
Technical Instructions Inventory of Forest Stands and Non-Timber Plants In Mangrove Forest Type







KEMENTERIAN
KEHUTANAN
REPUBLIK INDONESIA

Technical Instructions Inventory of Forest Stands and Non-Timber Plants in Mangrove Forest Types

©Directorate General of Forestry Planning
Directorate of Forest Resources Inventory and Monitoring
Ministry of Forestry 2025



**MINISTRY OF FORESTRY
DIRECTORATE GENERAL OF FORESTRY PLANOLOGY**

**DECISION OF THE DIRECTOR GENERAL OF FORESTRY PLANOLOGY
NUMBER 15 OF 2025**

ABOUT

**TECHNICAL GUIDELINES FOR INVENTORY OF FOREST STANDINGS AND NON-FOREST PLANTS
WOOD IN MANGROVE FOREST TYPE**

BY THE GRACE OF GOD ALMIGHTY

DIRECTOR GENERAL OF FORESTRY PLANOLOGY,

Considering:

- a. that based on the provisions in Article 19 paragraph (4)**
Regulation of the Minister of Environment and Forestry Number 7 of 2021 concerning Forestry Planning, Changes in Forest Area Designation and Changes in Forest Area Functions, as well as the Use of Forest Areas, Implementation of Forest Inventories refers to the Forest Inventory guidelines;
- b. that based on Attachment I 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, and Use of Forest Areas, one of the forest types in the implementation of forest stand and non-timber plant inventory activities is Mangrove Forest;**
- c. that the Forest Inventory guidelines as referred to in letter a require further detailing in the form of technical instructions;**
- d. that based on the considerations as referred to in letter a, letter b and letter c, 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 Mangrove Forest Types;**

Remember

- :**
- 1. Law Number 41 of 1999 concerning Forestry (State Gazette of the Republic of Indonesia 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 dated March 31, 2023 concerning the Stipulation of Government Regulation in Lieu of Law Number 2 of 2022 concerning Job Creation to Become Law;**

2. Regulations



2. Government Regulation Number 11 of 2018 concerning Procedures for Organizing Remote Sensing Activities
(State Gazette of the Republic of Indonesia Number 56 of 2018, 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 Number 33 of 2021, Supplement to the State Gazette of the Republic of Indonesia Number 6635); 4. Government Regulation Number 45 of 2021 concerning Geospatial Information Implementation (State Gazette of the Republic of Indonesia Number 55 of 2021, 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 of the Republic of Indonesia Number 7 of 2021 concerning Forestry Planning, Changes in Forest Area Designation and Changes in Forest Area Functions, and 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 Ministry of Environment and Forestry (State Gazette of the Republic of Indonesia 2021 Number 1387); 8. 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);

9. Regulation of the Minister of Forestry Number 3 of 2025 concerning the Organization and Work Procedures of the Forest Area Consolidation Center (State Gazette of the Republic of Indonesia 2025 Number 214);

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 2025 Number 84);

11. Decree of the Director General of Forestry Planning Number 3 of 2025 concerning Technical Instructions for Inventory of Forest Stands and Non-Timber Plants in the Framework of National Level Forest Inventory;

DECIDE:

To stipulate: **DECISION OF THE DIRECTOR GENERAL OF PLANNING
FORESTRY REGARDING TECHNICAL INSTRUCTIONS FOR INVENTORY
FOREST STANDING FOREST AND NON-TIMBER PLANTS IN
MANGROVE FOREST TYPE.**

FIRST : To stipulate the Technical Instructions for Inventory of Forest Stands and Non-Timber Plants in Mangrove Forest Types, hereinafter referred to as the Technical Instructions for Mangrove Forest Inventory (IHM), as stated in the Attachment which is an integral part of this Decree.

SECOND : Technical Instructions for Inventory of Forest Stands and Non-Timber Plants in Mangrove Forest Types as referred to in the FIRST dictum include, among other things: a. Planning Stage including Sampling Design;

Planning; Field Preparation; and b. Implementation
Stage includes Cluster Development; Field Data Collection and/or c. Implementation Reporting.

THIRD : The Technical Instructions as referred to in the FIRST dictum serve as a reference for work units within the Ministry of Forestry at the National level, Regional Governments at the Provincial level or other agencies/institutions that have competence in the field of Forest Inventory.

FOURTH: When these Technical Instructions come into force, their validity may automatically end 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 said Ministerial Regulation.

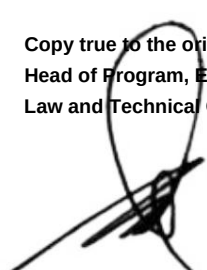
FIFTH : This decision shall come into effect on the date of stipulation.

Established in Jakarta on
June 12, 2025

DIRECTOR GENERAL,

Signed.

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


ALI MAIMUR NIP.
19750519 200003 1 002

ADE TRI AJIKUSUMAH NIP.
19751026 199603 1 001

A copy of this Decree 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.





ATTACHMENT
DECISION OF THE DIRECTOR GENERAL OF FORESTRY PLANOLOGY
NUMBER 15 OF 2025
ABOUT
TECHNICAL GUIDELINES FOR INVENTORY OF FOREST STANDINGS AND NON-FOREST PLANTS
WOOD IN MANGROVE FOREST TYPE



List of contents

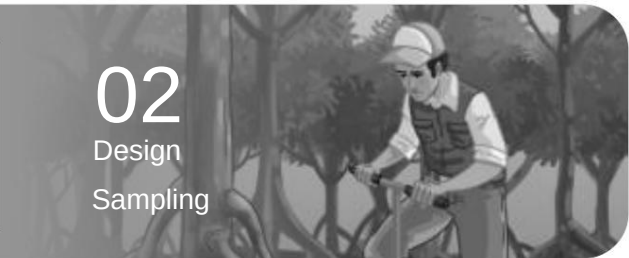
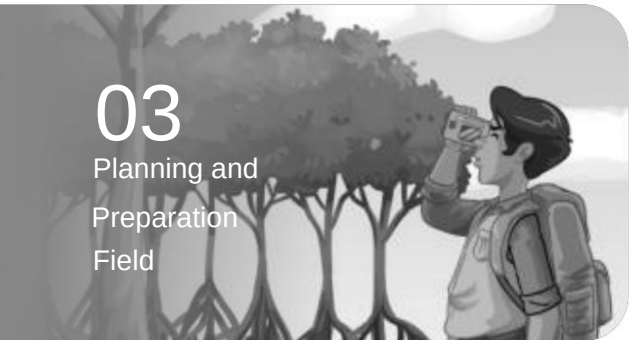
Table of contents vii

Table of Contents.....viii

List of Figures..... ix

List of Attachments x

Glossary of Terms and Abbreviations.....xi

1.1 Background	2	
1.2. Purpose and Objectives	4	
1.3. Scope	4	
1.4. Basis of Implementation	4	
2.1. Sampling Method	6	
2.2. Cluster Design, Size, & Type	8	
3.1. Identification of Cluster-Plot Locations	10	
3.2. Preparation of Equipment and Logistics	11	
3.3. Inventory Team Requirements	12	
3.4. Data recording form	14	
4.1. Coordination & Preparation for Cluster Development	16	
4.2. Access to the Plot	17	
4.3. Determining the Plot Center Point	17	
4.4. Identification of Witness Points	18	

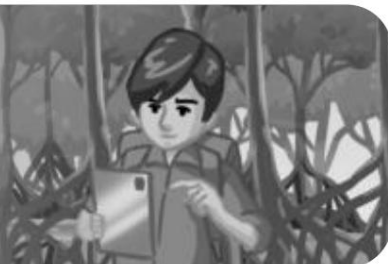
5.1. Cluster Information	22
5.2. Sample Plot Information	26
5.3. Canopy density	38
5.4. Regeneration	39
5.4. Understory Plants	40
5.5. Litter	41
5.6. Soil Carbon	42
5.7. pH and Salinity	46
5.8. Dead Wood	50
5.9. Liana	52
5.10. Palm and Nipah	53
5.11. Trees and Dead Trees	55
5.12. Survey Team Identity	62

05 Collection Field Data



6.1 Reporting Mechanism	64
6.2 Table of Contents of the Report	65
Bibliography	67

06 Reporting Implementation Inventory



Appendix List

07 Attachment



Appendix 1. Mangrove Field Form.....	70
Appendix 2. Field Measurement Techniques.....	89
Appendix 3. Making Herbarium in the Field	95
Appendix 4. List of Tree Species Identification Institutions/Laboratories	96
Appendix 5. Instructions for Using <i>the Vertex Laser Geo</i> for Measuring Distance and Height of Trees	98
Appendix 6. Format of IHM Activity Implementation Statement Letter	104
Attachment 7. IHM Minutes Format Cannot Be Implemented.....	105
Appendix 8. Collect Mobile Updating Procedure	106
Appendix 9. Procedure for Uploading Collect Mobile Data to the Server.....	110
Appendix 10. Mobile Data Collection Back Up Procedure	112



List of Tables

Table 1. Composition and duties of the Mangrove Forest Inventory Team members	12
Table 2. Field forms at each stage of the survey team's activities	14
Table 3. Summary of observation and measurement activities in each cluster.....	20
Table 4. Slope correction for distance measurement	91
Table 5. Slope correction for plot radius measurements.....	92

list of Figures

Figure 1. Example of distribution of Mangrove Forest Inventory clusters	6
Figure 2. Design and size of the Mangrove Forest Inventory cluster.....	8
Figure 3. Mangrove Forest Inventory Plot Center Nameplate	18
Figure 4. Delta type mangroves	33
Figure 5. River estuary type mangroves	34
Figure 6. Lagoon-type mangroves	34
Figure 7. Island type mangroves	35
Figure 8. Plot center for taking canopy density photos	38
Figure 9. Taking photos of the canopy with a fish-eye lens	38
Figure 10 Regeneration subplots (A1 and A2) with West–East or North–South positions on each plot.....	39
Figure 11. Frame-plot (clip-plot) of undergrowth (A1 and A2) with West–East position or North–South on each plot	40
Figure 12. Understory/litter sample labels for laboratory analysis.....	41
Figure 13. Ekelkamp drill	42
Figure 14. Soil sampling.....	43
Figure 15. Labeling of samples.....	44
Figure 16. Soil pH measurement	46
Figure 17. Water salinity measurement.....	47
Figure 18. Measuring water pH.....	48
Figure 19. Water salinity measurement	49
Figure 20. Location of dead wood measurements using the Line Intersect Sampling method.....	50
Figure 21. Deadwood measurement provisions using the LIS method	51
Figure 22. Liana measurements	52
Figure 23. Measurement of the diameter of an adult nipah palm	54

Figure 24. Possible positions of nipah palms (R1, R2, ..., R7) in subplot C	54	Figure
25. Size of radius and diameter limit (DBH) of trees measured in subplots B, C, and D in mangroves (Ministry of Forestry 2025)	55	
Figure 26. Sequence of tree measurements, determining which trees are measured and which are not measured, and determination of distance and azimuth of trees.....	55	
Figure 27. Labeling dead trees.....	56	
Figure 28. Diameter measurement points for various tree conditions	58	
Figure 29. Measuring tree diameter.....	60	
Figure 30. Height of base of crown and total height of tree	61	
Figure 31. Reporting mechanism for Mangrove Forest Inventory activities	64	
Figure 32. Illustration of slope gradient (a) 10% and (b) 100%	89	Figure
33. Method of determining (a) the 0% slope gradient point on the nose of a colleague (b) measurement of slope gradient by two members of the survey team.....	89	
Figure 34. Slope correction for distance measurement.....	90	
Figure 35. Correction of plot radius on slope	90	
Figure 36. Measuring (a) tree diameter using a 1.3 m measuring stick and (b) measuring the diameter of the stump.....	93	Figure 37.
Difference in tree length and height (a) and trigonometric principles in determining tree height (b).....	94	
Figure 38. IHM System Flow	106	
Figure 39. Collect Mobile download QR Code	106	
Figure 40. Figure 3. Collect Mobile application download page	107	
Figure 41. QR code to download the IHM survey form	107	
Figure 42. a. Complete data display b. Incomplete data display.....	110	
Figure 43. Data selection process before submitting data from Collect Mobile to Server	111	
Figure 44. Display of the data sending process from Collect Mobile to Server	111	



Glossary and Abbreviations

Glossary

Abrasion	The process of coastal erosion by wave and current activity
Aspect	The direction (<i>azimuth</i>) of the slope measured in degrees
<i>Azimuth</i>	The angle measured clockwise from north is used to determine position or direction.
<i>Base camp</i>	Lodging or base headquarters for the survey team
BBS	Sample weight before drying
BD	Soil mass density, the ratio between the dry weight of the soil and the total volume of the soil
BJ	Mass of a substance per unit volume
<i>Bole height</i>	Crown base height - the distance from ground level to the first branch on the tree trunk
BPKH	The Forest Area Stabilization Center is a technical implementation unit under the Ministry of Forestry which is responsible for forest area stabilization throughout Indonesia.
DBH	Tree trunk diameter measured at breast height (approximately 1.3 meters from the ground)
Dock	Structure at the water's edge for mooring and anchoring ships
Mangrove Ecosystem	An ecological system found in coastal areas dominated by mangrove plant communities.
Coastal Ecosystem	The ecological system found in the area where land and sea meet
Elevation	The height of a place above sea level (masl)
Fauna	All animals that live in a particular habitat
Flora	All plants that live in a particular habitat
Field form	Documents for recording data and observations during the survey
GPS	Positioning system using satellites
Herbarium	Preserved plant specimen samples used for species identification

NTFPs	Products produced from forests other than wood
Customary Forest	Forests located in the territory of customary law communities
Forest Rights	Forests located on land that is burdened with land rights.
Mangrove Forest	Forests that grow in wet and salty habitats along the coast, especially at the mouths of large rivers
State Forest	Forests controlled by the state
Canopy	The crown layer or cover of the tree crown
Cluster	A collection of sample plots arranged in a single sampling design for forest inventory
Coordinate	Geographic location point that determines the position of a place
<i>Line Intersect Sampling</i>	Sampling method using transect lines to measure the volume of dead wood or litter
Liana	A climbing plant that lives among trees in a forest ecosystem
Methodology	Systematic methods or procedures used in research or activities
Nipah	A type of palm commonly found in mangrove ecosystems or transition zones, with the species name <i>Nypa fruticans</i>
Ups and down	Periodic movement of sea level rising and falling
Palm	A woody plant from <i>the Areaceae family</i> that can be found in the mangrove ecosystem.
Leaf sheath	The leaf part of a palm, such as on a nipah palm
Climate Change	Long-term changes in weather patterns and climate conditions
Plot	A sample area of a certain size used for forest inventory data collection
ppt	Units for measuring salinity
Propagul	Mangrove seeds or seedlings that are ready to grow
Rehabilitation	Efforts to restore or repair damaged ecosystem conditions
Salinity	A measure of the dissolved salt content in water or soil



Sediment	Sedimentary material that forms in an area, especially in aquatic or coastal environments
Sedimentation	The process of material deposition in an area
Litter	Organic matter that falls on the forest floor such as leaves, twigs, flowers and fruit that have undergone decomposition
Stratified Systematic Sampling	Systematic stratified sampling based on a hexagonal grid, where sample units (plot clusters) are placed at the center of each hexagon at a certain distance in each stratum.
Stratification	Division of a region or population into layers or groups based on certain characteristics
Subplot	A small section or area within a plot used for specific measurements or observations.
Slope	Slope gradient expressed as a percentage
Title	Branching and leaf structure at the top of the tree
Transect	Observation lines used for ecological sampling
Understory Plants	Vegetation that grows on the forest floor, under the main tree canopy
Transponder	A tool used to determine flat distances using ultrasound technology, usually combined with a <i>range finder hypsometer</i> .
Ultrasonic laser hypsometer	A distance and height measuring tool that uses laser and <i>ultrasound technology</i> , some brands that are often used include <i>Vertex Haglof</i>
Work unit	An organizational unit that carries out certain tasks within a government structure

List of Abbreviations

BD *Bulk Density*

BBS **Wet Weight of Sample**

BJ **Specific gravity**

DBH *Diameter at Breast Height*

GPS *Global Positioning System*

Non-Timber Forest Products (NTFPs)

IHN **National Forest Inventory**

IPCC *Intergovernmental Panel of Climate Change*

KPH **Forest Management Unit**

PSP *Permanent Sample Plot*

LIS *Line Intersect Sampling*

M4CR *Mangroves for Coastal Resilience*

ppt **Parts Per Thousand**

SOC *Soil Organic Carbon*

TBB **Total Wet Weight**

QA/QC *Quality Assurance/ Quality Control*



©Directorate of IPSDH

01

Introduction

1.1 Background

1.2. Purpose and Objectives

1.3. Scope

1.4. Basis of Implementation

1.1 Background

Indonesia is an archipelagic nation blessed with abundant maritime and land resources. Its geographical location is strategic, situated on the equator and flanked by two continents (Asia and Australia) and two oceans (the Pacific and Indian).

Based on the reference data for Indonesian maritime areas launched by the Coordinating Ministry for Maritime Affairs and

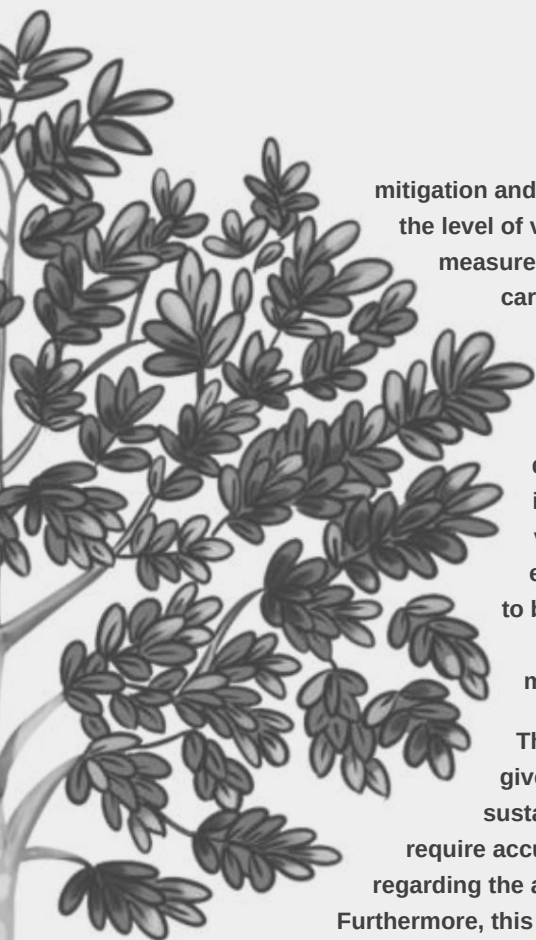
As of 2020, Indonesia's total land area reached 8,300,000 km², of which 6,400,000 km², or 77%, is water. Indonesia has the second-longest coastline in the world after Canada, at 108,000 km.

Indonesia's geographical location makes it home to mangrove forests, one of the world's most important coastal ecosystems. As a link between terrestrial and marine ecosystems, mangrove forests provide a variety of crucial ecosystem services. Mangrove forests have three main interrelated functions: physical, ecological, and socio-economic (Iswahyudi *et al.* 2019). Physically, mangroves play a role in maintaining seawater quality, retaining silt, neutralizing toxins, preventing erosion, and dampening waves to mitigate coastal disasters (Gedan *et al.* 2011; Soedarmo 2018; Melati 2021). Ecological functions include providing habitat for various species such as fish, crabs, mollusks, and shrimp (Kusmana 2014). Meanwhile, from a socio-economic perspective, mangroves provide a source of income for communities through the production of fish, plants, and wood, as well as providing eco-tourism services (Hernández-Blanco *et al.* 2021; Ofori *et al.* 2023).

The sustainability of Indonesia's mangroves faces serious threats from anthropogenic disturbances and natural factors. FAO data (2007) shows a decline in mangrove area of 3.6 million ha (19%) from 18.8 million ha to 15.2 million ha in the period 1980-2005, with a deforestation rate of 185,000 ha/year in the 1980s, decreasing to 118,500 ha/year in the 1990s, and 102,000 ha/year in 2000-2005. Mc Fadden *et al.* (2007) project a 30-40% reduction in the next 100 years, while GMA (2021) recorded a 4.3% decline in the last two decades.

Mangrove deforestation is driven primarily by human activities such as land conversion for fishponds, agriculture, and coastal development, as well as natural factors such as erosion, flooding, sea storms, and hydrological changes (GMA 2021). Climate change is worsening coastal conditions through rising sea levels and storm frequency. Given the strategic role of mangrove forests in





mitigation and adaptation to the impacts of climate change, as well as the high the level of vulnerability to damage, sustainable recovery and management measures are required. One of the efforts carried out in the implementation of forest inventory activities mangroves.

Mangrove forest inventory plays a crucial role in supporting sustainable coastal ecosystem management. Unlike previously developed terrestrial forest inventories, mangrove ecosystem inventory activities face unique challenges due to the complexity of vegetation structure, variability in carbon content, and other ecological conditions. Therefore, existing inventory methods need to be adapted to reflect these characteristics.

mangrove characteristics accurately.

The availability of mangrove data and information is crucial given their role in addressing climate change and supporting sustainable development. Effective policy management and evaluation require accurate and up-to-date data. regarding the area, condition, and dynamics of mangrove forests.

Furthermore, this information also plays a vital role in the preparation of national reports on mangrove forests. greenhouse gas emissions and biodiversity conservation efforts.

A strategic step has been taken through the development of technical guidelines for the Mangrove Forest Inventory. This guide is designed to integrate various aspects, from ecological understanding and biomass and carbon measurement techniques to meeting information needs for management and reporting at the national and international levels. In its development, this guide adapted the National Forest Inventory (NFI) 2.0 methodology, tailored to the needs of the Mangrove Forest Inventory. This adjustment allows for more comprehensive, accurate, consistent data collection, and comparable data both temporally and spatially. This method will subsequently be implemented in mangrove forests at the provincial level.

The Mangrove Forest Inventory Technical Guidelines are designed as a systematic guide for mangrove forest inventory in Indonesia. This document provides a standardized framework covering all stages, from planning and sampling methods to field measurements, through to presentation and reporting. This guide is intended to ensure accurate and consistent data collection.

1.2. Purpose and Objectives

These technical guidelines for the Mangrove Forest Inventory are intended as a guideline for conducting mangrove forest inventories in Indonesia. The development of these technical guidelines has several specific objectives, as follows:

1. Provide a guide for implementing Mangrove Forest Inventory which includes planning, sampling methods, field measurements, as well as data presentation and reporting.

2. Support integration and harmonization between Mangrove Forest Inventory activities and National Forest Inventory (IHN) 2.0.

1.3. Scope

The scope of the Mangrove Forest Inventory includes:

1. Mangrove Forest Inventory Activities cover all mangrove forests in Indonesia, including mangroves in state forests, customary forests, and private forests.
2. Implementation of the Mangrove Forest Inventory is carried out by the Ministry of Forestry's work unit in charge of inventory and monitoring of forest resources, in collaboration with the Ministry of Forestry's work unit in charge of mangrove forest management, Regional Governments, Universities and other related parties.
3. The inventory methodology is adapted to

The distinctive characteristics of mangrove ecosystems, with a focus on measuring and recording field data. These measurements and recording field data include:

 - a. Recording general forest conditions

mangroves that are the location of the Mangrove Forest Inventory cluster/plot (location coordinates, area status, elevation, etc.)
 - b. Identify the types of mangroves
 - c. Measurement of stem diameter and height trees to calculate stand potential
 - d. Taking photos of canopy density for canopy cover analysis

- e. Sampling (litter, undergrowth, soil) for biomass and carbon analysis
- f. Recording of existence and abundance non-woody plants
- g. Recording of forest environmental conditions mangrove

4. Mangrove Forest Inventory was carried out periodically, at least once every five years to monitor the potential, growth and changes in mangrove land cover.

1.4. Basis of Implementation

The basis for conducting mangrove forest inventory is as follows:

1. Law Number 41 of 1999 concerning Forestry, as amended by Law Number 19 of 2004 concerning the Stipulation of Government Regulation in Lieu of Law Number 1 of 2004 concerning Amendments to Law Number 41 of 1999 concerning Forestry into Law.
2. Law Number 6 of 2023 concerning the Stipulation of Government Regulation in Lieu of Law Number 2 of 2022 concerning Job Creation into Law.
3. Government Regulation Number 23 of 2003 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. Decision of the Director General of Planning Forestry Regulation Number 3 of 2025 concerning Technical Instructions for Inventory of Forest Stands and Non-Timber Plants in the context of the National Forest Inventory.



©Directorate of IPSDH

02

Design Sampling

2.1. Sampling Method

2.2. Cluster Design, Size, and Type

2.1. Sampling Method

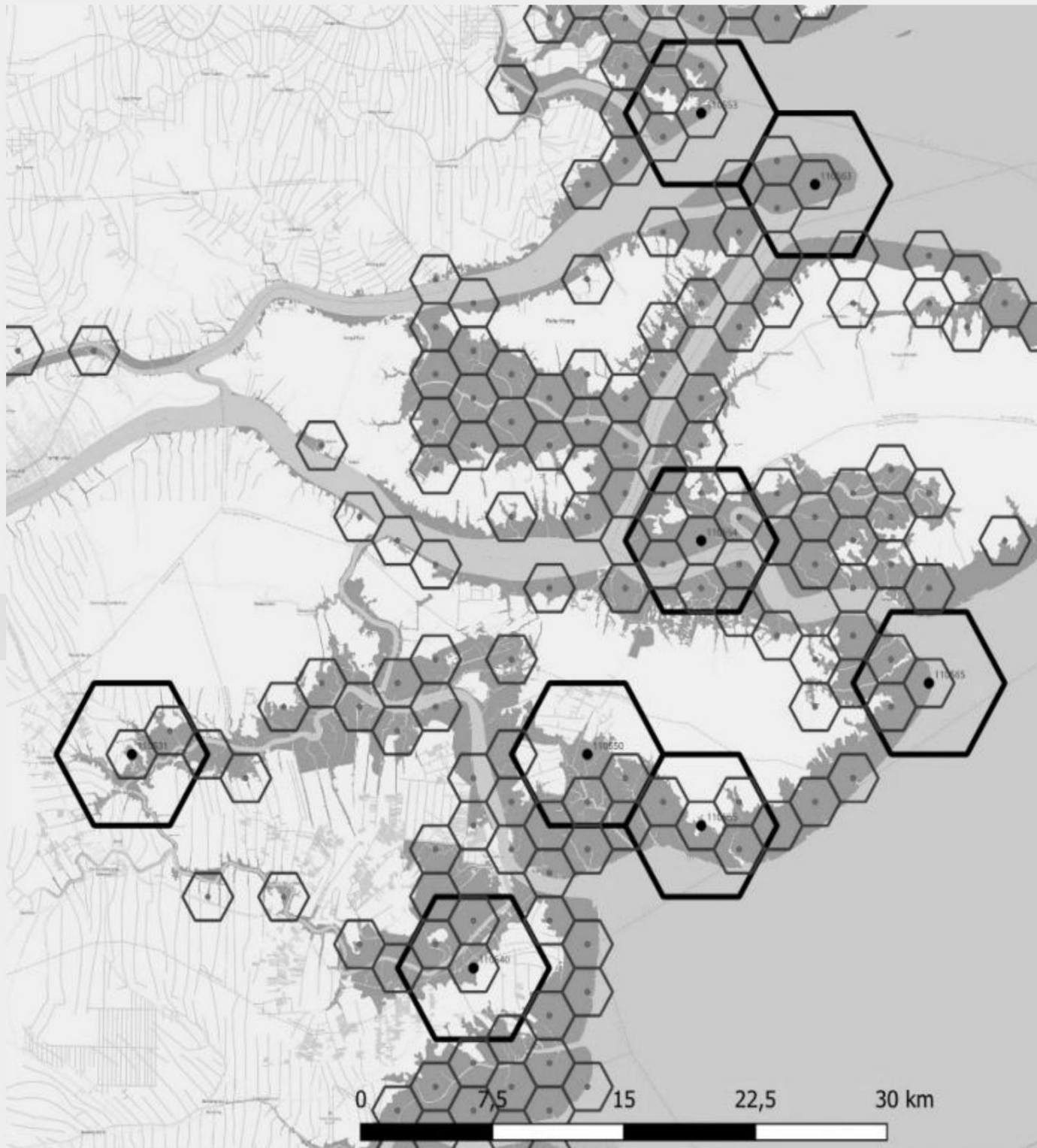


Figure 1. Example of distribution of Mangrove Forest Inventory clusters





The Mangrove Forest Inventory sampling design refers to and is integrated with the IHN 2.0 sampling design. The IHN 2.0 design uses the *Stratied Systematic Sampling* method (Ministry of Forestry 2025).

In the context of the Mangrove Forest Inventory, sampling was carried out on mangrove forest strata according to the land cover map, which includes the primary mangrove forest class (Hmp/2004) and secondary mangrove forest (Hms/20041) by paying attention to the representation of the canopy density class (dense, medium, and sparse) according to the National Mangrove Map.

The sample units (clusters) for the Mangrove Forest Inventory are distributed systematically with a sampling frame in the form of a hexagonal grid which is an intensification of the IHN 2.0 hexagonal *grid*. Distance/
grid *intervals* are adjusted based on Calculation of the sample size (number of clusters) required to achieve the desired level of accuracy in estimating mangrove populations. Cluster locations are aligned with the center point of each hexagon on the grid. The use of a hexagonal grid is intended to provide a consistent sampling framework, allowing for intensification of sampling for Mangrove Forest Inventories at other levels if necessary.

