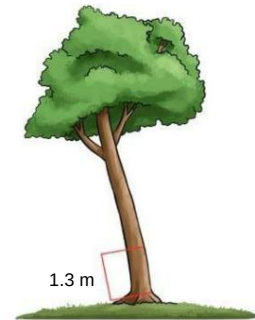
In detail, the method of measuring tree diameter is explained in **Appendix 2C**.



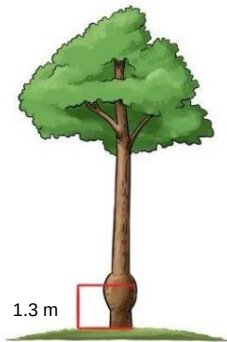
a. Normal tree: DBH is measured 1.3 m from the ground surface



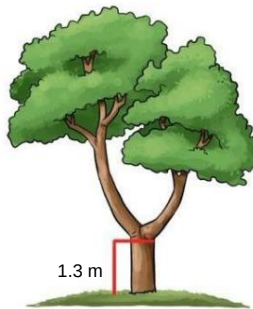
b. Normal trees on sloping land: DBH is measured 1.3 m from the highest ground surface.



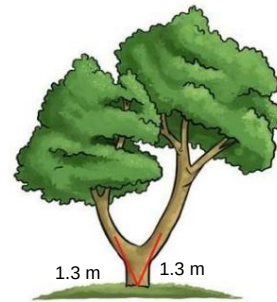
c. Leaning tree: DBH is measured 1.3 m from the nearest ground surface or in the same direction tree tilt



d. Defective tree: If 1.3 m is exactly on the defective (swollen) trunk, DBH is measured at the boundary of the section that is starting to return to normal. Above or below depending on the closest



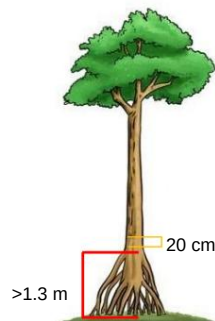
e. Branch tree: If 1.3 m is right at the start of the branch, DBH is measured at the top, under the branches that are still normal



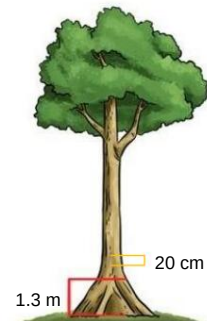
f. Branch tree: If 1.3 m is directly above the branch, measure the DBH on both sides. branches and adjusted as two trunks



g. Trees with supporting roots less than 1.3 m: DBH is still measured at a point 1.3 m from the land.



h. Trees with supporting roots exceeding 1.3 m: DBH is measured 20 cm from the end of the tree, the prop root.



i. buttress trees and mangroves: DBH is measured 20 cm from the buttress boundary

Figure 16. Diameter measurement points for various tree conditions



- 7) Measure the horizontal distance and azimuth from the center of the plot to each tree being measured (**Figure 15**). For ease and speed of measurement, horizontal distances should be measured using an electronic distance meter, such as a Vertex, which takes slope into account. Azimuth is the angle from north to the tree's position (0–360°), which can be measured using a compass or a navigation app on a *smartphone*. This data is needed to create a map of the tree distribution in each plot to facilitate re-measuring clusters in the future.
- 8) After measuring all tree diameters, select six sample trees for height measurement. If the number of trees in the plot is less than six, then height measurements are taken on all trees in the plot. Sample trees should represent the diameter range within the plot and should be growing normally (e.g., without crown breakage or irregular shape). To this end, the survey team can select two sample trees representing the small, medium, and large diameter classes. For each sample tree, measure the crown base height (*bole height*) and total height (*total height*), recorded to 1 decimal place, with the following limits (Husch et al., 2003; **Figure 17**):

- Height of the base of the crown (T-pt, m), namely the vertical distance from the base/base of the tree down to the base point of the header.
- Total height (T-total, m), which is the vertical distance from the base of the tree to the top. treetops.

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

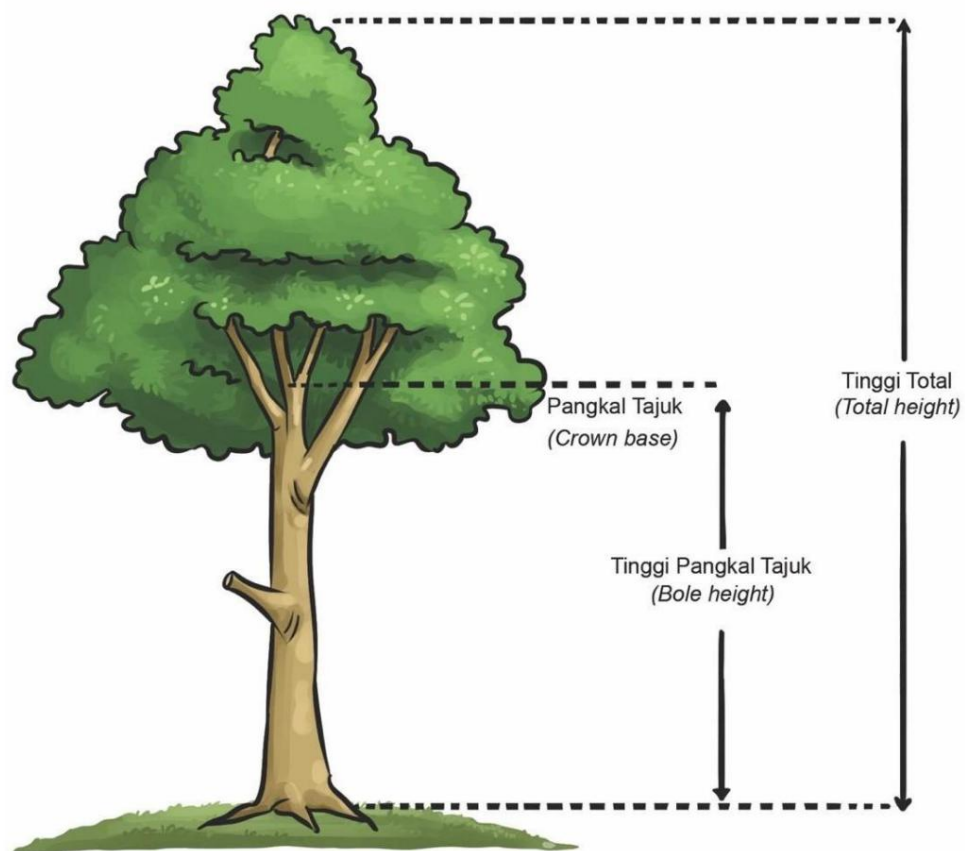


Figure 17. Height of base of crown and total height of tree



9) For each dead tree stump (status 5), measure the height of the stump (in addition to its diameter) and record it (to 1 decimal place) in the "T-total" column in form **F11**.

10) In living trees with a diameter of ≥ 20 cm, observe and record the level of wood quality.
(*timber quality*) according to the following code:

Code F11 (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 edged logs or those with other defects that can reduce the wood volume by up to 25%, such as rot, burnt, branched, or bent logs.
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 a 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 form **F12** with the following information:

- Name: filled with the full names of the team leader and members.
- Position: filled with the position in the team, whether as leader, member, or staff.
local.
- *Mobile phone*: fill in 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 measurements in the field, the survey team coordinated by the head of the inventory implementation team carried out the following post-survey activities:

- 1) Re-check the accuracy and completeness of the inventory data recorded via the *Collect Mobile* application or the 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 *Excel file format*) at BPKH.
- 4) Prepare a report on the implementation of inventory activities and submit it to the section head or person responsible for inventory activities. Data analysis and preparation of the annual IHN report are handled by the IPSDH Directorate.

The inventory report is submitted to the leadership (Head of BPKH or the implementing agency) for evaluation and approval. The inventory implementation report is then submitted to the Director of IPSDH. A schematic representation of this reporting mechanism is shown in **Figure 18**.

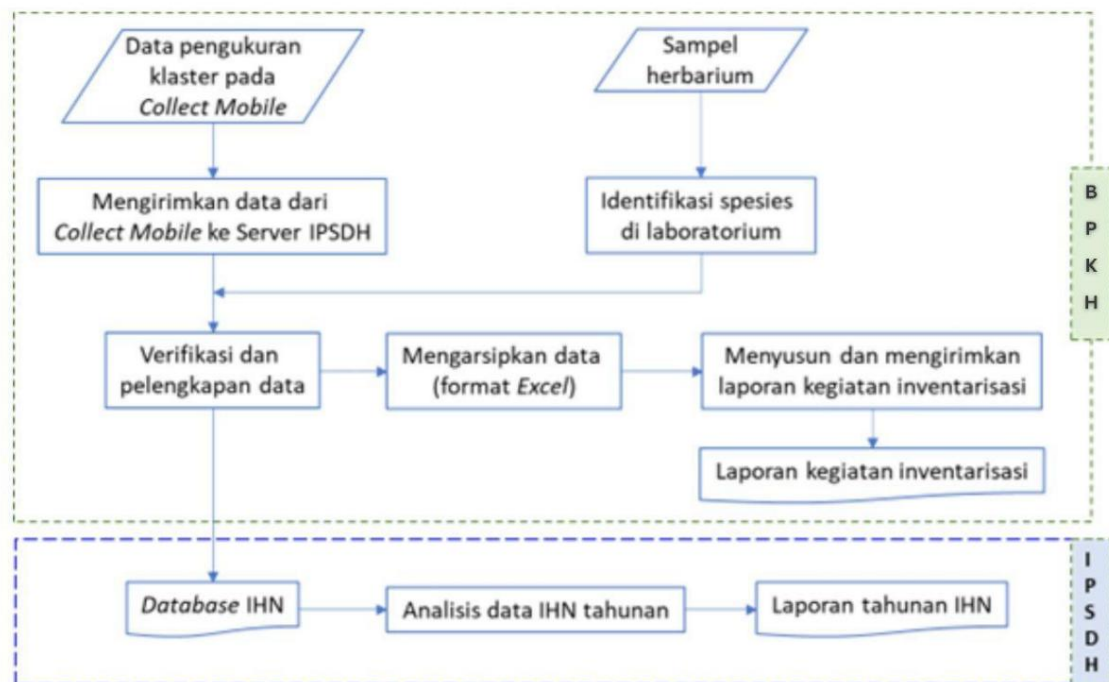


Figure 18. Reporting mechanism for forest inventory activities by BPKH

5.2 Table of Contents of the Report

The report on the implementation of inventory activities is compiled briefly with systematics as follows:

A. Composition of the implementation team

Contains information on the head and members of the implementation team and the person in charge 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. Location of activity

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 geographic coordinates according to the cluster locations determined on the IHN cluster distribution map.

D. Letter of statement regarding implementation of activities

Contains a statement from the Head of the Forest Management Agency (BPKH) stating that the forest inventory activities have been carried out according to the previously prepared activity plan. Furthermore, it should also explain that the field measurement data has been uploaded to the IHN *database* system established by the Directorate of IPSDH. The letter should include an explanation if the activity implementation does not align with the targets or previous plans.

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.



BIBLIOGRAPHY

- National Standardization Agency (BSN). 2011. Carbon Stock Measurement and Calculation – Field Measurement for Forest Carbon Stock Estimation (*ground-based forest carbon accounting*). Jakarta.
- DeYoung, J., 2016. Forest Measurements: An Applied Approach. Open Oregon Educational Resources, Oregon.
- FAO, 2012. National Forest Monitoring and Assessment - Manual for Integrated Field Data Collection, Version 3.0. ed. National Forest Monitoring and Assessment Working Paper NFMA 37/E. Food and Agriculture Organization (FAO), Rome.
- Fehrmann, L., Kleinn, C., Magdon, P., Perez-Cruzado, C., 2017a. Definition of a Minimum Standard for Forest Management Inventories at KPH Level. GIZ FORCLIME, Jakarta.
- Fehrmann, L., Kleinn, C., Magdon, P., Perez-Cruzado, C., 2017b. Definition of a Minimum Standard for Forest Management Inventories at KPH Level. Jakarta.
- Gerwing, JJ, Schnitzer, S.A., Burnham, RJ, Bongers, F., Chave, J., DeWalt, SJ, Ewango, CEN, Foster, R., Kenfack, D., Martinez-Ramos, M., Parren, M., Parthasarathy, N., Perez-Salicrup, DR, Putz, FE, Thomas, DW, 2006. A standard protocol for liana censuses. *Biotropica* 38, 256–261.
- Husch, B., Beers, T.W., Kershaw, J.A., 2003. Forest Mensuration. John Wiley & Sons, New Jersey.
- IPSDH, 2020. Technical Guidelines for Interpreting Medium-Resolution Satellite Imagery for Updating National Land Cover Data. Directorate of Forest Resources Inventory and Monitoring (IPSDH), Ministry of Environment and Forestry, Jakarta.
- IPSDH, 2021. Technical Guidelines for Bamboo Inventory in Forest Management Units (KPH). Directorate of Forest Resources Inventory and Monitoring (IPSDH), Ministry of Environment and Forestry, Jakarta.
- Kleinn, C., Traub, B., Hoffmann, C., 2002. A note on the slope correction and the estimation of the length of line features. *Canadian Journal of Forest Research* 32, 751–756. <https://doi.org/10.1139/x02-004>
- KLHK, 2020. Indonesian Forestry Vademecum. Ministry of Environment and Forestry (KLHK) Indonesia, Jakarta.
- Manuri, S., Putra, CAS, Saputra, AD, 2011. Forest Carbon Stock Estimation Techniques. Merang REDD Pilot Project - German International Cooperation (GIZ), Palembang.
- Marshall, P., Davis, G., LeMay, V., 2000a. Using Line Intersect Sampling for Coarse Woody Debris. Technical Report TR-003. Research Section, Vancouver Forest Region, Vancouver.
- Marshall, P., Davis, G., LeMay, V., 2000b. Using Line Intersect Sampling for Coarse Woody Debris. Vancouver.
- Rusolono, T., Tiryana, T., Purwanto, J., Sumantri, H., 2015. Guide to Carbon Stock and Flora Diversity Survey in South Sumatra. GIZ BIOCLIME, Palembang.
- Tokola, T., Vesa, L., 2023a. NFI Design Plan for Indonesian Forests. Food and Agriculture Organization (FAO), Jakarta.
- Tokola, T., Vesa, L., 2023b. NFI Design Plan for Indonesian Forests. Jakarta.
- Van Laar, A., Akca, A., 2007. Forest Mensuration. Springer, Dordrecht.
- Walker, SM, Pearson, TR, Casarim, FM, Harris, N., Petrova, S., Graiss, A., Swails, E., Netzer, M., Goslee, KM, Brown, S., 2012. Standard Operating Procedures for Terrestrial Carbon Measurement. Winrock International, Arlington.





