MEMORANDUM

FOR   :   All Regional Executive Directors
                All Provincial Environment and Natural Resources Officers (PENROs)
                All Community Environment and Natural Resources Officers (CENROs)

FROM   :   The Assistant Secretary for Policy, Planning and Foreign Assisted and
                Special Projects and Director, in concurrent capacity

SUBJECT :   **TECHNICAL BULLETIN NO. 34 - REVISED PROCEDURES IN
THE CONDUCT OF FOREST RESOURCES ASSESSMENT**

DATE   :   **APR 2 9 2021**

I.   Technical Bulletin

This technical bulletin provides for the revised procedures in the conduct of Forest Resources Assessment (FRA) in the Philippines. The FRA has the purpose of assessing existing forests and trees therein, as well as trees outside forests, and aims to provide updated qualitative and quantitative information on the state, use, management, and trends of forests and forest resources.

The revised FRA procedures builds on the *National Forest Inventory* methodologies developed for the FRA Project in 2002 and incorporates new concepts, best practices and other lessons learned from the different initiatives of the Department of Environment and Natural Resources (DENR). It takes into consideration carbon assessment needs in support of reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks (REDD+) and other climate change related initiatives in the Philippines.

This Technical Bulletin and the attached *"Forest Resources Assessment: Revised Field Manual"* shall now guide the conduct of FRA in the Philippines and will replace the previously used guidelines, *"National Forest Inventory Philippines Field Manual,"* published by the FAO Forestry Department in 2002.

I.   Users of the Technical Bulletin

The users of the technical bulletin are DENR officials and personnel, specifically members of the DENR Regional Forest Assessment Teams, involved in the conduct of forest resources assessment.

II. Forest Resources Assessment Design

The sampling design adopted for the country's Forest Resources Assessment (FRA) is systematic and without stratification. The tracts are selected every 5 minutes latitude and 5 minutes longitude as shown in Figure 1.
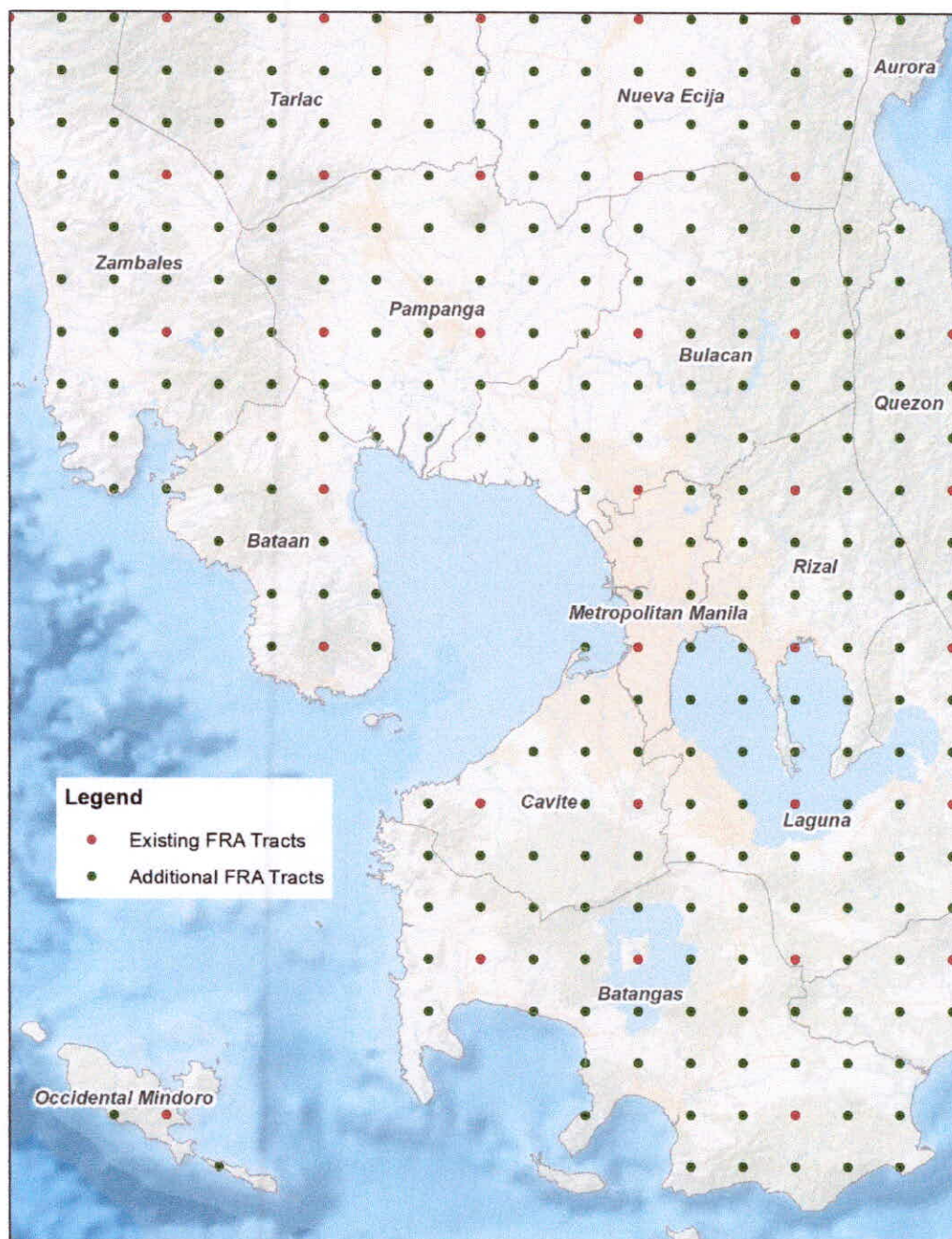

Figure 1. Distribution of Forest Resources Assessment tracts (Central and Southern Luzon subset). Red points symbolize the existing FRA tracts while the green points symbolize the additional FRA tracts with 5 minutes latitude and 5 minutes longitudes distance.

Each FRA tract consists of nested circular plots clustered on the sample point, i.e., **Tract Center**, as shown in Figure 2. The Tract Center is adapted from the previous FRA design

and shall be used for assessing information on land cover and land classification. The clustered plots include four (4) plots i.e., *Plots North (N), East (E), South (S), and West (W)*, with their *Plot Centers* at 40 meters horizontal distance from the Tract Center in the four (4) cardinal directions (north, east, south, and west). The plots have a radius of 20 meters starting from the Plot Center and used for measuring large trees. Each plot consists of a circular subplot, i.e., *Subplot North (N), East (E), South (S), and West (W)*, with a radius of 5 meters starting from the Plot Center and used for measuring small trees (saplings), dead wood, and litter.
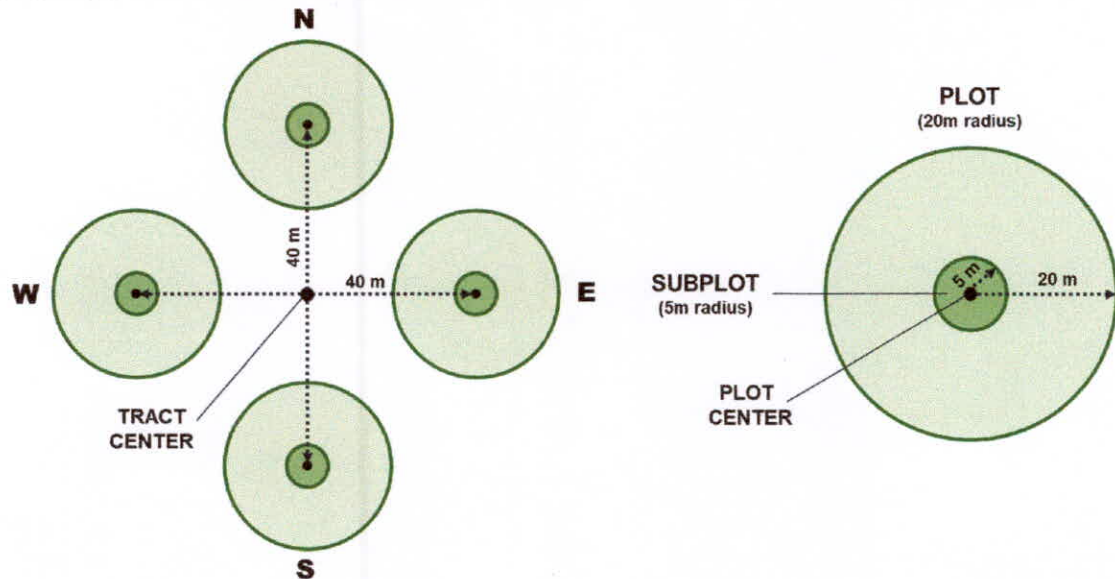

Figure 2. Nested circular plots clustered on the sample point of each FRA tract.