2.2. Cluster Design, Size, and Type

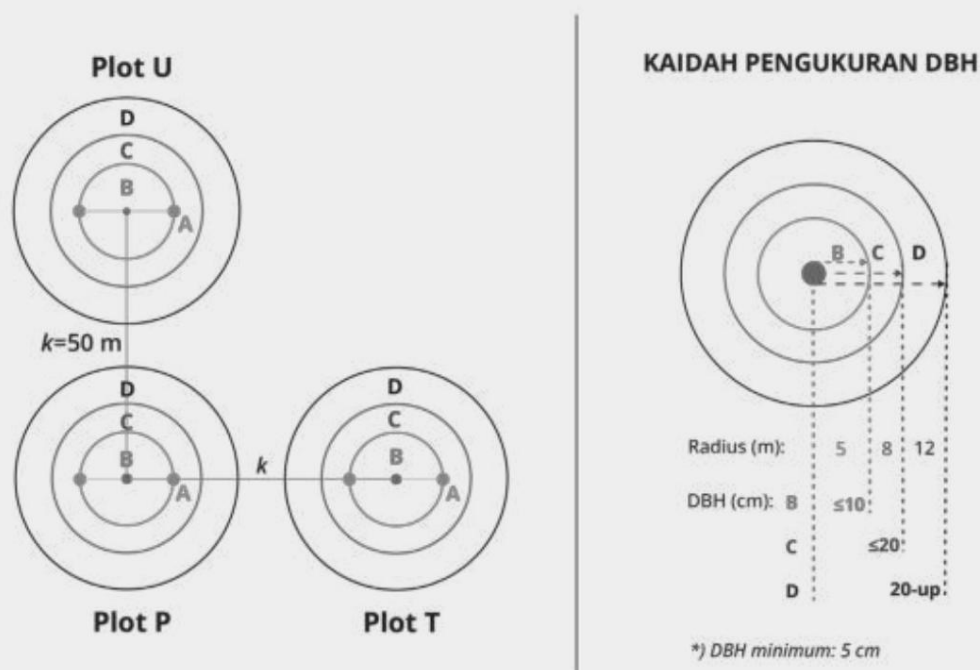


Figure 2. Design and size of the Mangrove Forest Inventory cluster (Ministry of Forestry 2025)

The cluster design for the Mangrove Forest Inventory uses an L-shape consisting of 3 circular plots, namely Plot P (in the center of the cluster), Plot U (in the north of the cluster), and Plot T (in the east of the cluster) with a distance (k) between plots of 50 m. Each plot consists of 4 circular subplots as follows (Figure 2):

1. Subplot A: radius 1 m, used for regeneration observation (DBH < 5 cm).
2. Subplot B: radius 5 m (from the center of the plot), used for measuring trees with a diameter of 5 cm to <10 cm.
3. Subplot C: radius 8 m (from the center of the plot), used for measuring tree diameter. 10 cm to <20 cm.
4. Subplot D: radius 12 m (from the center of the plot), used for measuring tree diameter. ≥20 cm.

To obtain data on the growth of *mangrove* forest resources over time, Mangrove Forest Inventory clusters are permanently established and measured periodically (every 5 years). Each cluster will serve as a permanent sample plot *representative* of the mangrove forest.

©Directorate of IPSDH

03

Planning and Preparation Field

3.1. Identification of Cluster-Plot Locations

3.2. Preparation of Equipment and Logistics

3.3. Inventory Team Requirements

3.4. Data Recording Form

3.1. Identification of Cluster-Plot Locations

Step 1

The coordinates of the distribution of Mangrove Forest Inventory clusters to be measured in the field are determined by the Ministry of Forestry (through the work units handling forest resource inventory and the work units handling mangrove rehabilitation management) which are then determined as a Mangrove Forest Inventory distribution map. These work units must overlay the coordinates of the distribution of Mangrove Forest Inventory clusters with provincial boundaries.

Step 2

The work unit handling the inventory and the work unit handling the management of mangrove rehabilitation determines the plan for the number and distribution of Mangrove Forest Inventory clusters to be measured annually. Sampling is carried out on mangrove forest strata according to the land cover map, which includes the primary mangrove forest class (Hmp/2004) and secondary mangrove forest (Hms/20041) by taking into account the representation of the canopy density class (dense, medium, and sparse) according to the National Mangrove Map. This is done to ensure that the clusters measured each year can represent the distribution of mangrove forest potential in each province.

Step 3

The work unit handling inventory and the work unit handling mangrove rehabilitation management coordinates Mangrove Forest Inventory activities by assigning field teams, which may involve other related institutions. The location of Mangrove Forest Inventory activities is based on the planned cluster distribution as stated in point 2.

Step 4

Overlay the distribution points of the Mangrove Forest Inventory clusters with a relevant base map for the mangrove forest, including the river and waterway network, tidal zones (if any), access to the mangrove location by water or land (if any), and the nearest settlements. This *overlay* map will be used to compile the Mangrove Forest Inventory working map, helping the field team in planning access and navigation to the Mangrove Forest Inventory cluster locations more effectively and understanding the typology of the mangroves to be inventoried.



3.2. Preparation of Equipment and Logistics

Mangrove forest inventory requires specialized equipment suited to the conditions of the mangrove forest. This includes tools for finding clusters, constructing clusters, measuring within the clusters, and erecting tents if necessary.

Search and Logging Equipment

Cluster Development:

1. Work map
2. GPS
3. Compass
4. Machete
5. Meter 25 m or 50 m
6. 40 x 30 cm yellow zinc plate
7. Zinc nails measuring at least 10 cm

Measuring & Recording Equipment:

1. Tablets that have a memory card with *Collect Mobile* application, or field form for a number of clusters to be measured as reserves
2. Batteries for measuring equipment and *power-bank* for tablet devices to fill out forms
3. Tree labels for individual tree markers that has been measured
4. Permanent marker for writing on labels tree
5. Nails and hammer for attaching tree labels
6. Phi band (minimum 2 pieces)
7. Vertex and *transponders* to determine the distance and height of trees
8. Compass to measure direction or *azimuth* tree position
9. *Protractor* or *Clinometer* or other measuring tool to measure the angle of inclination of dead wood
10. Caliper to measure the diameter of the liana
11. Laser *distance* meter to measure distance quickly (*optional*)

12. Canopy cover measuring tool (*Sh eye lens*)

13. Container box for storing tools soil measurement and sampling

14. Other measuring instruments (optional), which can be used when the main measuring instrument is damaged in the field. For example, *haga* *hypsonometer* or *spiegel relascope* for measuring tree height and *clinometer* for measuring slope gradient.

Litter Measurement Equipment and Understory Plants:

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

Parameter Measurement Equipment Soil Carbon:

1. *Eijkelpamp* soil drill / wing peat drill
2. Plastic/soil sample container (volume > 5 liter)
3. Sample name label
4. Sample bottle
5. Small scope
6. Lap
7. Aquades
8. Sprayer
9. Trash *bag* for the base
10. Container *box* for soil samples

Water Salinity Measuring Instrument and Land

1. Tools for measuring salt concentration (*Refractometer*, *Salt meter*, etc.)
2. Sample bottle
3. Dropper pipette
4. Water and Soil pH Measuring Equipment
5. pH meter
6. Plastic cups

Supporting Equipment:

1. Personal equipment (gloves, hat, raincoat)
2. Medicines
3. Food and drinking water
4. Water safety equipment (life jacket)
5. Insect repellent
6. Tent equipment (if needed)
7. Cooking equipment (if needed)
8. Chest bag
9. Special gloves (sensitive for *mobile collect tablets*)
10. *Frequently Asked Questions* Guide Pocket Book
11. Boots, reef shoes or waders for walking in mangrove mud

3.3. Inventory Team Requirements

Mangrove Forest Inventory activities require a well-organized team. A cluster measurement team typically consists of a core team and interim work teams that support each other in carrying out their tasks. The core team is typically led by a team leader with several assistants who assist with coordination and technical and administrative implementation in the field.

Intermediate work teams generally consist of several members with different skills that complement each other, such as pioneers who seek location access, species identifiers for vegetation identification, meters for collecting field data, as well as logistics personnel and cooks who support team operations.

The majority of the team members are usually local workers from surrounding villages who have in-depth knowledge of the area and characteristics of mangrove forests.

Table 1. Composition and duties of the Mangrove Forest Inventory team members

Position in the team	Task
Squad leader	1. Responsible for all measurement activities in the mangrove forest, including coordinating water/land transportation, logistics, and measurements in the mangrove plot. 2. Operate GPS during navigation to the mangrove plot. 3. Determine the starting point location of the mangrove plot and ensure the construction of the plot. done correctly according to technical instructions. 4. Record the results of plot monitoring and parameter measurements in the plot. mangroves. 5. Ensure team safety during the activity.
Assistant squad leader	1. Measure the distance, direction and height of the mangrove trees. 2. Prepare and operate measuring instruments, especially <i>Vertex</i>, compass, and <i>laser distance meter</i>. 3. Assist with measurements in small subplots if needed. 4. Measuring mangrove environmental parameters such as salinity and pH (water and soil). 5. Take soil samples.
Assistant squad leader (Administration)	1. Manage activity documentation including taking photos and videos during measurement. 2. Ensure the completeness of all forms and data collected from the team. 3. Organize the archiving of samples taken (soil, litter, plants). 4. Manage financial and logistical administration during field activities.



Position in the team	Task
Pioneer	1. Conduct pioneering or search for an access route from the last landing point to mangrove plots. 2. Establishing mangrove plots, including preparing waterproof stakes, measuring distances and <i>azimuths</i> for plot boundary locations, and installing <i>visible stakes</i> in the mangrove environment. 3. Assist with measurements within the mangrove plot. 4. Ensure the route is safe from hazards such as deep mud or wildlife.
Type identifier	1. Identify mangrove species and related vegetation. 2. Measure the parameters in the mangrove plot (stem diameter, tree height, crown density). 3. Take samples of mangrove litter and undergrowth. 4. Assist with pioneering if needed.
Gauge	1. Identify mangrove species and related vegetation. 2. Measure the parameters in the mangrove plot (stem diameter, tree height, canopy cover). 3. Take samples of mangrove litter and undergrowth. 4. Assist with pioneering if needed. 5. Take soil samples.
Logistics personnel	1. Helping to provide the necessary materials and tools 2. Bringing materials and tools during the activity 3. Building a tent if you have to stay overnight in the field 4. Helping to prepare food
Cook	1. Coordinating the provision of food ingredients 2. Cooking for all members

Special Notes:

1. The team leader comes from the work unit that handles inventory and the work unit that handles inventory. handling mangrove rehabilitation management, provincial regional apparatus in charge of forestry or other implementing agencies that have the competence to carry out mangrove forest inventory activities.
2. Logistics and food preparation functions are shared among team members, taking into account the specific working conditions in the mangroves.
3. Equipment checks must be carried out every day before starting inventory activities.
4. The work team should involve local personnel who are familiar with the mangrove ecosystem. local.
5. Safety *briefings* are carried out daily to anticipate special risks such as mud. depth, tides, and presence of wildlife.
6. Task rotation can be done to avoid fatigue when working in mangrove conditions. challenging.
7. If an overnight stay is required, the team can build a temporary *camp* in a safe and secure area. dry by paying attention to the ebb and flow of the water.

3.4. Data recording form

The survey team fills out the field form (Attachment 1) via the *Collect Mobile* application or the printed version (if needed as a *backup*) according to the stages of the Forest Inventory activity. Mangroves 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 Mangrove Forest Inventory cluster location (by boat/land). Then, observation and measurement of the general condition of the cluster when the survey team arrives at the central point of the Plot (P/U/T)	F1-M
2.	Observation and measurement of general conditions in the center of Plot P, Plot U, and Plot T.	F2-M
3.	At each plot center (Plot P, Plot U, or Plot T), the survey team collects data. canopy density.	F3-M
4.	On each plot (Plot P, U Plot, or T Plot), the survey team creates 2 subplots A (A1, A2) and Conducting observations of mangrove regeneration (DBH <5 cm). Subplot A is a circular plot with a radius of 1 m placed in a West–East or North–South direction.	F4-M
5.	In each subplot A (A1, A2), the survey team cut the undergrowth, collection of litter, and weighing the wet weight of undergrowth and litter in a 0.5 x 0.5 m <i>clip-plot</i> . In addition, the survey team took samples of undergrowth and litter weighing approximately 300 grams for further analysis in the laboratory.	F5-M, F6-M
6.	In each subplot A (A1 or A2), the survey team took mangrove soil samples in a 0.5 x 0.5 m <i>clip-plot</i> in the West-East or North-South direction. If there are constraints in taking soil samples, it can be done at another location in the cluster by noting <i>the azimuth</i> and distance from the center of the plot.	F7-M
7.	In each subplot A (A1 or A2), the survey team conducted parameter sampling. Environmental factors include soil salinity and pH. To determine soil pH and salinity, soil samples can be taken at the sampling location.	F8-M
8.	At each plot (Plot, U Plot, or T Plot), the survey team takes samples. environmental parameters in the form of salinity and pH of water at a location that represents the environmental conditions of the waters at the observation location.	F9-M
9.	In subplot B, the survey team took measurements of dead wood, including determining the level of weathering by slashing with a machete/parang.	F10-M
10.	In subplot C, the survey team took measurements of lianas and palms.	F11-M, F12-M
11.	In subplots B, C, and D, the survey team measured live and dead mangrove trees (DBH ≥5 cm). Tree height measurements were conducted on 6 sample trees, representing small, medium, and large diameter classes. In the PSP, horizontal distance and <i>azimuth</i> measurements were made from the center point of the subplot to each measured tree. For trees of unknown species, the survey team took photographs of tree parts (leaves, stems, fruits, roots) and made herbarium specimens for species identification.	F13-M
12.	The survey team filled in their personal details at the end of the survey activity.	F14-M



©Directorate of IPSDH

04

Development Cluster

4.1. Coordination and Preparation for Cluster Development

4.2. Access to the Plot

4.3. Determining the Plot Center Point

4.4. Identification of *Witness Points*



©Directorate of IPSDH

4.1. Coordination & Preparation for Cluster Development

Coordination with related parties at the district level needs to be carried out so that implementation activities in the field are known to related parties and receive the necessary support. Additionally, during coordination activities, additional initial data collection, logistical preparation, and labor recruitment may be conducted. Coordination with relevant stakeholders at the district level remains crucial, with particular emphasis

1. Mangrove area managers, including location permit holders, need information regarding accessibility, tides, and general conditions of the mangrove forest.
2. Village/hamlet officials for information on access to mangrove forests, local labor familiar with mangrove forests, and provision of special logistics such as boats, boots, and other special equipment.



4.2. Access to the Plot

Step 1: Use the pre-determined Mangrove Forest Inventory cluster distribution map. Before taking measurements, it is important to pay attention to the tidal schedule when planning access to the Mangrove Forest Inventory plot location.

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

Make sure the route to the location is safe and accessible during both high and low tide, especially if using a boat as a means of transportation.

Step 3: Use GPS to find the center point of the cluster. The coordinates of the cluster to be measured are previously entered into the GPS.

To avoid bias, the determination of the cluster center point must be in accordance with the GPS point (with an accuracy of ± 10 m). In certain conditions where the cluster is inaccessible due to mangrove conditions such as too deep mud, document and record the reasons in detail as part of the observation data.

4.3. Determining the Plot Center Point

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

Step 2: Install information boards around the center of the plot to mark the center point of the cluster.

The nameplate is installed on a tree that has a high level of durability/ on a sturdy tree in the central area of the plot.

Step 3: After measuring on Plot P, take measurements on Plot U which is 50 m to the north of the cluster center point.

Step 4: After the measurement on Plot U is complete, take measurements on Plot T which is 50 m to the east of the cluster center point.

The sequence of plot measurements can be adjusted to the accessibility of the mangrove forest.

For example, measure more easily accessible plots (such as those closer to the edge of mangroves or canals) first, while maintaining consistency in plot numbering. The plot center must match the coordinates specified in the cluster distribution, with a GPS accuracy tolerance of ± 10 m. Shifts in the plot location are not permitted. If the GPS signal at the plot center is weak (accuracy > 10 m), the survey team can determine the plot center using the following method:

1. Find a location around the center of the plot where GPS signal reception is strong (accuracy < 10 m), and determine the distance to the center of the plot from the GPS reading.
2. Measure the flat distance from that location to the center of the plot (according to the distance from the GPS reading).
3. Measure the *azimuth* from that location to plot center.

If the plot center is inaccessible, for example, if it is in a hazardous 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.

The last location that can be visited and conducting visual observations and recording general conditions according to the F2M form. For Forest Inventory

Mangrove, marking the center of the plot is done using a nameplate attached to the tree closest to the center point of the plot.

The yellow nameplate measures 40 x 30 cm and contains the following information: cluster number, plot number (P, U, or T), province and district, sub-district and village, field coordinates, and the time the plot was created. Marking is not necessary outside forest areas.



Figure 3. Mangrove Forest Inventory plot center nameplate

4.4. 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 a nameplate, the survey team must establish at least two witness points inside and/or outside the plot. These witness points are easily recognizable and relatively permanent natural or artificial objects in the mangrove environment, such as river forks, clear vegetation boundaries, relatively large trees, or coral reefs.

Step 1: Identify 2 or more witness points inside or outside the plot. Record them on the 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.

©Directorate of IPSDH

05

Collection Field Data

5.1. Cluster Information

5.2. Sample Plot Information

5.3. Canopy density

5.4. Regeneration

5.5. Understory Plants

5.6. Litter

5.7. Soil Carbon

5.8. pH and Salinity

5.9. Dead Wood

5.10. Liana

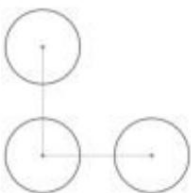
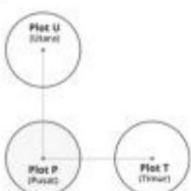
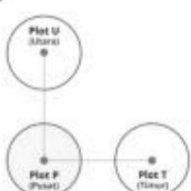
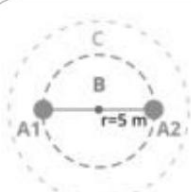
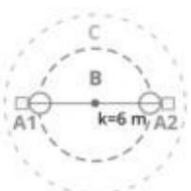
5.11. Palm

5.12. Trees and Dead Trees

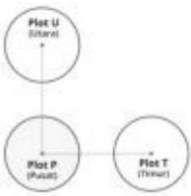
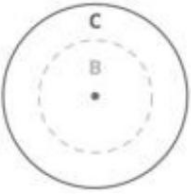
5.13. Survey Team Identity

In each cluster, the survey team conducted observations, measurements, and recording of cluster information, plot information, canopy density, regeneration, understory, litter, trees (living and dead), NTFPs, stumps, dead wood, soil carbon, and environmental parameters of pH and salinity. Table 3 presents a summary of data collection activities for each cluster, which are further explained in the subchapters below.

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

	Cluster	Cluster information:
	F1-M	Number, location, area status and cluster data type; Unit Implementer (Survey Team); Coordinates of accommodation; Survey time; Accessibility; Forest/land management
	Plot	Plot information:
	F2-M	Plot number and location; Measurement time; Accessibility; Marking Plot Center; Elevation and slope gradient; Land cover class in the field; Mangrove typology; Land use type; Proportion of plot area located within the observed land cover; Vertical structure of stands; Type of disturbance; Land condition in the plot; Photos in 4 cardinal directions at the plot location
	Plot Center	Header Density
	F3-M	Crown density value
	Sub Plot A	Regeneration:
	F4-M	Species and number of individuals
	Clip Plot in Sub Plot A	
	F5-M	Understory plants: Total wet weight & sample Dry weight of sample
	F6-M	Litter: Total wet weight & sample Dry weight of sample
	F7-M	Soil carbon: Soil type; Depth; Sample volume; Substrate type; & Substrate color
	F8-M	Soil pH and salinity: Soil pH and salinity values



	Plot	pH and salinity: ÿ pH and salinity values of water
	F9-M	
	Transect in subplot B	Dead wood: ÿ Diameter; Angle of inclination; Weathering class
	F10-M	
	Subplot C	
	F11-M	Liana: ÿ Category; Species; Number of clumps; Diameter; Length; Commerciality
	F12-M	Palm: ÿ Type; Species; Diameter; Height Young Nipah: ÿ Species name and number of fronds per clump Mature Nipah: ÿ Species name; Average leaf diameter; Average frond height and number of fronds per cluster
	Subplot B+C+D	Trees (living and dead): ÿ DBH; DBH Height; Distance; Azimuth; Species code; Species (local/ Latin name); Status; Wood quality; Specific gravity class; Crown base height; Total height; Photo or herbarium (for unknown species)
	F13-M	
	Cluster	Survey team identity: ÿ Name; Position; Mobile number; Email
	F14-M	

5.1. Cluster Information

When the survey team has arrived at the cluster location specified on the map, the survey team makes observations, measurements and records the general conditions of the cluster using the F1M form. with the following activity stages:

1. Select the island name code on the F1M-1 form according to the following list:

Code F1M-1	Island
1	Sumatra
3	Java
5	Bali & Nusa Tenggara
6	Kalimantan
7	Sulawesi
8	Maluku
9	Papua

2. Record the cluster number on F1M-2 according to the specified numbering system. Format: 6 digits

• 1st digit: island code (see F1M-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 sequence number (0001-9999)

Example: 140001 (Sumatra, M4CR program, cluster 1)

3. Record the year of cluster measurement on form F1M-3.
4. Note down the province name code on the F1M-4 form according to the following list (Note: the *Collect Mobile* application will provide a list of province codes/names according to the island code selected on F1M-1):

Code F1M-4	Province
11	Aceh
12	North Sumatra
13	West Sumatra
14	Riau
15	Jambi
16	South Sumatra
17	Bengkulu,
18	Lampung,
19	Bangka Belitung Islands
21	Riau
31	Islands, DKI Jakarta
32	West Java
33	Central Java
34	DI Yogyakarta
35	East Java



Code F1M-4	Province
36	Banten
51	Bali
52	West Nusa Tenggara
53	East Nusa Tenggara
61	West Kalimantan
62	Central Kalimantan
63	South Kalimantan
64	East Kalimantan
65	North Kalimantan
71	North Sulawesi
72	Central Sulawesi
73	South Sulawesi
74	Southeast Sulawesi
75	Gorontalo
76	West Sulawesi
81	Maluku
82	North Maluku
91	Papua
92	West Papua
93	South Papua
94	Central Papua
95	Papua Mountains
96	Southwest Papua

- 5. Select the area status that corresponds to the cluster location on the F1M-5 form.**
explanation as follows:

Code F1M-5	Area Status
1	Mangrove forests in forest areas
2	Mangrove forests outside forest areas

- 6. Select the type of cluster measurement on the F1M-6 form, whether Planned , Unplanned , or Quality Assurance/ Quality Control, with the following explanation:**

Code F1M-6	Cluster data type
1	Planned , if cluster measurements are carried out on the main coordinates/grid according to the sampling design)
2	Unplanned , if the cluster measurements are conducted at locations outside the main coordinates/grid. Data from these unplanned cluster measurements must be treated differently from planned cluster measurements when calculating forest resource statistical values.
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 the F1M-7 form according to the following explanation:

Variable	Code F1M-7	Description
Unit implementer	1	Work units that handle inventory and work units that handle mangrove rehabilitation management.
	2	Provincial regional apparatus in charge of forestry.
	3	QA/QC team, if the survey is conducted by a special team for quality assurance (QA/QC).
	4	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.

8. Record the name and coordinates of the survey team's accommodation on form F1M-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	The <i>longitude</i> coordinates of the GPS point in decimal degrees.
Y Coordinate	The <i>latitude</i> coordinates of the GPS in decimal degrees.

9. If the survey team can visit the mangrove forest inventory cluster location (see form **F1M-8**), record the survey time (date and time) on the **F1M-9** form when the team leaves for and returns from the parking location or cluster location:

- The starting point can be the nearest accommodation (**base-camp**) to the cluster location. inventory of mangrove forests, for example in villages.
- Parking location/boat mooring location: A place that can be accessed by vehicles (land or water) before the team continues their journey to the mangrove forest inventory cluster location.
- Cluster location: Can be the center point of Plot P or other plots (U and T) that are 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

- Start date and time: When the team departs from the nearest accommodation.
End time: When the team arrives at the parking location (if using a vehicle) or directly to the mangrove forest inventory cluster location.
- The time difference indicates the length of the trip from the accommodation to the parking location or mangrove forest inventory cluster.
- Pay attention to tidal schedules when planning travel times and measurements. • If using a boat, note the departure and arrival times at the dock or landing point closest to the mangrove forest inventory cluster. For difficult-to-access mangrove areas, consider using a small boat for navigation.

Departure from parking location to cluster location

- Start date and time: When the team departs from the parking lot. • End date and time: When the team arrives at the mangrove forest inventory cluster location. • Record only if using a vehicle from the starting point. If the cluster location is accessible by foot or small boat from the starting point, this record is not necessary.



Return from the cluster location to the parking location or starting point

- ÿ Start date and time: When the team started returning from the mangrove forest inventory cluster location (the last plot measured).
- ÿ End date and time: When the team arrives back at the parking location or starting point (lodging / base-camp).
- ÿ The time difference indicates the length of the return journey from the mangrove forest inventory cluster location to the parking location or starting point.

10. Observe and record the cluster accessibility level on the F1M-10 form according to the following code:

Code F1M-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 mangrove forest inventory cluster cannot be accessed (code options 2, 3, or 4 on the F1M-10 form), upload the following physical evidence on the F1M-11 form via the *Collect Mobile* application :

ÿ **Photos (3 pieces) showing the conditions around the mangrove forest inventory cluster** ÿ

Coordinates (X, Y) of the last accessible access point

ÿ **Minutes informing that the Forest Inventory cluster measurement**

Mangrove cannot be implemented. This Minutes of Meeting is approved by the relevant parties (village head/regional head).

12. Record on the F1M-12 form 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. Types of NTFPs can be seen in the Minister of Forestry Regulation Number P.35/ Minister of Forestry-III/2007 concerning Non-Timber Forest Products.**13. Record on the F1M-13 form the forest/land management party according to the following code:**

Code F1M-13	Description
1	Government
2	Private
3	Public

Provide important *remarks* on the F1M-14 form if there are things that need to be reported regarding the condition of the mangrove forest inventory cluster, such as:

ÿ **Indications of mangrove forest damage (logging, land conversion, etc.)**

ÿ **Signs of mangrove rehabilitation or restoration** ÿ

Natural phenomena that affect the condition of mangrove forests (coastal abrasion, sedimentation, and etc)

ÿ **Community activities around mangrove forests that are relevant to management** ÿ

Ecotourism potential of mangrove forests

5.2. 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 F2M-1 form according to the numbering system that has been provided. specified on the map or *Collect Mobile app*.
2. Record the plot code on the F2M-2 form according to the plot number being measured.

Code F2M-2	Description	Illustration
1	P Plot (Center)	
2	Plot U (North)	
3	Plot T (East)	

3. Observe and record the level of plot accessibility on the F2M-3 form according to the following code:

Code F2M-3	Description
1	Plot is accessible
2	Plot is inaccessible due to difficult or dangerous mangrove conditions
3	Plot is not accessible due to potential for dangerous wildlife/located in the waters
4	Plots are inaccessible but visible, where the survey team can see land cover type, forest type, land use, mangrove typology, and disturbance type, but cannot take measurements).

If the plot is inaccessible (code 2, 3, or 4), stop measurements for that plot.

4. Record the plot measurement time on form F2M-4 (date, start time, and end time).
5. Determine the plot center and record its coordinates according to the position specified on the map or *Collect Mobile* application on form F2M-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 the tie point that is close to the plot center point, and measure the horizontal and azimuth distance from the tie point to the supposed plot center point.

F2M-5 Variable	Description
X Coordinate	The <i>longitude</i> coordinate of the GPS point (in decimal degrees) at the center point of the plot or an auxiliary point close to the center of the plot.
Y Coordinate	The <i>latitude</i> coordinate of the GPS point (in decimal degrees) at the center point of the plot or an auxiliary point close to the center of the plot.
GPS Accuracy 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	<i>Azimuth</i> (°) from the auxiliary point position to the center point of the plot.



6. Note on form F2M-6 whether the plot center is permanently marked with a nameplate. or does not match the following code:

Code F2M-6	Description
1	Yes, if the plot center is marked with a nameplate.
2	No, if the plot center is not marked permanently, or only marked temporarily (wooden/bamboo stakes/ stakes)

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

F2M-6 variables	Description
X coordinate	<i>Longitude</i> coordinates from GPS (in decimal degrees) at each witness point.
Y Coordinate	The <i>latitude</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	<i>Azimuth</i> (°) 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 the elevation (masl) of the center of the plot and record the data on form F2M-7.

8. Measure the slope (%) of the plot and record the data on the form.

F2M-8. The slope gradient on a plot is the average slope direction between two opposite points along the plot radius. A detailed explanation of how to measure the slope gradient can be seen in Appendices 2A and 2B.

9. Perform an 'aspect' observation 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 gradient aspect on the F2M-9 form according to the following code:

Code F2M-9	Description
1	North (<i>North</i> , <i>azimuth</i> 0° – 22.5° or 337.5° – 360°)
2	Northeast (North-east, <i>azimuth</i> 22.5° – 67.5°)
3	East (<i>East</i> , <i>azimuth</i> 67.5° – 112.5°)
4	Southeast (<i>South-east</i> , <i>azimuth</i> 112.5° – 157.5°)
5	South (<i>South</i> , <i>azimuth</i> 157.5° – 202.5°)
6	Southwest (<i>South-west</i> , <i>azimuth</i> 202.5° – 247.5°)
7	West (<i>West</i> , <i>azimuth</i> 247.5° – 292.5°)
8	Northwest (<i>North-west</i> , 292.5° – 337.5°)
9	Flat

10. Determine and record on the F2M-10 form based on the technical instructions for interpreting medium resolution satellite imagery for updating national land cover data (KLHK 2020) land cover class :

F2M-10 Code	F2M-10 Code	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:

Class No.	Layer code/ toponymy	Operational definition (Working definition)	Notes
1. Primary dryland forest	Hp/2001	All appearances of lowland forests, hill forests, mountain forests (highlands and subalpine), dwarf forests, heath forests, forests on limestone, forests on ultrabasic rocks, coniferous forests, deciduous forests and moss forests (natural ecosystems) that do not show human disturbance (logging scars, fire scars, road networks, etc.), excluding natural disturbances (floods, landslides, earthquakes, etc.) Natural ecosystems that follow local knowledge as forests, are still classified as forests (not thickets) as examples of Natural Forest Types on the islands of Flores, Sumbawa, Rote, Southeast Maluku and other islands in the Wallacea and Webber lines; karst forests in Maros, Muna, and East Kalimantan; and low-density natural forests.	Primary forests that experience human disturbance (eg road networks) are classified as secondary forests up to 1 km away disturbance. Natural ecosystems that follow local knowledge as forests, are still classified as forests (not thickets) as examples of Natural Forest Types on the islands of Flores, Sumbawa, Rote, Southeast Maluku and other islands in the Wallacea and Webber lines; karst forests in Maros, Muna, and East Kalimantan; and low-density natural forests.