**DIREKTORAT JENDERAL
PLANOLOGI KEHUTANAN**

**KEMENTERIAN KEHUTANAN
REPUBLIK INDONESIA**

ATTACHMENT

Appendix 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-Mountain Papua ý96-Southwest Papua
F1-5 Land type	ý1/Drylands, swamps, and plants ý2/Mangroves ý3/Trees outside forest
F1-6 Cluster data types	ý1/Planned ý2/ Unplanned ý3/Quality assurance (QA/QC)
F1-7 Survey team:	
-Implementation unit	ý1/BPKH Unit ... ý2/ QA/QC Team ý3/ Other parties
- Team leader	...
F1-8 Accommodation (<i>base camp</i>)	Name: ... X coordinate: ... Y coordinate: ...



Appendix 1 (continued)

F1-9	Survey time:	
	Departure from the starting point to the parking location or cluster	Start date & time: End date & time:
	Departure from the parking location to the cluster location	Start date & time: End date & time:
	Return from cluster location to parking location or starting point	Start date & time: End date & time:
F1-10	Accessibility cluster	ý1/Accessible ý2/Inaccessible due to difficult topography and/or dangerous ý3/Cannot be accessed because it is not permitted by the administrator/community ý4/Inaccessible for other reasons....
F1-11	Physical evidence of cluster inaccessible	ýPhoto 1 ýPhoto 2 ýPhoto 3 ýX (<i>Easting</i>) coordinate of the last access point ýY (<i>Northing</i>) coordinate of the last access point ýMinutes
F1-12	Main types of HHBK	
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	ÿPlot P ÿPlot U ÿT Plot	
F2-3 Plot accessibility	ÿ1/Accessible ÿ2/ Inaccessible due to difficult/dangerous topography ÿ3/Inaccessible due to being located in water ÿ4/Inaccessible but visible	
F2-4 Plot measurement time:		
-Date (dd/mm/yy)		
-Start time (hours:minutes)		
-End time (hours:minutes)		
F2-5 Plot location:		
-X coordinate (<i>Easting</i>)		
-Y coordinate (<i>Northing</i>)		
-GPS accuracy (m)		
-Distance to plot center (m)		
-Azimuth to center of plot (°)		
-Photo of information board		
-Photo of PVC pipe		
F2-6 Plot center marking:	ÿ1/Yes ÿ2/No 1.1 Witness point 1: -X coordinate (<i>Easting</i>): -Y coordinate (<i>Northing</i>): -GPS accuracy (m): -Distance from plot center (m): -Azimuth from center of plot (°): -Photo: -Type: 1.2 Witness point 2: -X coordinate (<i>Easting</i>): -Y coordinate (<i>Northing</i>): -GPS accuracy (m): -Distance from plot center (m):	



		-Azimuth from center of plot (°):
		-Photo:
		-Type:

Appendix 1 (continued)

F2-7	Elevation (masl)		
F2-8	Slope gradient (%)		
F2-9	Slope gradient aspect	ý1/North ý2/Northeast ý3/East ý4/Southeast ý5/South ý6/Southwest ý7/West ý8/Northwest ý9/Flat	
F2-10	Land cover categories	ý1/Forest ý2/Non-forest/TOF	
F2-11	Class of <i>land</i> cover ý2001/Hp in the field ý2002/Hs ý2004/Hmp ý20041/Hms ý2005/Hrp ý20051/Hrs ý2006/Ht ý2007/ B	ý20071/Br ý2010/Pk ý2012/Pm ý2014/T ý3000/S ý20091/Pt ý20092/Pc ý20093/Sw	ý20094/Tm ý20121/Bdr/Plb ý20122/Tr ý20141/Tb ý50011/Rw ý5001/A
F2-12	Forest type	ý1/Ht-Mangrove ý7/Ht-Monsoon Mountains ý2/Ht-Nipah ý8/Monsoon Savanna ý3/Ht-Beach ý9/Ht-Plants ý4/Ht-Freshwater swamp ý10/Ht-Sago ý5/Ht-Peat swamp ý11/Ht-Bamboo ý6/Ht-Kerangas ý12/Other...	
F2-13	Non- <i>agricultural</i> land use forest/TOF	ý1/ Monoculture forest ý2/Forest people mixture ý3/Agroforestry	ý4/Agriculture ý5/Farming ý6/Tambak ý7/Other...
F2-14	Proportion (%) of area ý1/100% of plot located in the classroom area observed land closure	ý2/75–99% ý5/0–24% ý3/50–74% ý4/25–49%	
F2-15	Canopy density level	ý1/Meeting (>60%) ý2/Moderate (30–60%) ý3/Rarely (10 – 29%) ý4/Open (0–9%)	
F2-16	Structure vertical stand	ý1/One header layer at the same height ý2/One layer of canopy of different height ý3/Multi-layer header is clearly visible ý4/Vertical structure is diverse and gapped ý5/The vertical structure is very diverse	



Appendix 1 (continued)

F2-17	Fire forest/land	ÿ1/No fire ÿ2/Fire occurred recently ÿ3/Fire occurred a long time ago ÿ1/None ÿ2/Road construction
F2-18	Forest disturbance types	ÿ3/Logging ÿ4/Shifting cultivation ÿ5/Pests and diseases ÿ6/Other:
F2-19	Plot condition photo:	ÿ1/North, Photo number: ÿ2/East, Photo number: ÿ3/South, Photo number: ÿ4/West, Photo number:



Appendix 1 (continued)

Form 3: Regeneration

Plot General Information					
Cluster number ...					
Plot number		yP Plot yU Plot yT Plot			
Position of subplot A		y1/West East y2/North South	- -	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 Sp	Species code	Name (Latin/local) of the species			Number of stems
Notes:					



Appendix 1 (continued)

Form 4: Lower Plants

General Information Sample Plot			
Cluster number	...		
Plot number	yP Plot yU Plot yT Plot		
Subplot position A y1/	West – East	Opsi 1: Barat - Timur Opsi 2: Utara - Selatan	
y2/	North South		
Are undergrowth found? y No y Yes (fill in the table below)			
Understory weighing: <i>clip-plots</i> A1 and A2			
TBB (grams)	BBS (grams)	Sample number	BKS (grams)
Notes:			

Information:

- 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 laboratory analysis results.
- 2) The undergrowth sample number begins with the letters TB followed by the cluster and plot number, for example: TB-110001-PP, meaning the undergrowth sample is in Cluster 110001 and Plot P.
- 3) Sampling for laboratory analysis is only carried out in certain previously determined clusters.



Appendix 1 (continued)

Form 5: Litter

General Information Sample Plot			
Cluster number	...		
Plot number	ÿP Plot ÿU Plot ÿT Plot		
Subplot position A ÿ1	West – East	Opsi 1: Barat - Timur Opsi 2: Utara - Selatan	
ÿ2	North – South		
Was litter found? ÿ No ÿ Yes (fill in the table below)			
Litter weighing: <i>clip-plots</i> A1 and A2			
TBB (grams)	BBS (grams)	Sample number	BKS (grams)
Notes:			

Information:

- 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 laboratory analysis results.
- 2) The litter sample number begins with the letters SR followed by the cluster and plot number, for example: SR-110001-PP, meaning the litter sample is in Cluster 110001 and Plot P.
- 3) Sampling for laboratory analysis is only carried out in certain previously determined clusters.



*Appendix 1 (continued)***Form 6: Soil Carbon**

General Information Sample Plot	
Cluster number	...
Plot number	ÿP Plot ÿU Plot ÿT Plot
Soil type	ÿ Minerals ÿ Peat ÿ Mangroves
Depth (peat only)	 cm

Sampling:			
Depth layer	Sample code	Sample volume (cm3)	Notes



Appendix 1 (continued)

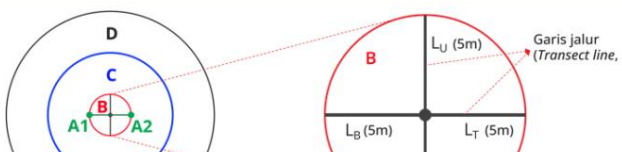
Form 7: Dead Wood

General Information Sample Plot	
Cluster number	...
Plot number	P Plot ŷ U Plot ŷ T Plot

Was dead wood found?

☐ No ☐ Yes (fill in the table below)

[illegible]

Notes:	Measurement location:
	

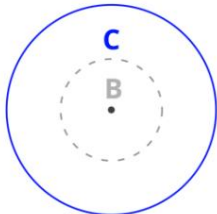


Appendix 1 (continued)

Form 9: Bamboo

General Information Sample Plot	
Cluster number	...
Plot number	ÿP Plot ÿU Plot ÿT Plot

[illegible]

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, it is measured on 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	ŷP Plot ŷU Plot ŷT Plot

[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.)	





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

Information:	Measurement location: Subplots 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 was not measured, the value is 0 (zero) or left blank. Photo/herbarium no.: Only for trees whose species name is not yet known	



Appendix 1 (continued)

Form 12: Survey Team List

No.	Name	Position *)	Mobile phone	E-mail

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



Appendix 2. Field Measurement Techniques

A. Slope Inclination 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 level distance. For example, a slope of 10% indicates that the field elevation changes by 10 m for every 100 m of level distance (**Figure 19a**). The slope can exceed 100% (equivalent to $>45^\circ$) if the incline is steep (**Figure 19b**).

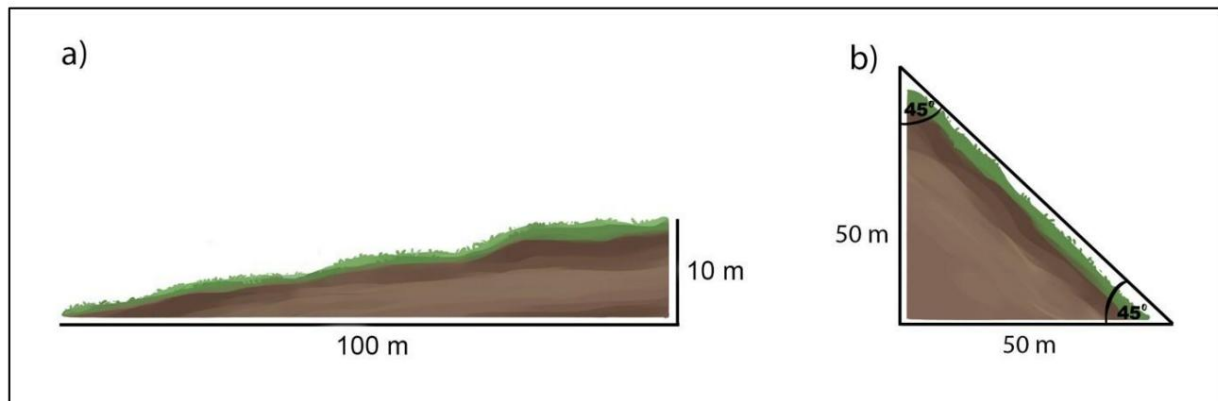


Figure 19. Illustration of slope gradient (a) 10% and (b) 100%

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

- 1) Determine the 0% *slope* point parallel to the eye level of the measuring instrument on a part of the coworker's body, for example the nose in **Figure 20a**. Alternatively, both measuring instruments use a stick that is the same height as the eye level.
- 2) Ask a coworker to walk up or down to the measurement point. certain in the field (e.g. plot boundaries).
- 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).



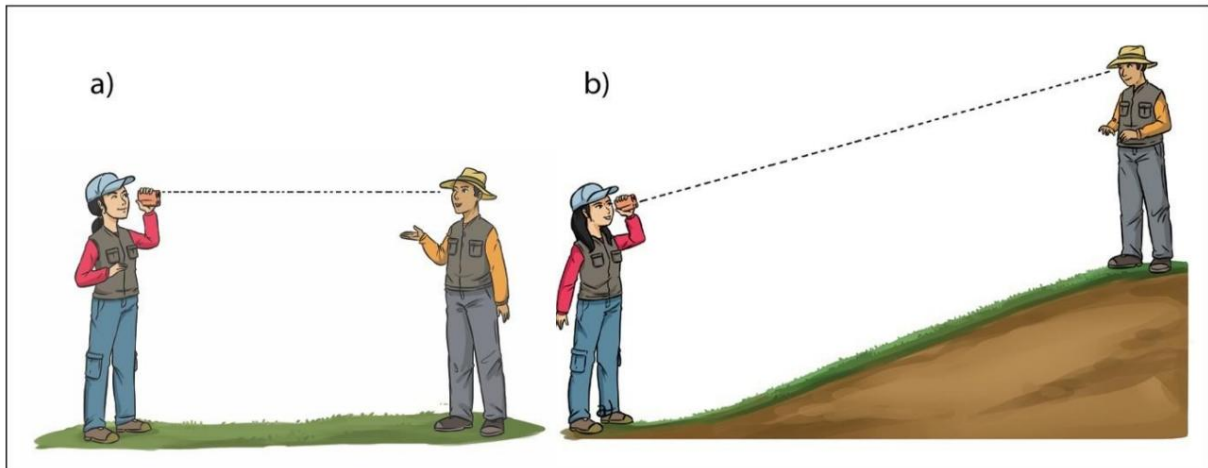


Figure 20. How to determine (a) the 0% slope point on the nose of a colleague and its use when (b) measuring the slope by two members of the survey team (source: adapted from DeYoung, 2016) How to determine (a) the 0% slope point on the nose of a colleague and its use when (b) measuring the slope by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

B. **Slope Correction for Plot Distance and Radius**

All distances *used* in field measurements are horizontal distances, such as the distance between plots or the distance from the center of a plot to each tree in the plot. If the land is flat, distance measurements can be made directly because the distance measured is already a horizontal distance. However, if the land is not flat, the field distance calculated based on the horizontal distance and the slope gradient can be used, as shown in **Figure 21**. For example, if the survey team requires a horizontal distance of 20 m on land with a slope of 20%, then the field distance measured on that land is 20.40 m. **Table 4** presents the values of field distances based on the desired horizontal distances (2, 5, 8, 12, 15, 25, and 50 m) at various slope gradients. If the desired horizontal distance is not available in **Table 4**, then the field distance at a certain slope gradient 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.