The Tract Center, Plot Centers, Plots and Subplots shall be accessed through a combination of a global positioning system (GPS) receiver, compass, and horizontal distance measurement using a distance tape or ranging laser.

If portions of the plot/s are inaccessible (ex. presence of cliff), it must be described in the remarks section of Form 2: Plot Center Information and Subplot (5-m radius) Inventory with geotagged photographs attached. The remaining area shall be assessed and measured using the prescribed forms.

III. Forest Resources Data

Forest resources data include biophysical and socioeconomic variables gathered through measurements and observations in the tracts, key informant and target group interviews, and secondary data gathering. Field observation must be used to confirm the information obtained from interviewees and secondary data.

A. Biophysical Variables

The following biophysical variables shall be collected in the nested plots:

o *Tract Center* – used for the ocular assessment of land cover and land classification. Data on Tract Center, as well as information on the field inventory

team, are encoded in Form 1: Field Assessment Team and Tract Center Information.

o *Plot Center* – 40 meters horizontal distance from the Tract Center in the four (4) cardinal directions (north, east, south, and west). Used for the ocular assessment of land cover and land classification. Data on Plot Center are encoded in Form 2: Plot Center Information and Subplot (5-m radius) Inventory.

o *Subplot* – 5-meter radius from the Plot Center (corresponding to an area of 0.0079 ha) used for:

- Inventory of small trees (saplings) with diameter at breast height (DBH) or diameter above buttress (DAB) of 5 to 14 centimeters for the estimation of their contribution to the above-ground biomass (AGB) and belowground biomass (BGB).
- Inventory of standing dead wood with DBH or DAB $\geq$ 5 centimeters for the estimation of their contribution to the dead organic matter (DOM).
- Inventory of lying dead wood down to a diameter of $\geq$ 5 centimeters for the estimation of their contribution to the DOM.
- Inventory of litter for the estimation of its contribution to the DOM.

Data on the Subplots are encoded in Form 2: Plot Center Information and Subplot (5-m radius) Inventory and Form 3: Subplot (5-m radius) - Inventory of Saplings.

o *Plot* – 20-meter radius from the Plot Center (corresponding to an area of 0.1257 ha) used for:

- Inventory of large trees with DBH or DAB $\geq$ 15 cm for the estimation of their contribution to the AGB and BGB.

Data on the Plots are encoded in *Form 4: Plot (20-m radius) - Inventory of Trees.*

B. Socioeconomic Variables

Socioeconomic variables on land status and management, forest management structure, and existing or potential forest threats shall be collected for the whole tract. The information shall be gathered during the preparatory phase (i.e., bibliographic research and preparation of maps) and the field implementation phase (i.e., key informant/target group interviews and direct field observations). Data sources during the field interviews are:

- *Key Informants* – external individuals that have knowledge of the forest, people, and area but are not necessarily direct forest users themselves. Examples are forestry extension workers, forest guards, non-governmental organization staff, and local government units.

- *Target Individuals/Groups* – people who are linked to or directly use the forests on a permanent basis. These people may live in or close to the tract. Examples are tenure holders, indigenous peoples, long-term residents, non-timber forest products gatherers, and private forest owners.

Socioeconomic variables are encoded in *Form 5: List of Interviewees and Tract Land Status and Management* and *Form 6: Forest Management Structure and Forest Threats.*

IV. Regional Forest Assessment Teams

The Regional Field Assessment Team (RFAT) shall be composed of at least five people (two foresters and three forestry workers). Ideally, the team should include both men and women, especially when carrying out interviews, particularly with local women. A team leader and assistant team leader (should be foresters and preferably from the Surveys and Mapping Division), must be designated for each team.

- *Team Leader* – overall in-charge in: (1) organizing all the phases of the assessment from fieldwork preparation, implementation, and data processing and analysis; (2) contacting and maintaining good relationships with the community and the key informants/target groups; (3) verifying field observations; and (4) preparing status reports on FRA tracts of the region.

- *Assistant Team Leader* – assists the team leader in ensuring: (1) necessary measurements and observations are carried out; (2) field materials and equipment are complete and functional; (3) team members and locally recruited workers are well oriented; and (4) analysis reports are complete and integrated.

- *Extension Worker/Interviewer* – shall carry out: (1) communication with key informants/target groups; (2) conduct of interviews or focused group discussions; (3) secondary data gathering (4) encoding of all information gathered during the interviews; and (5) preparation of analysis reports.

- *Mapping Analyst/Geographic Information System Specialist* – shall carry out: (1) initial and final mapping analysis; (2) uploading of tracts and waypoints in a handheld global positioning system (GPS) receiver; (3) operation of handheld GPS receivers during fieldwork; and (4) preparation of analysis reports.

- *Data Analyst* – shall carry out: (1) encoding of all information gathered from bibliographic research and field measurements and observations; (2) computation of secondary variables; and (3) preparation of analysis reports. It is highly encouraged that analysts accompany the team in fieldworks.

Additional people may be included to increase the working capacity. Local workers may be hired to ease access to tracts and plots, identify common or vernacular names of tree species, gather information on the use and management of forest resources and forest products, and transport field materials.

The Regional Offices shall issue a Special Order on the composition of the Regional Forest Assessment Team (RFAT), including the assigned Team Leader and Assistant Team Leader, and submit a copy to the Undersecretary for Field Operations copy furnished the concerned Assistant Secretary for Field Operations and the Forest Management Bureau. The Regional Offices may re-constitute the initially submitted RFAT members, as needed, provided that a new Special Order be issued and submitted to the concerned offices.

V. Forest Resources Assessment Workflow

The Forest Resources Assessment is divided into a preparatory phase, field implementation phase, and data processing and analysis phase. The major activities for each phase are as follows (detailed activities are in the attached Manual):

A. Fieldwork Preparation

1. Bibliographic research of secondary and auxiliary data.
2. Preparation of maps containing tract and plot locations vis-à-vis topographic maps, aerial photographs, and/or satellite images.
3. Initial site coordination with local government units, community/indigenous people's representatives, tenured holders, etc. through the concerned Community Environment and Natural Resources Office (CENRO) or Implementing Provincial Environment and Natural Resources Office (PENRO).
4. Preparation of printed field forms and maps.
5. Preparation of field tools and equipment.

B. Field Implementation

1. Introductory meeting with site stakeholders to discuss the background and objectives of the Forest Resources Assessment and finalize logistical requirements, among others. External key informants and target groups to be interviewed shall also be identified.
2. Field socioeconomic and biophysical data gathering through interviews with external key informants and target groups and measurement and observation of plots. The team may decide which activity will be conducted first depending on the availability of interviewees and/or local hires.
3. Quality assurance led by the Team Leader to ensure completeness and consistency of data.

C. Data Processing and Analysis

1. Data encoding at the Forest Resources Assessment Database.
2. Volume computation using regional volume equations.
3. Biomass computation using prescribed allometric equations.
4. Quality control to be conducted by an independent team from the Forest Management Bureau. At least ten percent (10%) of the tracts will be chosen at random and subjected to an independent re-measurement.

VI. Forest Resources Assessment Manual

The attached *Forest Resources Assessment: Revised Field Manual* shall serve as guide in the conduct of the assessment. Detailed information on the biophysical and socioeconomic variables and the specific instructions in the fieldwork preparation, field implementation, and data analysis and processing phases are found in the Manual. The Forest Management Bureau may publish additional manuals or technical bulletins, as needed.

VII. Report Submission

The Forest Resources Assessment reporting cycle shall be every five (5) years. The Forest Management Bureau shall develop a progressive reporting program identifying the number of tracts to be validated and timeline of activities every reporting cycle.
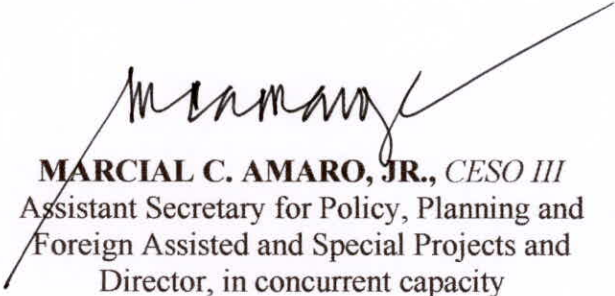
Regional Field Assessment Teams shall conduct field data gathering at the first part of the reporting cycle. The Team Leader shall prepare the Regional Accomplishment Report. The Regional Executive Director shall submit a hardcopy and electronic copy of the approved report to the Undersecretary for Field Operations through the Forest Management Bureau and concerned Assistant Secretary for Field Operations.