Class	No.	Layer code/ toponymy	Operational definition (Working definition)	Notes
2. Forest land		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 forests that experience human disturbance (for example: road networks) are classified as secondary forests up to 1 km from disturbance.
	secondary dry			
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 scars, fire scars, road networks, etc.), excluding natural disturbances (floods, landslides, earthquakes, etc.), including sago forests.	The swamp forests referred to are those in mineral swamp and peat swamp areas, usually having alluvial soil types. Sago forests are included in the swamp forest class. Under certain conditions, swamp forests can be found in the highlands, for example on Mount Gede Pangrango.
4. Secondary swamp forest		Hrs/ 20051	Primary swamp forests that have experienced human disturbance (ex-logging, fire scars, road networks, etc.). Severely logged areas if they do not show signs of inundation (water coverage) are permanently classified as open land, whereas if they show signs of inundation or are temporarily inundated they are classified as swamp.	Severely logged areas if they do not show signs of permanent inundation (water coverage) are classified as open land. The appearance of open land that has been inundated or temporarily flooded is classified as a swamp.
5. Forest primary mangroves		Hmp/ 2004	All forest features (mangrove, 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, earthquakes, etc.).	Coastal forest ecosystems that are outside brackish water environments and are not affected by the ebb and flow of sea water are not included in forests. mangroves.
6. Forest secondary mangroves		Hms/ 20041	Primary mangrove forests that have experienced human disturbance (logging sites, fire sites, road networks, etc.), including those growing/planted on sedimentary soil.	
7. Plantation forest	Ht/2006		The entire appearance of a uniform forest (monoculture) which can originate from reforestation/ reclamation/greening/industrial activities.	Rubber Plants in/ outside the PBPH-HT area is classified as Plantation class. Open land in the Plantation Forest class due to temporal harvest and planting rotation remains classified as a Plantation Forest class.

Field Data Collection

Class No.	Layer code/ toponymy	Operational definition (Working definition)	Notes
8. Plantations	Pk/2010	All the appearance of the results of cultivating hard plants which are included in the plantation group, including oil palm, rubber, coconut, chocolate, coffee, tea. Note: Plantations with homogeneously distinguishable perennial crops; Block sizes classified as plantations (oil palm) are approximately 30 ha (300 m x 1000 m); Open land in the Plantation class due to rejuvenation/temporary commodity replacement remains classified as Plantations.	Plantations with annual plant types that can be distinguished homogeneously. The size of the block classified as plantation (oil palm) is around 30 ha (300 m x 1000 m). Open land in the Plantation class due to rejuvenation/temporary commodity replacement remains classified as a Plantation.
9. Bushes B/2007		The entire appearance of the area/region is dominated by low vegetation on dry land.	Shrubs dominated by low vegetation (below 5 m) have the potential to regenerate into forest.
10. Bushes swamp	Br/20071	The entire appearance of the area/region is dominated by low vegetation and is located in an area inundated with fresh water and behind brackish water forests.	Water hyacinth is classified as a swamp (example: Rawa Pening in Semarang, Central Java).
11. Savanna/ Meadow	S/3000	All natural and permanent low vegetation features in the form of grasslands. This natural phenomenon is found in parts of Southeast Sulawesi, East Nusa Tenggara, and southern Papua, and can also be found in Java. Some savannas contain few shrubs or trees. Savanna can be found on dry land or swamps (swamp grass, for example swamp grass in Wasur).	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 can be found on dry land or swamps (swamp grass, for example swamp grass in Wasur).
12. Dry land farming	Pt/20091	All agricultural activities on dry land such as dry fields, mixed gardens and fields	
13. Mixed dry land farming	Pc/20092	All features that are a mixture of agricultural areas, plantations, shrubs, and bushes. This class often occurs in shifting cultivation areas, karst crop rotations, and includes classes understood as mixed gardens, community forests, or agroforestry.	This class often appears in shifting cultivation areas, and karst land crop rotation. This class also includes classes understood as mixed gardens, community forests or agroforestry.



Class No.	Layer code/ toponymy	Operational definition (Working definition)	Notes
14. Rice fields	Sw/ 20093	All appearances of annual crop cultivation in wetlands are characterized by embankment patterns. Wetland farming is classified as rice fields, including agricultural areas originally used as rice fields and planted with annual crops during the dry season, which are still classified as rice fields. Interpreters should pay attention to the crop rotation phases, which consist of the flooding phase, the young plant phase, the old plant phase, and the fallow phase. This class also includes seasonal rice fields, rain-fed rice fields, and irrigated rice fields. Seasonal rice fields in swampy areas require additional field information.	Wetland agriculture is classified as rice fields, including agricultural areas that were originally used as rice fields and during the dry season are planted with 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, young plant phase, old plant phase and fallow phase. This class also includes seasonal, rain-fed, and irrigated rice fields. Seasonal rice fields in swampy areas require additional field information.
15. Fish pond	Tm/ 20094	All inland fisheries (fish/ shrimp) or salting that appears with a dike pattern, usually located around the coast. In some locations it can originate from swamp forests, marshes or thickets swamp.	In some locations it can originate from swamp forests, marshes or swamp thickets.
16. Settlements	PM/2012	Residential areas, whether urban, rural, industrial, etc.	
17. Transmigration Settlement	Tr/20122	Residential areas in transmigration areas and located within transmigration permit areas. Cultivated land is separated from residential areas.	Located in the transmigration permit area. Transmigration Class is adjusted to become Transmigration Settlement. Cultivated land is separated from residential areas.
18. Mining Tb/20141		Open land used for open pit mining activities (e.g., coal, tin, copper, etc.), as well as large-scale closed mining areas that can be identified from images based on the association of object appearances, including tailings ground (mining waste dumps). Small-scale or unidentified closed mining areas are classified according to their surface appearance.	Small-scale or unidentified closed mining areas are classified according to their surface appearance.

Field Data Collection

Class	No.	Layer code/ toponymy	Operational definition (Working definition)	Notes
19.	Open land T/2014		All open land features without vegetation, whether occurring naturally or as a result of human activity (rock outcrops, snow-capped peaks, volcanic craters, sandbars, beach sand, river deposits, land clearing, and areas of former fires). Open land features for mining are classified as mining, while open land from land clearing is classified as open land. Open land for the purpose of rice field crop rotation/ ponds are still classified as rice fields/ pond.	Open land in the plantation forest class after harvesting which will be replanted is classified as plantation forest. Open land at the time of first land clearing indicated as being in a plantation forest is classified as open land. The appearance of open land for mining is classified as mining, while open land used for land clearing/ Land clearing is classified as open land. Open land for the purpose of rotating rice fields/ ponds is still classified as rice fields/ pond.
20.	Water body	A/5001	All aquatic features, including seas, rivers, lakes, reservoirs, coral reefs, seagrass beds, etc. The appearance of ponds, rice fields, and swamps have been classified separately.	
21.	Swamp	Rw/ 50011	The appearance of swampland (flooded with freshwater and behind brackish water forests) that is no longer forested. Swamps are usually found in depressions or lowlands compared to the surrounding area.	Swamps are usually located in depressions or plains that are lower than the surrounding areas.
22.	Clouds	Aw/2500	Cloud cover is defined as a layer of cloud covering an area with a surface area larger than 4 cm ² on the scale of the presentation. If the thin cloud cover still reveals the features below and allows for interpretation, it is still delineated.	
23.	Airport/ Harbor	Bdr/Plb/ 20121	The appearance of airports and ports is large and allows for separate delineation.	



11. Record the Mangrove Typology on the F2M-11 form according to the following code:

Code F2M-11	Description
1	Delta type mangrove
2	River estuary type mangrove
3	Lagoon type mangroves
4	Island type mangrove

The explanation of mangrove typology in the 2021-2030 National Mangrove Roadmap is as follows:

- **Delta type mangroves** are formed due to the presence of large amounts of sediment deposits carried by river currents or directional coastal currents and deposited by mangrove roots, which gradually expand to form deltas. The mangrove ecosystem in this environment is characterized by large rivers flowing into the sea, forming extensive mudflats and deltas at large river mouths. Delta-type mangroves, with their wide distribution, are found in Papua, Kalimantan, and the east coast of Sumatra.



Photo: Indah Zuli Pratami

Figure 4. Delta type mangrove

Estuarine mangroves grow along muddy rivers. The mudflats are influenced by waves or river currents, which generally result in a fertile mangrove area that supports a wide variety of mangrove diversity. This type of mangrove is found abundantly in Kalimantan and Sumatra, which have large rivers.



Photo: Acho Hatfield

Figure 5. River estuary type mangrove

Lagoon-type mangroves grow in lagoons separated from the sea and protected from large waves by islands or coral reefs. This *barrier* allows mangroves to grow on beaches with large waves, such as the mangroves found on Nusa Kambangan.

Mangroves grow on the side of the island that does not directly face the Indian Ocean.



Photo: Planning Working Group

Figure 6. Lagoon type mangrove



- Island-type mangrove ecosystems are found mostly on islands that are protected from large waves and are spread evenly across almost every island group, such as the Riau Islands, Seribu Islands, Karimun, Batam, Bintan, Natuna, Anambas, Tambelan, Singkep/Selayar.



Figure 7. Island type mangrove

12. Observe and record the type of land use *for* non-forest areas on the form.

F2M-12 according to the following code:

Code F2M-12	Description
1	Monoculture community forests
2	Mixed community forest
3	Agroforestry gardens
4	Agriculture
5	Plantation
6	Fishpond
7	Charcoal kitchen
8	oil palm plantation
6998	Others (write according to land use)

13. Estimate the proportion/percentage of the plot area located within the land cover observed on form F2M-10, and record the data on form F2M-13:

Code F2M-13	Description	Illustration
1	The entire (100%) plot area lies within the observed land cover.	
2	75–99% of the plot area lies within the observed land cover	
3	50–74% of the plot area lies within the observed land cover	
4	25–49% of the plot area lies within the observed land cover.	
5	<25% of the plot area lies within the observed land cover	

14. Observe and record the vertical structure of the stand (crown layer of the stand) on the F2M-14 form according to the following code and illustration:

1

A single layer of mangrove canopy of uniform height (example: zone *Avicennia* or *Sonneratia* in the front area)

©Directorate of IPSDH

2

One layer of mangrove canopy with moderate height variation (example: *Rhizophora* zone in the middle area)

©Directorate of IPSDH

3

Multi-layer mangrove canopy with **clear stratification** (example: back zone with *Bruguiera*, *Ceriops*, *Xylocarpus*)

©Directorate of IPSDH

4

Irregular and gapped vertical structure (example: disturbed mangrove areas or in the regeneration stage)

©Directorate of IPSDH

5

Very complex vertical structure **with** complete stratification (example: mature mangrove forest with diverse ecological zones)

©Directorate of IPSDH

Code
F2M-14

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



- 15. Observe and record indications of forest/land fires on the F2M-15 form accordingly. the following code:**

Code F2M-15	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.

- 16. Observe and record the types of forest disturbances (which can cause changes) biophysical). Select the most dominant type of disorder on the F2M-16 form according to the following code:**

Code F2M-16	Description
1	No disturbance
2	Road construction
3	Logging
4	Shifting cultivation
5	Pests and diseases
6	Port development
7	Bridge Construction
8	Abrasion
9	Pollution
6998	Others (write according to the facts)

- 17. Land conditions on the plot to find out the general conditions in the measuring plot area. Note on form F2M-17:**

Code F2M-17	Description
1	Dry land conditions
2	Wet conditions
3	Submerged condition

- 18. Take photos of the condition of the mangrove plot taken from the center of the plot in four directions. Cardinal direction (North, East, South, or West). All photos are taken in landscape orientation at the photographer's eye level. If possible, take photos at low tide to capture the mangrove root structure. Include the photo number on form F2M-18:**

Code F2M-18	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

5.3. Canopy density

After recording the plot information, the team measured the canopy density, which is the percentage of the projected roof area or canopy cover of the mangrove trees relative to the area or plot being measured. Canopy density is an important indicator of the structure and condition of mangrove forest vegetation. A photograph using a *wide-eye lens* is a tool used to measure canopy density.

Plot Determination

Perform data collection at the P, U & T plot center.

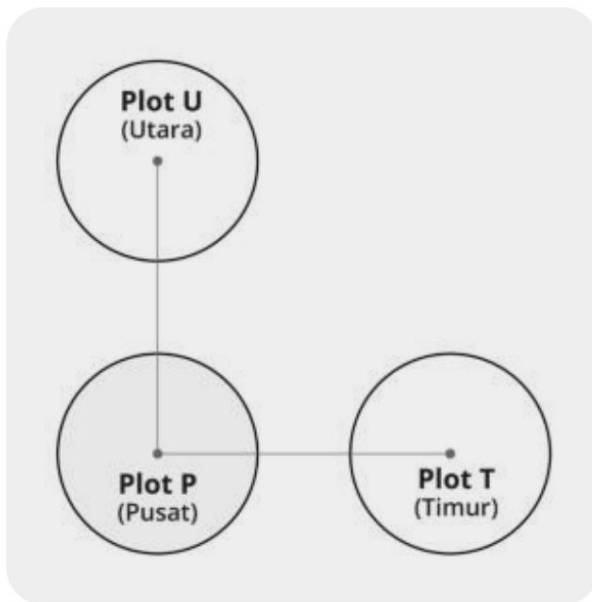


Figure 8. Plot center for taking canopy density photos

Taking Header Photos with a Lens Fish-eye

- Determine the center point of the plot to be photographed, and ensure that the area represents the condition of the canopy to be measured.
- Prepare a tablet camera that is equipped with with a *black-eye lens*.
- Position the camera at the center point of the plot at chest height (± 1.3 meters from the ground), then point the lens straight up (vertical 90°).
- Take a photo with the camera.
- Record the crown density value from the analysis results. in percentage units (%)



Figure 9. Taking a header photo with a *sh-eye* lens

Classification of canopy density according to National Mangrove Map

No	Description
1	Dense (>70%)
2	Moderate (30–70%)
3	Rare (<30%)



5.4. Regeneration

After recording the plot information, the survey team observed and recorded regeneration, namely individual mangrove plants with a diameter/DBH <5 cm and a height <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 10). 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.

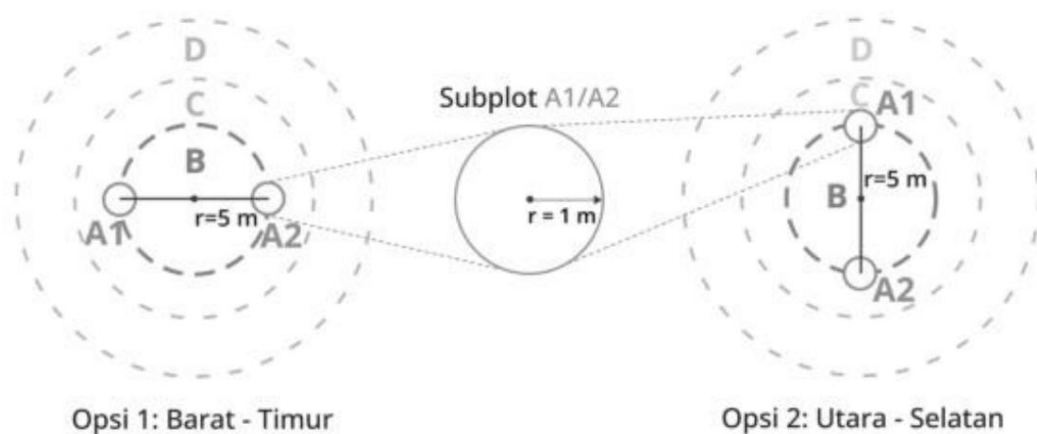


Figure 10. Regeneration subplots (A1 and A2) with West-East or North-South on each plot

Regeneration observations and recording (on the F4M form) 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 cluster number, plot number, and subplot A position (West-East or North-South) information on the F4M form.
2. In each subplot (A1 or A2), observe and record (on the F4M form) the species code, species name (Latin or local name), and number of stems/individuals for each mangrove species.
3. If necessary, make important notes about regeneration in each subplot.

5.4. Understory Plants

After completing the regeneration recording, at the subplot locations A1 and A2 at a distance of 6 m from the center of the plot, the survey team measured the understory, namely all living vegetation (including mangrove seedlings) growing above ground with a height of less than 1.5 m. The understory measurements were carried out by trimming and weighing all understory plants within the A1 and A2 *clip-plot* frames (Figure 11). Each *clip-plot* measuring 0.5 x 0.5 m which is made from PVC pipe which can be dismantled for easy carrying and use.

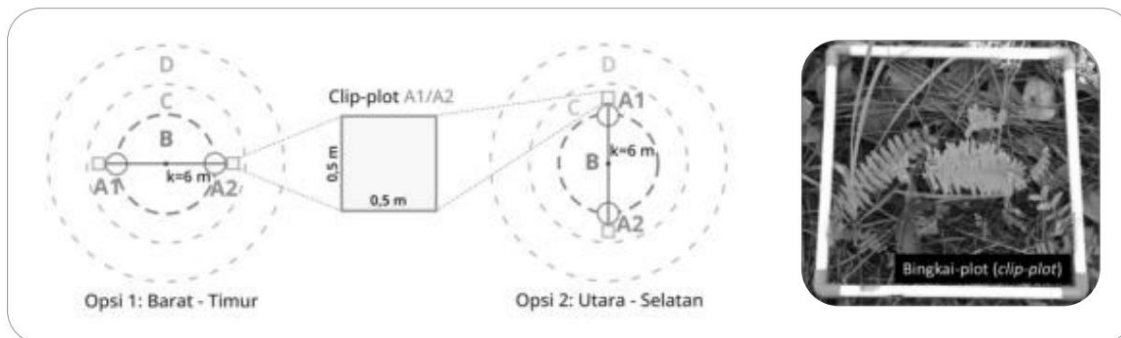


Figure 11. Frame-plot (*clip-plot*) of undergrowth (A1 and A2) with West–East or North–South on each plot

The stages of measuring undergrowth in subplots A1 and A2 in each sample plot are as follows:

Plot Installation and Preparation

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

Identification and Collection of Undergrowth

Identify and collect all undergrowth within the plot frame, including any mangrove 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 bag weight) on Form F5M.

Sampling for Laboratory Analysis

Next, take samples of the undergrowth for laboratory analysis.

To do this, stir the undergrowth in the large plastic bag (from the previous step) until all parts are evenly 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 sample's wet weight (BBS, grams) of the undergrowth. Record the results (after subtracting the bag weight) on the F5M form. Label the small plastic bag (Figure 12), and store the undergrowth sample bag in a large sack/bag for later transport to the laboratory.

determine the dry weight of the sample (BKS, grams) of the undergrowth. The remaining undergrowth in the large bag can be returned to the forest floor.

Sampel Tumbuhan Bawah / Serasah *)

Kode sampel :

Nomor klaster :	Total berat basah (TBB, gram) :	**)
Nomor plot :	Berat basah sampel (BBS, gram) :	**)

**) Coret yang tidak perlu, **) Setelah dikurangi berat kantong*

Figure 12. Understory/litter sample labels for laboratory analysis

5.5. Litter

After measuring the understory vegetation, the survey team measured mangrove litter in subplots A1 and A2. In the context of mangroves, litter includes fallen mangrove leaves or leaves of non-mangrove species on the ground, small branches with a diameter of less than 10 cm, fallen mangrove flowers and fruits/propagules that have undergone decomposition and changed color, loose fine roots, and other organic materials that have not yet fully decomposed.

Litter Collection and Weighing

Collect the litter in the A1 and A2 plot frames after pruning and collecting the undergrowth. If necessary, rake up any litter attached to the soil surface. Combine and mix all the litter from both plot frames (A1 and A2) and store it in a large plastic bag. Weigh the total wet weight (WW, grams) of the litter and record the data (after subtracting the weight of the bag) on form F6M.

Sampling for Laboratory Analysis

Next, take samples of the undergrowth 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 put it into a small, labeled plastic bag (Figure 12). Then, weigh the litter sample and record the results on the F6M form and label the sample bag to be taken to the laboratory to determine the dry weight (DW, grams) of the litter sample. Return the remaining unused litter to the forest floor.

5.6. Soil Carbon

According to the 2006 IPCC *Guidelines*, **soil organic carbon (SOC)** is all soil organic matter at a certain depth, including roots and fine litter with a diameter of less than 2 mm, because it is difficult to distinguish. Mangrove forests often have an organic-rich soil layer at a depth of 0.5-5 meters, with a fairly clear boundary with the mineral soil or sand below.

Soil Carbon Measurement

Measuring soil carbon in mangrove ecosystems has special characteristics due to the unique nature of the mangrove substrate. The following is a procedure adapted for soil carbon measurement:

Sampling Location

- a. Take samples on plot P in A1 or A2 with 2 options (west-east or north-south) at a distance of 6 meters from the center of the plot in the previously cleared *clip plot*. If there are obstacles in taking soil samples (obstructed by roots/corals), soil samples can be taken in subplots B, C, or D by noting *the azimuth and distance from the center of plot P*.
- b. Take samples in the U and T plots using a location determination mechanism. sampling is the same as in the P plot.

Equipment



Figure 13. *Eijkelpkamp* drill

- a. *Eijkelpkamp* mangrove drill or wing peat drill. Determine the volume of the drill section to be drilled. filled with soil.
- b. Waterproof sample plastic and waterproof label.



Sampling Procedure

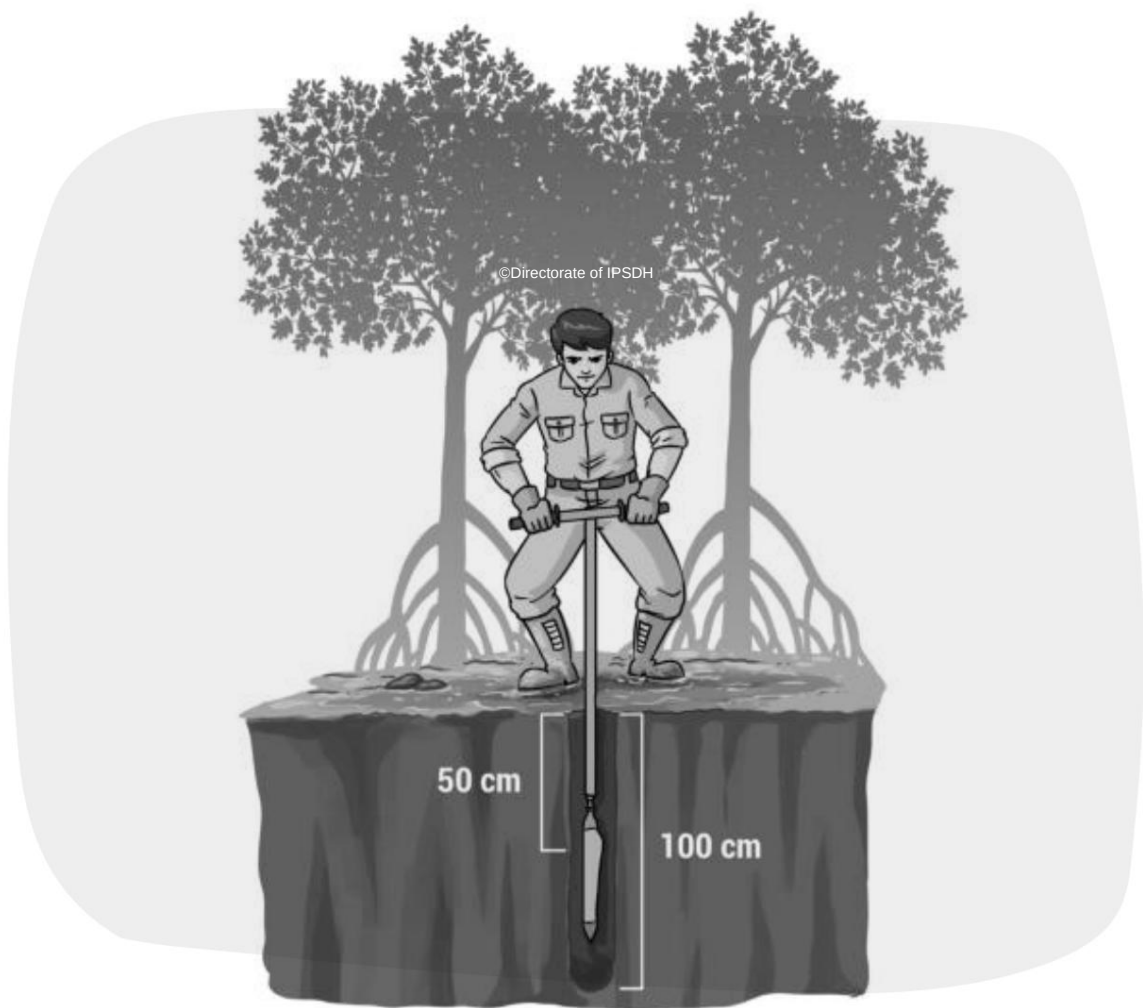


Figure 14. Soil sampling

- a. Set the soil sampling point in subplot A1 or A2 with 2 options (west-east or north-south).
- b. Clean the sampling point from litter.
- c. Drill at the designated point by taking samples at depths of 0-50 cm and 50-100 cm, then mix them into 1 sample for a depth of 1 meter (IPCC 2006, NFI Myanmar, SNI: 7724; 2019). If drilling cannot be done under these conditions, take samples at the maximum depth that the eijelkamp can reach (<50 cm and or <100 cm). The peat layer is separated as a separate sample by recording its depth and thickness.
- d. Take all the soil samples in the drill and put them in sample plastic.
Make sure that no soil outside the drill gets into the plastic.
- e. If the land conditions include diverse characteristics (heterogeneous) then it is recommended For more than one point, take soil samples using the composite method, which involves mixing soil samples from 3-5 points within the plot based on their depth. Each point is treated as in point 3.c, and the soil samples from these points are combined into one.

Label each sample with the information



Figure 15. Labeling of samples

- Sample code (cluster number - P/U/T plot - sample depth - team leader name)
- Cluster and plot numbers
- Depth of soil sampling
- Sample volume: calculated based on the volume of the tool (*Eijkelpkamp Drill*) (if the sample depth is less than 50 cm then the volume is calculated according to the soil depth). The standard *Eijkelpkamp* drill has an outer diameter of 60 mm, an inner diameter of 52 mm, so the volume of soil with a thickness of 50 cm is set at 500 cm³.

Soil Sample Identification

- a. Type of soil substrate (mud, sand, sandy mud, clay, sandy clay) and color substrate (dark or light)
- b. Date and time of sampling
- c. History of the land (natural forest, plantation forest, or other)
- d. Record the results on form F7M.
- e. Take the soil sample to the laboratory to determine the bulk density and content. C-organic.

Note: the volume of the soil sample must be informed to the laboratory assistant.

Sample Handling

- a. Keep the sample in its natural condition and do not lose its soil material.
- B. Store the sample in a *container box*.

Laboratory Testing Process

- a. Conduct laboratory tests with a combination of primary samples consisting of a combination 3 soil samples interval 0-100 plot P, U, and T.
- b. Conduct laboratory analysis to obtain C-organic and *bulk density test results*.

C-organic test

The organic carbon test is an analytical method used to determine the organic carbon content in mangrove soil, which is an important indicator in assessing soil quality and the carbon storage capacity of mangrove ecosystems. This test aims to determine the organic carbon content in mangrove sediments, evaluate the carbon storage capacity of the ecosystem, and assess the quality and health of the mangrove soil.

BulkDensity

Bulk density (BD) is the ratio of the dry weight of the soil to the total volume of the soil, including pore space, expressed in grams per cubic centimeter (g/cm^3). *Bulk density* measurement is an important parameter in mangrove soil analysis because it is necessary for calculating soil carbon storage and describes the level of soil compaction and porosity, which influence root growth.

5.7. pH and Salinity

Soil pH

Soil pH is the degree of acidity or alkalinity of the soil, measured using a pH scale, ranging from 0 (very acidic) to 14 (very alkaline), with 7 indicating neutral conditions. Measuring soil pH is an important parameter in assessing the characteristics and fertility of mangrove soil.

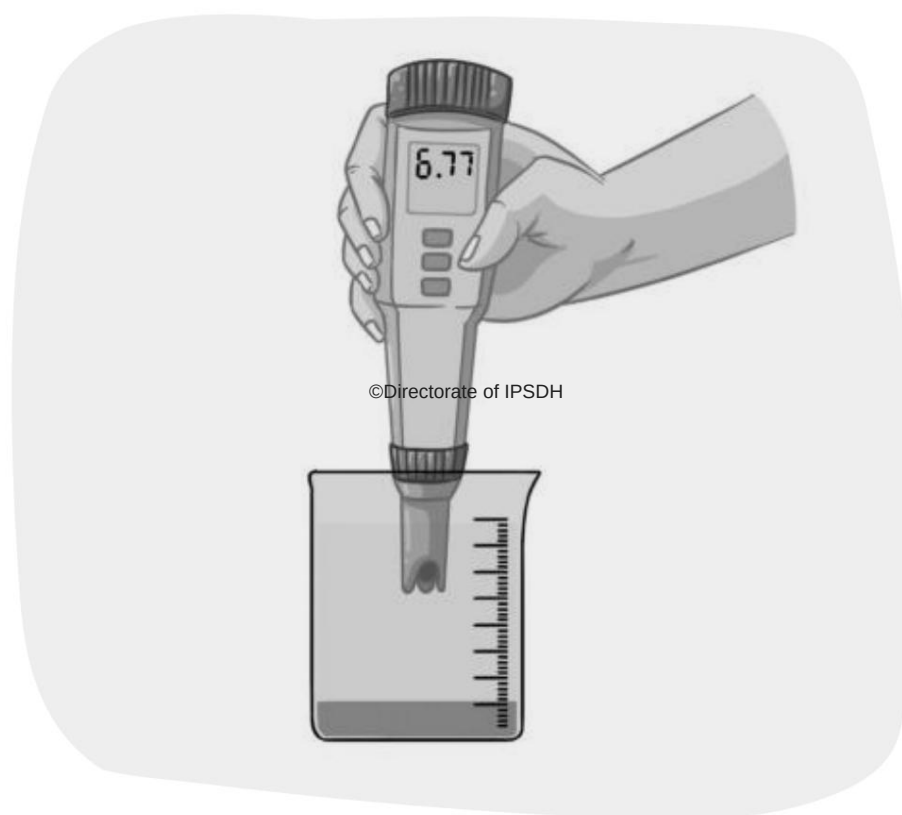


Figure 16. Soil pH measurement

Measurement Method

- a. Determine soil sampling points that represent soil conditions at the observation location, adjust the soil sampling method to the soil carbon parameters.
- b. Measure soil pH on plots P, U, and T.
- c. Clean the ground surface of litter and other vegetation.
- d. Use a digital pH meter that has been calibrated according to the procedure.
- e. Mix the soil sample with distilled water in a ratio of 1:5 (soil).
- f. Mix about 10 g of soil with about 50 ml of distilled water in a sample bottle, shake or stir. until mixed, and let it sit for a while to allow most of the soil to settle.
- g. Dip *the probe* of the measuring tool into the stirred soil-water solution until the reading is stable.
- h. Wait until the pH reading on *the display* stabilizes, then record the pH value listed on the F8M form.