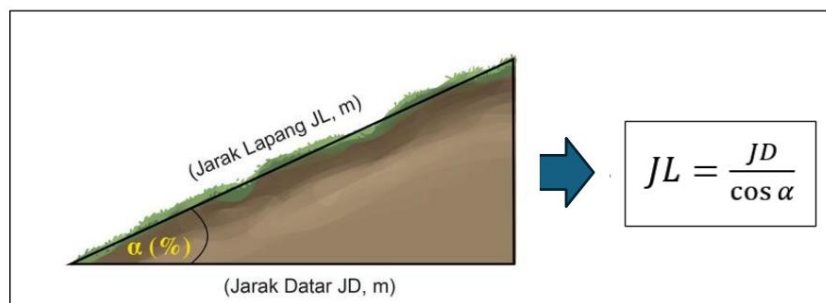


Figure 21. Slope correction for distance measurement

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 is necessary if the plot radius measurement is done manually or without using modern measuring tools that take slope into account (e.g., *Vertex*). **Table 5** presents the plot radius correction values for various slope angles and desired plot radii. For example, if the survey team is going to create a plot with a radius of 15 m on land with a slope of 30%, then in the field the survey team must create a plot with a radius of 15.33 m.

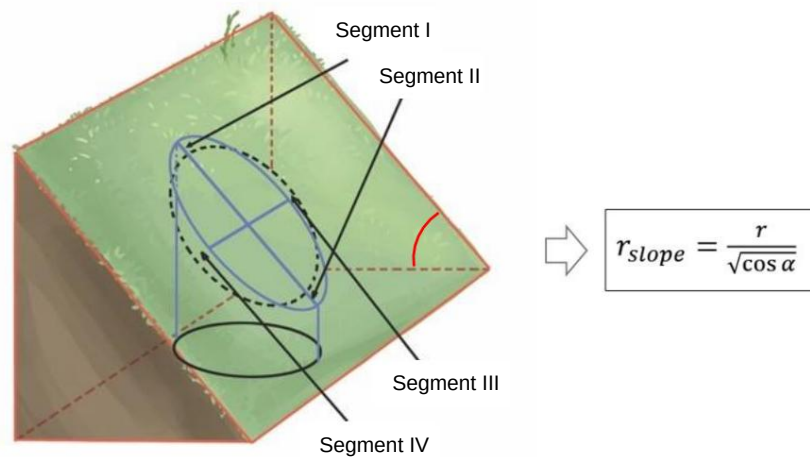


Figure 22. Correction of plot radius on slope (source: adapted from Kleinn et al. (2002))



Table 4. Slope correction for distance measurement

Kemiringan α (%)	Faktor α (°)	Jarak (m)								Kemiringan α (%)	Faktor α (°)	Jarak (m)							
		(f)	2	5	8	12	15	25	50			(f)	2	5	8	12	15	25	50
1	0.6	1.000	2.00	5.00	8.00	12.00	15.00	25.00	50.00	66	33.4	1.198	2.40	5.99	9.59	14.38	17.97	29.95	59.91
2	1.1	1.000	2.00	5.00	8.00	12.00	15.00	25.00	50.01	67	33.8	1.204	2.41	6.02	9.63	14.44	18.06	30.09	60.19
3	1.7	1.000	2.00	5.00	8.00	12.01	15.01	25.01	50.02	68	34.2	1.209	2.42	6.05	9.67	14.51	18.14	30.23	60.46
4	2.3	1.001	2.00	5.00	8.01	12.01	15.01	25.02	50.04	69	34.6	1.215	2.43	6.07	9.72	14.58	18.22	30.37	60.75
5	2.9	1.001	2.00	5.01	8.01	12.01	15.02	25.03	50.06	70	35.0	1.221	2.44	6.10	9.77	14.65	18.31	30.52	61.03
6	3.4	1.002	2.00	5.01	8.01	12.02	15.03	25.04	50.09	71	35.4	1.226	2.45	6.13	9.81	14.72	18.40	30.66	61.32
7	4.0	1.002	2.00	5.01	8.02	12.03	15.04	25.06	50.12	72	35.8	1.232	2.46	6.16	9.86	14.79	18.48	30.81	61.61
8	4.6	1.003	2.01	5.02	8.03	12.04	15.05	25.08	50.16	73	36.1	1.238	2.48	6.19	9.90	14.86	18.57	30.95	61.91
9	5.1	1.004	2.01	5.02	8.03	12.05	15.06	25.10	50.20	74	36.5	1.244	2.49	6.22	9.95	14.93	18.66	31.10	62.20
10	5.7	1.005	2.01	5.02	8.04	12.06	15.07	25.12	50.25	75	36.9	1.250	2.50	6.25	10.00	15.00	18.75	31.25	62.50
11	6.3	1.006	2.01	5.03	8.05	12.07	15.09	25.15	50.30	76	37.2	1.256	2.51	6.28	10.05	15.07	18.84	31.40	62.80
12	6.8	1.007	2.01	5.04	8.06	12.09	15.11	25.18	50.36	77	37.6	1.262	2.52	6.31	10.10	15.15	18.93	31.55	63.11
13	7.4	1.008	2.02	5.04	8.07	12.10	15.13	25.21	50.42	78	38.0	1.268	2.54	6.34	10.15	15.22	19.02	31.71	63.41
14	8.0	1.010	2.02	5.05	8.08	12.12	15.15	25.24	50.49	79	38.3	1.274	2.55	6.37	10.20	15.29	19.12	31.86	63.72
15	8.5	1.011	2.02	5.06	8.09	12.13	15.17	25.28	50.56	80	38.7	1.281	2.56	6.40	10.24	15.37	19.21	32.02	64.03
16	9.1	1.013	2.03	5.06	8.10	12.15	15.19	25.32	50.64	81	39.0	1.287	2.57	6.43	10.30	15.44	19.30	32.17	64.34
17	9.6	1.014	2.03	5.07	8.11	12.17	15.22	25.36	50.72	82	39.4	1.293	2.59	6.47	10.35	15.52	19.40	32.33	64.66
18	10.2	1.016	2.03	5.08	8.13	12.19	15.24	25.40	50.80	83	39.7	1.300	2.60	6.50	10.40	15.59	19.49	32.49	64.98
19	10.8	1.018	2.04	5.09	8.14	12.21	15.27	25.45	50.89	84	40.0	1.306	2.61	6.53	10.45	15.67	19.59	32.65	65.30
20	11.3	1.020	2.04	5.10	8.16	12.24	15.30	25.50	50.99	85	40.4	1.312	2.62	6.56	10.50	15.75	19.69	32.81	65.62
21	11.9	1.022	2.04	5.11	8.17	12.26	15.33	25.55	51.09	86	40.7	1.319	2.64	6.59	10.55	15.83	19.78	32.97	65.95
22	12.4	1.024	2.05	5.12	8.19	12.29	15.36	25.60	51.20	87	41.0	1.325	2.65	6.63	10.60	15.91	19.88	33.14	66.27
23	13.0	1.026	2.05	5.13	8.21	12.31	15.39	25.65	51.31	88	41.3	1.332	2.66	6.66	10.66	15.98	19.98	33.30	66.60
24	13.5	1.028	2.06	5.14	8.23	12.34	15.43	25.71	51.42	89	41.7	1.339	2.68	6.69	10.71	16.06	20.08	33.47	66.93
25	14.0	1.031	2.06	5.15	8.25	12.37	15.46	25.77	51.54	90	42.0	1.345	2.69	6.73	10.76	16.14	20.18	33.63	67.27
26	14.6	1.033	2.07	5.17	8.27	12.40	15.50	25.83	51.66	91	42.3	1.352	2.70	6.76	10.82	16.22	20.28	33.80	67.60
27	15.1	1.036	2.07	5.18	8.29	12.43	15.54	25.90	51.79	92	42.6	1.359	2.72	6.79	10.87	16.31	20.38	33.97	67.94
28	15.6	1.038	2.08	5.19	8.31	12.46	15.58	25.96	51.92	93	42.9	1.366	2.73	6.83	10.92	16.39	20.48	34.14	68.28
29	16.2	1.041	2.08	5.21	8.33	12.49	15.62	26.03	52.06	94	43.2	1.372	2.74	6.86	10.98	16.47	20.59	34.31	68.62
30	16.7	1.044	2.09	5.22	8.35	12.53	15.66	26.10	52.20	95	43.5	1.379	2.76	6.90	11.03	16.55	20.69	34.48	68.97
31	17.2	1.047	2.09	5.23	8.38	12.56	15.70	26.17	52.35	96	43.8	1.386	2.77	6.93	11.09	16.63	20.79	34.66	69.31
32	17.7	1.050	2.10	5.25	8.40	12.60	15.75	26.25	52.50	97	44.1	1.393	2.79	6.97	11.15	16.72	20.90	34.83	69.66
33	18.3	1.053	2.11	5.27	8.42	12.64	15.80	26.33	52.65	98	44.4	1.400	2.80	7.00	11.20	16.80	21.00	35.00	70.01
34	18.8	1.056	2.11	5.28	8.45	12.67	15.84	26.41	52.81	99	44.7	1.407	2.81	7.04	11.26	16.89	21.11	35.18	70.36
35	19.3	1.059	2.12	5.30	8.48	12.71	15.89	26.49	52.97	100	45.0	1.414	2.83	7.07	11.31	16.97	21.21	35.36	70.71
36	19.8	1.063	2.13	5.31	8.50	12.75	15.94	26.57	53.14	101	45.3	1.421	2.84	7.11	11.37	17.06	21.32	35.53	71.07
37	20.3	1.066	2.13	5.33	8.53	12.80	15.99	26.66	53.31	102	45.6	1.428	2.86	7.14	11.43	17.14	21.43	35.71	71.42
38	20.8	1.070	2.14	5.35	8.56	12.84	16.05	26.74	53.49	103	45.8	1.436	2.87	7.18	11.48	17.23	21.53	35.89	71.78
39	21.3	1.073	2.15	5.37	8.59	12.88	16.10	26.83	53.67	104	46.1	1.443	2.89	7.21	11.54	17.31	21.64	36.07	72.14
40	21.8	1.077	2.15	5.39	8.62	12.92	16.16	26.93	53.85	105	46.4	1.450	2.90	7.25	11.60	17.40	21.75	36.25	72.50
41	22.3	1.081	2.16	5.40	8.65	12.97	16.21	27.02	54.04	106	46.7	1.457	2.91	7.29	11.66	17.49	21.86	36.43	72.86
42	22.8	1.085	2.17	5.42	8.68	13.02	16.27	27.12	54.23	107	46.9	1.465	2.93	7.32	11.72	17.57	21.97	36.61	73.23
43	23.3	1.089	2.18	5.44	8.71	13.06	16.33	27.21	54.43	108	47.2	1.472	2.94	7.36	11.77	17.66	22.08	36.80	73.59
44	23.7	1.093	2.19	5.46	8.74	13.11	16.39	27.31	54.63	109	47.5	1.479	2.96	7.40	11.83	17.75	22.19	36.98	73.96
45	24.2	1.097	2.19	5.48	8.77	13.16	16.45	27.41	54.83	110	47.7	1.487	2.97	7.43	11.89	17.84	22.30	37.17	74.33
46	24.7	1.101	2.20	5.50	8.81	13.21	16.51	27.52	55.04	111	48.0	1.494	2.99	7.47	11.95	17.93	22.41	37.35	74.70
47	25.2	1.105	2.21	5.52	8.84	13.26	16.57	27.62	55.25	112	48.2	1.501	3.00	7.51	12.01	18.02	22.52	37.54	75.07
48	25.6	1.109	2.22	5.55	8.87	13.31	16.64	27.73	55.46	113	48.5	1.509	3.02	7.54	12.07	18.11	22.63	37.72	75.45
49	26.1	1.114	2.23	5.57	8.91	13.36	16.70	27.84	55.68	114	48.7	1.516	3.03	7.58	12.13	18.20	22.75	37.91	75.82
50	26.6	1.118	2.24	5.59	8.94	13.42	16.77	27.95	55.90	115	49.0	1.524	3.05	7.62	12.19	18.29	22.86	38.10	76.20
51	27.0	1.123	2.25	5.61	8.98	13.47	16.84	28.06	56.13	116	49.2	1.532	3.06	7.66	12.25	18.38	22.97	38.29	76.58
52	27.5	1.127	2.25	5.64	9.02	13.53	16.91	28.18	56.36	117	49.5	1.539	3.08	7.70	12.31	18.47	23.09	38.48	76.96
53	27.9	1.132	2.26	5.66	9.05	13.58	16.98	28.29	56.59	118	49.7	1.547	3.09	7.73	12.37	18.56	23.20	38.67	77.34
54	28.4	1.136	2.27	5.68	9.09	13.64	17.05	28.41	56.82	119	50.0	1.554	3.11	7.77	12.44	18.65	23.32	38.86	77.72
55	28.8	1.141	2.28	5.71	9.13	13.70	17.12	28.53	57.06	120	50.2	1.562	3.12	7.81	12.50	18.74	23.43	39.05	78.10
56	29.2	1.146	2.29	5.73	9.17	13.75	17.19	28.65	57.31	121	50.4	1.570	3.14	7.85	12.56	18.84	23.55	39.24	78.49
57	29.7	1.151	2.30	5.76	9.21	13.81	17.27	28.78	57.55	122	50.7	1.577	3.15	7.89	12.62	18.93	23.66	39.44	78.87
58	30.1	1.156	2.31	5.78	9.25	13.87	17.34	28.90	57.80	123	50.9	1.585	3.17	7.93	12.68	19.02	23.78	39.63	79.26
59	30.5	1.161	2.32	5.81	9.29	13.93	17.42	29.03	58.05	124	51.1	1.593	3.19	7.96	12.74	19.12	23.89	39.82	79.65
60	31.0	1.166	2.33	5.83	9.33	13.99	17.49	29.15	58.31	125	51.3	1.601	3.20	8.00	12.81	19.21	24.01	40.02	80.04
61	31.4	1.171	2.34	5.86	9.37	14.06	17.57	29.28	58.57	126	51.6	1.609	3.22	8.04	12.87	19.30	24.13	40.22	80.43
62	31.8	1.177	2.35	5.88	9.41	14.12	17.65	29.42	58.83	127	51.8	1.616	3.23	8.08	12.93	19.40	24.25		