The Forest Management Bureau shall consolidate and analyze the submitted regional reports and conduct the necessary quality control activities. It shall then prepare the national report for submission to concerned national and international agencies (e.g., Food and Agriculture Organization of the United Nations).

VIII. Capacity Building

The FMB shall prepare a capacity building program for the orientation of the Regional Forest Assessment Teams on the revised methodology.

FOR INFORMATION AND GUIDANCE.

MARCIAL C. AMARO, JR., *CESO III*
Assistant Secretary for Policy, Planning and
Foreign Assisted and Special Projects and
Director, in concurrent capacity

Forest Resources Assessment: Revised Field Manual

Department of Environment and Natural Resources
Forest Management Bureau

April 2021

Table of Contents

Introduction

The *Forest Resources Assessment: Revised Field Manual* contains the procedures, definitions, and standards used to carry out the Forest Resources Assessment or FRA, which serves as the country's national forest inventory. The FRA has the purpose of assessing existing forests and trees therein, as well as trees outside forests, and aims to provide updated qualitative and quantitative information on the state, use, management, and trends of forests and forest resources.

This revised FRA guidelines builds on the *National Forest Inventory* methodologies developed for the FRA Project in 2002 and incorporates new concepts, best practices and other lessons learned from the different initiatives of the Department of Environment and Natural Resources (DENR). It takes into consideration carbon assessment needs in support of reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks (REDD+) and other climate change related initiatives of the Philippines.

The Manual is divided into seven main parts that describes the new FRA design, workflow (i.e., fieldwork preparation, field implementation, and data processing and analysis phases), inventory standards, reporting mechanism, and a glossary of terms used. The field forms are annexed at the end of this document.

Forest Resources Assessment Design

Field Assessment Tracts and Plots

The sampling design adopted for the country's Forest Resources Assessment (FRA) is systematic and without stratification. The tracts are selected every 5 minutes latitude and 5 minutes longitude as shown in Figure 1.
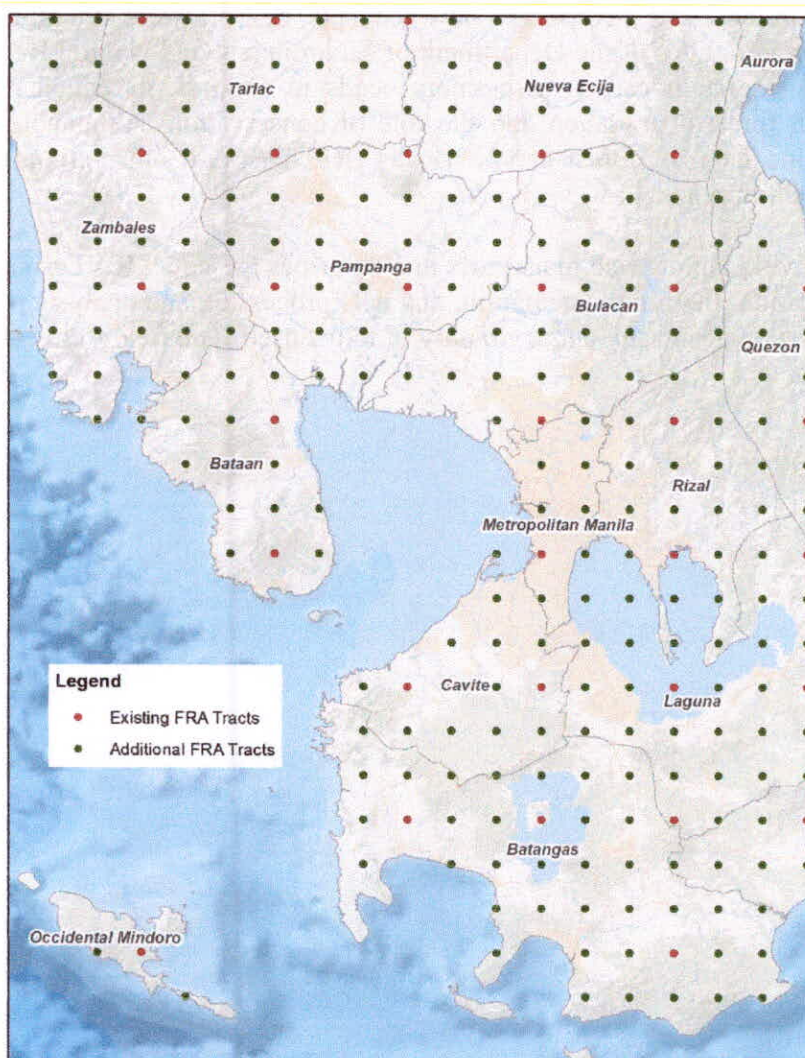
Figure 1. Distribution of Forest Resources Assessment tracts (Central and Southern Luzon subset). Red dots symbolize the existing FRA tracts while the green dots symbolize the additional FRA tracts with 5 minutes latitude and 5 minutes longitudes distance.

Each FRA tract consists of nested circular plots clustered on the sample point, i.e., **Tract Center**, as shown in Figure 2. The Tract Center is adapted from the previous FRA design and shall be used for assessing information on land cover and land classification. The clustered plots include four (4) plots i.e., **Plots North (N), East (E), South (S), and West (W)**, with their **Plot Centers** at 40 meters horizontal distance from the Tract Center in the four (4) cardinal directions (north, east, south, and west). The plots have a radius of 20 meters starting from the Plot Center and used for measuring large trees. Each plot consists of a circular subplot, i.e., **Subplot North (N), East (E), South (S), and West (W)**, with a radius of 5 meters starting from the Plot Center and used for measuring small trees (saplings), dead wood, and litter.

Figure 2. Nested circular plots clustered on the sample point of each FRA tract.

The Tract Center, Plot Centers, Plots and Subplots shall be accessed through a combination of a global positioning system (GPS) receiver, compass, and horizontal distance measurement using a distance tape or ranging laser.

If portions of the plot/s are inaccessible (ex. presence of cliff), it must be described in the remarks section of *Form 2: Plot Center Information and Subplot (5-m radius) Inventory* with geotagged photographs attached. The remaining area shall be assessed and measured using the prescribed forms.

Forest Resources Data

Forest resources data include biophysical and socioeconomic variables gathered through measurements and observations in the tracts, key informant and target group interviews, and secondary data gathering. Field observation must be used to confirm the information obtained from interviewees and secondary data.

Biophysical Variables

The following biophysical variables shall be collected in the nested plots:

- o **Tract Center** – used for the ocular assessment of land cover and land classification. Data on Tract Center, as well as information on the field inventory team, are encoded in *Form 1: Field Assessment Team and Tract Center Information*.

- o **Plot Center** – 40 meters horizontal distance from the Tract Center in the four (4) cardinal directions (north, east, south, and west). Used for the ocular assessment of land cover and land classification. Data on Plot Center are encoded in *Form 2: Plot Center Information and Subplot (5-m radius) Inventory*.

- o **Subplot** – 5-meter radius from the Plot Center (corresponding to an area of 0.0079 ha) used for:

  - Inventory of small trees (saplings) with diameter at breast height (DBH) or diameter above buttress (DAB) of 5 to 14 centimeters for the estimation of their contribution to the above-ground biomass (AGB) and belowground biomass (BGB).
  - Inventory of standing dead wood with DBH or DAB $\geq$ 5 centimeters for the estimation of their contribution to the dead organic matter (DOM).

- Inventory of lying dead wood down to a diameter of ≥ 5 centimeters for the estimation of their contribution to the DOM.
- Inventory of litter for the estimation of its contribution to the DOM.

Data on the Subplots are encoded in *Form 2: Plot Center Information and Subplot (5-m radius) Inventory* and *Form 3: Subplot (5-m radius) - Inventory of Saplings*.

o *Plot* – 20-meter radius from the Plot Center (corresponding to an area of 0.1257 ha) used for:

- Inventory of large trees with DBH or DAB ≥ 15 cm for the estimation of their contribution to the AGB and BGB.