Soil Salinity

Soil salinity is a measure of the dissolved salt content in the soil, usually expressed in *parts per thousand* (ppt). Measuring soil salinity is an important parameter in assessing the characteristics and fertility of mangrove soil.

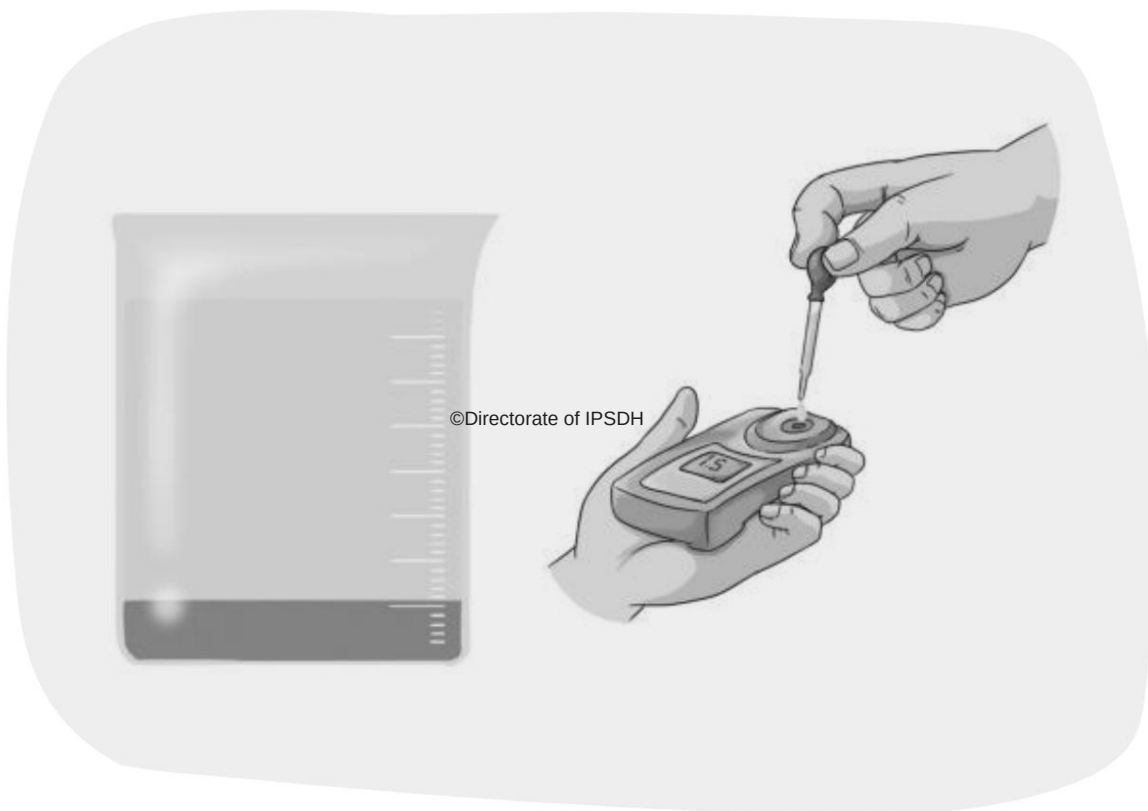


Figure 17. Water salinity measurement

Measurement Method

- a. Determine soil sampling points that represent soil conditions at the location.
observations, adjust to the location of soil sampling in the soil carbon parameters.
- b. Take salinity measurements on the P, U, and T plots.
- c. Clean the ground surface of litter and other vegetation.
- d. Take soil samples at a depth of 0-15 cm using a soil drill or other tool.
other sample takers.
- e. Put the soil sample into the sample bottle.
- f. Use a soil salinity measuring tool (refractometer/salt meter) that has been calibrated.
according to procedure.
- g. Mix the soil sample with distilled water in a ratio of 1:5 (soil).
- h. Can use a mixture of soil and distilled water to measure soil pH.
- i. Wait for the mixture of soil and water to settle a little, take the water using it
pipette then drop 3-5 drops.
- j. Record the salinity value shown on the measuring instrument *display on form F8M*.

Water pH

The pH value of water is the degree of acidity or alkalinity of a body of water, measured using a pH scale, with values ranging from 0 (very acidic) to 14 (very alkaline), with 7 indicating neutral conditions. Measuring water pH is an important parameter in assessing the characteristics of mangrove aquatic environments.



Figure 18. Measuring water pH

Measurement Method:

- a. Determine water sampling points that represent the environmental conditions of the waters at the location. observation.
- b. Take pH measurements of the water at or near the P, U, and T plots.
- c. Use a digital pH meter that has been calibrated according to the procedure to measure the pH of the water.
- d. Dip the pH meter probe into the water sample until the reading is stable.
- e. Record the pH value shown on the pH meter *display* on form F9M.



Water Salinity

Water salinity is a measure of the dissolved salt content in water, usually expressed in *parts per thousand* (ppt). Measuring water salinity is an important parameter in assessing the characteristics of mangrove aquatic environments.



Figure 19. Water salinity measurement

Measurement Method

- a. Determine water sampling points that represent the environmental conditions of the waters at the location. observation and put water into the sample bottle.
- b. Take water salinity measurements at or near the P, U, and T plots.
- c. Use a digital salinity measuring tool (refractometer/salt *meter*) that has been calibrated accordingly. procedure.
- d. Take water using a dropper, then drip 3-5 drops of water.
- e. Record the salinity value shown on the measuring instrument *display* on form F9M.

5.8. Dead Wood

Deadwood in the mangrove ecosystem is the parts of mangrove plants that have died and are found above the surface of the soil or sediment (also called *lying/fallen/down deadwood*), for example stems and branches, with a minimum diameter of 10 cm. Measurement of deadwood uses the *Line Intersect Sampling* method (Marshall et al. 2000; Walker et al. 2012) with 4 transect lines each 5 m long (at a flat distance) forming a '+' sign around subplot B (Figure 20) which is adjusted to the condition of the mangrove forest.

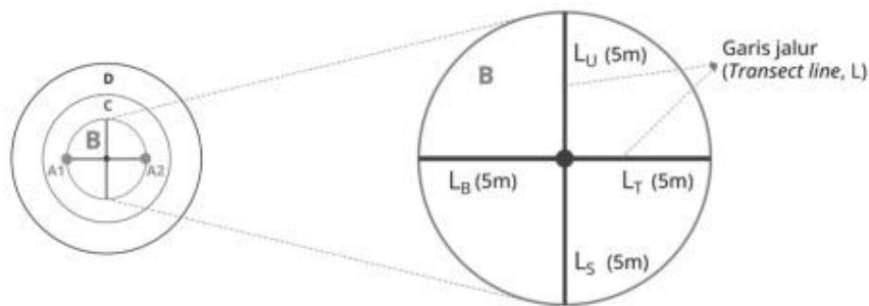


Figure 20. Location of dead wood measurements using the intersecting line sampling method. (*Line Intersect Sampling*)

Deadwood measurements using the LIS method can be conducted by the survey team prior to tree measurements (both 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 the **F10M form**.
2. From the center point of subplot B, create four transect lines by extending 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 horizontal 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 horizontal distance of the 5 m transect line, then the slope angle correction is automatically calculated by **Vertex** (note: this method is preferred). However, if the transect line distance is measured using a measuring tape or rope, then the transect line distance must be corrected by the slope angle (see **Table 4** in **Appendix 2**). In this case, the survey team must ensure that the length of the transect line is always exactly 5 m when projected onto a flat surface. In certain conditions, it may happen that the length of the transect line exceeds the boundaries of subplot B or remains within the boundaries of subplot B.
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:
 - Deadwood diameter is measured at the point where the deadwood intersects (e.g. the trunk or fallen branches) with a transect line (**Figure 21a**), and measured perpendicular to the center axis of the dead wood.
 - After measuring the diameter of the dead wood, at the intersection point do Measurement of the tilt angle of dead wood, namely the angle between the center axis of the dead wood trunk and an imaginary horizontal line at the point of intersection (the dotted red line in **Figure 21a**). Measurement of the tilt angle of dead wood (in units of

degrees) can use *Vertex* or other tools, including a protractor, digital angle ruler, or angle measuring app on a **smartphone**.

- **Dead wood is measured if most (>50%) of its diameter is above the surface land (Figure 21b).**

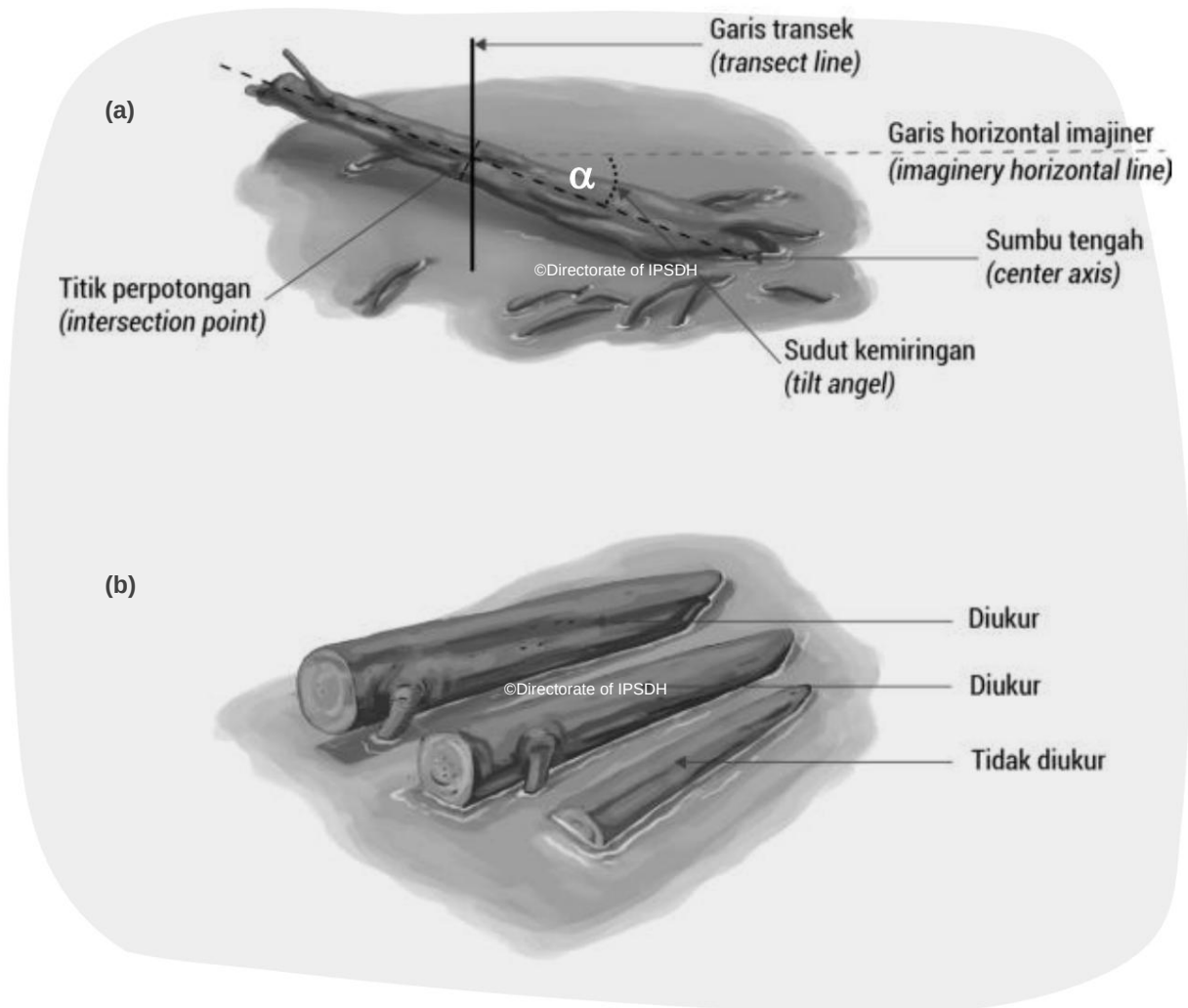


Figure 21. Deadwood measurement requirements using the LIS method

4. Estimate the level of decay of each mangrove dead wood by hitting it.

or slashing a machete/parang at a part that represents the condition of 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 can very easily penetrate the dead wood.**

5. Record the results of the dead wood measurements on the four line lines (Lt, Lb, Lu, and Ls) on form F10M.

5.9. Liana

Liana Measurement

After measuring dead wood, in subplot C, measurements were also carried out on lianas, namely "woody plants (having *xylem*) that creep or climb the canopy of other mangrove trees (Gerwing *et al.* 2006)" with the following procedure:

1. Observe the presence of small lianas (<5 cm in diameter) and large lianas (≥ 5 cm in diameter) contained in subplot C.
2. If small lianas are found, record them on form F11M: species name and sales value information (commercial, non-commercial, or unknown).
3. If a large liana is found, record on form F11M: 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 mangrove roots or substrate.

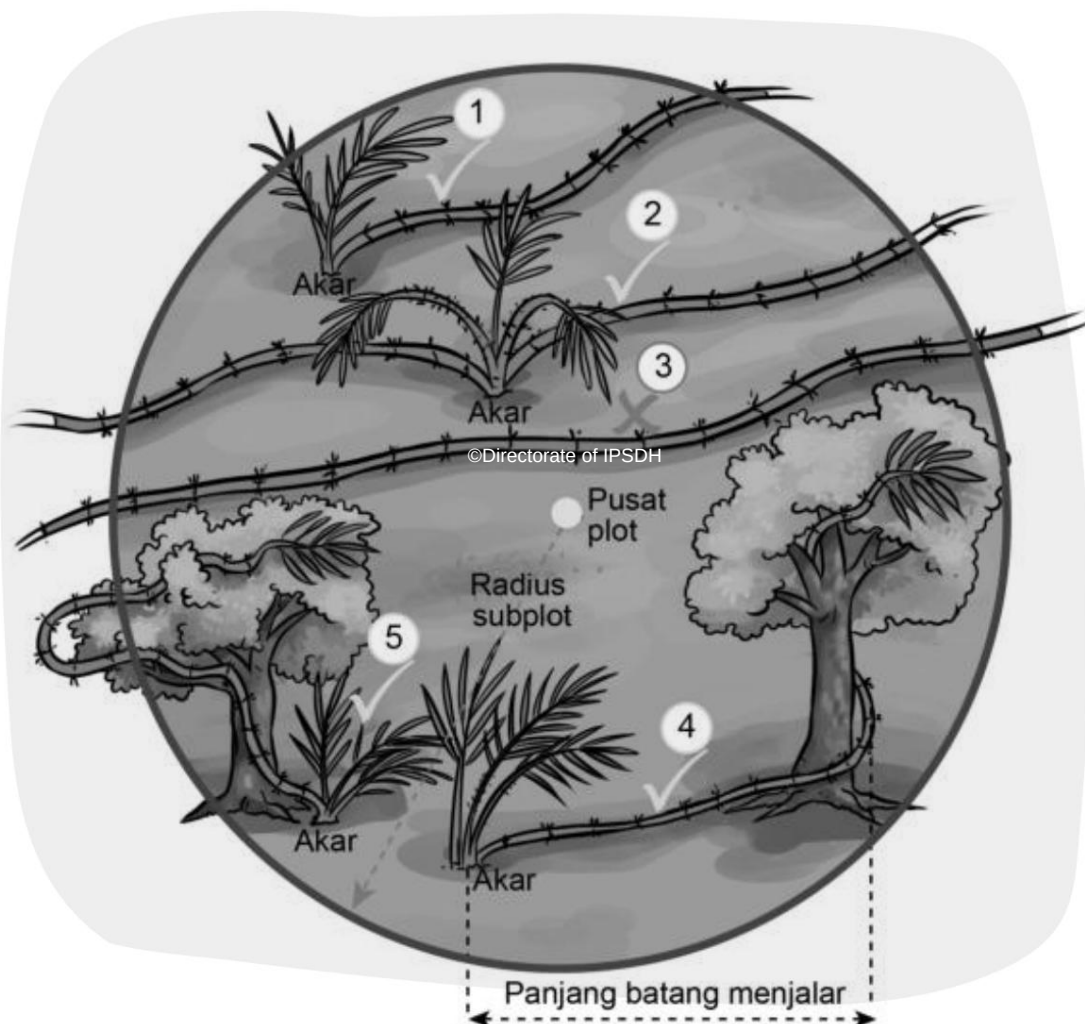


Figure 22. Liana measurements

5.10. Palm and Nipah

Palm trees are a type of vegetation commonly found in mangrove forests and tropical coastal areas, belonging to the *Arecaceae* (*Palmae*) family. Palm trees are characterized by morphologically pinnately compound leaves arranged on a sheath, and a single, upright, cylindrical stem without lateral branches. Commonly found palm species include the areca nut (*Areca* spp.), coconut (*Cocos nucifera*), and sago palm (*Metroxylon* spp.), and oil palm (*Elaeis guineensis*).

One type of palm commonly found in mangrove ecosystems is the nipa palm (*Nypa fruticans*). This plant belongs to the *Arecaceae* family, but it has a distinctive morphology: it grows in clumps, without upright stems, and its fronds rise directly from a horizontal root system (*rhizome*). Therefore, the nipa palm's measurement approach is tailored to its growth characteristics.

Palm (including nipah) measurements were conducted in subplot C within each plot. Due to the different characteristics of nipah compared to other palms, the nipah measurement procedure differs from that of palms in general. The procedure for measuring palms and nipah is explained as follows:

Palm Measurement Procedures

1. Identify the types of palms found in subplot C.
2. For each individual palm (diameter ≥ 5 cm), take measurements and record them. on the F12M form: species name, palm type, trunk 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, and (3) Medium height (such as coconut, sago, etc.). Diameter measurements are carried out at a height of 1.3 m from the ground surface or from the top of the supporting roots if any.
3. Attach a serial number label to each palm that has been measured.

Procedures for Measuring Nipah (*Nypa fruticans*)

1. Identify all the nipah clumps in subplot C.
2. Nipah measurements are only carried out if the center of the clump is located inside subplot C (see R1, R2, R4, R5, and R7 in Figure 24). If there are two or more nipa palms whose center point is exactly on the subplot boundary (for example R5, R6, and R7 in Figure 24), then the clump measurements are carried out alternately, for example clump R5 is measured, clump R6 is not measured, and clump R7 is measured, as shown in Figure 24).
3. On the nipah palm that has been determined to be measured, take measurements and record them. Form F12M with the following provisions:
 - a. Nipah is classified into two groups based on the height of the frond, namely
 - Young Nipah: has a frond height of < 1.5 meters
 - Mature Nipah: has a frond height of ≥ 1.5 meters
 - b. Measurements for young nipah: Species name and number of fronds per clump.
 - c. Measurements for mature nipah palms: Species name, Average frond diameter, Height average fronds, and number of fronds per clump.

4. Measurement of the diameter of mature nipah palms is carried out on three fronds representing small sizes, medium, and large. Diameter is measured at a height of 1.3 meters from the ground, or slightly adjusted if the position is at a leaf node.

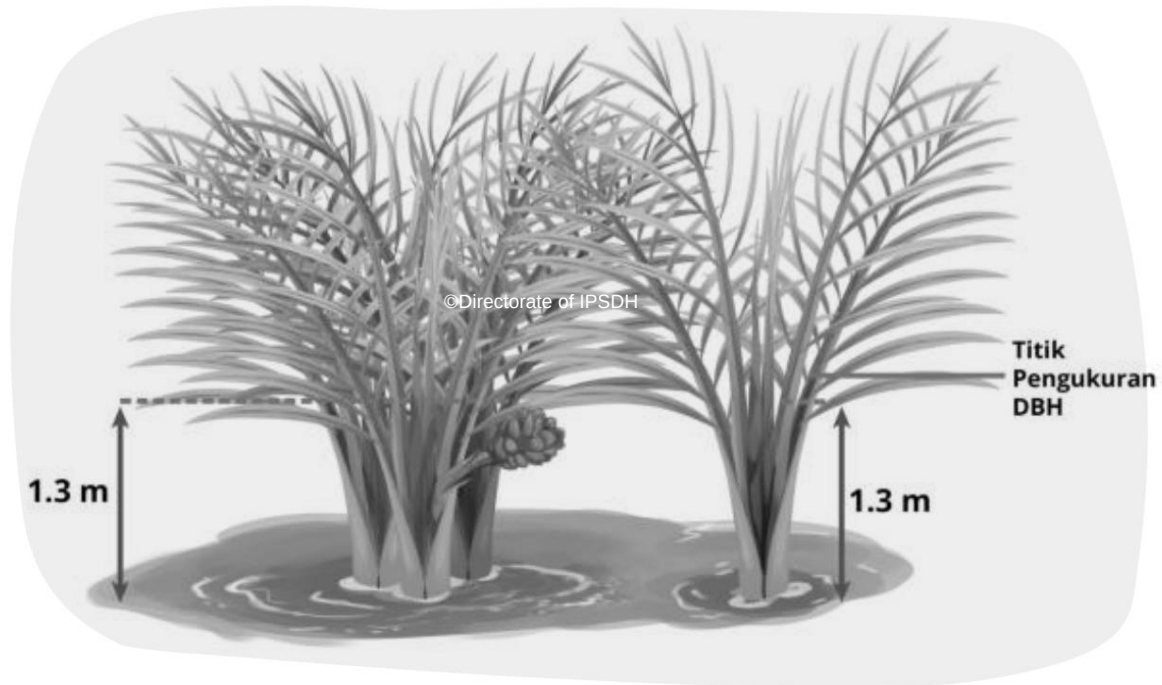


Figure 23. Measuring the diameter of an adult nipah palm

5. Counting the number of young and mature nipah fronds in one clump is done by directly in the field.

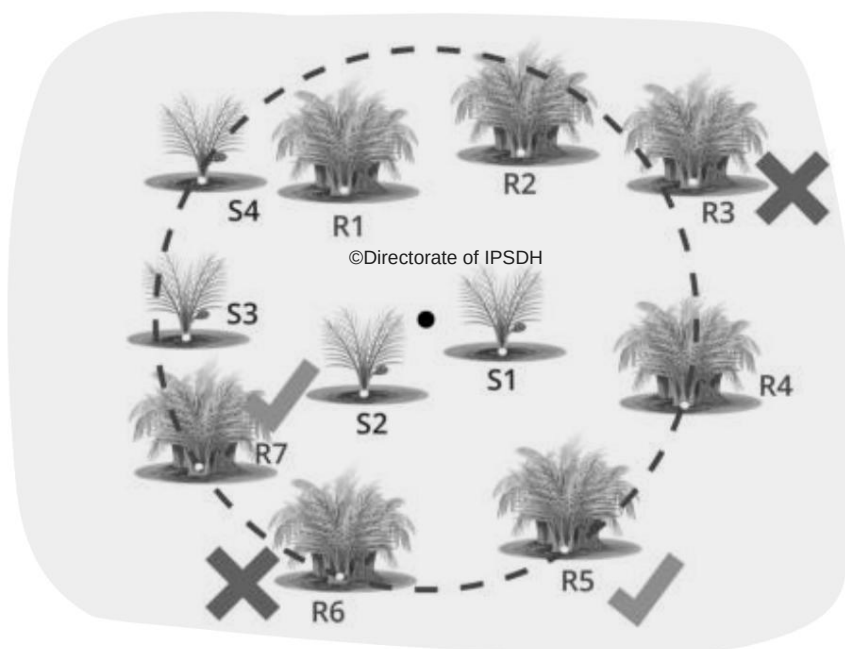


Figure 24. Possible positions of nipah palms (R1, R2, ..., R7) in subplot C



5.11. Trees and Dead Trees

Measurements of live and dead trees were carried out in subplots B, C, and D with the following provisions for the subplot radius and tree diameter limit (DBH):

1. Subplot B: radius 5 m, DBH 5 - <10 cm
2. Subplot C: radius 8 m, DBH 10 - <20 cm
3. Subplot D: radius 12 m, DBH 20-up.

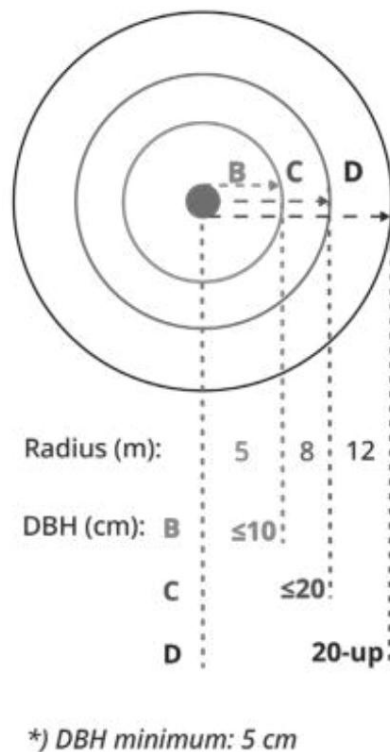


Figure 25. Radius size and diameter limits (DBH) of trees measured in subplots B, C, and D in mangroves (Ministry of Forestry 2025)

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 the F13M form.
2. Starting from the center of the plot, the survey team moves north to measure trees in subplots B, C, and D, and then moves clockwise so that all trees in a plot are measured (Figure 25). A tree is measured if:

- Estimated center point of the base plane the stem is located in the subplot or most (>50%) of the stem is located in the subplot, for example trees 2, 3, 4, 5 and 6 in Figure 25. 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' which has a diameter of 9 cm it is not measured in subplot B because the center point of the stem is outside the boundaries of subplot B. If the estimated center point of the base plane of the stem is exactly on the boundary of the subplot, then the trees are measured alternately, for example trees 5 and 6 measured but tree 'c' was not measured in Figure 25.

- Has a diameter of no more than the upper limit of the DBH class of a particular subplot (Figure 25). For example, if tree b (in Figure 21) 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.

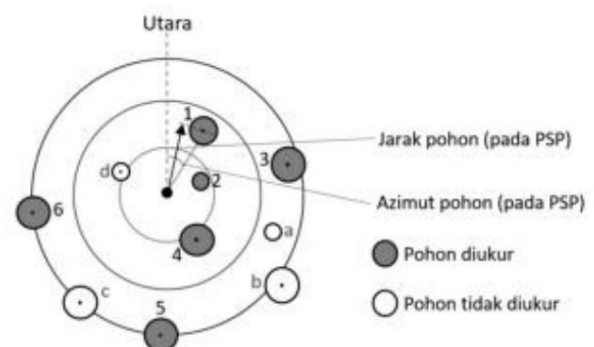


Figure 26. Sequence of tree measurements, determination of measured and unmeasured trees, and determination of tree distance and azimuth.

3. All trees and dead trees are labeled with the tree number, diameter, azimuth, and horizontal distance. Tree labels can be made of plastic or a durable yellow/red material. All tree labels are placed facing the center of the plot where the diameter is measured.

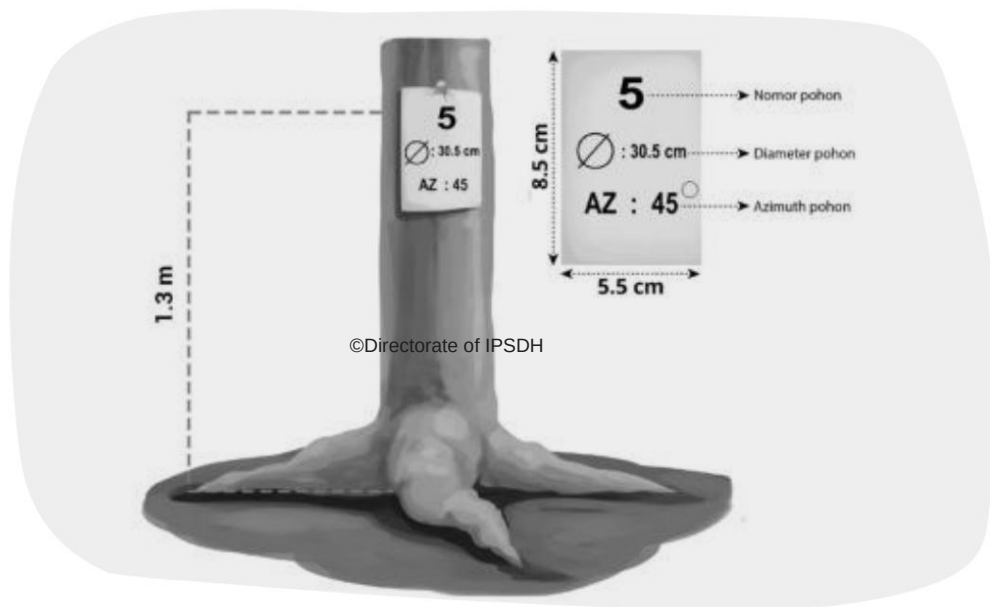
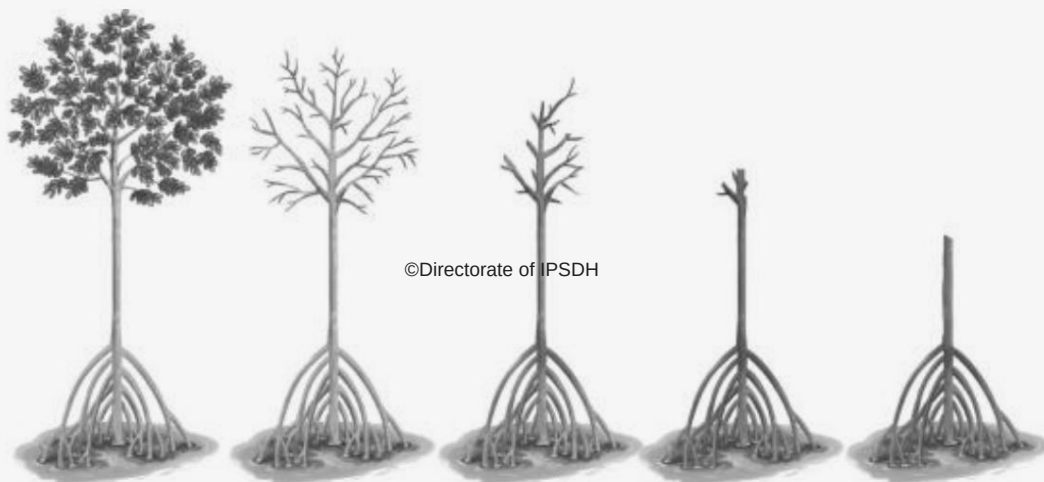


Figure 27. Labeling dead trees

4. For each 'measured tree', observe and record the tree's status on form F13M with the following code:

Code F13M (Status)	Description
1	Life
2	Dead with branches and twigs without leaves
3	Dead with large branches without twigs and leaves
4	Dead with almost no branches, twigs, and leaves
5	Dead in the form of stumps of varying heights

Illustration:



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



5. Identify and record the code and species name of each tree measured on the F13M form. Known tree species can be selected from the tree list in the *Collect Mobile* (CM) application. For trees with unknown species names, local names can be used, accompanied by photographs (leaf, stem, fruit, etc.) and/or a herbarium for further species identification. Instructions for creating a herbarium refer to Appendix 3 of this guide.