Table 5. Slope correction for plot radius measurement

Kemiringan		Faktor	Radius plot (m)						Kemiringan		Faktor	Radius plot (m)					
α (%)	α (°)		2	5	8	12	15	25	α (%)	α (°)		2	5	8	12	15	25
1	0.6	1.000	2.00	5.00	8.00	12.00	15.00	25.00	66	33.4	1.095	2.19	5.47	8.76	13.14	16.42	27.37
2	1.1	1.000	2.00	5.00	8.00	12.00	15.00	25.00	67	33.8	1.097	2.19	5.49	8.78	13.17	16.46	27.43
3	1.7	1.000	2.00	5.00	8.00	12.00	15.00	25.01	68	34.2	1.100	2.20	5.50	8.80	13.20	16.50	27.49
4	2.3	1.000	2.00	5.00	8.00	12.00	15.01	25.01	69	34.6	1.102	2.20	5.51	8.82	13.23	16.53	27.56
5	2.9	1.001	2.00	5.00	8.00	12.01	15.01	25.02	70	35.0	1.105	2.21	5.52	8.84	13.26	16.57	27.62
6	3.4	1.001	2.00	5.00	8.01	12.01	15.01	25.02	71	35.4	1.107	2.21	5.54	8.86	13.29	16.61	27.69
7	4.0	1.001	2.00	5.01	8.01	12.01	15.02	25.03	72	35.8	1.110	2.22	5.55	8.88	13.32	16.65	27.75
8	4.6	1.002	2.00	5.01	8.01	12.02	15.02	25.04	73	36.1	1.113	2.23	5.56	8.90	13.35	16.69	27.82
9	5.1	1.002	2.00	5.01	8.02	12.02	15.03	25.05	74	36.5	1.115	2.23	5.58	8.92	13.38	16.73	27.88
10	5.7	1.002	2.00	5.01	8.02	12.03	15.04	25.06	75	36.9	1.118	2.24	5.59	8.94	13.42	16.77	27.95
11	6.3	1.003	2.01	5.02	8.02	12.04	15.05	25.08	76	37.2	1.121	2.24	5.60	8.97	13.45	16.81	28.02
12	6.8	1.004	2.01	5.02	8.03	12.04	15.05	25.09	77	37.6	1.123	2.25	5.62	8.99	13.48	16.85	28.09
13	7.4	1.004	2.01	5.02	8.03	12.05	15.06	25.10	78	38.0	1.126	2.25	5.63	9.01	13.51	16.89	28.15
14	8.0	1.005	2.01	5.02	8.04	12.06	15.07	25.12	79	38.3	1.129	2.26	5.64	9.03	13.55	16.93	28.22
15	8.5	1.006	2.01	5.03	8.04	12.07	15.08	25.14	80	38.7	1.132	2.26	5.66	9.05	13.58	16.97	28.29
16	9.1	1.006	2.01	5.03	8.05	12.08	15.10	25.16	81	39.0	1.134	2.27	5.67	9.08	13.61	17.02	28.36
17	9.6	1.007	2.01	5.04	8.06	12.09	15.11	25.18	82	39.4	1.137	2.27	5.69	9.10	13.65	17.06	28.43
18	10.2	1.008	2.02	5.04	8.06	12.10	15.12	25.20	83	39.7	1.140	2.28	5.70	9.12	13.68	17.10	28.50
19	10.8	1.009	2.02	5.04	8.07	12.11	15.13	25.22	84	40.0	1.143	2.29	5.71	9.14	13.71	17.14	28.57
20	11.3	1.010	2.02	5.05	8.08	12.12	15.15	25.25	85	40.4	1.146	2.29	5.73	9.16	13.75	17.18	28.64
21	11.9	1.011	2.02	5.05	8.09	12.13	15.16	25.27	86	40.7	1.148	2.30	5.74	9.19	13.78	17.23	28.71
22	12.4	1.012	2.02	5.06	8.10	12.14	15.18	25.30	87	41.0	1.151	2.30	5.76	9.21	13.82	17.27	28.78
23	13.0	1.013	2.03	5.06	8.10	12.16	15.19	25.32	88	41.3	1.154	2.31	5.77	9.23	13.85	17.31	28.85
24	13.5	1.014	2.03	5.07	8.11	12.17	15.21	25.35	89	41.7	1.157	2.31	5.79	9.26	13.88	17.36	28.93
25	14.0	1.015	2.03	5.08	8.12	12.18	15.23	25.38	90	42.0	1.160	2.32	5.80	9.28	13.92	17.40	29.00
26	14.6	1.016	2.03	5.08	8.13	12.20	15.25	25.41	91	42.3	1.163	2.33	5.81	9.30	13.95	17.44	29.07
27	15.1	1.018	2.04	5.09	8.14	12.21	15.27	25.44	92	42.6	1.166	2.33	5.83	9.33	13.99	17.49	29.14
28	15.6	1.019	2.04	5.10	8.15	12.23	15.29	25.48	93	42.9	1.169	2.34	5.84	9.35	14.02	17.53	29.21
29	16.2	1.020	2.04	5.10	8.16	12.24	15.31	25.51	94	43.2	1.172	2.34	5.86	9.37	14.06	17.57	29.29
30	16.7	1.022	2.04	5.11	8.17	12.26	15.33	25.54	95	43.5	1.174	2.35	5.87	9.40	14.09	17.62	29.36
31	17.2	1.023	2.05	5.12	8.19	12.28	15.35	25.58	96	43.8	1.177	2.35	5.89	9.42	14.13	17.66	29.43
32	17.7	1.025	2.05	5.12	8.20	12.30	15.37	25.62	97	44.1	1.180	2.36	5.90	9.44	14.16	17.70	29.51
33	18.3	1.026	2.05	5.13	8.21	12.31	15.39	25.65	98	44.4	1.183	2.37	5.92	9.47	14.20	17.75	29.58
34	18.8	1.028	2.06	5.14	8.22	12.33	15.42	25.69	99	44.7	1.186	2.37	5.93	9.49	14.23	17.79	29.66
35	19.3	1.029	2.06	5.15	8.23	12.35	15.44	25.73	100	45.0	1.189	2.38	5.95	9.51	14.27	17.84	29.73
36	19.8	1.031	2.06	5.15	8.25	12.37	15.46	25.77	101	45.3	1.192	2.38	5.96	9.54	14.31	17.88	29.80
37	20.3	1.033	2.07	5.16	8.26	12.39	15.49	25.81	102	45.6	1.195	2.39	5.98	9.56	14.34	17.93	29.88
38	20.8	1.034	2.07	5.17	8.27	12.41	15.51	25.86	103	45.8	1.198	2.40	5.99	9.59	14.38	17.97	29.95
39	21.3	1.036	2.07	5.18	8.29	12.43	15.54	25.90	104	46.1	1.201	2.40	6.01	9.61	14.41	18.02	30.03
40	21.8	1.038	2.08	5.19	8.30	12.45	15.57	25.95	105	46.4	1.204	2.41	6.02	9.63	14.45	18.06	30.10
41	22.3	1.040	2.08	5.20	8.32	12.48	15.59	25.99	106	46.7	1.207	2.41	6.04	9.66	14.49	18.11	30.18
42	22.8	1.041	2.08	5.21	8.33	12.50	15.62	26.04	107	46.9	1.210	2.42	6.05	9.68	14.52	18.15	30.25
43	23.3	1.043	2.09	5.22	8.35	12.52	15.65	26.08	108	47.2	1.213	2.43	6.07	9.71	14.56	18.20	30.33
44	23.7	1.045	2.09	5.23	8.36	12.54	15.68	26.13	109	47.5	1.216	2.43	6.08	9.73	14.59	18.24	30.41
45	24.2	1.047	2.09	5.24	8.38	12.57	15.71	26.18	110	47.7	1.219	2.44	6.10	9.75	14.63	18.29	30.48
46	24.7	1.049	2.10	5.25	8.39	12.59	15.74	26.23	111	48.0	1.222	2.44	6.11	9.78	14.67	18.33	30.56
47	25.2	1.051	2.10	5.26	8.41	12.61	15.77	26.28	112	48.2	1.225	2.45	6.13	9.80	14.70	18.38	30.63
48	25.6	1.053	2.11	5.27	8.43	12.64	15.80	26.33	113	48.5	1.228	2.46	6.14	9.83	14.74	18.43	30.71
49	26.1	1.055	2.11	5.28	8.44	12.66	15.83	26.38	114	48.7	1.231	2.46	6.16	9.85	14.78	18.47	30.79
50	26.6	1.057	2.11	5.29	8.46	12.69	15.86	26.43	115	49.0	1.234	2.47	6.17	9.88	14.81	18.52	30.86
51	27.0	1.060	2.12	5.30	8.48	12.71	15.89	26.49	116	49.2	1.238	2.48	6.19	9.90	14.85	18.56	30.94
52	27.5	1.062	2.12	5.31	8.49	12.74	15.92	26.54	117	49.5	1.241	2.48	6.20	9.92	14.89	18.61	31.02
53	27.9	1.064	2.13	5.32	8.51	12.77	15.96	26.60	118	49.7	1.244	2.49	6.22	9.95	14.92	18.66	31.09
54	28.4	1.066	2.13	5.33	8.53	12.79	15.99	26.65	119	50.0	1.247	2.49	6.23	9.97	14.96	18.70	31.17
55	28.8	1.068	2.14	5.34	8.55	12.82	16.02	26.71	120	50.2	1.250	2.50	6.25	10.00	15.00	18.75	31.25
56	29.2	1.071	2.14	5.35	8.56	12.85	16.06	26.76	121	50.4	1.253	2.51	6.26	10.02	15.03	18.79	31.32
57	29.7	1.073	2.15	5.36	8.58	12.87	16.09	26.82	122	50.7	1.256	2.51	6.28	10.05	15.07	18.84	31.40
58	30.1	1.075	2.15	5.38	8.60	12.90	16.13	26.88	123	50.9	1.259	2.52	6.30	10.07	15.11	18.89	31.48
59	30.5	1.078	2.16	5.39	8.62	12.93	16.16	26.94	124	51.1	1.262	2.52	6.31	10.10	15.15	18.93	31.55
60	31.0	1.080	2.16	5.40	8.64	12.96	16.20	27.00	125	51.3	1.265	2.53	6.33	10.12	15.18	18.98	31.63
61	31.4	1.082	2.16	5.41	8.66	12.99	16.23	27.06	126	51.6	1.268	2.54	6.34	10.15	15.22	19.02	31.71
62	31.8	1.085	2.17	5.42	8.68	13.02	16.27	27.12	127	51.8	1.271	2.54	6.36	10.17	15.26	19.07	31.78
63	32.2	1.087	2.17	5.44	8.70	13.05	16.31	27.18	128	52.0	1.274	2.55	6.37	10.20	15.29	19.12	31.86
64	32.6	1.090	2.18	5.45	8.72	13.08	16.34	27.24	129	52.2	1.278	2.56	6.39	10.22	15.33	19.16	31.94
65	33.0	1.092	2.18	5.46	8.74	13.11	16.38	27.30	130	52.4	1.281	2.56	6.40	10.25	15.37	19.21	32.02



C. Measuring Tree Diameter and Height

In general, tree diameter measurements are taken at a height of 1.3 m above ground level. However, the tree diameter measurement point may vary depending on the condition of the tree in the field, as illustrated in **Figure 16** (see **Chapter 5**). For consistent measurement results, the survey team is advised to use only a *phi-band* (not a tape measure) because the use of different measuring tools 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**).

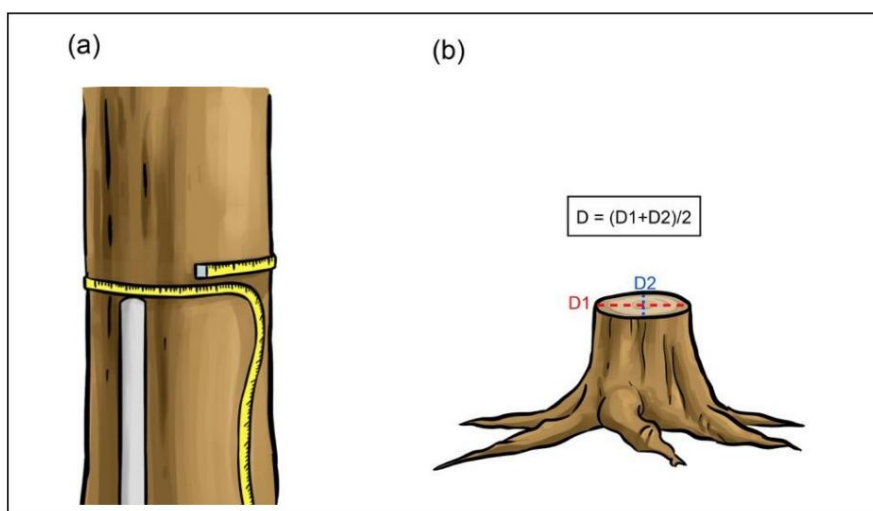


Figure 23. Measurement of (a) tree diameter using a 1.3 m measuring stick and (b) measurement of stump diameter

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 to the axis. stem.
- 2) *Phi-band* is wrapped around the tree trunk in an unfolded or untwisted condition.
- 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 hindered 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 the *Vertex* or *laser hypsometer*, for greater accuracy and efficiency (because they do not require prior horizontal distance measurements). For leaning trees, height is not measured along the trunk length, but rather the vertical distance between the crown top (for total height) and its projection point on the ground surface (**Figure 24a**). Tree height is calculated using trigonometric principles from the instrument's scale readings to the top (A) and 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 tree height will automatically appear on the electronic height measuring instrument's 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 is 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 this position, the surveyor can clearly see the treetops.
On the other hand, if the measuring position is much lower than the base of the tree, the meter 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 in a direction perpendicular to the slope of the tree.
(Figure 24a).
- 4) If measuring height using *Vertex*, place the *transponder* on a tree trunk 1.3 m above ground level. Also, calibrate *Vertex* periodically, as its sensitivity is affected by temperature and humidity.