Data on the Plots are encoded in *Form 4: Plot (20-m radius) - Inventory of Trees*.

Socioeconomic Variables

Socioeconomic variables on land status and management, forest management structure, and existing or potential forest threats shall be collected for the whole tract. The information shall be gathered during the preparatory phase (i.e., bibliographic research and preparation of maps) and the field implementation phase (i.e., key informant/target group interviews and direct field observations). Data sources during the field interviews are:

- *Key Informants* – external individuals that have knowledge of the forest, people, and area but are not necessarily direct forest users themselves. Examples are forestry extension workers, forest guards, non-governmental organization staff, and local government units.

- *Target Individuals/Groups* – people who are linked to or directly use the forests on a permanent basis. These people may live in or close to the tract. Examples are tenure holders, indigenous peoples, long-term residents, non-timber forest products gatherers, and private forest owners.

Socioeconomic variables are encoded in *Form 5: List of Interviewees and Tract Land Status and Management* and *Form 6: Forest Management Structure and Forest Threats*.

Summary of Number of Field Forms to be Accomplished per Tract

In order to ensure the completeness of data to be collected on the ground, the following number of field forms shall be accomplished by the Regional Field Assessment Teams (RFAT) per Tract (consisting of four nested plots):

- One (1) set of *Form 1: Field Assessment Team and Tract Center Information*
- Four (4) sets of *Form 2: Plot Center Information and Subplot (5-m radius) Inventory* [i.e., 1 set each for Plots North (N), East (E), South (S), and West (W)]
- Four (4) sets of *Form 3: Subplot (5-m radius) - Inventory of Saplings* [i.e., 1 set each for Subplots North (N), East (E), South (S), and West (W)]
- Four (4) sets of *Form 4: Plot (20-m radius) - Inventory of Trees* [i.e., 1 set each for Plots North (N), East (E), South (S), and West (W)]
- One (1) set of *Form 5: List of Interviewees and Tract Land Status and Management*
- One (1) set of *Form 6: Forest Management Structure and Forest Threats*

Form Nos. 1, 5 and 6 pertain to Tract information while Form Nos. 2, 3 and 4 pertain to Plot/Subplot information.

Regional Field Assessment Teams

The Regional Field Assessment Team (RFAT) shall be composed of at least five people (two foresters and three forestry workers). Ideally, the team should include both men and women, especially when carrying out interviews, particularly with local women. A team leader and assistant team leader (should be foresters and preferably from the Surveys and Mapping Division), must be designated for each team.

- *Team Leader* – overall in-charge in: (1) organizing all the phases of the assessment from fieldwork preparation, implementation, and data processing and analysis; (2) contacting and maintaining good relationships with the community and the key informants/target groups; (3) verifying field observations; and (4) preparing status reports on FRA tracts of the region.

- *Assistant Team Leader* – assists the team leader in ensuring: (1) necessary measurements and observations are carried out; (2) field materials and equipment are complete and functional; (3) team members and locally recruited workers are well oriented; and (4) analysis reports are complete and integrated.

- *Extension Worker/Interviewer* – shall carry out: (1) communication with key informants/target groups; (2) conduct of interviews or focused group discussions; (3) secondary data gathering (4) encoding of all information gathered during the interviews; and (5) preparation of analysis reports.

- *Mapping Analyst/Geographic Information System Specialist* – shall carry out: (1) initial and final mapping analysis; (2) uploading of tracts and waypoints in a handheld global positioning system (GPS) receiver; (3) operation of handheld GPS receivers during fieldwork; and (4) preparation of analysis reports.

- *Data Analyst* – shall carry out: (1) encoding of all information gathered from bibliographic research and field measurements and observations; (2) computation of secondary variables; and (3) preparation of analysis reports. It is highly encouraged that analysts accompany the team in fieldworks.

Additional people may be included to increase the working capacity. Local workers may be hired to ease access to tracts and plots, identify common or vernacular names of tree species, gather information on the use and management of forest resources and forest products, and transport field materials.

Forest Resources Assessment Workflow

The Forest Resources Assessment is divided into a preparatory phase, field implementation phase, and data processing and analysis phase. The major activities for each phase are as follows:

Field Work Preparation

1. Bibliographic research of secondary and auxiliary data.
2. Preparation of maps containing tract and plot locations vis-à-vis topographic maps, aerial photographs, and/or satellite images.
3. Initial site coordination with local government units, community/indigenous people's representatives, tenured holders, etc. through the concerned Community Environment and Natural Resources Office (CENRO) or Implementing Provincial Environment and Natural Resources Office (PENRO).
4. Preparation of printed field forms and maps.
5. Preparation of field tools and equipment.

Field Implementation

1. Introductory meeting with site stakeholders to discuss the background and objectives of the Forest Resources Assessment and finalize logistical requirements, among others. External key informants and target groups to be interviewed shall also be identified.
2. Field socioeconomic and biophysical data gathering through interviews with external key informants and target groups and measurement and observation of plots. The team may decide which activity will be conducted first depending on the availability of interviewees and/or local hires.
3. Quality assurance led by the Team Leader to ensure completeness and consistency of data.

Data Analysis and Processing

1. Data encoding at the Forest Resources Assessment Database.
2. Volume computation using regional volume equations.
3. Biomass computation using prescribed allometric equations.
4. Quality control to be conducted by an independent team from the Forest Management Bureau. At least ten percent (10%) of the tracts will be chosen at random and subjected to an independent re-measurement.

Phase 1: Fieldwork Preparation

The Team Leader and Assistant Team Leader shall ensure that the following preparatory activities be conducted prior to the field inventory and interviews/focus group discussions. The activities may be done simultaneously by different team members.

Bibliographic Research

The information generated from secondary data is necessary in preparation for the field inventory and interviews. Previous forest inventory reports, national policies, and community forestry issues, among others, are needed to understand the local reality. These auxiliary data are also useful for the data processing and analysis phase.

The following documents, if available, shall be reviewed to provide secondary data: previous inventory reports, tenure management plans, watershed management plans, population census, and published local research.

Map Preparation

Maps containing the site shall be prepared to indicate tract location. These may be enlarged and photocopied for use during stakeholder coordination meetings, interviews, and field measurements. The tract and nested plots shall be overlaid with topographic maps, aerial photographs, and/or satellite images (e.g., Google Earth). The tract center should be clearly indicated together with its geographic coordinates.

Initial Site Coordination

The Regional Field Assessment Team (RFAT) shall coordinate with the Community Environment and Natural Resources Office (CENRO)/Implementing Provincial Community Environment and Natural Resources Office (PENRO) with jurisdiction over the tracts. The CENRO/Implementing PENRO shall assist the RFAT in contacting local people (e.g., local government units, community and indigenous people's representatives, and tenured holders) needed for interviews and field measurements.

Field Form Preparation

The field forms, attached as annexes, and maps shall be printed out and distributed to team members prior to the conduct of interviews and field measurements.

Some of the needed data, particularly on socioeconomic variables, may already be gathered through bibliographic research and encoded in the forms. These will then be validated through direct field observations and during interviews with key informants and target individuals/groups.

Field Tools and Equipment Preparation

The following field equipment and tools used in forest inventory shall be prepared prior to the conduct of field measurements:

- *Diameter Tape* – used to measure (direct reading) the diameter of a given tree (diameter at breast height or above buttress) in centimeters.

- *Bearing Compass* – used to pinpoint the direction (north, south, west, east) of the four nested plots and the azimuth of trees and saplings being measured.

- *Meter Tape* – used to measure distance in meters.

- *Handheld global positioning system (GPS) receiver* – used to locate the exact location/position of a given point by giving its coordinates acquired through satellite feeds.

- *Laser Dendrometer or Haga Altimeter* – used to measure the height of a given tree in meters.

- *Densiometer* – used to determine the forest overstory density.

The Team shall also prepare other necessary fieldwork materials such as but not limited to small aluminum/metal tags for tree marking, galvanized steel bars for plot marking, waterproof bags to protect instruments and forms, alkaline batteries, waterproof boots and outfits, emergency kit, topographic maps, flipboard for field forms, indelible markers and pens, floral species list (common and scientific names), and flashlight/emergency lights.

Phase 2: Field Implementation

Introductory Meeting with Stakeholders

For inhabited tracts, the Team shall meet with the previously contacted persons and local people (e.g., local government units, community and indigenous people's representatives, tenured holders) upon its arrival to the tract site.