6. Measure the diameter of the tree using a diameter tape (*phi-band*) at a height

1.3 m above ground level (called *diameter at breast height*, DBH), and recorded 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 must be wrapped (without twisting) perpendicular to the axis of the trunk that has been cleared of climbing plants (if any). In the field, the diameter measurement point is adjusted to the condition of the tree as illustrated in Figure 28 (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 surface land (Figure 28a).

• Leaning tree on flat ground: DBH is measured 1.3 m from the nearest ground surface. or in the direction of the slope of the stem (Figure 28b).

• Trees standing upright on sloping ground: DBH is measured 1.3 m from the highest ground surface/top side (Figure 28c).

• 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, depending on which is closest (Figure 28d).

• Trees with branches >1.3 m: DBH is measured 1.3 m from the ground surface and is considered as one tree (Figure 28e).

• 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 28f).

• Trees with supporting roots (e.g. *Rhizophora* spp.): if the height of the supporting roots is <1.3 m then the DBH is measured 1.3 m from the ground surface (Figure 28g), 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.

• Trees with buttresses >1.3 m: DBH is measured 20 cm above the buttresses on the part of the trunk that is start to normal (Figure 28h).

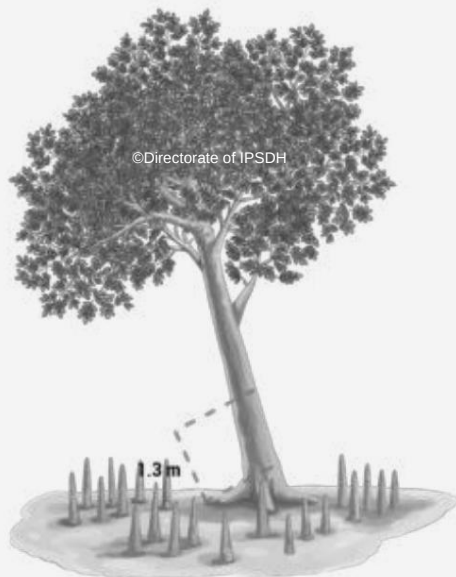
In detail, the method of measuring tree diameter is explained in Appendix 2C.



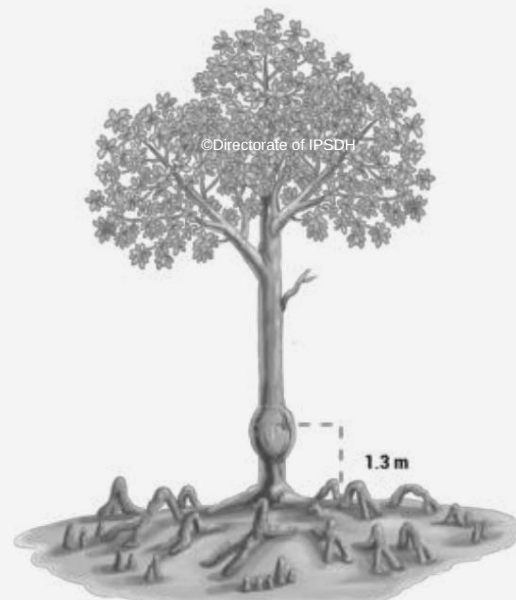
a. Pohon normal:
DBH diukur 1,3 m dari permukaan tanah



b. Pohon normal pada tanah miring:
DBH diukur 1,3 m dari permukaan tanah tertinggi



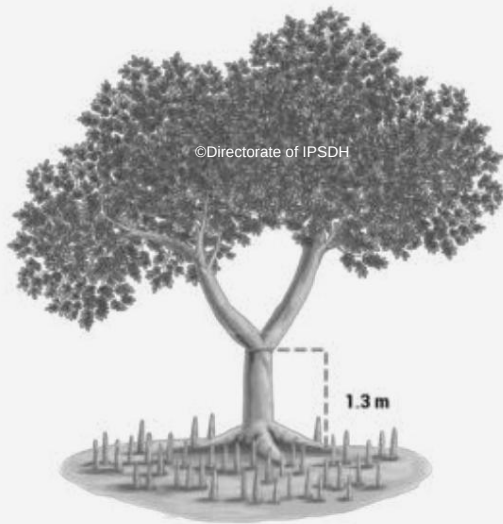
c. Pohon miring:
DBH diukur 1,3 m dari permukaan tanah terdekat, atau searah kemiringan pohon



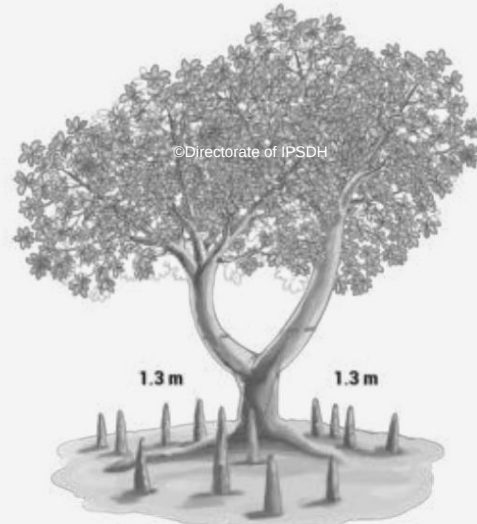
d. Pohon normal:
jika 1,3 m tepat berada pada batang cacat (gembung) DBH diukur pada batas bagian yang mulai normal di atas atau bawah tergantung yang terdekat

Figure 28. Diameter measurement points for various tree conditions

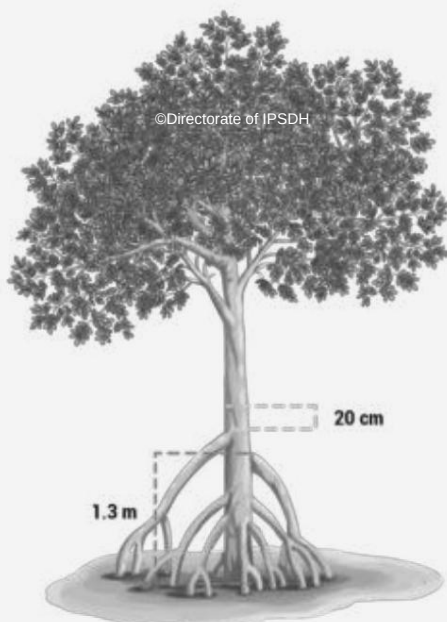




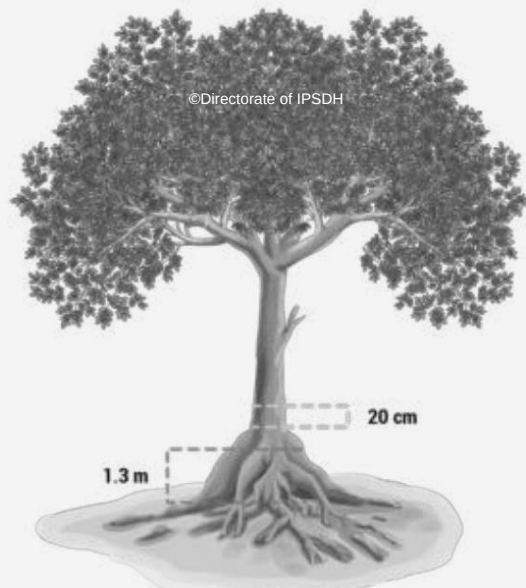
e. Pohon cabang:
jika 1,3 m terdapat berada pada awal percabangan, DBH diukur di bagian bawah cabang yang masih normal



f. Pohon cabang:
jika 1,3 m terdapat berada di atas cabang, ukur DBH di kedua cabang dan diasumsikan sebagai 2 batang

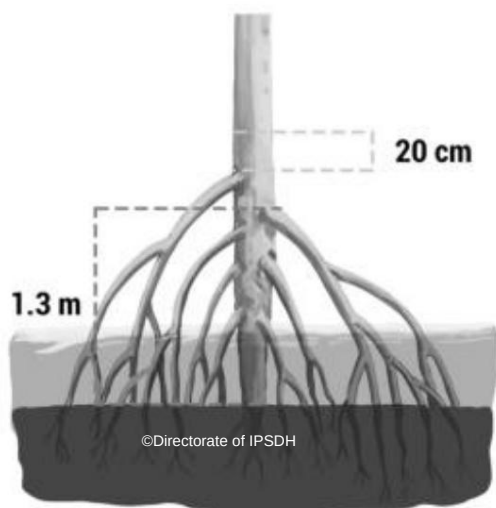


g. Pohon berakar menunjang :
DBH diukur 1,3 dari atas akar panjang



h. Pohon berbarin dan mangrove:
DBH diukur dari 20cm dari atas banir

7. To complete (Figure 28), here are the measurement procedures based on the type of mangrove root:



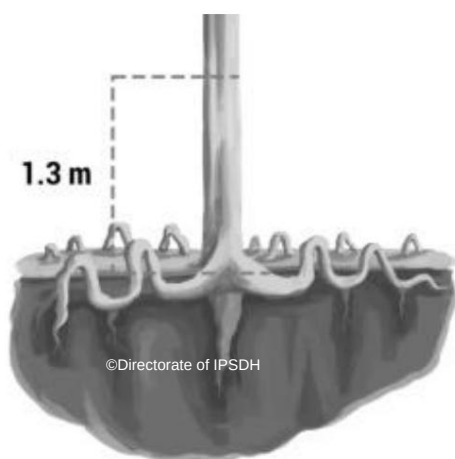
**Mangroves with long roots
(such as *Rhizophora* sp.)**

- Measure the stem diameter 20 cm above the highest supporting root.
- If the taproot is higher than the 1.3 m, then measure 20 cm above the last root.



**Mangrove with Plank Roots/
Banir (such as *Xylocarpus* sp.)**

- Measure the diameter 20 cm above the buttress highest.
- If the buttress is very high (>1.3 m), measure 20 cm above the end of the buttress.



**Mangrove with Knee Root (*Bruguiera gymnorrhiza*) /
Pneumatophore Breath Root (such as *Avicennia* sp. and *Sonneratia* sp.)**

- Measure the diameter at a height of 1.3 m from the ground surface.
- If branching occurs below 1.3 m, each branch is counted as separate individuals.

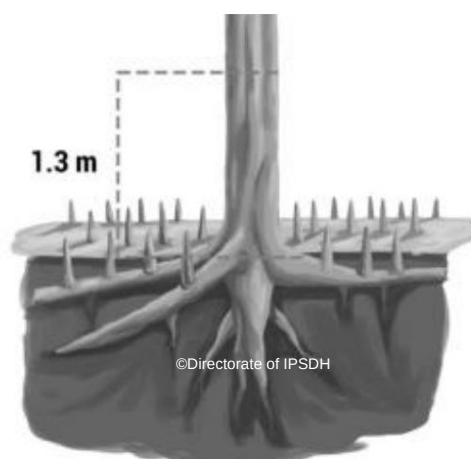


Figure 29. Measuring tree diameter



8. Diameter measurements are recorded on form F13M.
9. Take horizontal and azimuthal distance measurements from the center of the plot to each tree measured (Figure 22). For ease and speed of measurement, flat distances should be measured using an electronic distance meter, such as the Vertex, which takes slope into account. Azimuth is the angle from north to the tree 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 tree distribution in each plot to facilitate re-measuring clusters in the future.
10. Height Measurements: Record on Form F13M: After measuring all tree diameters, select 6 sample trees for height measurement. If the number of trees in the plot is less than 6, then height measurements are carried out on all trees in the plot. Sample trees must represent the diameter range in the plot and grow normally (e.g., without crown breakage or irregular shape). For this reason, the survey team can select 2 sample trees representing 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 22):

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

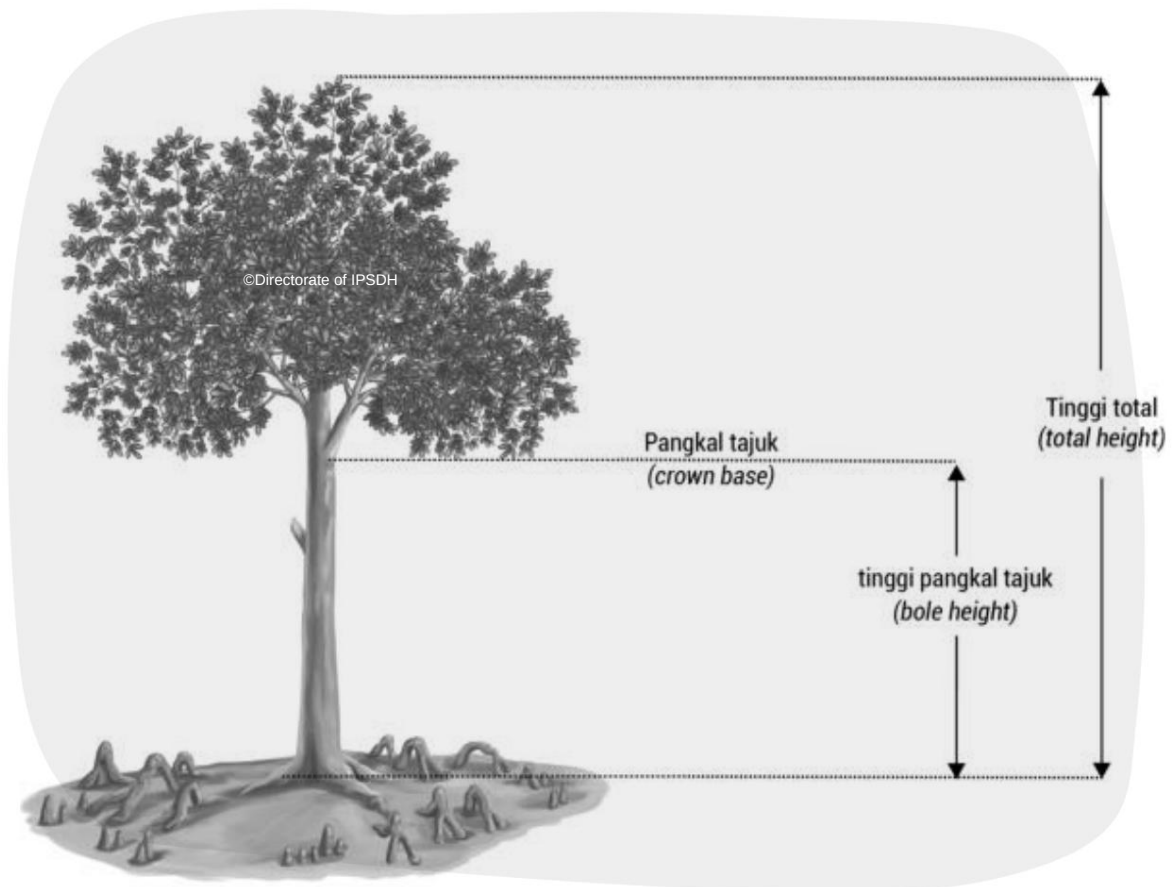


Figure 30. Height of base of crown and total height of tree

11. Record measurements of dead trees on form F13M: For dead trees in the form of stumps (status 5), measure the height of the stump and record it (up to 1 decimal place) in the “T-total” column in the special mangrove inventory form.

12. Record wood quality on form F13M: For living trees with a diameter of ≥ 20 cm, observe and note the quality level of the wood according to the following code:

Code F13M (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.

For each tree species (living or dead) whose Latin name is not yet known, ask local people for the estimated specific gravity class (hardness level) of the tree according to the following code, recorded on form F13M.

Code F13M (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

5.12. Survey Team Identity

After completing the measurement of a cluster, record the identity of the survey team on the form. F14M 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 local worker.

• **Mobile:** filled with *telephone/mobile* 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.



06

Reporting Implementation Inventory

6.1 Reporting Mechanism

6.2 Table of Contents of the Report

©Directorate of IPSDH

6.1 Reporting Mechanism

After the cluster measurements in the field, the survey team, coordinated by the head of the mangrove forest inventory implementation team, must carry out the following post-survey activities:

1. Re-check the accuracy and completeness of the mangrove forest inventory data recorded via the *Collect Mobile* application or the printed form (if used).
2. Complete the scientific names of tree species not identified in the field. If the survey team collects herbarium samples, these samples must be sent to a laboratory or competent expert for tree species identification.
3. Handle the inventory data flow process, starting from sending data from *Collect Mobile* to the mangrove forest inventory database server to archive the data (in *Excel* and *.collect data file formats*) in the work unit that handles the inventory.
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 mangrove forest inventory report are handled by the work unit that handles forest resource inventory/mangrove rehabilitation management.

The inventory report is submitted to the head of the work unit responsible for the inventory for evaluation and approval. The inventory implementation report is then submitted to the head of the work unit responsible for mangrove inventory/rehabilitation management. A schematic representation of this reporting mechanism is shown in Figure 31.

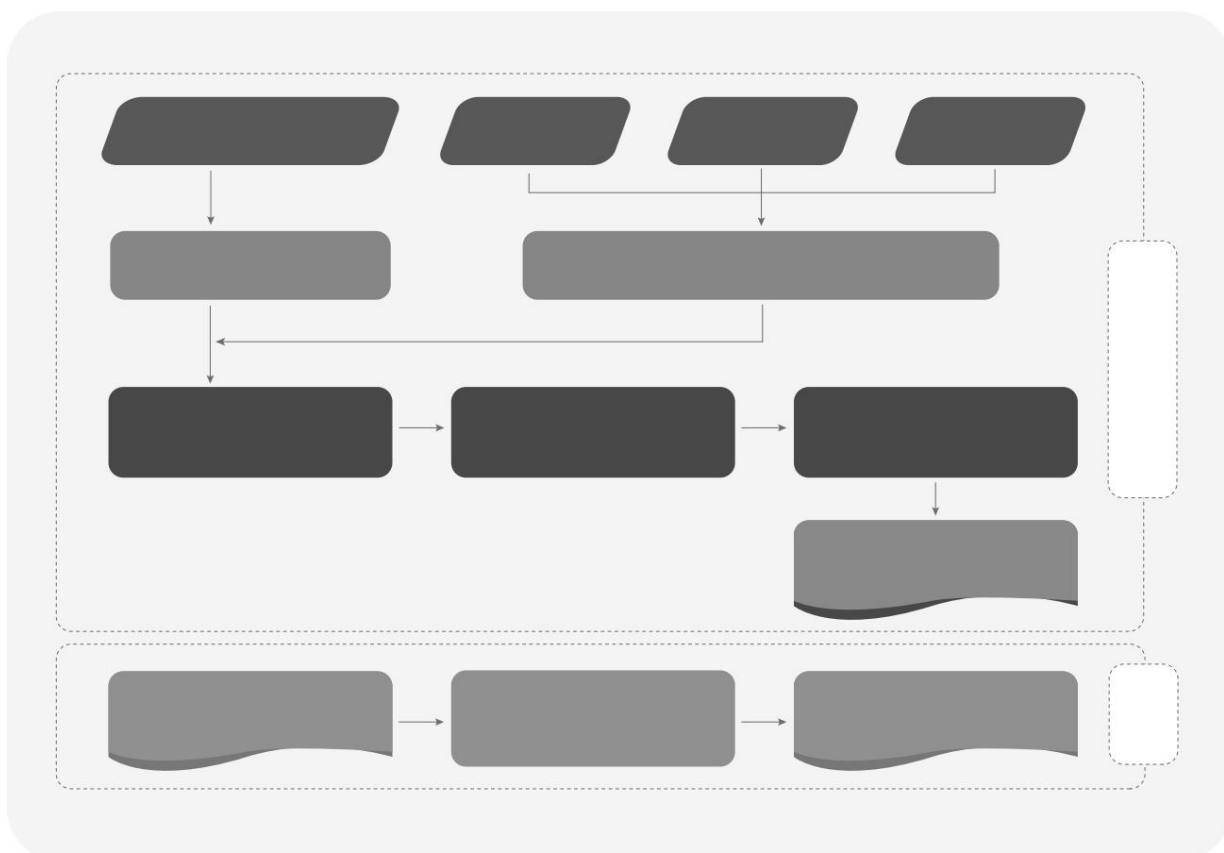


Figure 31. Reporting mechanism for Mangrove Forest Inventory activities



6.2 Table of Contents of the Report

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

- **1. Composition of the implementation team**
Contains information on the head and members of the implementation team and the person responsible for mangrove forest inventory activities, including contact details that can be contacted.
- **2. Time of implementation**
Contains information on the date/time of implementation of mangrove forest inventory activities according to the previously determined cluster measurement activity schedule in the field.
- **3. 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 mangrove forest inventory cluster distribution map.
- **4. Letter of statement regarding implementation of activities**
Contains a statement from the head of the work unit handling the inventory or the person responsible for the inventory activity, stating that the mangrove forest inventory activity has 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 mangrove forest inventory database system established by the work unit handling the forest resource inventory. The letter should include an explanation if the activity implementation does not align with the targets or previous plans.
- **5. Summary of forest inventory activities**
Contains information about the targets and realization of cluster measurements, explanations of inaccessible clusters (if any), results of mangrove species identification (including results of herbarium sample analysis), results of measurement data verification, and other relevant matters related to mangrove forest inventory.



List Library

Bibliography

- F.A.O. (2007). *The World's Mangroves 1980-2005*. Food and Agriculture Organization of The United Nations
- F.A.O. (2012). *National forest monitoring and assessment - Manual for integrated field data collection, Version 3.0* (National Forest Monitoring and Assessment Working Paper NFMA 37/E). Food and Agriculture Organization.
- F.A.O. (2023). *The World's Mangroves 2000-2020*. Food and Agriculture Organization of The United Nations.
- Fehrmann, L., Kleinn, C., Magdon, P., & Perez-Cruzado, C. (2017a). *Denition of a minimum standard for forest inventory management at KPH level*. FORCLIME GIZ.
- Fehrmann, L., Kleinn, C., Magdon, P., & Perez-Cruzado, C. (2017b). *Denition of a minimum standard for forest inventory management at KPH level*. FORCLIME GIZ.
- Gedan, K.B., Kirwan, M.L., Wolanski, E., Barbier, E.B., & Silliman, B.R. (2011). The present and future role of coastal wetland vegetation in protecting shorelines: Answering recent challenges to the paradigm. *Climate Change*, 106(1), 7-29.
- Gerwing, J.J., Schnitzer, S.A., Burnham, R.J., Bongers, F., Chave, J., DeWalt, S.J., Ewango, CEN, Foster, R., Kenfack, D., Martinez-Ramos, M., Parren, M., Parthasarathy, N., Perez-Salicrup, D.R., Putz, F.E., & Thomas, D.W. (2006). A standard protocol for liana censuses. *Biotropica*, 38, 256-261.
- GMA. (2021). *The state of the world's mangroves*.
- Hernández-Blanco, M., Costanza, R., & Cifuentes-Jara, M. (2021). Economic valuation of the ecosystem services provided by the mangroves of the Gulf of Nicoya using a hybrid methodology. *Ecosystem Services*, 49, Article 101275.
- Husch, B., Beers, T. W., & Kershaw, J. A. (2003). *Forest mensuration* (4th ed.). John Wiley & Sons.
- KLHK. (2020). *Technical guidelines for interpreting medium-resolution satellite imagery for updating national land cover data*. Directorate of Forest Resources Inventory and Monitoring, Ministry of Environment and Forestry.
- Iswahyudi, I., Kusmana, C., Hidayat, A., & Noorachmat, BP (2019). Evaluation of suitability Land for rehabilitation of mangrove forests in Langsa City, Aceh. *Journal of Mathematics, Science and Technology*, 20(1), 45-56.
- Ministry of Forestry. (2025). *Decree of the Director General of Forestry Planning Number 3 of 2025 concerning Technical Instructions for Inventory of Forest Stands and Non-Timber Plants in the Framework of National Forest Inventory*. Directorate General of Forestry Planning.
- Ministry of Environment and Forestry, Ministry of Marine Affairs and Fisheries, & BRGM. (2021). *National mangrove rehabilitation roadmap 2021-2030*. Indonesian government.

- Kusmana, C. (2014). Distribution and current status of mangrove forests in Indonesia. *Mangrove Ecosystems of Asia*, 1-471.
- Manuri, S., Putra, CAS, & Saputra, AD (2011). *Forest carbon stock estimation techniques*. Merang REDD Pilot Project - German International Cooperation (GIZ).
- Marshall, P., Davis, G., & LeMay, V. (2000a). *Using line intersect sampling for coarse woody debris* (Technical Report TR-003). Research Section, Vancouver Forest Region.
- Marshall, P., Davis, G., & LeMay, V. (2000b). *Using line intersect sampling for coarse woody debris*. Research Section, Vancouver Forest Region.
- McFadden, L., et al. (2007). Broad-scale modeling of coastal wetlands: What is required? *Hydrobiologia*, 577, 5-15.
- Melati, DN (2021). The role of coastal vegetation in addressing coastal hazard threats. *ALAMI Journal : Journal of Disaster Risk Reduction Technology*, 4(2), 106-113.
- Murdiyarso, D., Purbopuspito, J., Kauffman, JB, Warren, MW, Sasmito, SD, Donato, D. C., Manuri, S., Krisnawati, H., Taberima, S., & Kurnianto, S. (2015). The potential of Indonesian mangrove forests for global climate change mitigation. *Nature Climate Change*, 5(12), 1089-1092.
- Ofori, S.A., Asante, F., Boatemaa Boateng, T.A., & Dahdouh-Guebas, F. (2023). The composition, distribution, and socio-economic dimensions of Ghana's mangrove ecosystems. *Journal of Environmental Management*, 345, Article 118622.
- Rusolono, T., Tiryana, T., Purwanto, J., & Sumantri, H. (2015). *Carbon stock survey guide and diversity of ora in South Sumatra*. GIZ BIOCLIME.
- Soedarmo, SPK (2018). Mangrove forest conservation and the role of coastal communities. In A. Widyanto & AMN Ardhanie (Eds.), *Coastal natural resource management*. Undip Press.
- Tokola, T., & Vesa, L. (2023a). *NFI design plan for Indonesian forests*. Food and Agriculture Organization.
- Tokola, T., & Vesa, L. (2023b). *NFI design plan for Indonesian forests*. Food and Agriculture Organization.
- Van Laar, A., & Akca, A. (2007). *Forest mensuration*. Springer.
- Walker, S.M., Pearson, T.R., Casarim, F.M., Harris, N., Petrova, S., Grais, A., Swails, E., Netzer, M., Goslee, K.M., & Brown, S. (2012). *Standard operating procedures for terrestrial carbon measurements*. Winrock International.





07

Attachment

- | | |
|--|---|
| 1. Mangrove Field Form | 6. Format of Statement Letter |
| 2. Field Measurement Techniques | Implementation of IHM Activities |
| 3. Making Herbarium in the Field | 7. IHM Minutes Format No. |
| 4. List of Institutions/Laboratories | Implementable |
| Tree Type Identification | 8. Collect Mobile Updating Procedure |
| 5. Instructions for Using the Vertex Laser | 9. Data Collect Upload Procedure |
| Geo for Measuring Distance and | Mobile to Server |
| Height of Trees | 10. Back Up Data Collect Procedure |
| | Mobile |

Appendix 1. Mangrove Field Form

Form 1-M: Cluster Information

F1M-1	Island	ý1/SM ý3/JW ý5/BN ý6/KL ý7/SL ý8/ML ý9/PP
F1M-2	Cluster number	...
F1M-3	Year of measurement	...
F1M-4	Province	ý11-Aceh ý12-North Sumatra ý13-West Sumatra ý14-Riau ý15-Jambi ý16-South Sumatra ý17-Bengkulu ý18-Lampung ý19-Bangka Belitung Islands ý21-Riau Islands ý31-DKI Jakarta ý32-West Java ý33-Central Java ý34-DI Yogyakarta ý35-East Java ý36-Banten ý51-Bali ý52-West Nusa Tenggara ý53-East Nusa Tenggara ý61-West Kalimantan ý62-Central Kalimantan ý63-South Kalimantan ý64-East Kalimantan ý65-North Kalimantan ý71-North Sulawesi ý72-Central Sulawesi ý73-South Sulawesi ý74-Southeast Sulawesi ý75-Gorontalo ý76-West Sulawesi ý81-Maluku ý82-North Maluku ý91-Papua ý92-West Papua ý93-South Papua ý94-Central Papua ý95-Papua Mountains ý96-Southwest Papua
F1M-5	Area Status	ý1/Mangrove forests within forest areas ý2/Mangrove forests outside forest areas
FM1-6	Cluster data type	ý1/ Planned , if cluster measurements are carried out on the main coordinates/ grid according to the sampling design) ý2/ Unplanned , if cluster measurements are carried out at locations outside the main coordinates/grid. ý3/Quality assurance (QA/QC)
F1M-7	Survey team:	
	-Implementation unit	ý1/ Work unit that handles inventory and units work that handles rehabilitation management mangroves. ý2/ Provincial regional apparatus in charge of forestry. ý3/ QA/QC Team, if the survey is conducted by a special team for quality assurance (QA/QC). ý4/Other parties, if the survey is carried out independently by the agency/ other parties, for example by forestry companies. Write the name of the survey.
	- Chairman m	...