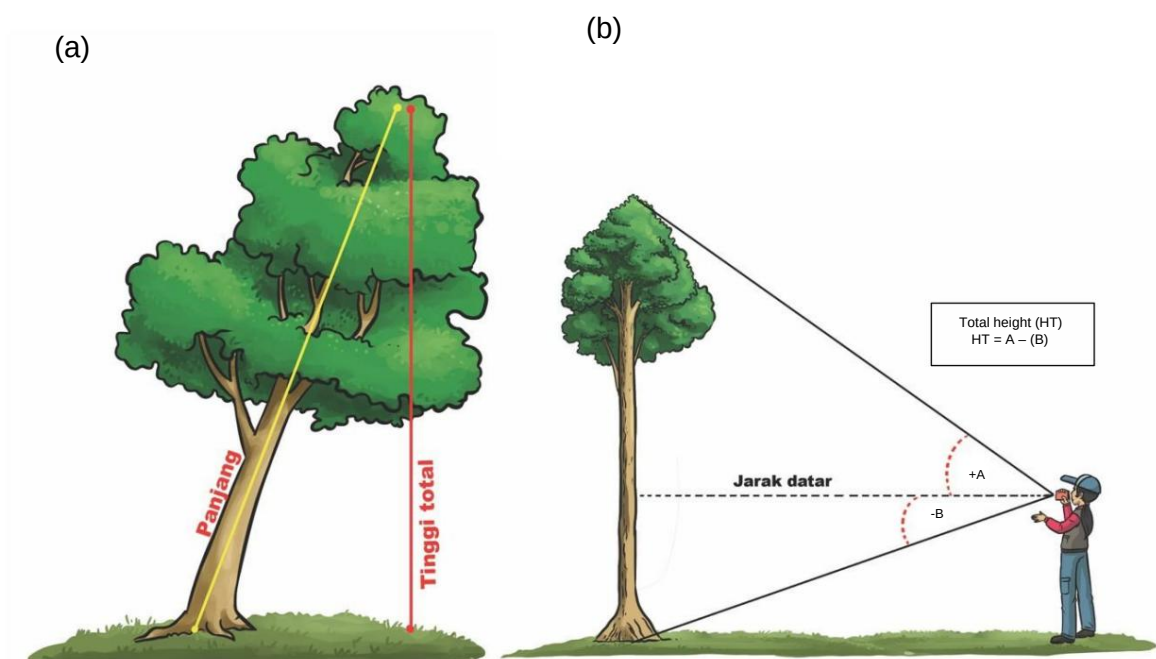


Figure 24. Differences in tree length and height (a) and trigonometric principles in determining tree height (b) (adapted from Rusolono et al. (2015))



Appendix 3. Making Herbarium in the Field

A herbarium is a preserved plant specimen for scientific research. A herbarium specimen can be made from part or all of a dried plant, placed on a paper base, or stored in a sealed container filled with alcohol or formalin solution for a wet herbarium. The method for creating herbarium specimens for forestry tree species typically involves placing the herbarium on paper in two ways: dry and wet herbarium. Dry herbariums require a bamboo rack as a clamp to ensure the specimen remains level. Dry herbariums, on the other hand, require an alcohol solution for specimen preservation. In forest inventory activities, herbariums are used to store specimens whose species are unknown, either by local or Latin name. The herbarium specimens are then sent to a laboratory to be identified by their Latin names. Wet herbariums are often used in forest inventory activities because of the ease of specimen management.

The tools and materials used to make a wet herbarium are:

1. Machete, knife or pruning shears to cut branches from the 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, parchment paper, flip chart paper
4. Paper tape to stick the specimen on the paper
5. Labels to mark specimens, can use cardboard and string
6. Pencil for writing label codes
7. Rope to tie the entire specimen, you can use a similar type of rope.
which is used for labels.
8. Large plastic for storing airtight herbarium
9. Insulating tape to seal the plastic to make it airtight

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

Next, pick the whole branch including the main branch and leaf veins. If there are flowers or fruit, it's best to collect them as well. Store them in a safe place and take them to the tent or accommodation where the herbarium will be set up. Collect several specimens of other species at once. Upon arrival at the tent or accommodation, the herbarium specimens should be processed immediately.

Prepare the materials. Place the plant specimen on a sheet of newspaper. Use tape to secure the specimen to the newspaper. Label the specimen with its identification code, then tie it to the branch. In a notebook, record the specimen's identification code, as shown on the label, the local name, the place name, the elevation, and the type of ecosystem where the specimen was collected.

Cover the specimen with folded newspaper so that it is completely covered. Do the same for the other specimens. Stack each specimen one by one until there are about 10–15 pieces of herbarium paper, then tie them with string. Next, place the stack of herbariums in a large plastic bag. Then, pour alcohol evenly over the entire stack of herbariums inside the plastic bag. Then, tie and seal the bag tightly using electrical tape. The herbarium is ready to be taken to the office in the provincial city or the nearest city to be sent to a laboratory for identification by Latin name. A list of institutions in each region in Indonesia that have laboratories or *taxonomists* for herbarium identification is available below.



Appendix 4. List of Tree Species Identification Institutions/Laboratories

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, IPB, 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. Herbarium Bandungense SITH ITB, Jatinangor Campus
Address: Jalan Let. Jen. Ret. Dr. (HC). Mashudi N0.1/ Jl. Raya Jatinangor 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. Raya Bandung Sumedang KM.21, Hegarmanah, Jatinangor District, Sumedang Regency, West Java 45363
Contact Botanist/Taxonomy: Budi Irawan (+62 815-7190-043)

KALIMANTAN

1. Dendrology and Wildlife Laboratory, Faculty of Forestry, Mulawarman University, East Kalimantan

Address: Jl. Kuaro, Mt. Kelua, Kec. Samarinda Ulu, 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, Lambung Mangkurat University, South Kalimantan
Address : Jl. Brigjen Jl. Brigjen Hasan Basri, Pangeran, North Banjarmasin District, City Banjarmasin, South Kalimantan 70123
Contact Botanist/Taxonomy's: Gunawan (+62 812-3432-500)
3. Plant Taxonomy Lab, Faculty of Mathematics and Natural Sciences, Tanjungpura University, West Kalimantan.
Address : Jl. Prof. Dr. H Jl. ProfessorDokterH. Hadari Nawawi, Bansir Laut, Pontianak Tenggara District, Pontianak City, West Kalimantan 78124
Contact Botanist or Taxonomy: Emma Khairiah +62 852-4556-7232

SULAWESI – MALUKU

1. Laboratory of Plant Biosystematics and Taxonomy, Biology, Faculty of Mathematics and Natural Sciences, Tadulako University, Central Sulawesi.
Address: Jl. Soekarno Hatta No. KM. 9, Tondo, Mantikulore District, Palu City, Central Sulawesi 94148
Contact Botanist/Taxonomy: +62 852-9830-0440

East Nusa Tenggara



1. Plant Lab, Biology, Faculty of Mathematics and Natural Sciences, University of Timor, NTT.

Address: **KEFAMENANU** KM.09, Sasi Subdistrict. Email:

Tel: 0812-3956-4700

universitastimor@yahoo.co.id

Contact Botanist/Taxonomy: Ite Morina Yostianti Tnunay +62 812-3866-6730

SUMATERA

1. Plant Biology Lab, Faculty of Teacher Training and Education, Biology, Samudra University, Langsa,

ACEH Address: Jalan Prof. Syarief Thayeb, Meurandeh, Langsa

Contact Botanist/Taxonomy: Zidni Ilman Navia (+62 813-4508-9062)

2. Plant Taxonomy Lab, Biology, Faculty of Mathematics and Natural Sciences, University of North Sumatra

Address: Jalan Dr. T. Mansur No. 9, Padang Bulan, Medan Baru District, Medan City, North Sumatra 20222

Contact Botanist / Taxonomy: Nursahara Pasaribu +62 8116333554

3. Plant Taxonomy Lab, Biology, Faculty of Mathematics and Natural Sciences, University of Riau

Address: Bina Widya Campus, KM. 12.5, Simpang Baru, Tampan District, Pekanbaru City, Riau 28293

Contact Botanist / Taxonomy: Fatmawati +62 811-7602-073

4. Dendrology Lab, Faculty of Forestry, Jambi University, Jambi

Address: Jl. Jambi - Muara Bulian No.KM. 15, Mendalo Darat, Jambi Outer City District, Muaro Jambi Regency, Jambi

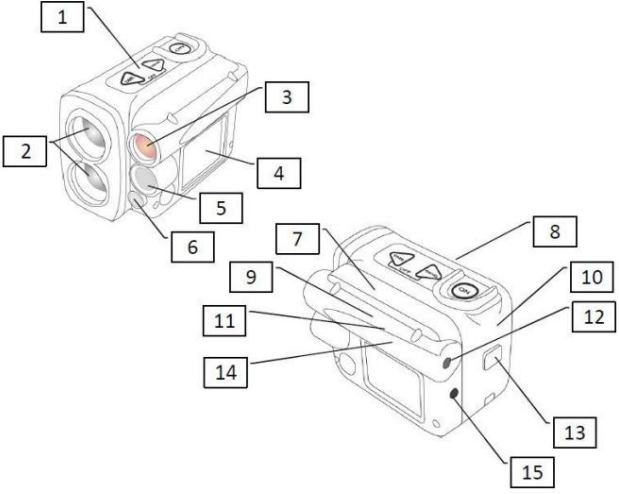
Contact Botanist/Taxonomy: Nursanti (+62 853-7855-8676), Rike Puspitasari (+62 822-8276-4882)



Appendix 5. Instructions for Using the Vertex Laser Geo for Measuring Distance and Height of Trees



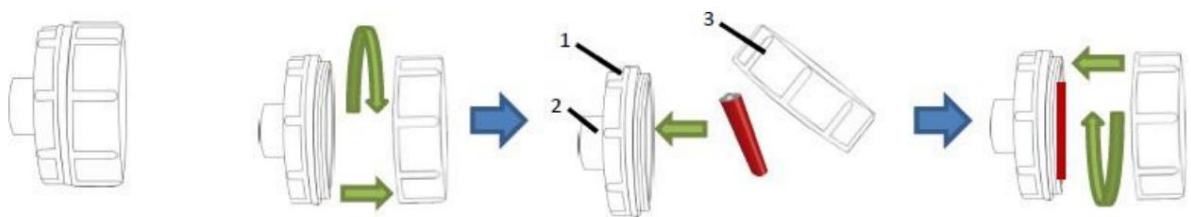
Tool components:

	1. Buttons 2. Laser optics 3. Lenses for appearance Vision 4. LCD screen 5. Recipient ultrasonic (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 and protective cover 14.Compass Sensor 15. IR (Infra Red) Transmitter
--	--



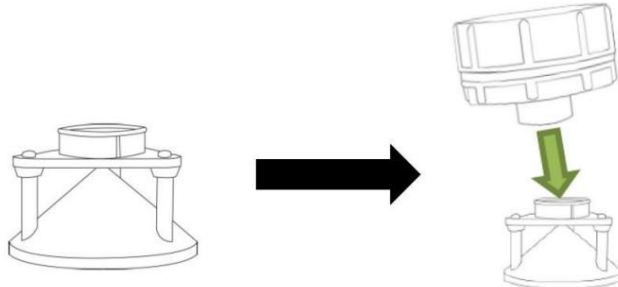
T3 Transponder

- This transponder is equipped with an ultrasonic transmitter and receiver. communicate with measuring instruments.
- The T3 transponder is equipped with a beep signal, which indicates the ON or OFF status. DEAD.
- The T3 has no switch and the VERTEX LASER GEO instrument is essentially used as a remote control to turn it on and off. When turned on, the Transponder remains active until it is turned off or after approximately 20 minutes of inactivity.
- The transponder uses one 1.5-volt AA alkaline battery.
 1. Transponder container
 2. Ultrasonic receiver-transmitter
 3. Battery cover



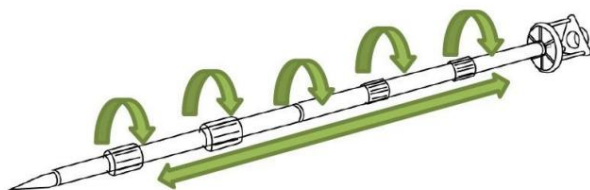
360 Adapter/Spreader

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

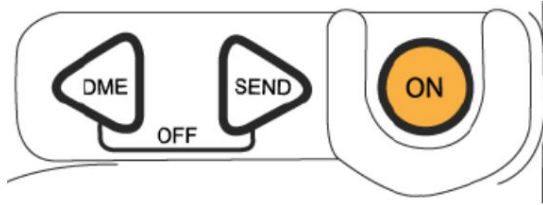


Monopod

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



Using Buttons on Vertex



ON button

- Press On to activate Vertex
- When 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 the menu, and to change the values and choices

SEND button

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

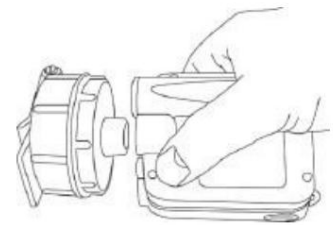
Disabling Vertex

- Press the DME and SEND buttons simultaneously to disable the 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)
- Press the **DME** button until you hear a **“beep”** sound.
2 times



2. Turn off the Vertex connection with the Transponder

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

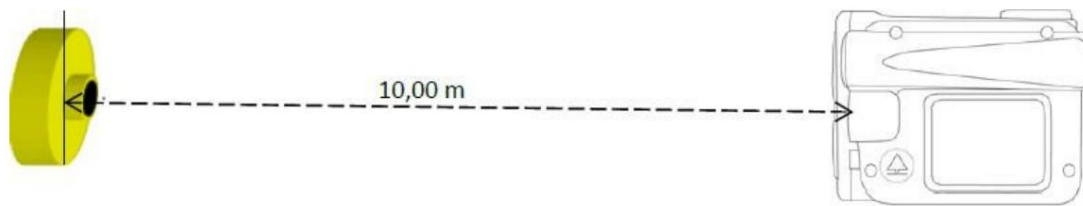
Vertex and Transponder Calibration

1. Connect Vertex with Transponder:

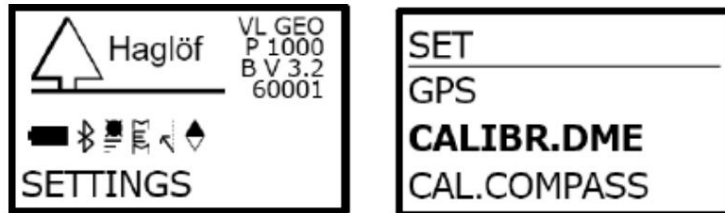
- Bring the Vertex and Transponder close together as shown in the picture (make sure the Vertex screen is off)
 - Press the **DME** button until you hear a **“beep”** sound twice.
 - Turn off the Vertex display (DME and SEND)

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





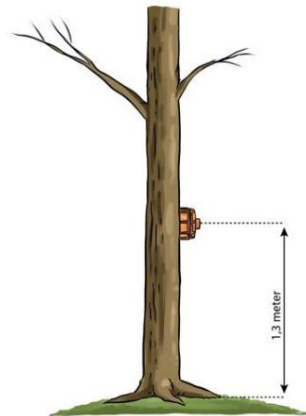
4. Press the ON button, then select SETTING, then select CALIBR.DME



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

Using Vertices to Measure Tree Distance and Height

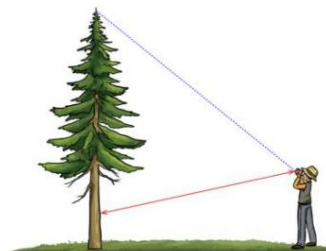
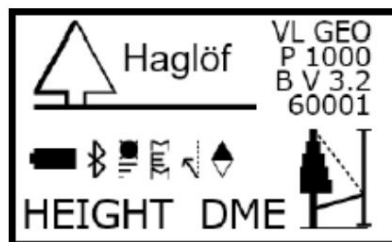
1. Place the transponder on the tree whose distance and height you want to measure, place it transponder at a height of 1.3 meters.