The background and objectives of the inventory must be explained to the locals to avoid misunderstandings or raise false expectations. A map or an aerial photograph showing the borders of the tract and subplots may be useful to facilitate the discussion. Ensure that both the local people and field team understand the area for assessment. Other topics to be discussed may include forest access, interview and inventory schedules, logistical requirements, hiring of additional laborers, identification of key persons/target groups for interview, and food and accommodation arrangements.

Access to the Tract

The identification of tracts will be carried out using topographic maps, aerial photographs and/or satellite images. The Tract Center and Plot Center will be delineated and marked with reference points to facilitate its identification in the field. A local guide will be also useful to easily access the centers.

The Tract Center shall correspond to the given X & Y coordinates of the tract and be accessed using handheld GPS receivers. Since the GPS receivers have limited precision, the last 10m to 15m to the tract center shall be covered by compass and horizontal distance measurement (azimuth and distance). It shall then be marked as a "waypoint" once the remaining distance is less than 15m, when closing a sample point.

The Tract Center shall be marked permanently by inserting a galvanized steel tube on the ground. The marker is positioned, as much as possible, exactly on the tract geographic coordinates. If an obstacle hampers such operation (e.g., tree, rock or river), the marker will be inserted as close as possible to the Tract Center. At least three precise and fixed points of reference (e.g., rock, largest tree, houses) shall be chosen and its orientation and distance from the marker (compass bearing in degrees starting from the Tract Center) shall be measured.

Data Gathering: Biophysical Variables

The following biophysical variables shall be collected for the tract.

Tract Center

The following parameters shall be observed and measured in the Tract Center. The data shall be encoded in *Form 1: Field Assessment Team and Tract Center Information*.

- *Administrative location* – Province, city or municipality, and barangay.
- *Coordinates* – Displayed by the GPS receiver using "averaging" based on at least 30 location acquisitions. The averaged coordinates may differ from the target coordinates.
- *Elevation* – Measured in meters above sea level and displayed in the GPS receiver.
- *Reference points* – These can be trees or landmarks surrounding the Tract Center that will be useful in relocating.
- *Land Cover* – Assessed through ocular inspection from the tract center and based on the NAMRIA land cover classification:
  - Forest
  - Mangrove Forests
  - Open/Barren
  - Built-up

- o Brushland/Shrubs
- o Grassland
- o Annual Crop
- o Perennial Crop
- o Marshland/Swamp
- o Fishpond
- o Inland Water

- ■ **Tree Crown Cover** – Assessed using densiometers from the tract center and based on the 3 classes currently used by NAMRIA for forest cover mapping:
  - o Closed forest (tree crown cover >40%)
  - o Open forest (tree crown cover 10-40%)
  - o Non-forest (tree crown cover <10%)
- ■ **Forest Condition** – Assessed through ocular inspection from the tract center and based on the Lawin Forest and Biodiversity Protection System patrolling data:
  - o Old Growth Forest
  - o Advanced Secondary Growth Forest
  - o Early Secondary Growth Forest
  - o Industrial Forest Plantation
  - o Open, Uncultivated Area
  - o Open Cultivated Area
- ■ **Geotagged photos** of the tract center.

Additionally, information on the team members from the DENR and additional members/local hires shall also be recorded in *Form 1*.

Plot Center

The following parameters shall be observed and measured in the Plot Center. The data shall be encoded in *Form 2: Plot Center Information and Subplot (5-m radius) Inventory*.

- ■ **Coordinates** – displayed by the GPS receiver using "averaging" based on at least 30 location acquisitions. The averaged coordinates may differ from the target coordinates.
- ■ **Elevation** – Measured in meters above sea level and displayed in the GPS receiver.
- ■ **Reference points** – These can be trees or landmarks surrounding the Plot Center that will be useful in relocating.
- ■ **Land Cover** – Assessed through ocular inspection from the tract center and based on the NAMRIA land cover classification.
- ■ **Tree Crown Cover** – Assessed using densiometers from the tract center and based on the 3 classes currently used by NAMRIA for forest cover mapping.
- ■ **Forest Condition** – Assessed through ocular inspection from the tract center and based on the Lawin Forest and Biodiversity Protection System patrolling data.
- ■ **Geotagged photos** of the plot center.

Subplot (5-m radius subplot of the four nested plots)

The following shall be measured for all standing dead wood with DBH or DAB $\geq$ 5 centimeters and encoded on *Form 2: Plot Center Information and Subplot (5-m radius) Inventory*. For the Forest Resources Assessment project, the inventory threshold/minimum diameter for dead wood is set to 5.0 cm.

- ■ **Species Name** (if recognizable) – Local and scientific names.
- ■ **Diameter at Breast Height (DBH) or Diameter Above Buttress (DAB)** – Measured in centimeters using a diameter tape.
- ■ **Height** – Measured in meters using Laser Dendrometer or Haga Altimeter
- ■ **Azimuth** – Measured from the plot center using a compass.
- ■ **Distance (HD)** – Horizontal distance in meters from the plot center and measured using a distance tape or ranging laser.

The following shall be measured for all lying dead wood with DBH or DAB $\geq$ 5 centimeters and encoded on *Form 2: Plot Center Information and Subplot (5-m radius) Inventory*. For the Forest

Resources Assessment project, the inventory threshold/minimum diameter for dead wood is set to 5.0 cm.

- **Species Name** (if recognizable) – Local and scientific names.
- **Mid-diameter Outside Bark** – Measured in centimeters of the dead wood section, without considering those portions extending beyond the plot.
- **Length** – Measured in meters, rounded to 0.1 meter of the dead wood section, without considering those portions extending beyond the plot.
- **Azimuth** – Measured from the plot center using a compass.
- **Distance (HD)** – Horizontal distance in meters from the plot center and measured using a distance tape or ranging laser.

The following shall be measured/observed for forest litter. It shall be encoded on *Form 2: Plot Center Information and Subplot (5-m radius) Inventory.*

- **Ground Coverage Percentage** – Estimated percentage of the surface of the plot covered by litter.
- **Average Depth** – Estimated depth/thickness in centimeter of the litter

The following shall be measured/observed for all live trees with DBH or DAB of 5-14 centimeters. It shall be encoded on *Form 3: Subplot (5-m radius) - Inventory of Saplings.*

- **Species Name** (if recognizable) – Local and scientific names.
- **Diameter at Breast Height (DBH) or Diameter Above Buttress (DAB)** – Measured in centimeters using a diameter tape.
- **Total Height (TH)** – It is the linear distance along the axis of the bole from the ground to the top of the crown.
- **Merchantable Height (MH)** – It is the linear distance along the axis of the bole from the stump height, approximately 50 centimeters (0.5 meter) above the ground or end of buttress, to the first major branch.
- **Azimuth** – Measured from the plot center using a compass.
- **Distance (HD)** – Horizontal distance in meters from the plot center and measured using a distance tape or ranging laser.
- **Stem Quality** – defects or damages due to fire, fungus, animals, etc.
  - o High – straight tree without visible damage
  - o Medium – tree with little defects or damage
  - o Low – tree with several defects or damage
- **Health State**
  - o Slightly Affected
  - o Strongly Affected
  - o Dying Tree
  - o Not Applicable - does not show any symptoms of disease or the presence of parasites.
- **Disease/Damage Causing Element** (if applicable) – insects, fungus, disease, wind-broken tree, fires, stem debarked, hollow stem, damage due to animals, damage due to humans, others.

Plot (20-m radius plots of the four nested plots)

The following shall be measured for all live trees with DBH or DAB ≥ 15 centimeters. It shall be encoded on *Form 4: Plot (20-m radius) - Inventory of Trees.*

- **Species Name** (if recognizable) – Local and scientific names.
- **Diameter at Breast Height (DBH) or Diameter Above Buttress (DAB)** – Measured in centimeters using a diameter tape.
- **Merchantable Height (MH)** – It is the linear distance along the axis of the bole from the stump height, approximately 50 centimeters (0.5 meter) above the ground or end of buttress, to the first major branch.

14

Resources Assessment project, the inventory threshold/minimum diameter for dead wood is set to 5.0 cm.

- **Species Name** (if recognizable) – Local and scientific names.
- **Mid-diameter Outside Bark** – Measured in centimeters of the dead wood section, without considering those portions extending beyond the plot.
- **Length** – Measured in meters, rounded to 0.1 meter of the dead wood section, without considering those portions extending beyond the plot.
- **Azimuth** – Measured from the plot center using a compass.
- **Distance (HD)** – Horizontal distance in meters from the plot center and measured using a distance tape or ranging laser.