F1M-8	Accommodation (base camp)	Name: ... X coordinate: ... Y coordinate: ...
F1M-9	Survey time:	
	Departure from the initial k to the parking location or cluster	Start date & time: End date & time: ÿ1/Land Vehicles ÿ2/Boat ÿ3/Walking
	Departure from parking location to cluster location	Start date & time: End date & time: ÿ1/Land Vehicle ÿ2/ Boat ÿ3/ On Foot
	Return from the cluster location to the parking location or starting point	Start date & time: End date & time: ÿ1/Land Vehicles ÿ2/Boat ÿ3/Walking
F1M-10	Cluster accessibility	ÿ1/Accessible ÿ2/The plot is not accessible due to difficult mangrove conditions or dangerous ÿ3/The plot is not accessible due to the potential for dangerous wildlife/located in the waters ÿ4/The plot is not accessible but visible, where the survey can see land cover, forest cover, land use, mangrove pathology, and disturbances, but cannot do measurement)
F1M-11	Buk sik cluster can't accessible	ÿPhoto 1 ÿPhoto 2 ÿPhoto 3 ÿX (Easng) coordinate of last access ÿY (Northing) coordinate of last access ÿMinutes
F1M-12	Main types of HHBK	
F1M-13	Forest/land managers	ÿ1/Government ÿ2/Private ÿ3/Community
F1M-14	Important notes:	

Form 2-M: Plot Information

F2M-1	Cluster number ...	HUTAN MANGROVE	
F2M-2	Plot number ŸP ŸU ŸT		
F2M-3	Plot accessibility	Ÿ1/Accessible Ÿ2/The plot is not accessible due to difficult mangrove conditions or dangerous Ÿ3/The plot is not accessible due to the potential for dangerous wildlife/ located in the waters Ÿ4/The plot is not accessible but visible, where the survey can see land cover, forest cover, land use, mangrove pathology, and disturbances, but cannot do measurement).	
F2M-4	Plot measurement time:		
	-Date (dd/mm/yy)		
	-Start time (hours:minutes)		
	-End time (hours:minutes)		
F2M-5	Plot location:		
	-X coordinate (Easng)		
	-Y coordinate (Northing)		
	-GPS accuracy (m)		
	-Distance to plot center (m)		
	-Azimuth to center of plot (°)		
	-Photo of the signpost		
F2M-6	Plot center marking:	Ÿ1/Yes Ÿ2/No	
	1.1 Witness Tick 1:		
	-X coordinate (Easng):		
	-Y coordinate (Northing):		
	-GPS accuracy (m):		
	-Distance from plot center (m):		
	-Azimuth of the plot center (°):		
	-Photo		
	1.2 Witness Tick 2:		
	-X coordinate (Easng):		
	-Y coordinate (Northing):		
	-GPS accuracy (m):		
	-Distance from plot center (m):		
	-Azimuth of the plot center (°):		
	-Photo		

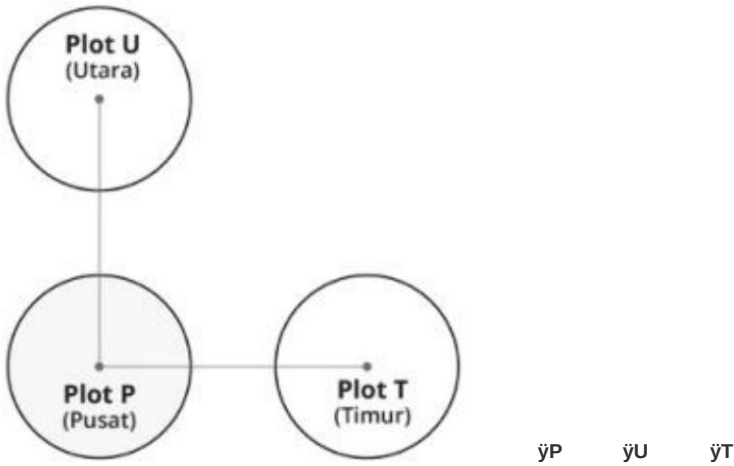


F2M-7	Elevation (masl)			
F2M-8	Slope gradient (%)			
F2M-9	Slope gradient aspect	ý1/North ý4/Southeast ý7/West	ý2/Northeast ý5/South ý8/Northwest	ý3/East ý6/Southwest ý9/Flat
F2M-10	Land cover class in the field	ý2001/Hp ý2002/Hs ý2004Hmp ý20041/Hms ý2005/Hrp ý20051/Hrs ý2006/Ht ý2007/B	ý20071/Br ý2010/Pk 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
F2M-11	Mangrove Typology	ý1/Mangrove pe delta ý2/Mangroves at river mouths ý3/Mangroves at lagoons ý4/Mangrove pe pulau		
F2M-12	Land use	ý1/Monoculture community forest ý2/Mixed community forest ý3/Agroforestry gardens ý4/Agriculture ý5/Plantation ý6/Fishponds ý7/Charcoal kitchen ý8/Palm oil plantation ý6998/Other (write according to land use)		
F2M-13	Proportion (%) of plot area located within the observed land cover class area	ý1/100% ý3/50–74%	ý2/75–99% ý4/25–49%	ý5/0–24%
F2M-14	Vertical structure of the stand	ý1/One layer of mangrove canopy that is uniform in height (example: zone <i>Avicennia</i> or <i>Sonneraa</i> in the front area) ý2/One layer of mangrove canopy with moderate height variation (example: <i>Rhizophora</i> zone in the middle area) ý3/Mul-layer mangrove canopy with clear stratification (example: back zone with <i>Bruguiera</i> , <i>Ceriops</i> , <i>Xylocarpus</i>) ý4/Vertical structure is irregular and has gaps (example: area mangroves are disturbed or in the regeneration stage) ý5/Very complex vernal structure with complete stratification (example: mature mangrove forest with diverse ecological zones)		
F2M-15	Forest/land fires	ý1/No fire occurred ý2/Not long ago a fire occurred ý3/The fire has been going on for a long time		

F2M-16	Types of forest disturbances	ý1/No disturbance ý2/ Road construction ý3/ Logging ý4/ Shifting cultivation ý5/ Pests and diseases ý6/ Port construction ý7/ Bridge construction ý8/ Abrasion ý9/ Forest and Land Fires ý10/ Pollution ý6998/ Others (write according to the facts)
F2M-17	General conditions	ý1/Dry land conditions ý2/Wet conditions ý3/Submerged condition
F2M-18	Plot condition photos:	ý1/North, Photo number: ý2/East, Photo number: ý3/South, Photo number: ý4/West, Photo number:



Form 3-M: Crown density

General Information Sample Plot	
Cluster number	...
Plot number	
Headline Percentage	 %
Header Density Classification (Data analysis)	ŷRare (<30%) ŷMedium (30-70%) ŷDense (>70%)

[illegible]

Form 5-M: Undergrowth

General Information Sample Plot			
Cluster number	...		
Plot number	ŸP ŸU ŸT		
Position of subplot A	Ÿ1/West – East Ÿ2/North – South	Diagram illustrating the layout of subplot A1/A2. It shows two options: Opsi 1: Barat - Timur (West - East) and Opsi 2: Utara - Selatan (North - South). Both options show a central point B with a distance k=6 m to points A1 and A2. A clip-plot A1/A2 is shown with dimensions 0.5 m x 0.5 m.	
Are undergrowth found? Ÿ No Ÿ Yes (fill in the table below)			
Understory weighing: clip-plots A1 and A2			
TBB (grams)	BBS (grams)	Sample number	BKS (grams)
Notes:			

Information:

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.

Form 6-M: Litter

General Information Sample Plot			
Cluster number	...		
Plot number	ŷP ŷU ŷT		
Position of subplot A	ŷ1/West – East ŷ2/North – South		
Was litter found? ŷ No ŷ Yes (fill in the table below)			
Litter weighing: clip-plots A1 and A2			
TBB (grams)	BBS (grams)	Sample number	BKS (grams)
Notes:			

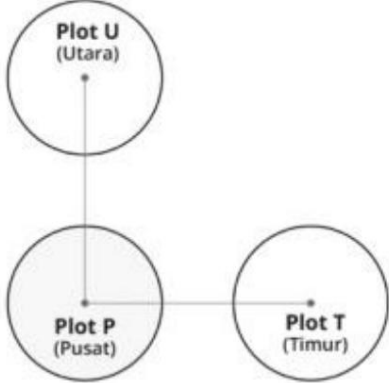
Information:

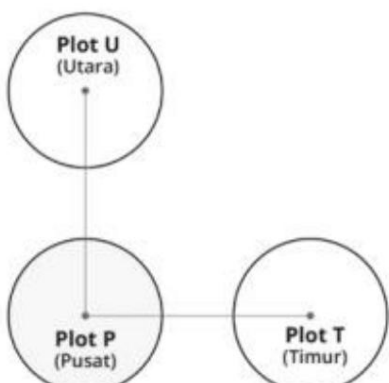
TBB = Total Wet Weight, BBS = Wet Weight of Sample, BKS = Dry Weight of Sample. TBB and BBS are measured directly in the field (after deducting the weight of the bag/container), while BKS is obtained from laboratory analysis results.



General Information Sample Plot	
Cluster number	...
Plot number	
Soil type	☐ Mangrove ☐ Peat ☐ Mineral
Depth	☐ 0-100 cm ☐ Others..... cm
Substrate Type	☐ Mud ☐ Sand ☐ Sandy Mud ☐ See ☐ Sandy Clay
Substrate Color	☐ Dark ☐ Bright
Land History	☐ Natural forest ☐ Planted forest ☐ Other.....
Sampling Date	
Organic C Test	
Bulk Density Test	

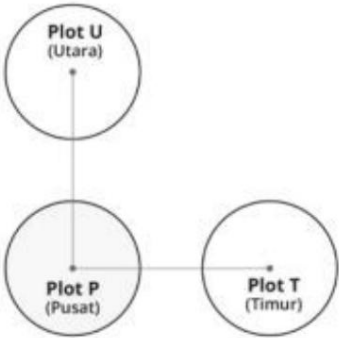
Form F8-M: Soil pH and Salinity

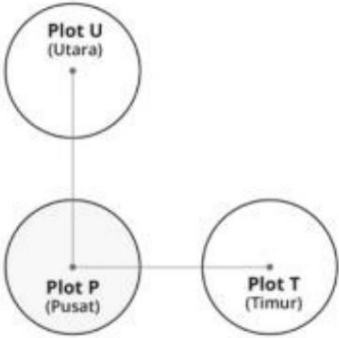
General Information Sample Plot	
Cluster number	...
Plot number	 yP yU yT
Soil type	yMangrove yPeat yMineral
pH value	

General Information Sample Plot	
Cluster number	...
Plot number	 yP yU yT
Soil type	yMangrove yPeat yMineral
Salinity Value (ppt)	



Form F9-M: Water pH and Salinity

General Information Sample Plot	
Cluster number	...
Plot number	 P U T
Soil type	Mangrove Peat Mineral
Ph Value	

General Information Sample Plot	
Cluster number	...
Plot number	 P U T
Soil type	Mangrove Peat Mineral
Salinity Value (ppt)	

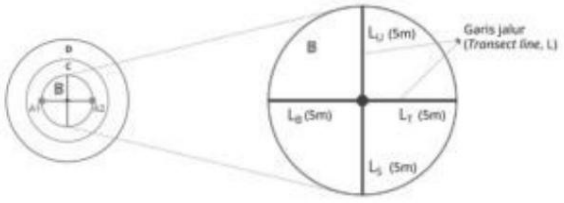
Form 10-M: Deadwood

General Information Sample Plot	
Cluster number	...
Plot number	ŷP ŷU ŷT

Was the wood found ma?

ŷ No ŷ Yes (fill in the table below)

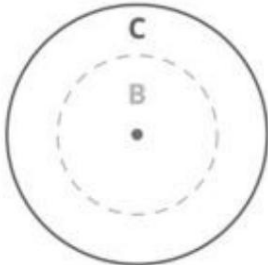
Line (Lt / Lb / L _u / L _s)	No.	Diameter (cm)	Tilt angle (°)	Class of obsolescence (1/2/3)

Notes:	Measurement location:
	



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

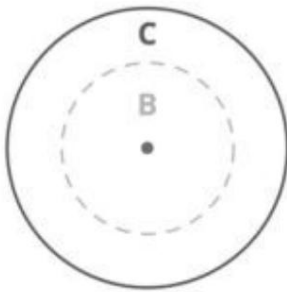
[illegible]

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

Form 12-M: Palm

General Information Sample Plot	
Cluster number	...
Plot number	ŸP ŸU ŸT

Were palms found? Ÿ No Ÿ Yes (fill in the table below)				
Palm Type	Sp Code	Species	Diameter	Tall
Was Nipah found? Ÿ Young				
Clump	Sp Code	Number of fronds per clump		
Ÿ Adults				
Clump	Sp Code	Number of fronds	Average diameter	Average height

Information:	Measurement location:
Palm type: 1) Tall and thin (like a pinang) 2) Short fat (like young oil palm) 3) Medium high (like coconut, sago, etc.) Nipah Type: 1) Young (height <1.5) 2) Adults (Ÿ 1.5)	



Form	General	Cluster	Plot
------	---------	---------	------

Measurement

[illegible]

Technical Instructions for Forest Standing Stock Inventory and Non-Wood Plants in Mangrove Forest Types

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 31a). The slope can exceed 100% (equivalent to >45°) if the incline is steep (Figure 32b).

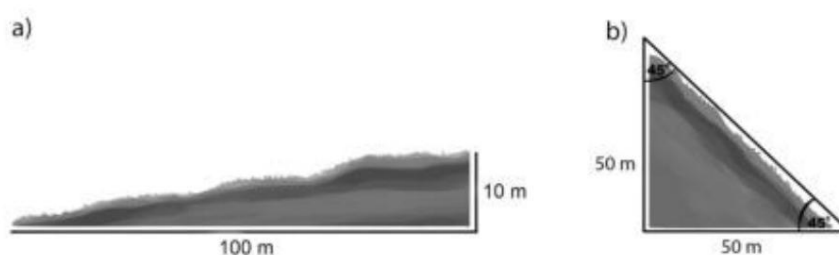


Figure 32. Illustration of slope gradient (a) 10% and (b) 100%

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

Determine the 0% slope point parallel to the eye level on a part of the coworker's body, such as the nose in Figure 33a. Alternatively, both measurers use a stick that is the same height as the eye level.

Ask a coworker to walk up or down to a specific measurement point in the field (e.g., a plot boundary).

Aim from the measuring tool to the 0% slope point on the coworker (Figure 33b). When aiming, use both eyes, with one eye used to see the 0% slope point on the coworker and the other eye used to read the scale on the measuring tool.

Record the slope measurement results on the field form in percentage (%) and/or use the slope value to determine the flat distance (for example when determining the subplot radius).

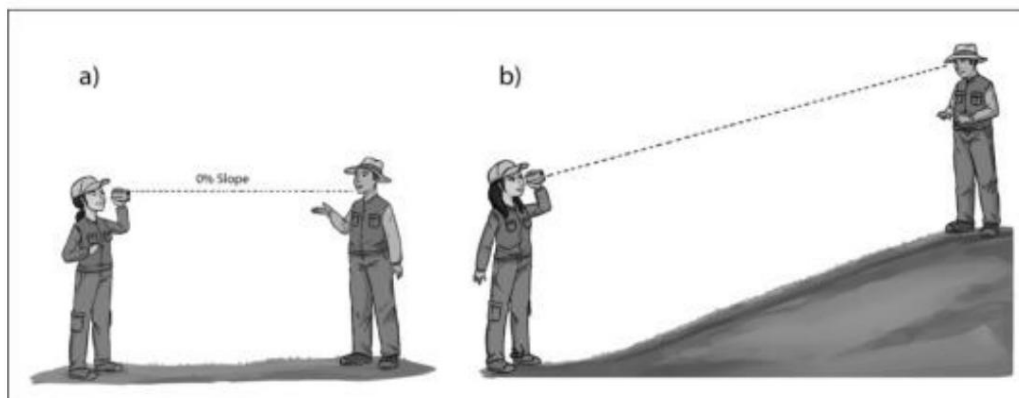


Figure 33. How to determine (a) the 0% slope point on the nose of a colleague (b) measurement slope gradient by two members of the survey team (source: DeYoung, 2016)

B. Slope Correction for Plot Distance and Radius

All distances *used* in field measurements are horizontal distances, *such* as the distance between plots or the distance from the center of a plot to each tree within the plot. If the land is flat, distance measurements can be made directly because the distance measured is already horizontal. However, if the land is not flat, the field distance can be calculated based on the horizontal distance and the slope, as shown in Figure 34. 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 clear distance values based on the desired level distance (2, 5, 8, 12, 15, 25, and 50 m) at various slope values. If the desired level distance is not available in Table 4, then the field distance at a certain slope can be calculated by multiplying the values in the 'Factor (f)' column by the desired level distance. For example, on a slope of 40% and the desired level distance is 30 m, the field distance is: 1,077 * 30 = 32.31 m.

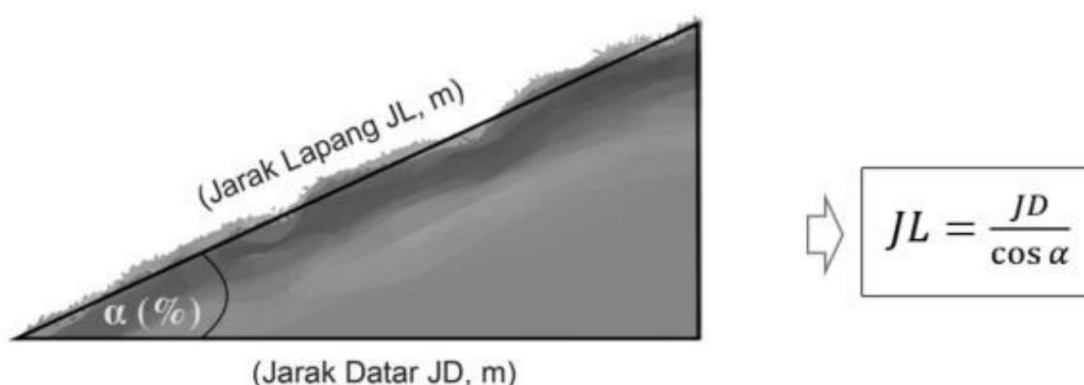


Figure 34. Slope correction for distance measurement

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 35). This correction is necessary if the plot radius measurement is done manually or not using modern measuring instruments that take slope into account (such as *Vertex*). Table 5 presents the plot radius correction values for various slope angles and desired plot radii. For example, if the survey team wants 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.

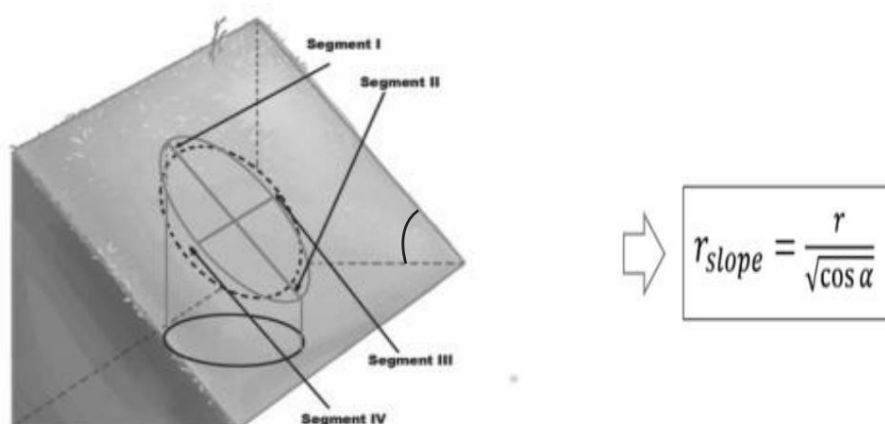


Figure 35. Correction of plot radius on slope

Slope a (%) Factor										Distance									
a (°)	(f)	2	5	8	(m)	12	15	25	50	a (°)	(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.			

Table 5. Slope correction for plot radius measurement

Slope a (%) a (°)		Factor		Plot radius (m)													
		(f)		2		5		12		15		25					
1	0.6	1.000	2.00	5.00	8.00	12.00	15.00	25.00									
2	1.1	1.000	2.00	5.00	8.00	12.00	15.00	25.00									
3	1.7	1.000	2.00	5.00	8.00	12.00	15.00	25.01									
4	2.3	1.000	2.00	5.00	8.00	12.00	15.01	25.01									
5	2.9	1.001	2.00	5.00	8.00	12.01	15.01	25.02									
6	3.4	1.001	2.00	5.00	8.01	12.01	15.01	25.02									
7	4.0	1.001	2.00	5.01	8.01	12.01	15.02	25.03									
8	4.6	1.002	2.00	5.01	8.01	12.02	15.02	25.04									
9	5.1	1.002	2.00	5.01	8.02	12.02	15.03	25.05									
10	5.7	1.002	2.00	5.01	8.02	12.03	15.04	25.06									
11	6.3	1.003	2.01	5.02	8.02	12.04	15.05	25.08									
12	6.8	1.004	2.01	5.02	8.03	12.04	15.05	25.09									
13	7.4	1.004	2.01	5.02	8.03	12.05	15.06	25.10									
14	8.0	1.005	2.01	5.02	8.04	12.06	15.07	25.12									
15	8.5	1.006	2.01	5.03	8.04	12.07	15.08	25.14									
16	9.1	1.006	2.01	5.03	8.05	12.08	15.10	25.16									
17	9.6	1.007	2.01	5.04	8.06	12.09	15.11	25.18									
18	10.2	1.008	2.02	5.04	8.06	12.10	15.12	25.20									
19	10.8	1.009	2.02	5.04	8.07	12.11	15.13	25.22									
20	11.3	1.010	2.02	5.05	8.08	12.12	15.15	25.25									
21	11.9	1.011	2.02	5.05	8.09	12.13	15.16	25.27									
22	12.4	1.012	2.02	5.06	8.10	12.14	15.18	25.30									
23	13.0	1.013	2.03	5.06	8.10	12.16	15.19	25.32									
24	13.5	1.014	2.03	5.07	8.11	12.17	15.21	25.35									
25	14.0	1.015	2.03	5.08	8.12	12.18	15.23	25.38									
26	14.6	1.016	2.03	5.08	8.13	12.20	15.25	25.41									
27	15.1	1.018	2.04	5.09	8.14	12.21	15.27	25.44									
28	15.6	1.019	2.04	5.10	8.15	12.23	15.29	25.48									
29	16.2	1.020	2.04	5.10	8.16	12.24	15.31	25.51									
30	16.7	1.022	2.04	5.11	8.17	12.26	15.33	25.54									
31	17.2	1.023	2.05	5.12	8.19	12.28	15.35	25.58									
32	17.7	1.025	2.05	5.12	8.20	12.30	15.37	25.62									
33	18.3	1.026	2.05	5.13	8.21	12.31	15.39	25.65									
34	18.8	1.028	2.06	5.14	8.22	12.33	15.42	25.69									
35	19.3	1.029	2.06	5.15	8.23	12.35	15.44	25.73									
36	19.8	1.031	2.06	5.15	8.25	12.37	15.46	25.77									
37	20.3	1.033	2.07	5.16	8.26	12.39	15.49	25.81	38	20.8	1.034	2.07	5.17	8.27	12.41	15.51	25.86
39	21.3	1.036	2.07	5.18	8.29	12.43	15.54	25.90									
40	21.8	1.038	2.08	5.19	8.30	12.45	15.57	25.95									
41	22.3	1.040	2.08	5.20	8.32	12.48	15.59	25.99									
42	22.8	1.041	2.08	5.21	8.33	12.50	15.62	26.04									
43	23.3	1.043	2.09	5.22	8.35	12.52	15.65	26.08									
44	23.7	1.045	2.09	5.23	8.36	12.54	15.68	26.13									
45	24.2	1.047	2.09	5.24	8.38	12.57	15.71	26.18									
46	24.7	1.049	2.10	5.25	8.39	12.59	15.74	26.23									
47	25.2	1.051	2.10	5.26	8.41	12.61	15.77	26.28									
48	25.6	1.053	2.11	5.27	8.43	12.64	15.80	26.33									
49	26.1	1.055	2.11	5.28	8.44	12.66	15.83	26.38									
50	26.6	1.057	2.11	5.29	8.46	12.69	15.86	26.43									
51	27.0	1.060	2.12	5.30	8.48	12.71	15.89	26.49									
52	27.5	1.062	2.12	5.31	8.49	12.74	15.92	26.54									
53	27.9	1.064	2.13	5.32	8.51	12.77	15.96	26.60									
54	28.4	1.066	2.13	5.33	8.53	12.79	15.99	26.65									
55	28.8	1.068	2.14	5.34	8.55	12.82	16.02	26.71									
56	29.2	1.071	2.14	5.35	8.56	12.85	16.06	26.76									
57	29.7	1.073	2.15	5.36	8.58	12.87	16.09	26.82									
58	30.1	1.075	2.15	5.38	8.60	12.90	16.13	26.88									
59	30.5	1.078	2.16	5.39	8.62	12.93	16.16	26.94									
60	31.0	1.080	2.16	5.40	8.64	12.96	16.20	27.00									
61	31.4	1.082	2.16	5.41	8.66	12.99	16.23	27.06									
62	31.8	1.085	2.17	5.42	8.68	13.02	16.27	27.12									
63	32.2	1.087	2.17	5.44	8.70	13.05	16.31	27.18									
64	32.6	1.090	2.18	5.45	8.72	13.08	16.34	27.24									
65	33.0	1.092	2.18	5.46	8.74	13.11	16.38	27.30									

Slope a (%) a (°)		Factor		Plot radius (m)											
		(f)		2		5		8		12		15		25	
66	33.4	1.095	2.19	5.47	8.76	13.14	16.42	27.37							
67	33.8	1.097	2.19	5.49	8.78	13.17	16.46	27.43							
68	34.2	1.100	2.20	5.50	8.80	13.20	16.50	27.49							
69	34.6	1.102	2.20	5.51	8.82	13.23	16.53	27.56							
70	35.0	1.105	2.21	5.52	8.84	13.26	16.57	27.62							
71	35.4	1.107	2.21	5.54	8.86	13.29	16.61	27.69							
72	35.8	1.110	2.22	5.55	8.88	13.32	16.65	27.75							
73	36.1	1.113	2.23	5.56	8.90	13.35	16.69	27.82							
74	36.5	1.115	2.23	5.58	8.92	13.38	16.73	27.88							
75	36.9	1.118	2.24	5.59	8.94	13.42	16.77	27.95							
76	37.2	1.121	2.24	5.60	8.97	13.45	16.81	28.02							
77	37.6	1.123	2.25	5.62	8.99	13.48	16.85	28.09							
78	38.0	1.126	2.25	5.63	9.01	13.51	16.89	28.15							
79	38.3	1.129	2.26	5.64	9.03	13.55	16.93	28.22							
80	38.7	1.132	2.26	5.66	9.05	13.58	16.97	28.29							
81	39.0	1.134	2.27	5.67	9.08	13.61	17.02	28.36							
82	39.4	1.137	2.27	5.69	9.10	13.65	17.06	28.43							
83	39.7	1.140	2.28	5.70	9.12	13.68	17.10	28.50							
84	40.0	1.143	2.29	5.71	9.14	13.71	17.14	28.57							
85	40.4	1.146	2.29	5.73	9.16	13.75	17.18	28.64							
86	40.7	1.148	2.30	5.74	9.19	13.78	17.23	28.71							
87	41.0	1.151	2.30	5.76	9.21	13.82	17.27	28.78							
88	41.3	1.154	2.31	5.77	9.23	13.85	17.31	28.85							
89	41.7	1.157	2.31	5.79	9.26	13.88	17.36	28.93							
90	42.0	1.160	2.32	5.80	9.28	13.92	17.40	29.00							
91	42.3	1.163	2.33	5.81	9.30	13.95	17.44	29.07							
92	42.6	1.166	2.33	5.83	9.33	13.99	17.49	29.14							
93	42.9	1.169	2.34	5.84	9.35	14.02	17.53	29.21							
94	43.2	1.172	2.34	5.86	9.37	14.06	17.57	29.29							

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 tree's condition in the field, as illustrated in Figure 28 (see Chapter 5).

For consistency of measurement results, the survey team is advised to only use *phi-band*. (not a tape measure) because using different measuring instruments can lead to errors in reading the measurement scale. In addition, the survey team is advised to use a 1.3 m measuring stick (Figure 36a) when measuring tree diameter. For stumps, the diameter can be measured in two perpendicular directions (i.e., the longest and shortest diameters) and then the average value is taken (Figure 36b).

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 position or perpendicular to the trunk axis.
2. *Phi-band* is wrapped around the tree trunk in an unfolded or untwisted condition.
3. The *Phi-band* used is not a band stretchy.
4. Clean the part of the stem that will be cut. measured if it is entangled in vines or obstructed by other things so that the measurement results are not *overestimated*.

Unlike diameter, tree height is quite difficult to measure in the field. It is recommended to use electronic height measuring instruments, such as the *Vertex* or *laser hypsometer*, for greater accuracy and efficiency (because they eliminate the need for 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 onto the ground surface.