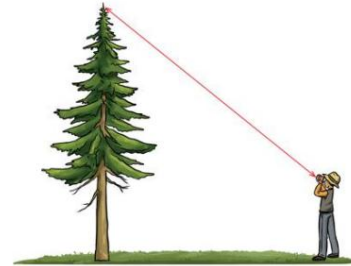
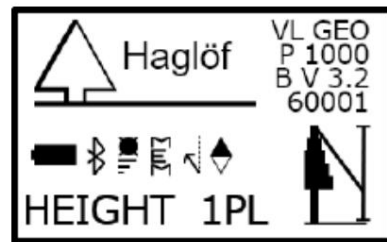
2. Press ON to activate Vertex

There are 3 measurement modes in Vertex Laser Geo:

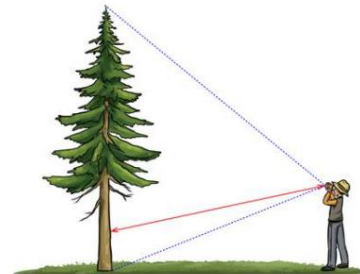
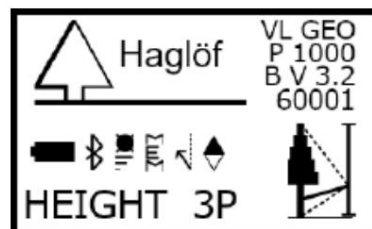
- a. Height DME** – this mode uses ultrasound, this mode can measure height base of crown and total height simultaneously..



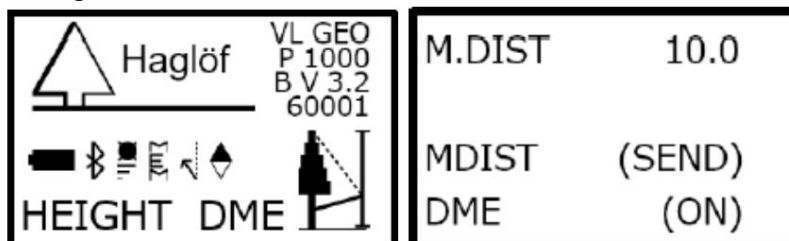
- b. **Height 1 PL** – this mode uses Laser, this mode is recommended **for use** when the field conditions are flat and can only measure 1 time (cannot measure the height of the base of the crown and the total height simultaneously).



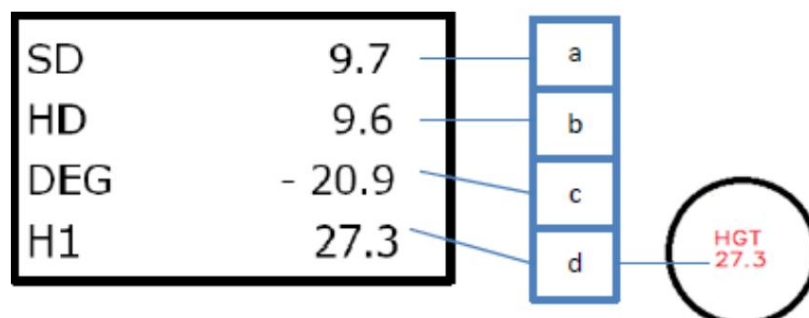
- c. **Height 3P** – this mode uses a laser. The angle – slope – is measured at the base and the highest (top) part of the object.



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 the height of the base of the crown and press the ON button until it beeps once and the information on the screen "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 once, then point to the total height point, press the ON button until the Vertex beeps once to save the height data on the Vertex screen.

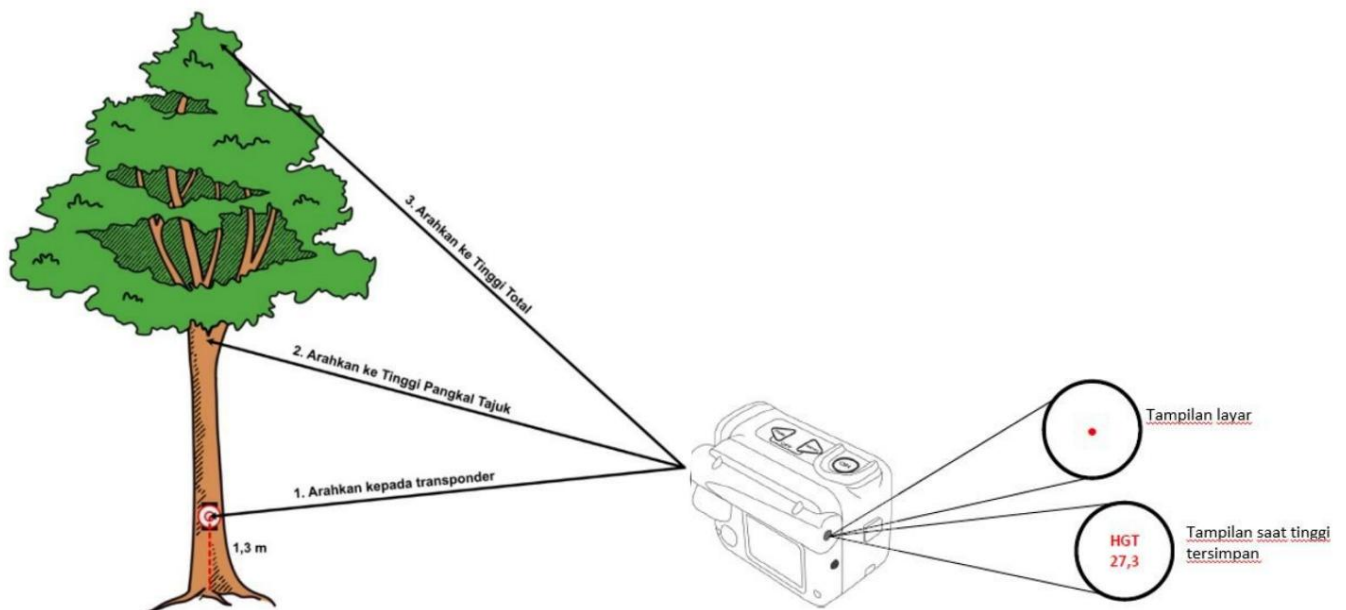


Illustration of height measurement using Vertex



Appendix 6. Format of Statement Letter for Implementation of IHN 2.0 Activities

STATEMENT LETTER IMPLEMENTATION OF IHN2.0 ACTIVITIES We, the undersigned: Name/NIP: Xxxxx Position: Head of the Regional Forest Area Stabilization Center.... State that : 1. The National Forest Inventory Activity in Cluster No. xxxxxx located in xxxx district, xxxxx Province has been carried out in accordance with the previously prepared plan. 2. Field measurement data has been uploaded to the Directorate's IHN database system IPSDH. 3. Realization of activities in Cluster No. xxxxxx is in accordance/not in accordance* with the target or previous plans. Thus, we have made this statement letter to be used as appropriate. Place of residence, date month year Signed. <u>Name of Head of BPKH</u> NIP. xxxxxxxxxxxxxxxxxxxx
--

*select one



Attachment 7. IHN 2.0 Minutes Format Cannot Be Implemented

NEWS

IMPLEMENTATION OF IHN 2.0 ACTIVITIES CANNOT BE IMPLEMENTED

On the day, date, year, the undersigned below:

Name : Xxxxx

Position : Village Apparatus xxxx/Head of Regional Stakeholders

As that is apparatus village.../Head Stakeholders Region...

Name: Yyyy

NIP xxxxxxxxxxxxxxxxxxxx

As the Head of the Forest Inventory Implementation Team for Cluster...Plot Number...

Location of National Forest Inventory Activities with Cluster Number... Plot... located in Kampung... Desa... Sub-districts, Regencies, Provinces, cannot carry out National Forest Inventory activities because (choose one or more):

- a. Changes in land cover
- b. Plot location is inaccessible (steep terrain/ravine/etc.)
- c. Security factors (wildlife/riots/etc.)
- d. Rejection by land owners/community
- e. Other :

With documentary evidence submitted on the *Collect Mobile application*.

Thus, this Minutes is made to be used as appropriate.

Village Officials/Regional Stakeholders

Team Leader
National Forest Inventory

signature (stamp)

XXX

Signed

YYY



Appendix 8. *Collect Mobile Updating* Procedure

The National Forest Inventory System 2.0 (IHN 2.0) is a comprehensive system from data collection using an Android tablet to web-based visualization data presentation, which is divided into 5 supporting platforms.

The following is a description of the system flow of IHN 2.0, which can be explained as follows:

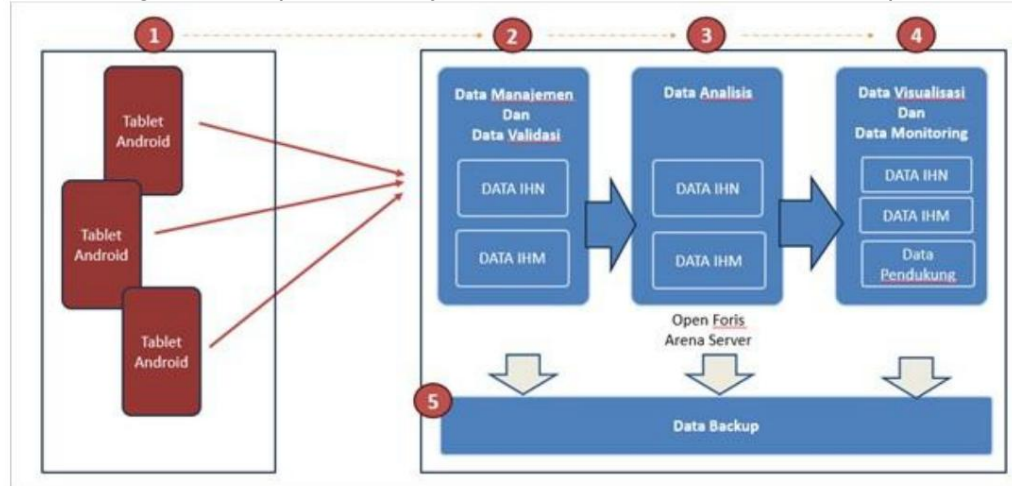


Figure 1. IHN 2.0 System Flow

With the following information:

1. Android tablet that has *Collect Mobile* installed and also installed with *survey good form* for IHN 2.0 data collection.
2. Data Management and Validation Platform, this uses the *Collect Server* platform from *Open Foris*, which receives submitted data from Android tablets and then the data will be validated per cluster point.
3. Data analysis platform, it uses the *Arena Server* platform from *open source* with the available *plug-in*, namely *R-Studio*, to perform data analysis.
4. Data visualization and data monitoring platform, this is a data presentation platform as a reference for viewing data collection results and as a tool for monitoring the progress of data collection in the field.

Collect Mobile Installation on Tablet

If the tablet is first received, it does not have a *collect mobile application*, application can be downloaded on the Google Play Store.

With the following address:

<https://play.google.com/store/apps/details?id=org.openforis.collect>

Or you can install it by scanning the following QR Code:





Figure 2: QR Code URL to download the *Collect Mobile* Application

Then click *install* and follow the instructions from Google Play to install it. Here is the display on Google Play for the *Open Foris Collect Mobile* download page with the app owner, namely *the Open Foris Initiative*:

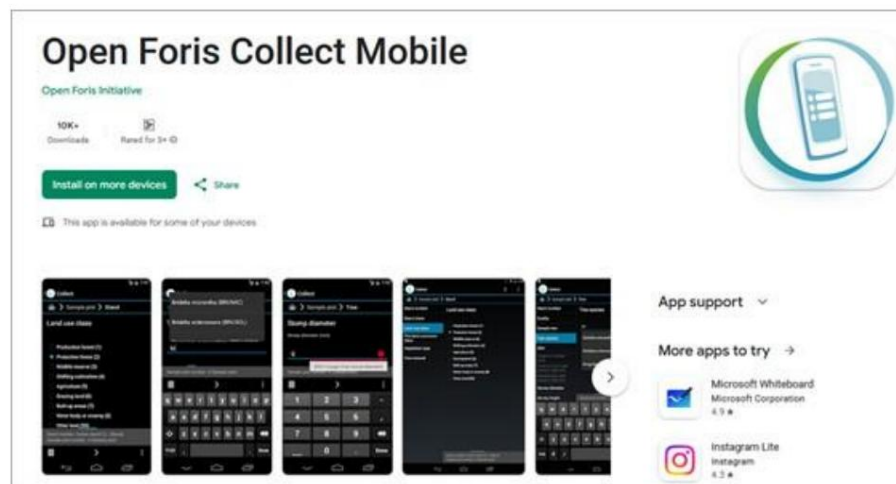


Figure 3: *Collect Mobile* app download page

Note: If Collect Mobile is already installed on your tablet, it is a good idea to do the final update of the apps by rescanning, and make sure there is no Update button on the page, if there is, click update, if not, then the existing apps are already the latest apps.

IHN Survey Form 2.0 Installation

After installing *Collect Mobile* on the server, a *survey form* is required, namely the National Forest Inventory (IHN) 2.0 *survey form* to be able to fill in the fields - The required fields for IHN 2.0 data collection are required. To do this, the survey form file needs to be downloaded from the server and saved in order to then be *imported* into the *Collect Mobile application*. The following is an overview of the steps:



Download the IHN survey form

To download data, open the URL on your tablet by typing the following address:

https://drive.google.com/drive/folders/1XSHwoi9AENIfkT4I_E_r_683BQgSHo6j

or use the QR Code as follows:



Figure 4: QR Code to download the IHN 2.0 Survey form

Note: Usually by default, files will be saved in the "downloads" folder on each tablet.