The following shall be measured/observed for forest litter. It shall be encoded on *Form 2: Plot Center Information and Subplot (5-m radius) Inventory*.

- **Ground Coverage Percentage** – Estimated percentage of the surface of the plot covered by litter.
- **Average Depth** – Estimated depth/thickness in centimeter of the litter

The following shall be measured/observed for all live trees with DBH or DAB of 5-14 centimeters. It shall be encoded on *Form 3: Subplot (5-m radius) - Inventory of Saplings.*

- **Species Name** (if recognizable) – Local and scientific names.
- **Diameter at Breast Height (DBH) or Diameter Above Buttress (DAB)** – Measured in centimeters using a diameter tape.
- **Total Height (TH)** – It is the linear distance along the axis of the bole from the ground to the top of the crown.
- **Merchantable Height (MH)** – It is the linear distance along the axis of the bole from the stump height, approximately 50 centimeters (0.5 meter) above the ground or end of buttress, to the first major branch.
- **Azimuth** – Measured from the plot center using a compass.
- **Distance (HD)** – Horizontal distance in meters from the plot center and measured using a distance tape or ranging laser.
- **Stem Quality** – defects or damages due to fire, fungus, animals, etc.
  - o High – straight tree without visible damage
  - o Medium – tree with little defects or damage
  - o Low – tree with several defects or damage
- **Health State**
  - o Slightly Affected
  - o Strongly Affected
  - o Dying Tree
  - o Not Applicable - does not show any symptoms of disease or the presence of parasites.
- **Disease/Damage Causing Element** *(if applicable)* – insects, fungus, disease, wind-broken tree, fires, stem debarked, hollow stem, damage due to animals, damage due to humans, others.

Plot (20-m radius plots of the four nested plots)

The following shall be measured for all live trees with DBH or DAB ≥ 15 centimeters. It shall be encoded on *Form 4: Plot (20-m radius) - Inventory of Trees.*

- **Species Name** (if recognizable) – Local and scientific names.
- **Diameter at Breast Height (DBH) or Diameter Above Buttress (DAB)** – Measured in centimeters using a diameter tape.
- **Merchantable Height (MH)** – It is the linear distance along the axis of the bole from the stump height, approximately 50 centimeters (0.5 meter) above the ground or end of buttress, to the first major branch.

Existing or Potential Forest Threats

The following information on existing and potential forest threats shall be encoded on *Form 6: Forest Management Structure and Forest Threats*.

- *Disturbance Impact*: undisturbed forest, slightly disturbed forest, moderately disturbed forest, or heavily disturbed forest.
- *Environmental Problems*: loss of water levels in rivers and other sources, drought, inundation, poor water quality, pests, erosion, landslide, windthrow, or others.
- *Fire Occurrence*: presence or absence of fire evidence; area in hectares of fire damaged surface; and fire type (underground fire, surface fire or crown fire).
- *Anthropogenic Threats*: overharvesting, land use conversion, construction of infrastructure, illegal logging, wildlife poaching, overpopulation or others.

Quality Assurance

The Team should strictly comply with the instructions or protocols during the establishment, assessment, and measurement of the nested plots in the field. Issues and concerns encountered during the field inventory and/or interviews and the solution temporarily adopted shall be documented and reported. The Team Leader shall recommend the temporary solutions. Best practices and lessons learned during the inventory should also be documented to improve Forest Resources Assessment implementation.

The Team Leader shall ensure that the inventory data is complete, consistent, and verified and that the equipment are complete prior to leaving the tract and/or interview location. He/She shall also be responsible for the storage of field forms prior to data encoding. Data encoding shall be done immediately after inventory so that gaps and errors observed can be addressed swiftly in the field at minimal effort and cost.

Field Implementation Standards

Recommended Procedures in Conducting Interviews

Two major groups of people shall be interviewed as shown in Table 1.

Table 1. Interview Groups

Groups/Individuals to be interviewed	How to contact/ identify them?	Where?	Information needed
Key informants	Directly	By phone, correspondence, or visit	Logistics, access to the plot, land status and management, forest management structure, and forest threats
Target individuals/ groups	Recommended by external key informants and found close to the site or in it.	At their house or in the village. On the studied site (e.g., while on the transect walk with persons working in the fieldwork)	Forest management structure and forest threats

Identifying Key Informants

Key informants are external individuals that have particular knowledge of the forest, people and area. They are not forest users themselves, but more likely, they are local foresters or forest rangers with oversight duties in the area. Examples are forestry extension workers, forest guards, non-governmental organization staff, and local government units.

During the fieldwork preparation phase, the local foresters and representatives of local development organizations and local government units will be contacted to organize the logistics and scheduled activities. Some of them may provide very useful general information and will be selected as key informants.

Key informants may sometimes be interviewed before accessing the sampling site. Often, these informants have knowledge about the path to follow in order to access the site. They may also provide literature and existing data.

Identifying Target Individuals/Groups

The target individuals/groups are people who are linked to or directly use the forests on a permanent basis. These people may live in or close to the tract. They may be interviewed as a group or as individuals. Examples are tenure holders, indigenous peoples, long-term residents, non-timber forest products gatherers, and private forest owners. The main forest user groups or stakeholders to be interviewed must be identified through discussions with community representatives, people living in the forest, and external key informants.

Representativity is a complex issue and it is important to be aware of it when identifying target individuals/groups for the interviews. Many forest users have common characteristics and are classified within the same group when carrying out the analysis. Nevertheless, cultural and social factors (sex, age, health, status, religion, etc.) vary and must be taken into account. It is recommended to identify stakeholders together with local participants in order to appropriately

define the forest user groups. Many groups may be identified but the study must focus on the individuals and groups that directly use the forest products and services.

Data Collection from Interviews

The data may be collected from key informants prior to the field visit. Some variables may be verified with the target individuals/groups. The response of both key informants and target individuals/groups shall also be verified through direct field observation.

The data collection may start at the introductory meeting with the key informants and the local people, or during the first meeting with the target individuals/groups identified. The tools and techniques that may be adopted include:

- The participatory analysis of maps may stimulate discussions on a number of variables. This exercise may be carried out during the introductory meeting, or later on, when the target group meets. It facilitates collection of essential information both on the variables (use of resources, who uses them, where etc.) and on the logistics, to find out how the Team must proceed to access the tract. It is highly recommended to carry out a cross-checking or triangulation exercise.

- Direct observation is a very useful tool for data collection and testing of the information given by the interviewees.

- Carry out the interviews in the site itself, by organizing, for instance, a transect walk or by collecting information from a locally recruited worker who takes part in the plot measurement task. It creates a better link between the information collected and the field tracts.

- The analysis exercise to identify the stakeholders is a good opportunity to discuss the use of forest products and services.

External key informants may also have an opinion on the variables that may be requested from the target individuals/groups, such as ecological problems and the issues related with the rights and conflicts. Note that in the absence of local people, the information will be provided mostly by the key informants. Moreover, even when the information was provided by the target groups, it must be verified by cross-checking with the data provided by the key informants.

Standard Procedures in Measuring Standing Live Trees

The following procedures shall be done in measuring the diameter and height of standing live trees.

Diameter Measurement

The diameter is expressed as Diameter at Breast Height (DBH) or Diameter Above Buttress (DAB) measured and recorded to the nearest centimeter. The DBH is the average stem diameter outside bark at point 1.3 meters above the ground as measured from the uphill side of the stem while DAB is measured at 0.30 meter above the highest flange/buttress. DBH/DAB shall be determined by the use of diameter tape, tree caliper or any measuring instrument suitable for the purpose.

To avoid overestimation of volume and compensate measurement error, DBH/DAB is adjusted in a decreasing sense (e.g., 24.5 cm is recorded at 24 cm DBH).