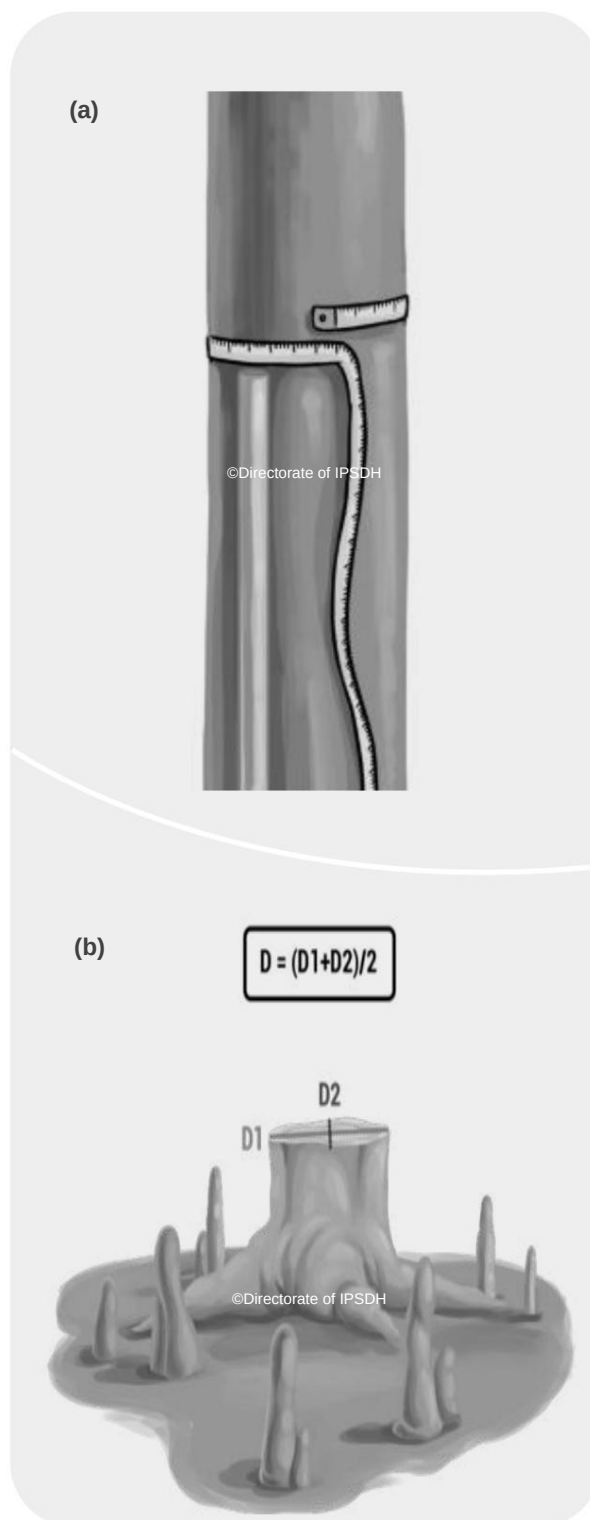


Figure 36. Measurement of (a) tree diameter using a 1.3 m measuring stick and (b) measurement of stump diameter

(Figure 37a). Tree height is calculated based on trigonometric principles from the results of the instrument scale readings to the top (A) and to the base (B) of the tree (Figure 37b). 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 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.
In this position, the surveyor can clearly see the treetop. Conversely, if the surveyor is positioned much lower than the base of the tree, the surveyor cannot clearly see the treetop, which can lead to measurement errors.
2. For trees with dense/thick crowns, first observe the top of the tree from a distance.
close so that there are no measurement errors because at a distance the top of the tree is not clearly visible due to being blocked by the thick canopy.
3. For leaning trees, measure the height in a direction perpendicular to the slope of the tree.
(Figure 37a).
4. If measuring height using *Vertex*, place *the transponder* on the tree trunk at a height of 1.3 m above ground level. Also perform *Vertex* calibration.
periodically because its sensitivity is affected by temperature and humidity.

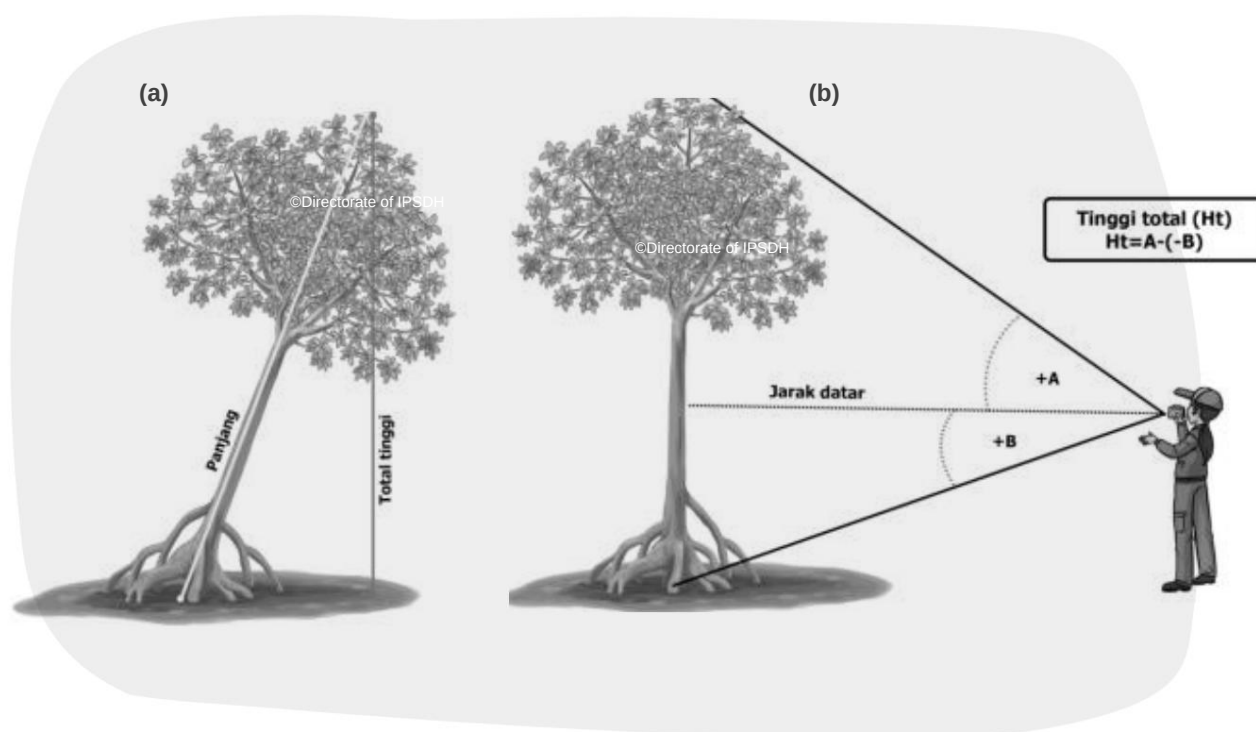


Figure 37. Differences in tree length and height (a) and trigonometric principles in determining tree height (b)

Appendix 3.

Making a Herbarium in the Field

A herbarium is a plant specimen preserved for scientific research. A herbarium specimen can consist of part or all of a dried plant, placed on a paper base, or stored in a sealed container filled with alcohol or formalin for wet herbariums.

The method for creating herbarium specimens for forestry tree species typically involves placing herbarium specimens on paper in two ways: dry and wet. Dry herbarium specimens require bamboo racks as clamps to ensure the specimens remain level. Dry herbarium specimens, on the other hand, require an alcohol solution for specimen preservation. In forest inventory activities, herbarium specimens are used to store specimens whose species are unknown, either by local or Latin name. The herbarium specimens are then sent to a laboratory for identification of their Latin names. Wet herbarium specimens are often used in forest inventory activities due to the ease of specimen management.

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

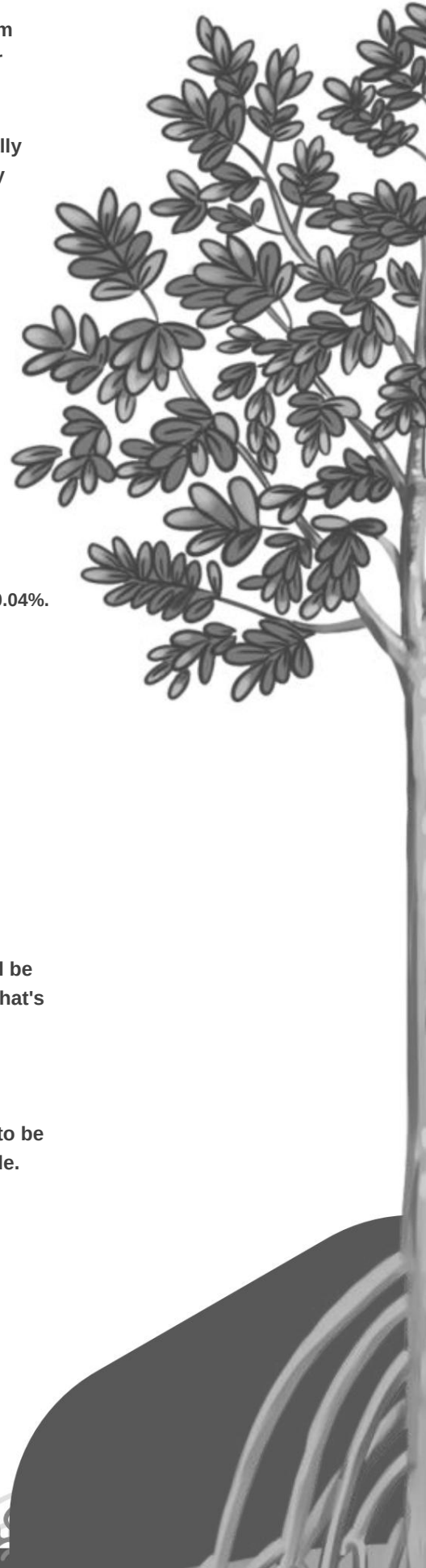
1. Machete, knife or pruning shears to cut branches from the tree.
2. Alcohol solution with a concentration of 70% or formalin with a concentration of 0.04%.
3. Acid-free stiff paper such as newspaper, parchment paper, *ip chart* paper
4. Paper tape to stick the specimen on the paper
5. Labels to mark 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, they should also be taken. Store it in a safe place, to be taken to the tent or accommodation location, where the herbarium will be made.





Collect several specimens of different types 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 in the plastic bag. Then, tie and seal the plastic 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 the 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 in Appendix 4.

Appendix 4. List of Tree Species Identification Institutions/Laboratories

(updated September 2023)

JAVA

- **Herbarium Bogoriense (BO), BRIN Address:**
Jl. LIPI, Cibinong, Cibinong District, 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
- **Forest Ecology Lab, Faculty of Forestry and Environment, Bogor Agricultural University, Bogor Address :** IPB Campus, Jl. Raya Dramaga, Babakan, Dramaga District, Bogor Regency, West Java 16680
Contact Botanist/Taxonomy: Zakaria Anshori (+62 812-1814-6117)
- **Bandungense Herbarium 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)
- **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

- **Dendrology and Wildlife Laboratory, Faculty of Forestry, Mulawarman University, East Kalimantan**
Address: Jl. Kuaro, Gn. Kelua, Samarinda Ulu District, Samarinda City, East Kalimantan 75119 **Contact Botanist / Taxonomist:** Prof. Paulus Matius and Team (+62 813-4917-8548, Sarah Agustiorini (+62 812 555 67264), Medi Hendra (+62 813-4787-2504)
- **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, Banjarmasin City, South Kalimantan 70123
Contact Botanist/Taxonomy's: Gunawan (+62 812-3432-500)
- **Plant Taxonomy Lab, Faculty of Mathematics and Natural Sciences, Tanjungpura University, West Kalimantan.**
Address: Jl. Prof. Dr. H Jl. Professor Doctor H. Hadari Nawawi, Bansir Laut, Pontianak Tenggara District, Pontianak City, West Kalimantan 78124
Contact Botanist or Taxonomy: Emma Khairiah +62 852-4556-7232





SULAWESI – MALUKU

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

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

Address: KEFAMENANU KM.09, Sasi Subdistrict. Tel: 0812-3956-4700

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

SUMATERA

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

Address: Jalan Prof. Syarif Thayeb, Meurandeh, Langsa

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

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

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

Dendrology Lab, Faculty of Forestry, University of Jambi, Jambi Address: Jl.

Jambi - Muara Bulian No.KM. 15, Mendalo Darat, Jambi Luar Kota District, Muaro Jambi Regency, Jambi

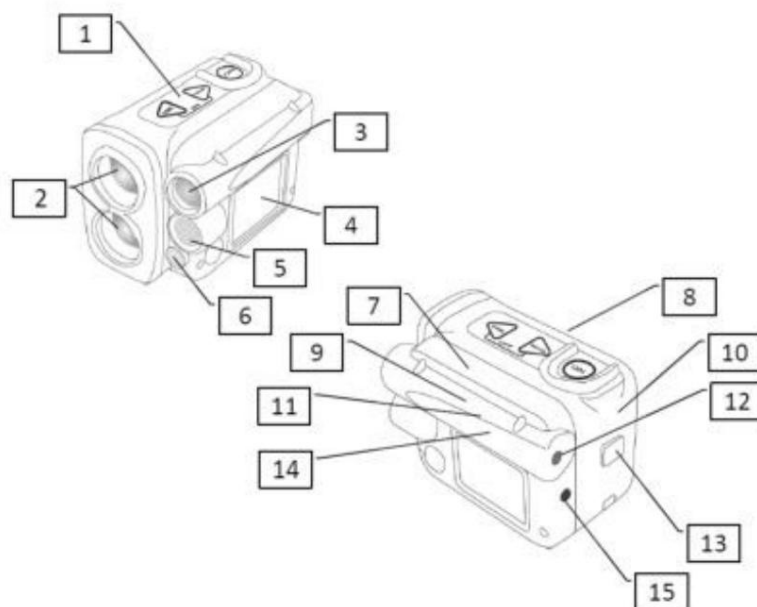
Contact Botanist/Taxonomy: Nursanti

(+62 853-7855-8676), Rike Puspitasari (+62 822-8276-4882)

Appendix 5. Instructions for Using Laser Geometer Measuring Distance and Height of Trees



Tool components:



1. Buttons

2. Laser optics

3. Lens for Sight display

4. LCD screen

5. Ultrasonic receiver
(VERTEX LASER GEO)

6. Ultrasonic temperature sensor
(VERTEX LASER GEO)

7. Bluetooth Transmitter

8. Rechargeable Li-Ion battery

9. GPS Receiver

10. SSD drive

11. Tilt sensor

12. Vision Display

13. USB connection and
charging as
well as protective cover

14. Compass Sensor

15. IR (Infra Red) Transmitter



T3 Transponder

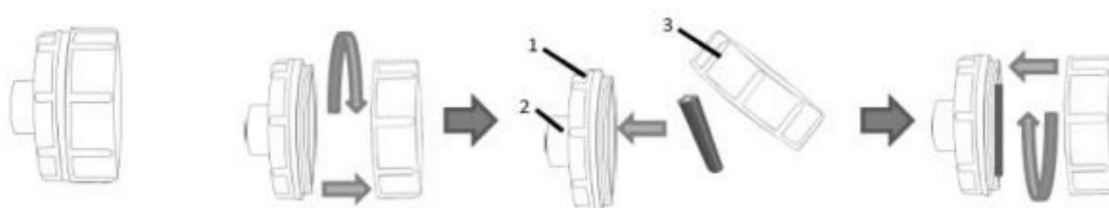
• This transponder is equipped with an ultrasonic transmitter and receiver that communicate with measuring instruments.

• The T3 transponder is equipped with a beep signal, which indicates the ON or OFF status.

The T3 has no switch and the VERTEX LASER GEO instrument is essentially used as a remote control for turning the transponder on and off. When turned on, the transponder remains active until it is turned off or after approximately 20 minutes of inactivity.

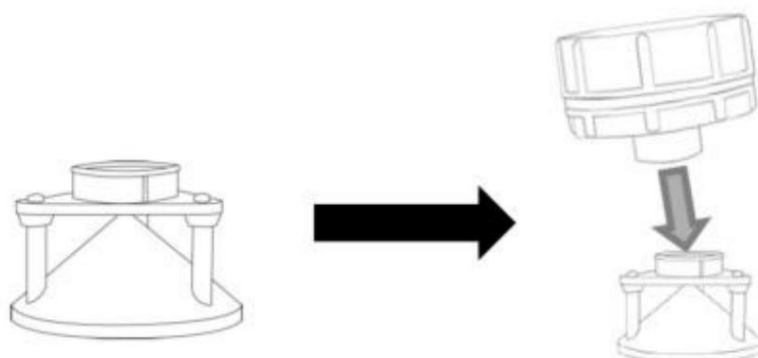
• The transponder uses one 1.5-volt AA alkaline battery.

1. Transponder container
2. Ultrasonic receiver-transmitter
3. Battery cover



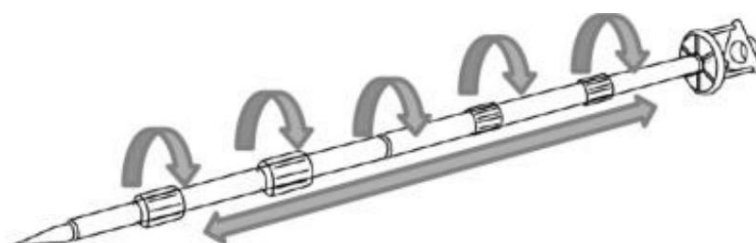
360 Adapter/Spreader

• Adapter allows ultrasonic signals to propagate in a full 360 degree circle for circular sample plotting work.

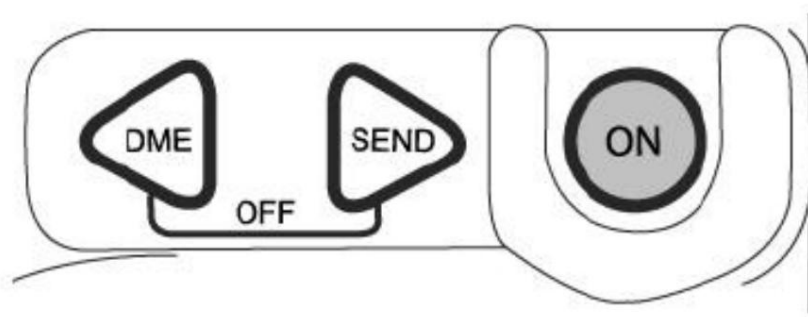


Monopod

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



Use of Buttons on Vertex



ON button

ÿ Press On to activate Vertex

ÿ When you use 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

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

SEND button

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

Disabling Vertex

ÿ Press the DME and SEND buttons simultaneously to deactivate the Vertex.

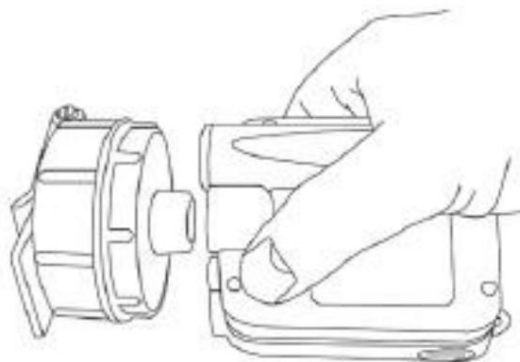
Connecting Vertex and Transponder

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.

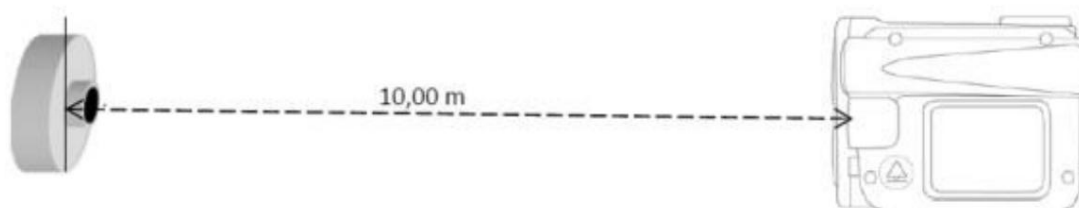
Disconnect the Vertex connection with Transponder:

- 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 4 times.

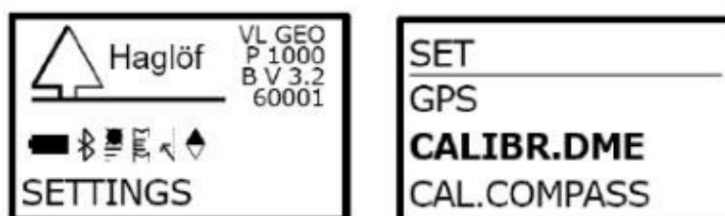


Vertex and Transponder Calibration

1. Connect Vertex with Transponder:
2. Bring the Vertex and Transponder close together as shown in the picture (make sure the Vertex screen is off)
 - a. Press the DME button until you hear a “beep” sound twice.
 - b. Turn off the Vertex display (DME and SEND)
3. Then after that, stretch the Vertex and Transponder as far as 10 meters, as shown in the image below:



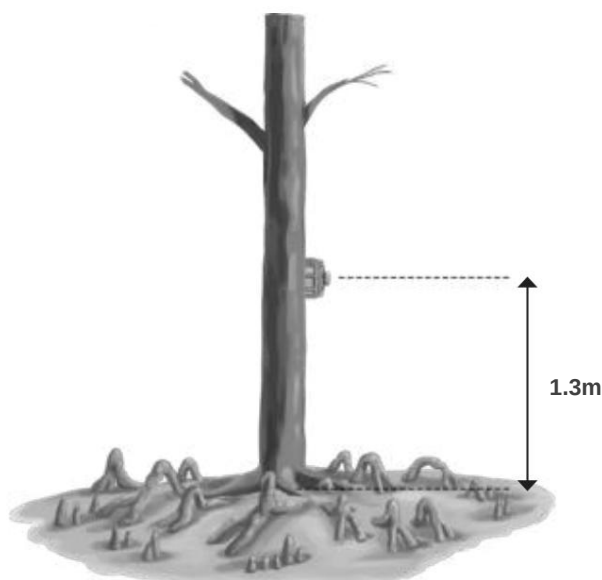
4. Press the ON button, then select SETTING, then select CALIBR.DME



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

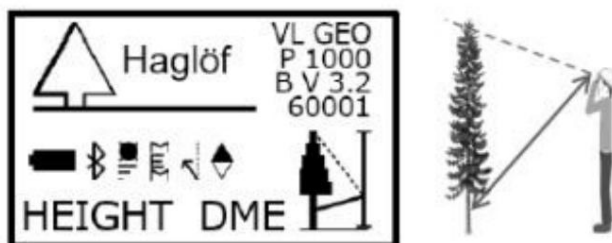
1. Place the transponder on the tree whose distance and height you want to measure, place the transponder at a height of 1.3 meters.



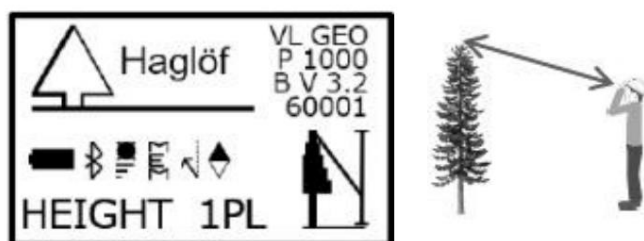
2. Press ON to activate *Vertex*

There are 3 measurement modes in *Vertex Laser Geo*:

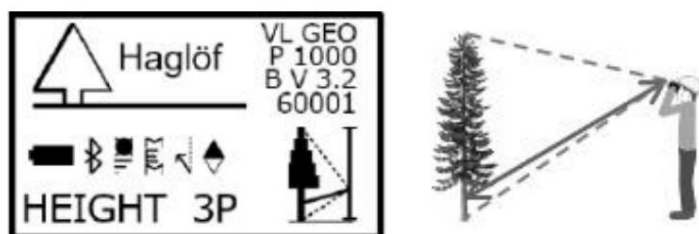
- a. Height DME – this mode uses ultrasound, this mode can measure the branch-free height and total height simultaneously.



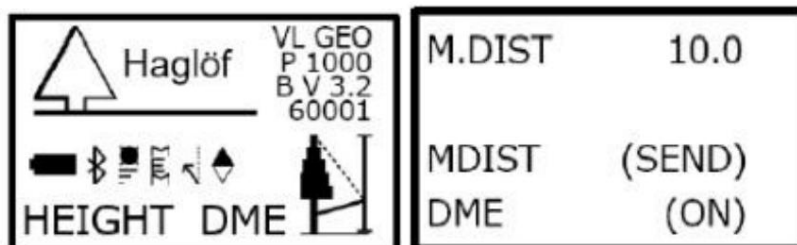
- b. Height 1 PL – this mode uses Laser, this mode is recommended for use when flat field conditions and can only measure once (cannot measure branch-free height and total height simultaneously).



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



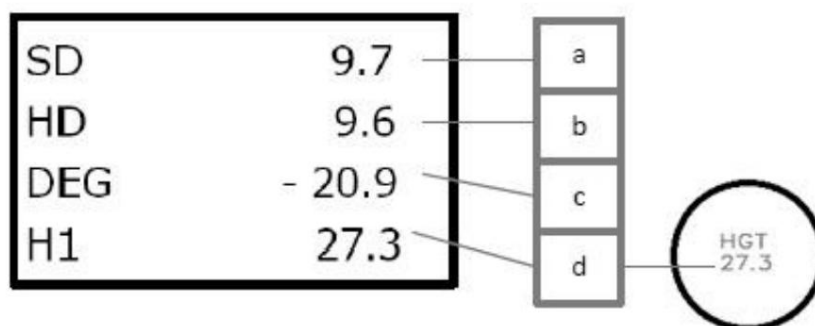
3. Select Height DME mode, then click ON



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 branch-free height and total height).



5. The next step is to direct the center point on the observation screen to the branch-free height and press the ON button until it beeps once and the information on the screen "H1" is locked (does not change).

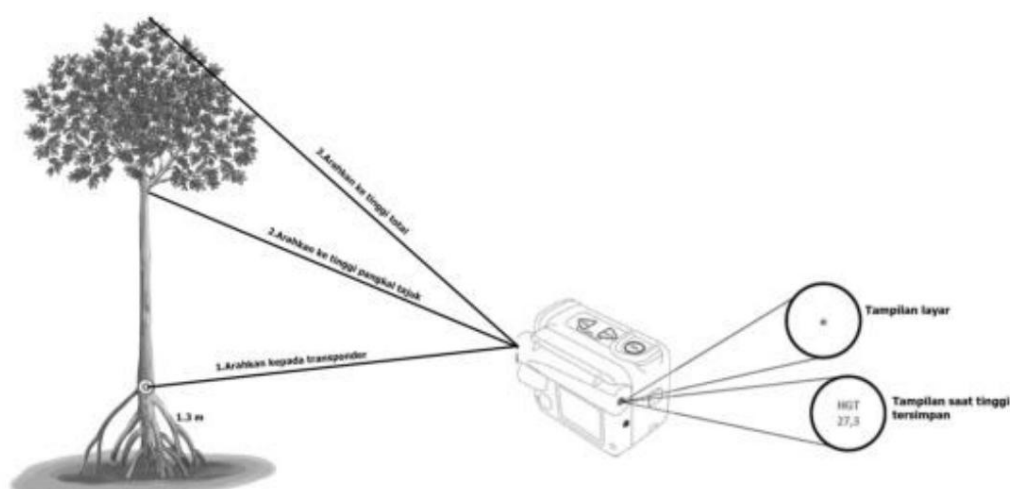


- a. SD – Slope Distance (m or feet)
- b. HD - Horizontal Distance (m or feet)
- c. DEG - Angle (Degree, % or Grads)
- d. H1 – Branch Free Height (m or feet)

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 the Statement Letter for the Implementation of IHM Activities

STATEMENT LETTER IMPLEMENTATION OF IHM ACTIVITIES

We, the undersigned:

Name/NIP: Xxxxx

Position: Head of the Regional Forest Area Stabilization Center....

State that :

1. The Mangrove 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 IHN database system.
Directorate of 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.

Name of Head of BPKH

NIP. xxxxxxxxxxxxxxxxxxxx

*select one



NEWS

IMPLEMENTATION OF IHM ACTIVITIES CANNOT BE IMPLEMENTED

As a village official.../Head of Regional Stakeholder...

NIP : xxxxxxxxxxxxxxxxxxxxxxxxx

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

- a. Land cover changes
- b. Plot location is inaccessible (steep terrain/ravine/etc.)
- c. Security factors (wildlife/riots/etc.)
- d. Land owner/community rejection
- 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 Mangrove Forest Inventory
signature (stamp)	Signed
XXX	YYY

Appendix 8. Collect Mobile Updating Procedure

The Mangrove Forest Inventory System (IHM) is an integrated system, encompassing data collection via *Android* tablets and web-based visualization . It is supported by five main platforms :

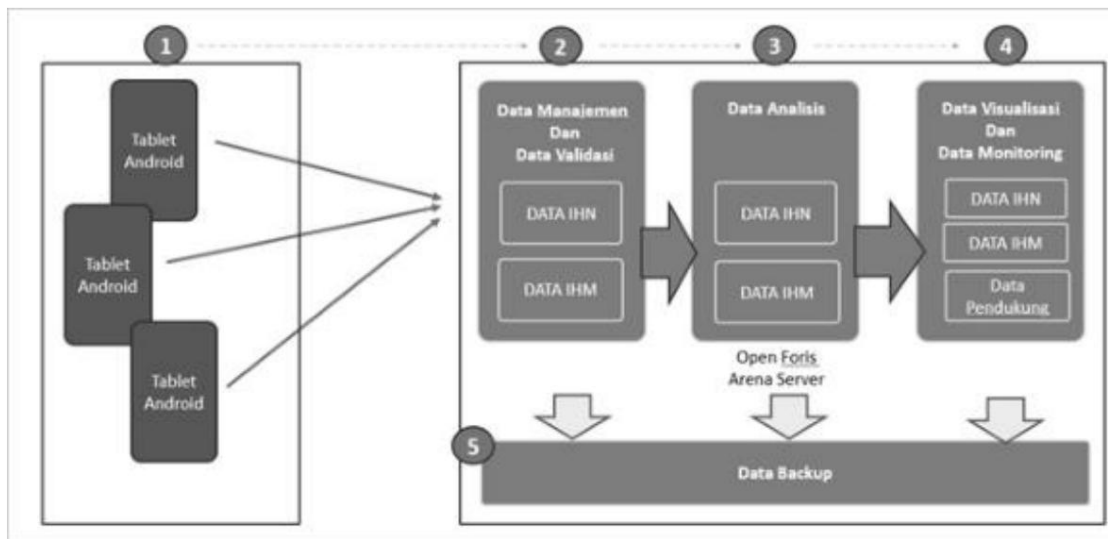


Figure 38. IHM System Flow

Information:

1. An *Android tablet* device that has *Collect Mobile* installed and is equipped with the IHM survey form .
2. Data management and validation platform : using *Collect Server* from *Open Foris*, functions to receive data from *tablets* and perform validation per cluster.
3. Data analysis platform : using *Arena Server* from *OpenForis*, with *plug-in* support *R-Studio* for processing and analysis.
4. Data visualization and monitoring platform : used to display survey results field in *real-time*, as well as a medium for disseminating forest inventory data (IHN 1.0, IHN 2.0, IHM, and others).