Importing the IHN 2.0 Survey Form

After downloading the National Forest Inventory (IHN) 2.0 survey form , then open the *collect mobile* application and *import the survey*, with the following procedures:



Click the three dots button on the top right

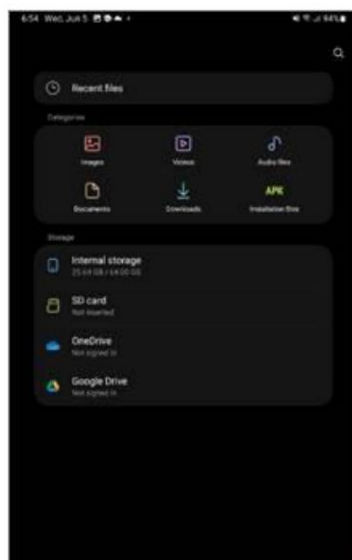


Click the survey button

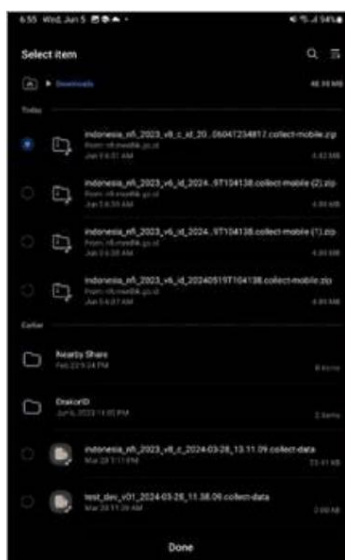


Click the *Import* Button





Click the "Internal" button
Storage"



Select the downloads folder

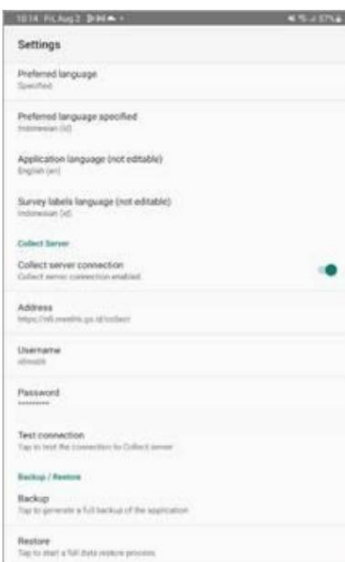


And automatically form IHN 2.0

The survey selection menu will appear
"Select a survey" and select the IHN 2.0
survey

Server **Settings** on Tablet

After installing *the collect mobile* and *IHN 2.0 survey form*, the next step is to fill in the server settings to ensure that after filling in the data, the data can be sent/submitted to the IHN 2.0 server, with the following steps:



Click **Settings** and activate "Collect
Server Connection"

Note: For the address, enter <https://nfi.menlk.go.id/collect>, then fill in the username and password provided by IPSDH.



Appendix 9. Procedure for Uploading Collect Mobile Data to the Server

For filling in and filling in what fields will be filled in, please see the Technical Instructions (Juknis) sheet for IHN 2.0. In this guide, after filling in, data submission and *data backup will be carried out*, with a brief explanation as follows:

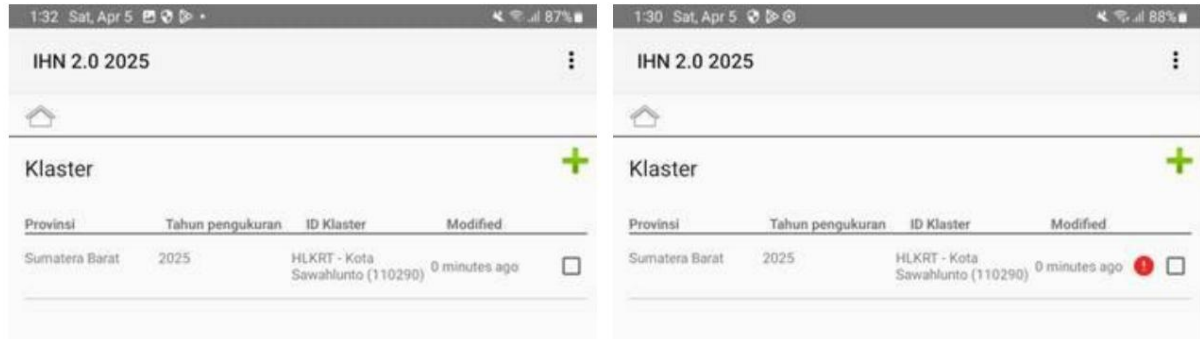
Submit Data

After data collection is complete, the next step is to submit the field data to the IHN 2.0 server that has been prepared. Before doing so, ensure the following:

1. The tablet used is connected to a good enough internet network to upload field data which is estimated to be between 200mb to 500mb.
2. Ensure that the field data has been filled in correctly and appropriately.
3. Make sure the battery is more than 50% to ensure it doesn't disconnect.
connection When submitting data.

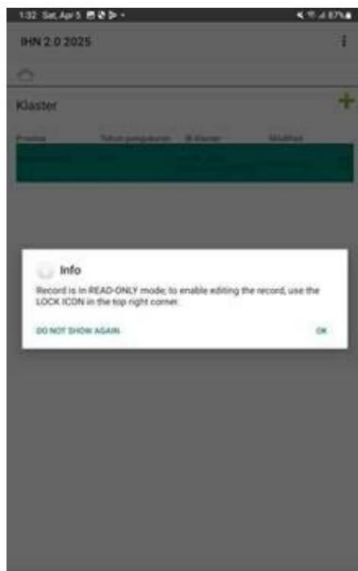
The steps are as follows:

Make sure that the field data to be submitted has been filled in properly and correctly as indicated by the NO red icon, as seen in the image below, where the image on the left shows data that is ready to be sent (without the red icon) and the image on the right shows data that has not been filled in completely, it is best to check the data again (there is a red icon).

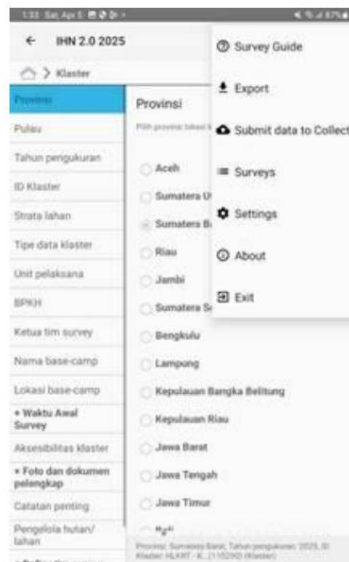


After ensuring that the data is complete and correct, then click on the field data that will be submitted to the server, which will take you to the detailed data display, as shown in the following image:

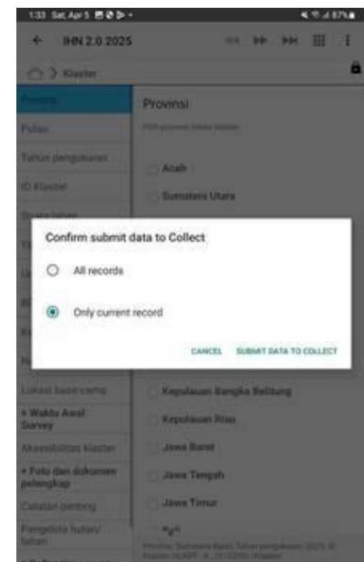




Click on one of the field data that will be submitted to the server, and click OK to continue

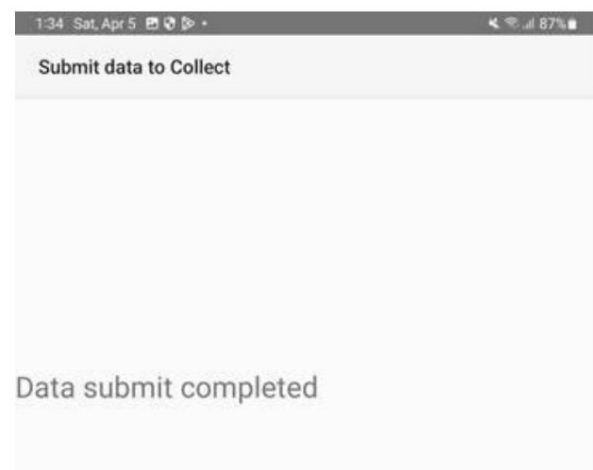
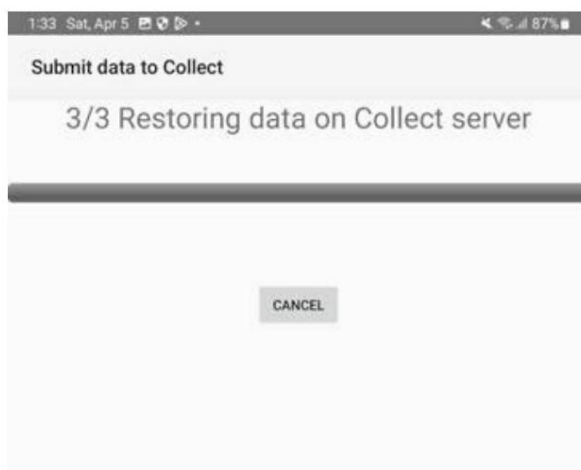


Then the detailed data display will appear, continue by clicking on the top right menu button, and select the "Submit data to collect" menu.



A confirmation *pop-up* will appear, and select "Only Current Records" is important to ensure that only this data will be submitted.

After this is done, the data sending process (*submitting data*) will be carried out, this process will take time depending on the size of the data, the internet network on *the wifi* and the network conditions on the server, as for the display of the data submitting process, as seen in the following image:



Please wait until the field *data submission* process is complete. Once completed, a display will appear as shown in the top right image "Data submission completed." Please confirm with the IPSDH Center/Office that the data has been submitted.



Appendix 10. Mobile Collect Data Back Up Procedure

Data *backup* in IHN 2.0 is a crucial anticipatory step to secure data that has been taken from the field, considering that collecting this data requires a lot of preparation, effort, time and costs to get to the cluster location, this is mandatory.

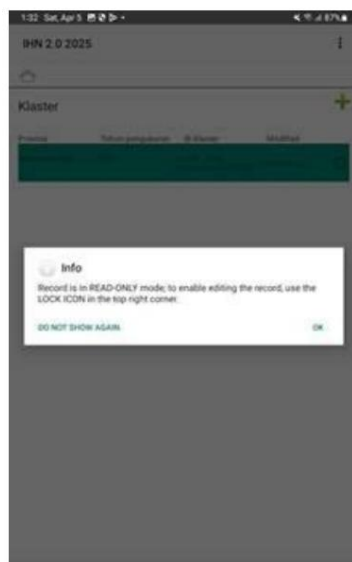
There are two *backup* methods that will be carried out, namely:

1. *Cloud backup* to Google Drive, each team: this *backup* is done to ensure that field data is stored in *the cloud* (in this case Google Drive).
2. *Local backup* to MicroSD or *external hard disk*: this *backup* is done to ensure that field data is backed up locally on each team.

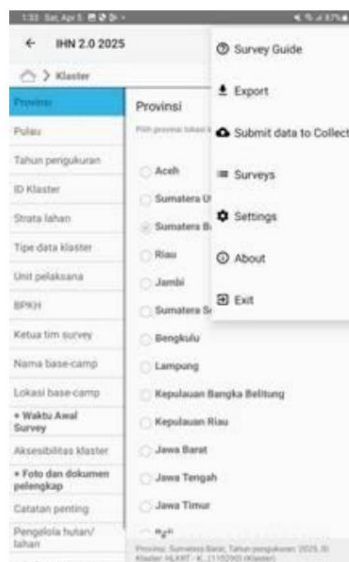
These two methods **MUST** be done, here are more or less the steps:

Backup to Google Drive

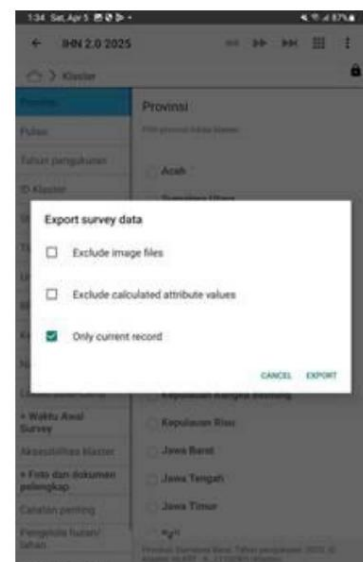
After the data is submitted, back up the data to *the cloud*. This can be done via tablet, with the following steps:



Click on one of the field data that you want to *backup*, and click OK to continue.

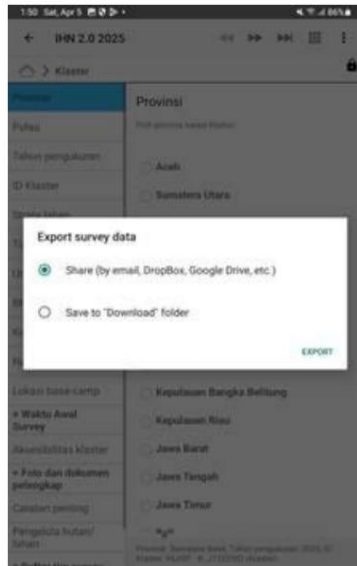


Then the detailed data display will appear, continue by clicking on the top right menu button, and select the "Export" menu.



A *checklist* menu will appear and *check* "Only current record" as in the image above, and click "EXPORT"

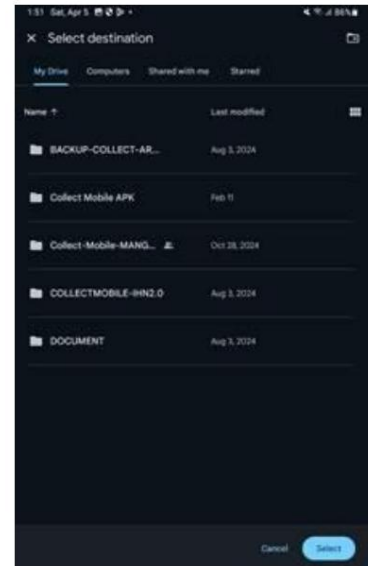




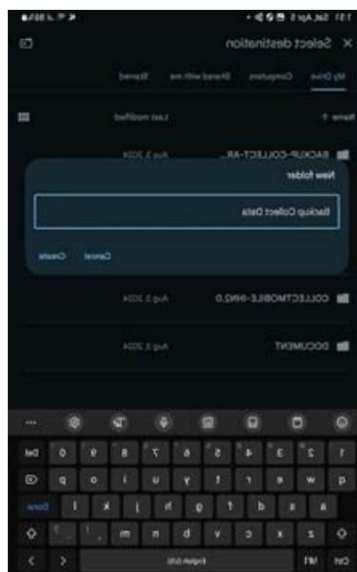
The Export menu will appear, for this step, select it
"Share (by email, dropbox, Google Drive, etc.)"



Next, the share option will appear, and select Google Drive on the logo that appears and click Drive.



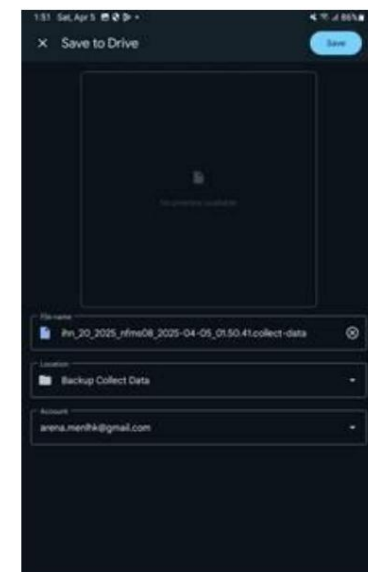
Then a folder option will appear where the export file will appear.



If there is no folder for *backup*, click the add folder logo button on the top right, and name the *folder* "Backup Collect Data" and click Create.