- *Normal Tree*: Measure the DBH at 1.3 meters above the ground. If the ground is sloping, measure the 1.3 meters from the upper portion of the slope.
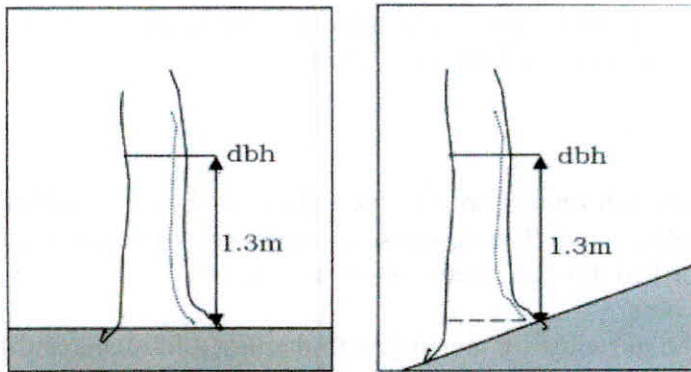
- **Swell/Butted Tree**: If the tree has natural swell/butted/high basal flanges, the DAB shall be measured 30 centimeters above the highest buttress or flange.
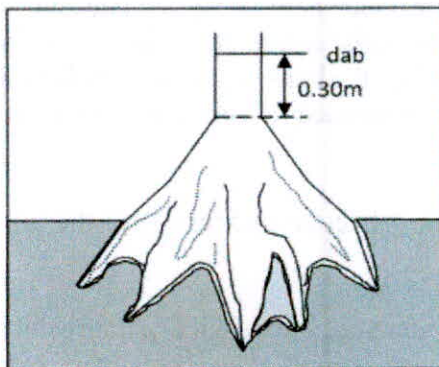
- **Leaning Tree**: If the tree is naturally leaning, measure the DBH at 1.3 meters above the ground, reckon from the lower leaned portion of the tree parallel to the axis.
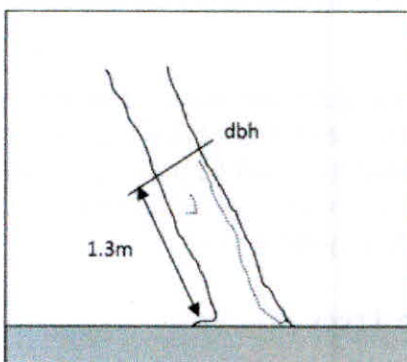
- **Forked Tree**: If forking is above 1.3 meters, consider as one tree and measure the DBH at 1.3 meters above the ground. However, if forking is less than 1.3 meters from the ground, consider the stems as separate trees and measure the DBH at each stem 1.3 meters above the ground.
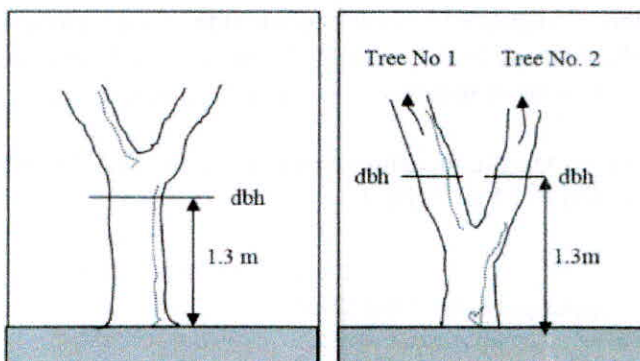
- ***Trees with Bulges/Swelling/Depressions/Abnormalities***: When bulges, swelling, depressions, branches or other abnormalities occur at breast height, the DAB is measured just above the abnormalities at a point where it ceases to affect normal stem form.
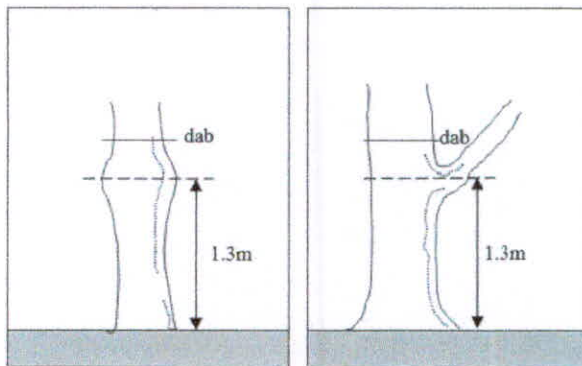
- ***Trees with Stilt Roots***: Diameter is measured at 1.3 meters from the highest stilt root.
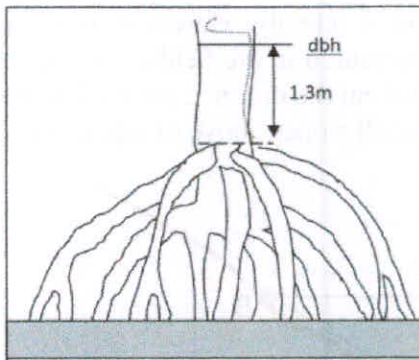
Tree Height Measurement

- ***Merchantable Height (MH)***: It is the linear distance along the axis of the bole from the stump height, approximately 50 centimeters (0.5 meter) above the ground or end of buttress, to the first major branch. However, it could be extended beyond the first major branch if there is a clear length of at least 2.0 meters up to the succeeding branch or at top end diameter of 30 centimeters. It shall be recorded to the nearest meter.
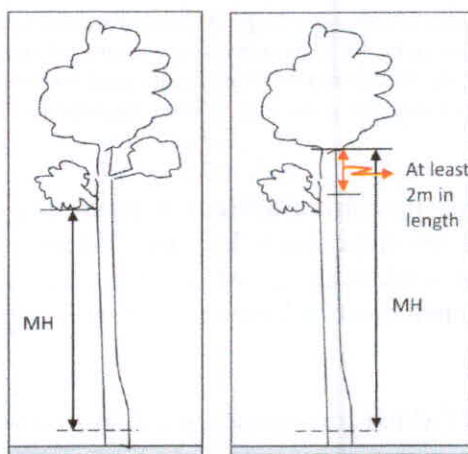
- ***Total Height (TH)***: It is the linear distance along the axis of the bole from the ground to the top of the crown. It shall also be recorded to the nearest meter.
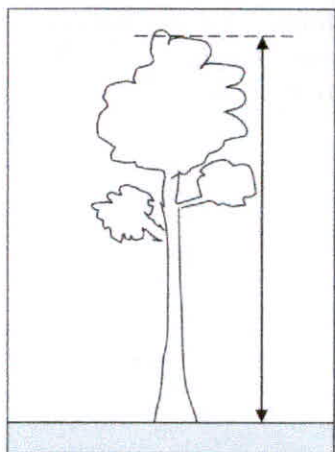
Standard Procedures in Measuring Horizontal Distance

All reference distances, such as plot and subplot dimensions, are measured in horizontal distances. When the terrain is flat, these distances may be measured directly. However, in steep terrain, horizontal distances differ from distances covered and measured in the field as seen in the figure below. A correction factor must be applied in order to find out the distance covered in the field, in order to reach a given point. Corrections will be made for all slopes above or equal to 15 percent.
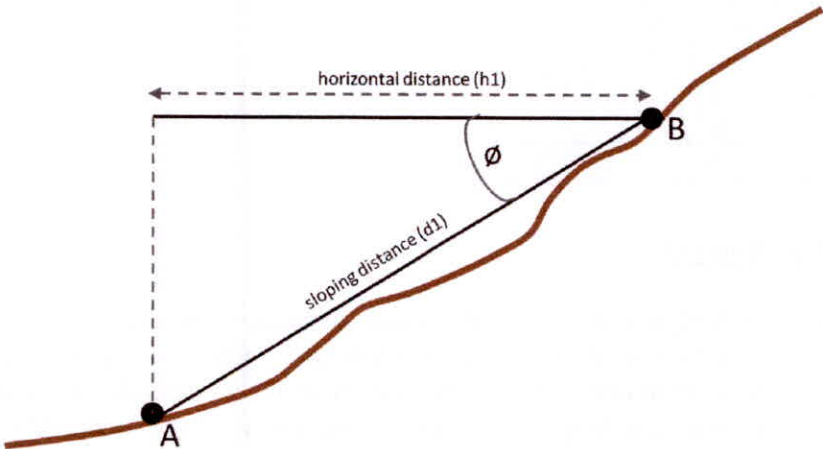
*Note: The distance between two points (A and B), measured along one slope (**sloping distance** or **d1**) is always longer than an equivalent horizontal distance (**h1**). On slope terrain, the sloping distance (**d1**) must be multiplied by a factor that corresponds to the inclination to obtain a corrected horizontal distance (**h1**). Ø is the angle between the horizontal and the right A-B.d1 (i.e., horizontal distance) = **h1/cosine (Ø)***

1. With the help of a clinometer (or other slope measuring device), measure the slope of landmark **A** in direction of point **B**. When the slope angle has been determined, it is important to make sure that the measurement is taken along one parallel observation line to the average slope of the ground: the instrument must be located at the same height level of the target.