Collect Mobile Installation on Tablet

If your *tablet* device does not have the *Collect Mobile* app, download it via the *Google Play Store*.

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

or by scanning the following *QR Code* :



Figure 39. QR Code
Collect Mobile download



Proceed by clicking *Install* and following the installation instructions from *Google Play*. The download page can be seen at:

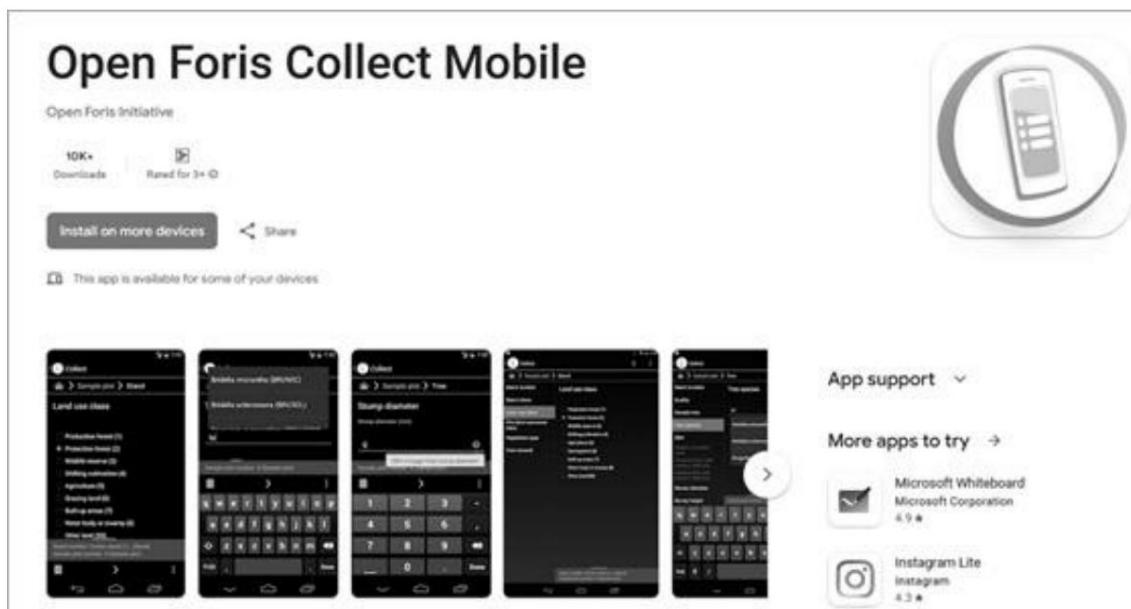


Figure 40. Figure 3. *Collect Mobile* application download page

Note: If the app is already installed, it's recommended to update it. Run a rescan and check if there's an *Update* button on the page. If it's not, the app version is up-to-date.

IHM Survey Form Installation

Once *Collect Mobile* is installed, the next step is to enter the IHM survey form for data recording. The survey form is downloaded from the server and imported into the application. The procedure is as follows:

1. Download the IHM survey form

The first step before using the application is to download the Mangrove Forest Inventory survey form. This form serves as a data recording tool in the field and must be saved on a tablet.

The procedure is as follows:

a. Access the following link in a browser on your tablet

https://drive.google.com/drive/folders/1XSHwoi9AENIfkT4I_E_r_683BQqSHo6j

b. Or for easy access, use QR Code below this:

Note: Downloaded files will usually be automatically saved in the "Downloads" folder on your tablet device.



Figure 41. QR code to download the IHM survey form

2. Import Form Survey Collect Mobile IHM

Once the survey form has been successfully downloaded, the next step is to import it into the *Collect Mobile* app installed on your tablet. This process will allow users to begin recording field data in the specified format. The import steps are as follows:

1. Open the *Collect Mobile* app on your tablet.
2. Click the three dots icon in the top right corner of the screen.
3. Select "Survey"
4. Select "Import"
5. Select "Internal Storage" as the file source.
6. Navigate to the "Downloads" folder.
7. Find the IHM survey form file, then click on it and make sure it appears in the "Select a survey" menu.
After that, select the IHM survey to activate.

The steps above can be seen visually in the following image:



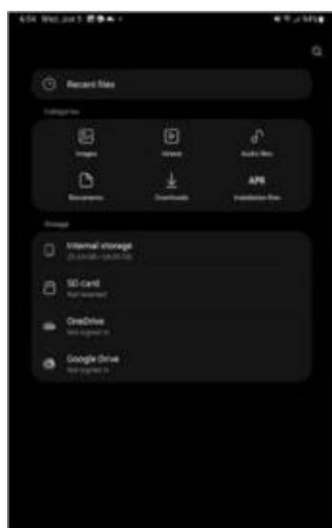
Step 1



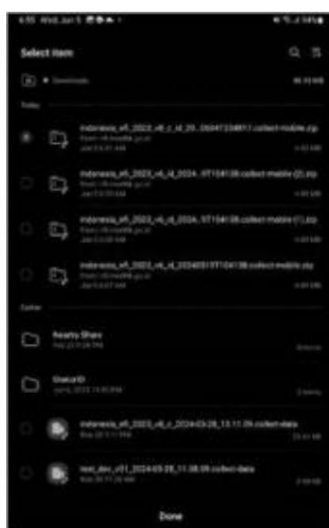
Step 2



Step 3



Step 4



Step 5



Step 6



3. SettingsServer Connection on Tablet

After the survey form has been successfully imported, the next step is to connect the *Collect Mobile* application to the IHM server so that the recorded data can be sent directly. This setup only needs to be done once before data collection begins. The setup steps are as follows:

1. Open the “Settings” menu in the *Collect Mobile* application.
2. Enable the “Collect Server Connection” option.
3. Enter the address: <https://nfi.menlhk.go.id/collect>
4. Fill in the username and password provided by the IPSDH Directorate admin.

These steps can be seen in the following image:



Step 1



Step 2



Step 3

Appendix 9. Upload Procedure Collect Mobile Data to Server

All data recorded through the *Collect Mobile* application must comply with the IHM Technical Instructions. Once field data collection is complete, the next step is to upload (*submit*) the data to the IHM server and perform a backup for data security. The *submission* procedure is explained as follows:

Submit Data

The *submission* process is carried out after all field data has been filled in. Before proceeding, ensure the following requirements have been met:

1. The *tablet* device is connected to a stable internet network to upload data measuring ±200–500 MB.
2. All data entered is complete and valid.
3. Battery capacity is above 50% to avoid interruption during the delivery process.

The steps for submitting data are as follows:

1. Ensure that the field data to be submitted has been filled in correctly and completely.
Complete is indicated by the absence of a red mark icon as shown in the image below.

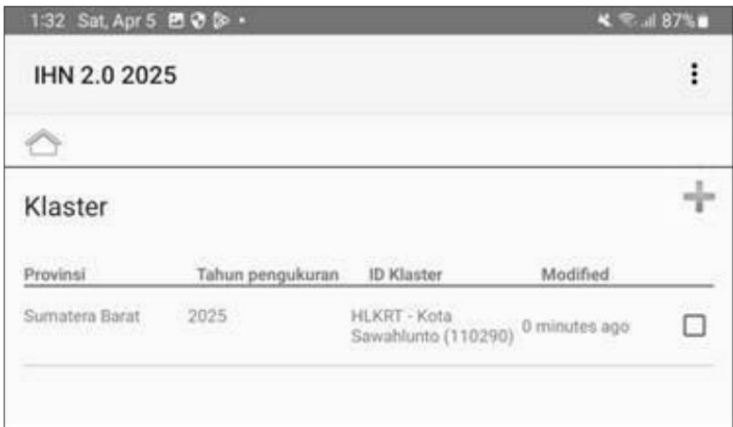


Figure 42.
a. Complete data display



b. Incomplete data display



2. Select the data entry to be sent → open the details view → click the top right menu icon → select **"Submit data to collect."** A confirmation *pop-up* will appear → select **"Only Current Records"** to ensure only that data is sent to the server. The process for selecting data to be submitted to the server is shown in Figure 6.

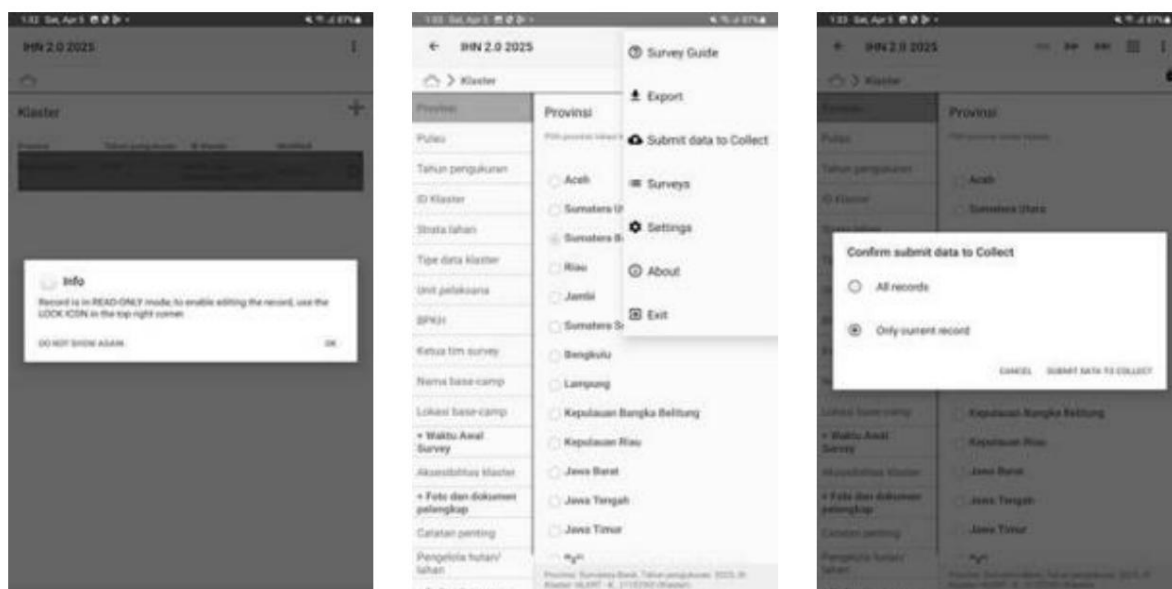


Figure 43. Data selection process before submitting data from *Collect Mobile* to Server

3. The uploading (*submitting*) process will run automatically. The delivery duration depends on file size, internet speed, and server conditions. If successful, the screen will display the notification **"Data submission completed."** The *data submission* process is shown in Figure 7.

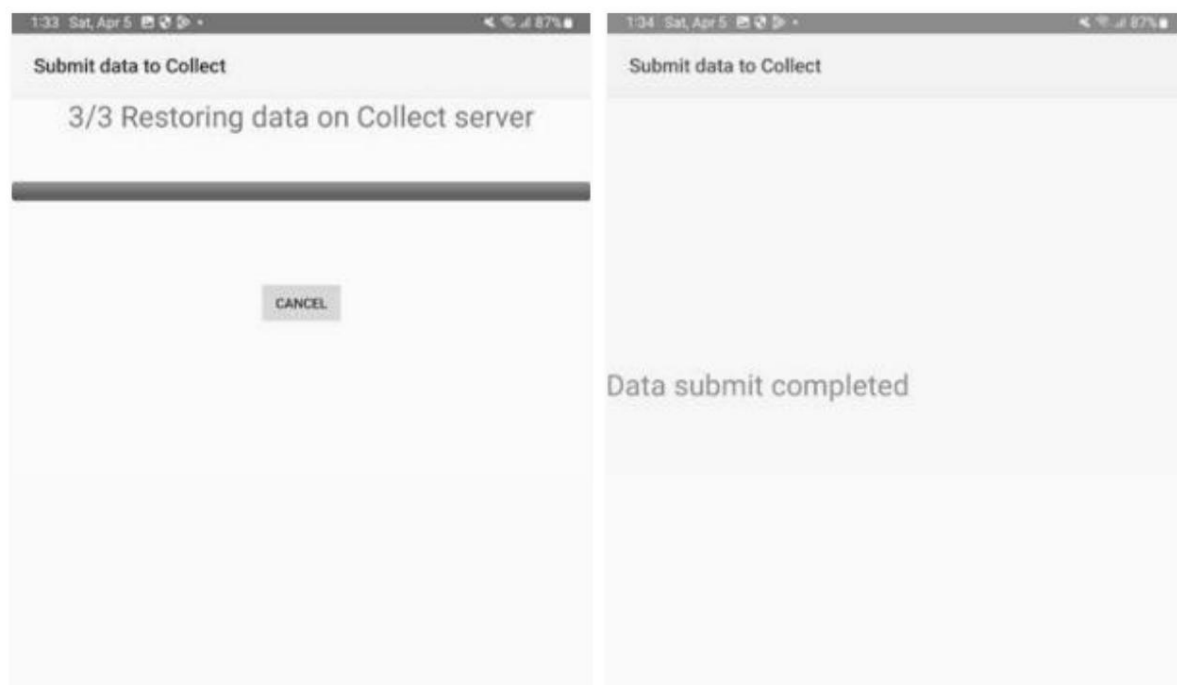


Figure 44. Display of the data sending process from *Collect Mobile* to Server

Appendix 10. Back Up Procedure Data Collect Mobile

Performing *backups* is a crucial risk mitigation step to ensure the security of field data collection. There are two methods that every implementation team should use:

1. Backupcloud to Google Drive

Used to store data online in *cloud* storage , to anticipate data loss from the device.

2. Backuplocal to MicroSD or external hard disk

Used to store a physical copy of data on an external storage device as an additional backup.

Both *backup* methods are MANDATORY. The steps for the first method are outlined below:

1. Backup to Google Drive

After the process of submitting data to the server is complete, immediately back up to Google Drive. via *tablet* device by following these steps:

1. Select one of the field data entries to be backed up, then click OK.
2. After the data details page appears, click the menu icon at the top right ÿ select “Export”.
3. A checklist window will appear ; activate the “Only current record” option, then click “EXPORT”.
4. In the export menu, select the “Share (by email, Dropbox, Google Drive, etc.)” option.
5. Several sharing options will appear; select the Google Drive icon and click.
6. Select the storage folder location in Google Drive.
7. If the *backup* folder is not available, click the add folder icon at the top right ÿ name it “Backup Collect Data” ÿ click “Create”.
8. Once the folder is created, go into it and click the “Select” button to select as a storage destination.
9. Click the “Save” button at the top right to start the upload process.
10. Wait until the notification “Uploaded 1 le” appears as a sign that the backup process is complete. has been successfully.
11. Perform a final check to ensure the *Collect Data* file has been saved in the selected folder.

These steps can be seen visually in the following image:





Step 1



Step 2



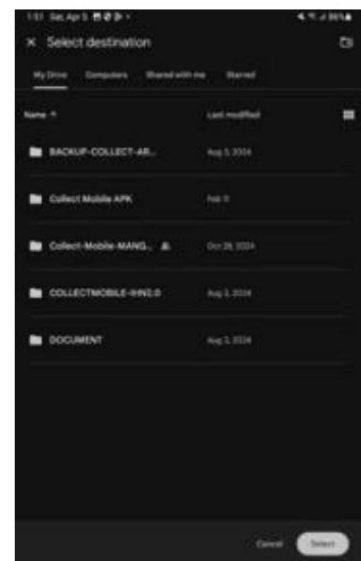
Step 3



Step 4



Step 5



Step 6



Step 7



Step 8



Step 9

2. Backup to MicroSD/External Hard disk

In addition to storing data online, it's also important to *back up* locally to physical storage media such as a *microSD card* or *external hard drive*. This method is useful as an additional backup in case of connectivity issues or device failure. The steps are as follows:

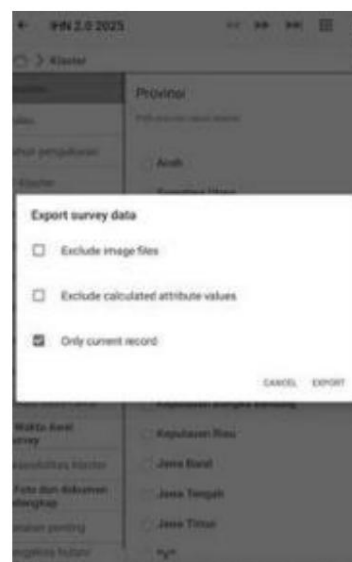
1. Select one of the field data entries to be *backed up*, then click OK to display data details.
2. Click the menu icon at the top right of the application, then select "Export".
3. A checklist window will appear ; activate "Only current record", then click "Export".
4. In the *export menu*, select the "Save to download folder" option, then click the "Export" button.
5. The *backup* file will be saved automatically to the "Downloads" folder. After the process is complete, finished, click OK.
6. Open a file explorer application such as "My Files" (yellow folder icon) to access the saved files.
7. Navigate to the left menu & select the "Downloads" folder. A list of files will appear on the right side. Find the exported file (usually at the top of the list based on the export time). Press and hold the file until a blue checkmark appears, then click "Copy."
8. If your tablet has a *MicroSD*, *SD card*, or *external hard drive* connected , the device will be automatically detected and appear in the menu on the left. Select "SD Card."
9. If there is no dedicated backup folder available , click the top right menu icon and select "Create Folder". Name the folder "Backup Collect Data" then click "Create".
10. Go to the "Backup Collect Data" folder by clicking on the folder.
11. Once in the destination folder, click the "Copy Here" button located in the bottom of the screen.
12. The *backup* files will be copied to the external storage media. This procedure also applies to storage to an *external hard disk* via a USB-C connection.



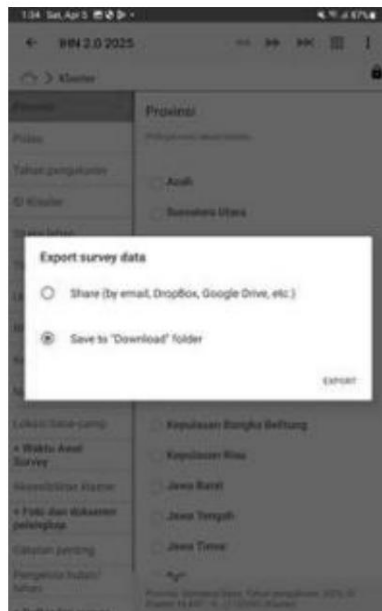
Step 1



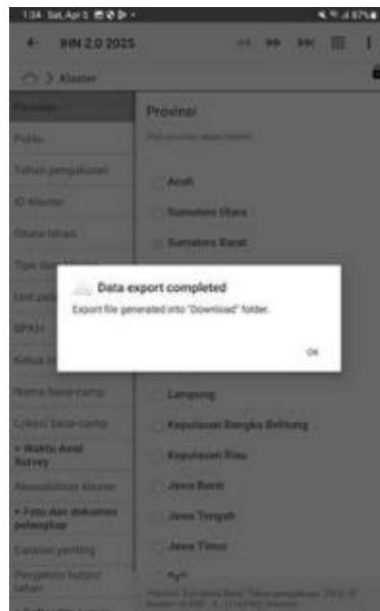
Step 2



Step 3



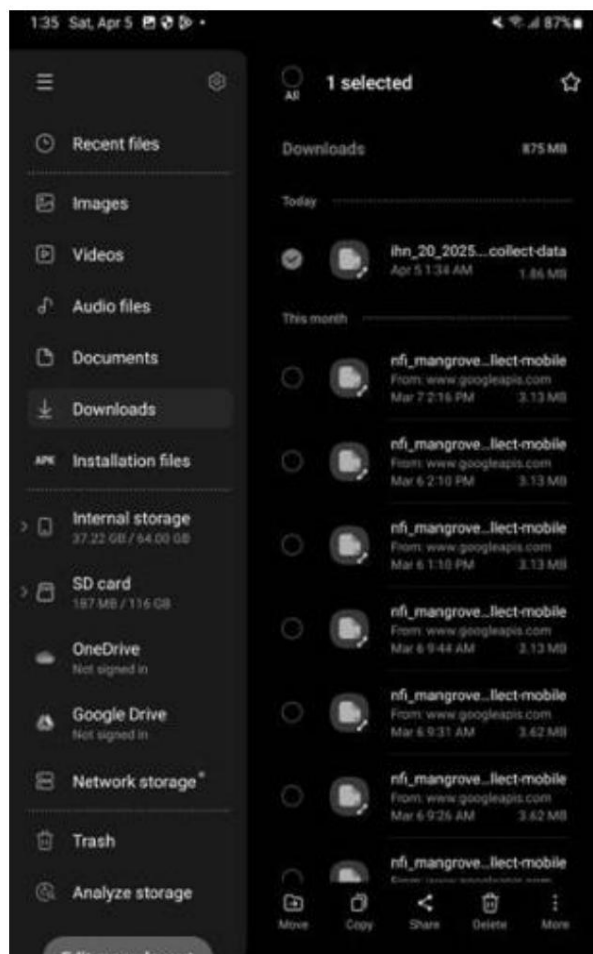
Step 4



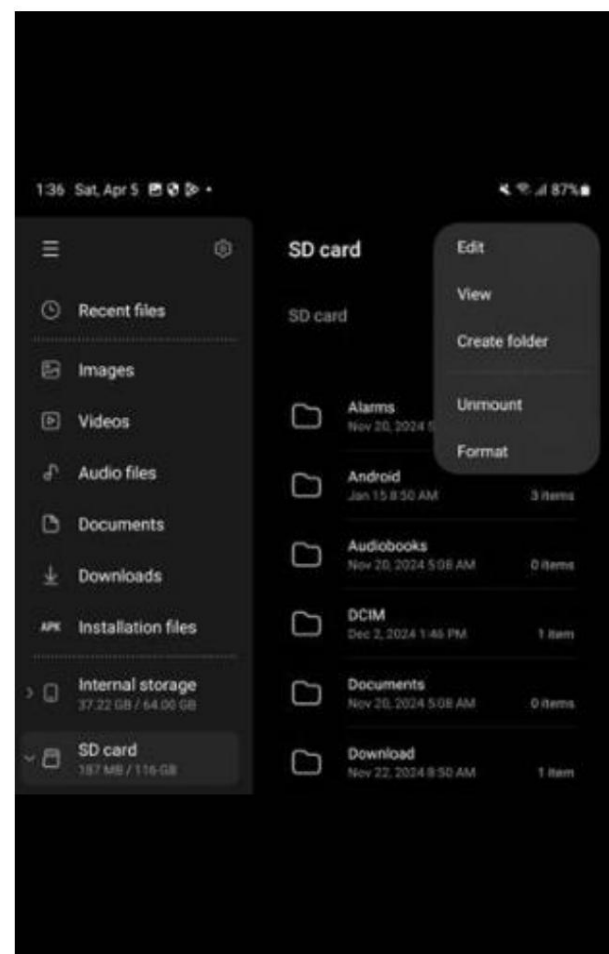
Step 5



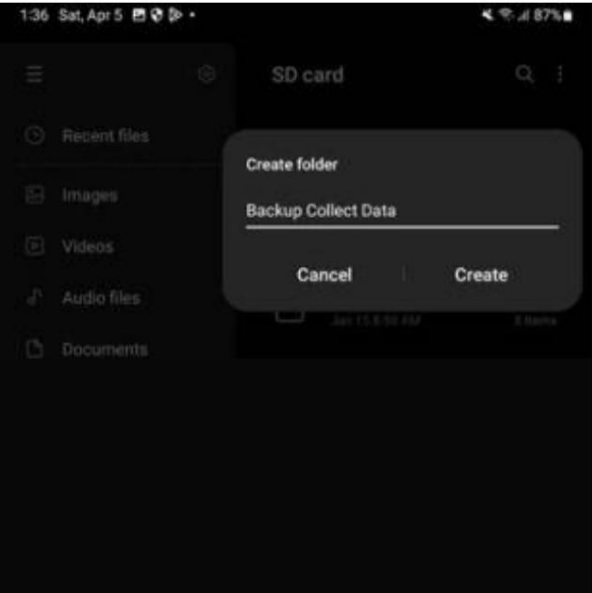
Step 6



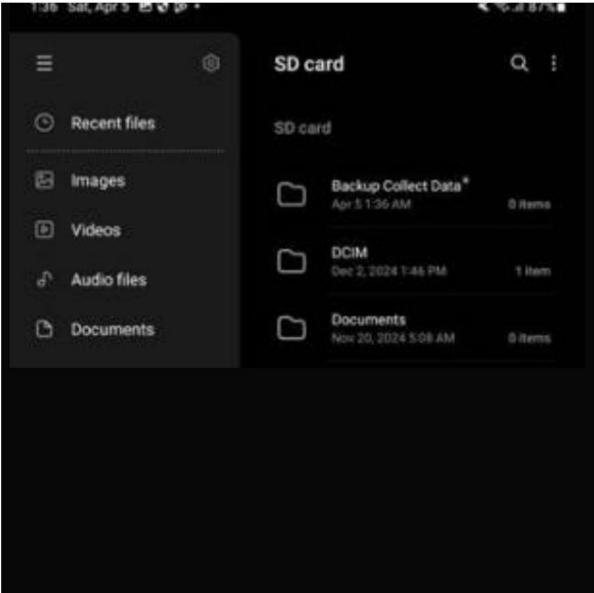
Step 7



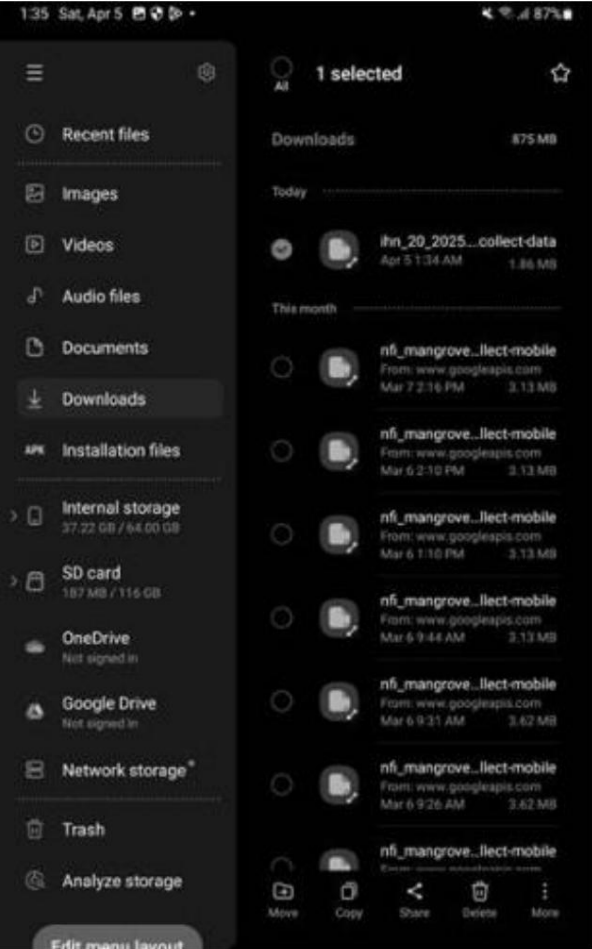
Step 8



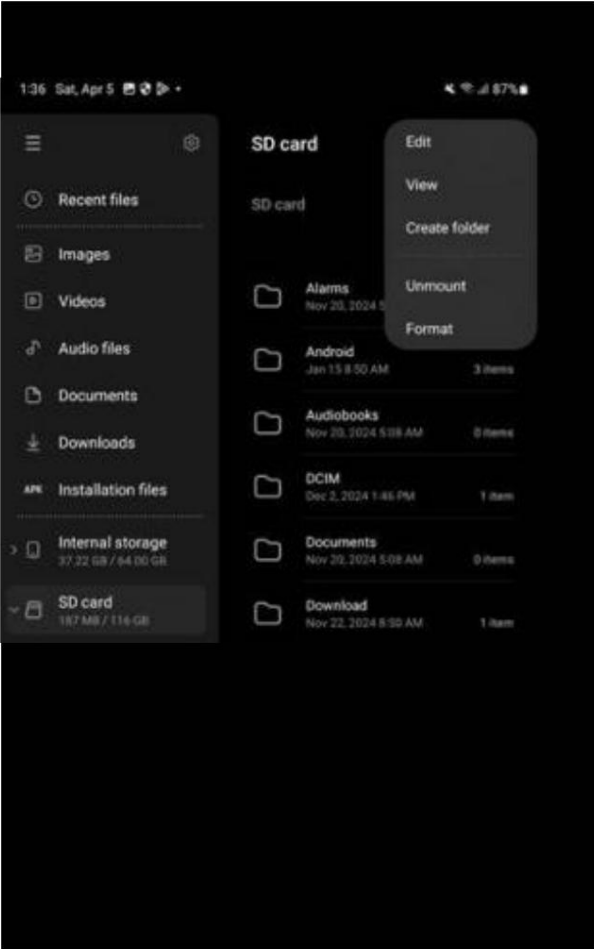
Step 9



Step 10



Step 11



Step 12





KEMENTERIAN
KEHUTANAN
REPUBLIK INDONESIA

**DIRECTORATE GENERAL
FORESTRY PLANOLOGY**

MINISTRY OF FORESTRY OF THE REPUBLIC OF INDONESIA

Manggala Wanabakti Building, Block
I, It. 2, Jl. Jenderal Gatot Subroto - Jakarta 10270, PO Box 6505,
Indonesia.