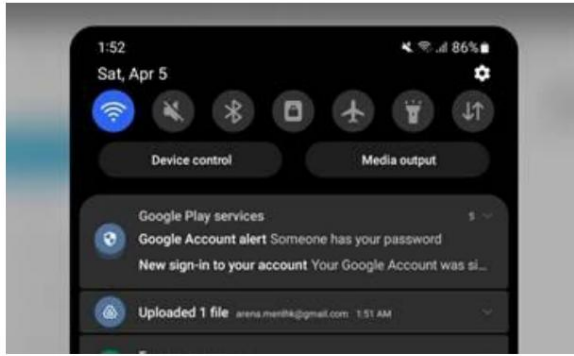


After *creating* the folder, go to the folder and click the button
"Select" to choose the folder as the place where we want to save the file.



And then click **SAVE**, which is located at the top right, as in the image above.





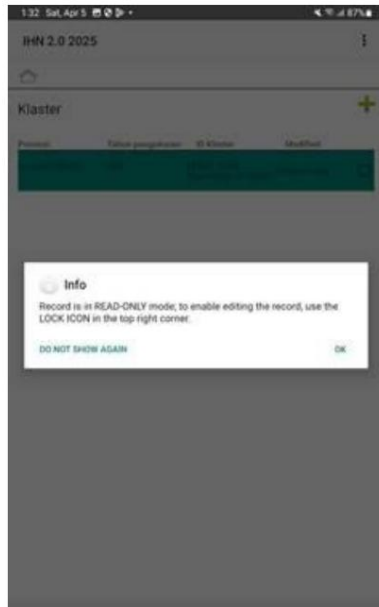
After the *export* process to Google Drive is carried out, there will be a notification that the process is complete, as seen in the image next to "Uploaded 1 file" if this notification appears, the backup process to Google Drive is complete.

To be sure, please check whether the Collect Data file is already in that folder.

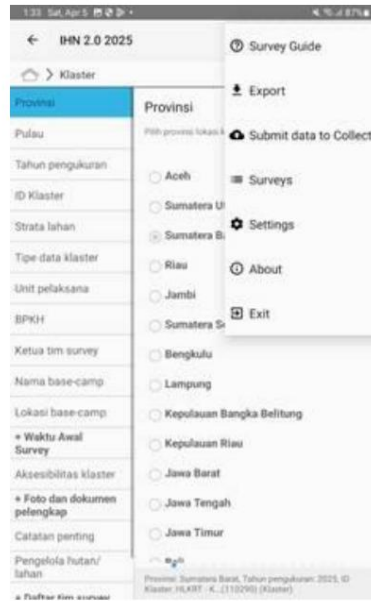


Backup to MicroSD/External Hard-disk

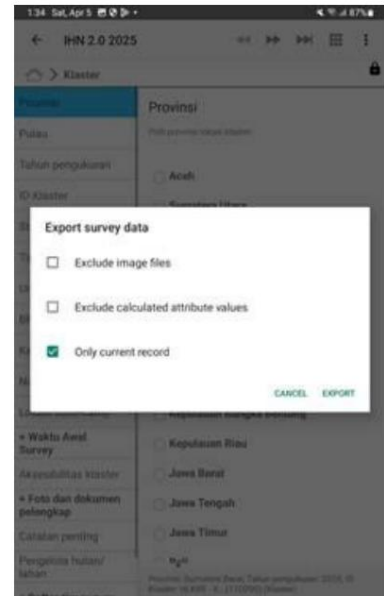
To back up to MicroSD/External hard disk, please follow these steps:



Click on one of the field data that you want to backup, and click OK to continue.

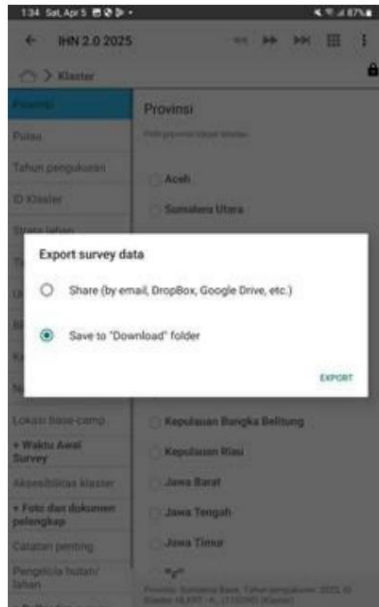


Then the detailed data display will appear, continue by clicking on the top right menu button, and select the "Export" menu.

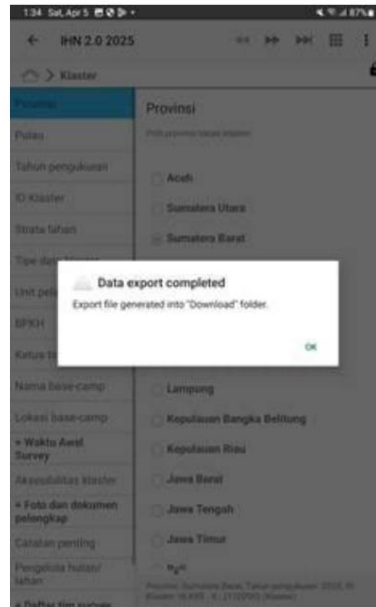


A checklist menu will appear and check it "Only current record" as in the image above, and click "EXPORT"





The *Export* menu will appear and select "Save to download Folder" and click the Export button.



The *backup* data file will be *exported* to the download folder on the tablet and a menu will appear as above. If the *export* process is complete, click OK.

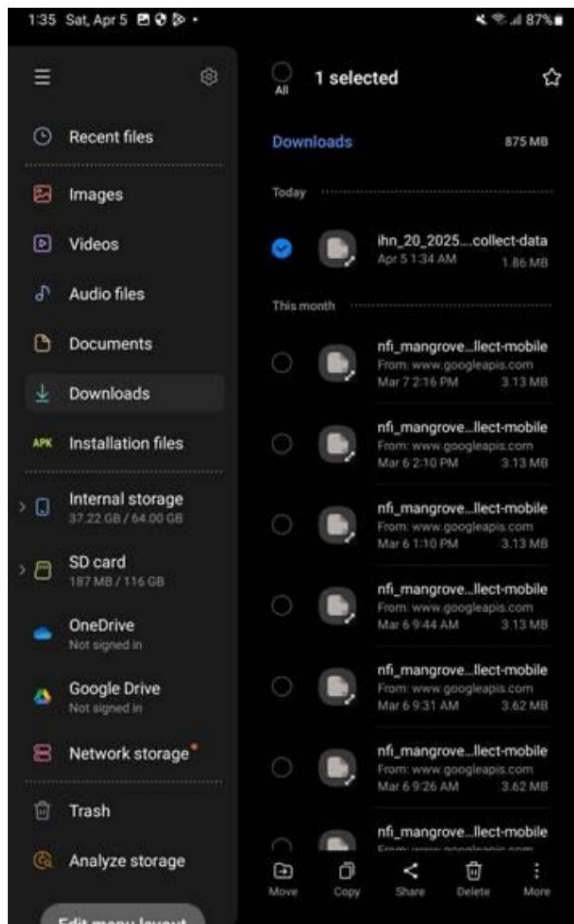


Next, we will copy the files that have been saved in the "Download" folder to the MicroSD or External HD that we have prepared.

Select the "My Files" app icon to browse the folders on the tablet.

As in the yellow icon with a picture of a folder





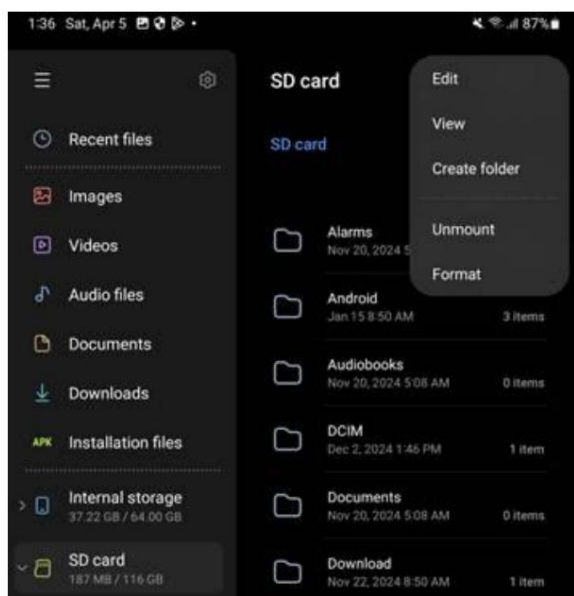
Select the “Downloads” folder on the left menu and on the right side a list of files in the *download* folder will appear .

Select the exported file , usually at the top according to the time and date the data was exported.

Long press on the *backup* file, until a blue *checked* button appears , as shown in the image.

Once the file is *checked*, click Copy to copy the file.

The Copy button is located at the bottom, as shown in the image.



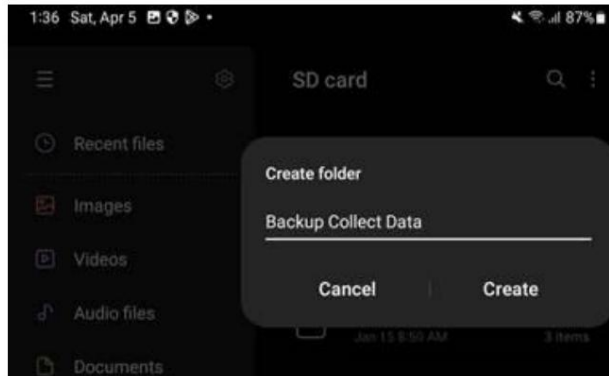
If the tablet is connected to a MicroSD/SDCard/External HD, it will be detected and appear in the menu on the left.

In this simulation, select SD CARD because the backup will be done to the installed MicroSD.

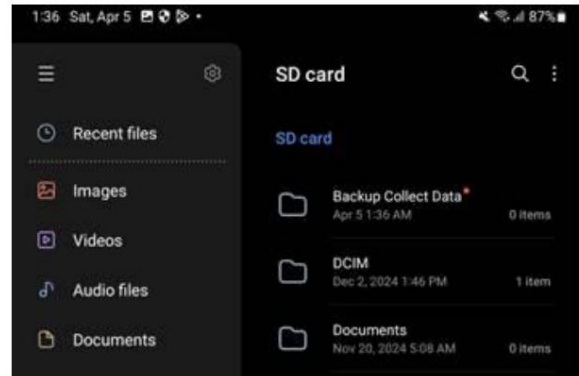
And click on the SD card on the left, then on the right will appear a list of files and folders stored on the SD Card.

If there is no backup folder yet, create a backup folder by selecting the menu on the top right and the “Create Folder” menu will appear as shown in the image.



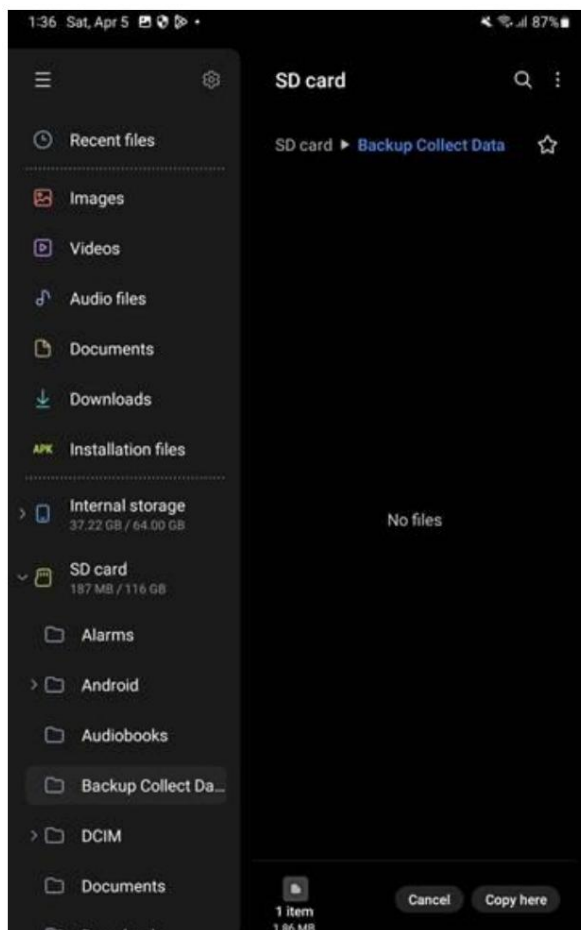


Create a new folder with the name “Backup Collect Data” and click Create.

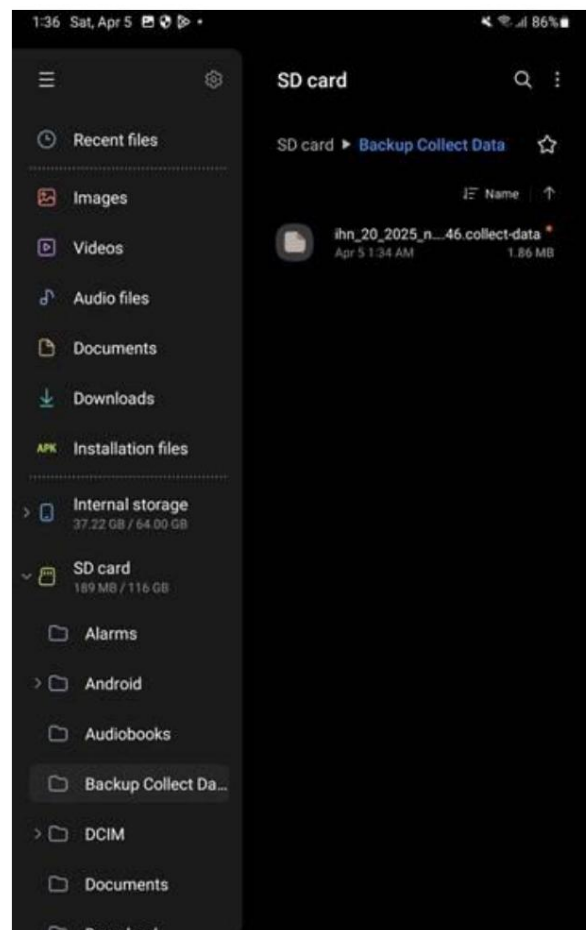


Then a new folder will be created on the SD card.

Enter the folder by clicking on the “Backup Collect Data” folder.



After entering the “Backup Collect Data” folder, click the “Copy Here” button on the bottom menu.



If the file copy has been done, the backup file will be saved on the SD Card as shown in the image above, this step is also the same for backing up to HD.

External via USB C





**DIREKTORAT JENDERAL
PLANOLOGI KEHUTANAN**

KEMENTERIAN KEHUTANAN
REPUBLIK INDONESIA

Gedung Manggala Wanabakti
Blok I Lt. 7, Jl. Jenderal Gatot Subroto - Jakarta
10270, Po Box 6505, Indonesia.