2. Find out the corrected horizontal distance (**h1**) which corresponds to the desired horizontal distance, by using the slope correction table.

Slope (%)	Degree (°)	Factor (Fp)	Horizontal Distances (meter)							
			5	10	15	20	25	30	40	50
15	9	1.0112	5.1	10.1	15.2	20.2	25.3	30.3	40.4	50.6
20	11	10198	5.1	10.2	15.3	20.4	25.5	30.6	40.8	51.0
25	14	1.0308	5.2	10.3	15.5	20.6	25.8	30.9	41.2	51.5
30	17	1.0440	5.2	10.4	15.7	20.9	26.1	31.3	71.8	52.2

Slope (%)	Degree (°)	Factor (Fp)	Horizontal Distances (meter)							
			5	10	15	20	25	30	40	50
35	19	1.0595	5.3	10.6	15.9	21.2	26.5	31.8	42.4	53.0
40	22	1.0770	5.4	10.8	16.2	21.5	26.9	32.3	43.1	53.9
45	24	1.0966	5.5	11.0	16.4	21.9	27.4	32.9	43.9	54.8
50	27	1.1180	5.6	11.2	16.8	22.4	28.0	33.5	44.7	55.9
60	31	1.1662	5.8	11.7	17.5	23.3	29.2	35.0	46.6	58.3
70	35	1.2207	6.1	12.2	18.3	24.4	30.5	36.6	48.8	61.0
80	39	1.2086	6.4	12.8	19.2	25.6	32.0	38.4	51.2	64.0
90	42	1.3454	6.7	13.5	20.2	26.9	33.6	40.4	53.8	67.3
100	45	1.4142	7.1	14.1	21.2	28.3	35.4	42.4	56.6	70.7
110	48	1.4866	7.4	14.9	22.3	29.7	37.2	44.6	59.5	74.3
120	50	1.5620	7.8	15.6	23.4	31.2	39.1	46.9	62.5	78.1
130	52	1.6401	8.2	16.4	24.6	32.8	41.0	49.2	65.6	82.0
140	54	1.7205	8.6	17.2	25.8	34.4	43.0	51.6	68.8	86.0
150	56	1.8028	9.0	18.0	27.0	36.1	45.1	54.1	72.1	90.1

*Note: The table provides corrected distances for some sloping distances, in function of the slope. For instance, the distance correction for a sloping distance of 20 meters with a slope of 30% is 20.9 meters. For other sloping distances, not included in the table, it is possible to get a corrected horizontal distance by multiplying the sloping distance by the slope correction factor scf. For instance, on a terrain with a 25% slope, the aim is to find the horizontal distance of 7.5 meters, it is necessary to carry out the following operation: 7.5 * 1.0308 = 7.73 meters.*

3. Go to point **B**, and measure the slope again, in direction of point **A**. If the result is different from the first measurement, repeat the operation.

When the operator cannot see the position of the next point or when the slope is not constant, one or several intermediate measurements become necessary. The horizontal distance is corrected by segments.

Phase 3: Data Processing and Analysis

Data Encoding

The data shall be encoded into the Forest Resources Assessment database developed by the Forest Management Bureau. It is recommended that field forms be encoded immediately, at most 5 days after the conduct of the field inventory.

Volume Computation

The volume of every tree recorded shall be computed based on the Regional Volume Equations for Standing Trees as shown in Table 2.

Table 2. Regional Volume Equations for Standing Trees

Region	Species Group	
	Dipterocarp	Non-Dipterocarp
Northern Luzon (Regions 1, 2, 3 and CAR)	$V = 0.00005203(D^2 * H)$	$V = 0.00005109(D^2 * H)$
Southern Luzon (Regions 4A, 4B and 5 except Palawan)	$V = 0.00005171(D^2 * H)$	$V = 0.00005204(D^2 * H)$
Western Visayas (Region 6, 7 and Palawan)	$V = 0.00004649(D^2 * H)$	$V = 0.00004874(D^2 * H)$
Eastern Visayas (Region 8 and Bohol)	$V = 0.00005231(D^2 * H)$	$V = 0.00005109(D^2 * H)$
Eastern Mindanao (Region 11 and 13; portion of Agusan, East of Agusan River, Davao and Surigao)	$V = 0.00005087(D^2 * H)$	$V = 0.00004961(D^2 * H)$
Central Mindanao (Regions 10, 12 and ARMM; Bukidnon, Cotabato, Lanao, Misamis and portion of Agusan, West of Agusan River)	$V = 0.00005019(D^2 * H)$	$V = 0.00005039(D^2 * H)$
Western Mindanao (Region 9; Basilan, Sulu and Zamboanga)	$V = 0.00004668(D^2 * H)$	$V = 0.00004840(D^2 * H)$

Where:

V = Tree Volume in cubic meter

D = Diameter at Breast Height/Diameter Above Buttress in centimeter

H = Merchantable Height in meter

Biomass Computation

The 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas (GHG) Inventories proposed two (2) methods of calculating carbon stock changes in a given carbon pool for a given land-use category in the Agriculture, Forestry and Other Land Use (AFOLU) Sector.

a. *Gain-Loss Method* – Estimates the difference between increase in biomass (removals) and decrease in biomass (emissions).

b. **Stock Difference Method** – Estimates the change of carbon stocks through measurements of two (or more) points in time. It also reflects both emissions and removals.

The "Stock Difference Method" is robust and transparent, particularly to monitor carbon stock changes from deforestation and forest degradation, which are key category emission sources in the Philippines. This method requires two estimations:

o Forest area by category or strata, which is being mapped nationwide by the National Mapping and Resource Information Authority (NAMRIA) through visual classification of medium- to high-resolution multispectral satellite data. The latest forest area map was produced in 2015. Other sources of forest area maps can also be used if it is the latest available data with strata that can be correlated to carbon stocks.

o Carbon stock per unit area for the different forest category or strata must be determined using appropriate statistical field sampling inventory methods. The inventory method builds on the experiences gained, considering existing international standards and good practices.

In the absence of allometric equations specifically developed for the trees, bamboos and arborescent palms found in the tropical rainforests of the Philippines, the biomass (expressed in kg or t of dry matter [d.m.]) shall be calculated using available equations found in the literature and databases (notably GlobAllomeTree - http://www.globallometree.org), as well as the data to be sampled in the field.

Allometric Equations

Above-ground Biomass of Live Trees

The above-ground biomass (AGB) is calculated based on diameter at breast height (DBH) or above buttress (DAB) of the sampled live trees with DBH ≥5.0 cm, using either of the following equations:

a. The allometric model developed by Chave et al. (based on the destructive measurement of 4,004 trees, with 5.0 cm ≤ DBH ≤ 180.0 cm):

o When tree height is available:

$$AGB = 0.0673 \times (\rho \times DBH^2 \times H)^{0.976}$$

o When tree height is not available:

$$AGB = exp\left[-1.803 - 0.976 \times E + 0.976 \times ln(\rho) + 2.673 \times ln(DBH) - 0.0299 \times \left(ln(DBH)\right)^2\right]$$

Where:

AGB	Oven-dry above-ground biomass of live trees, in kg d.m
ρ	Wood specific gravity, in g/cm³; See annex for the list of species that may be found in the Philippines with the corresponding values of ρ

24

DBH	Diameter at breast height which is 1.30 m or above buttress (30 cm), in centimeters
H	Total height, in meters
E	Environmental variable measuring stress, defined as: $E = (0.178 \times TS - 0.938 \times CWD - 6.61 \times PS) \times 10^{-3}$
TS	Temperature seasonality, the standard deviation of the monthly mean temperature over a year, expressed in degrees Celsius multiplied by 100
CWD	Climatological water deficit in millimeters (mm) per year, computed by summing the difference between monthly rainfall and monthly evapotranspiration, only when this difference is negative
PS	Precipitation seasonality, the coefficient of variation in monthly rainfall values, expressed in percent of the mean value

b. The equations developed by Brown (for moist climatic zones and based on the destructive measurement of 170 trees, with $5.0 \, cm \leq DBH \leq 148.0 \, cm$):

$$AGB = exp(-2.134 + 2.530 \times ln(DBH)) \qquad (R^2 = 0.97)$$

$$AGB = 42.690 - 12.800 \times DBH + 1.242 \times DBH^2 \qquad (R^2 = 0.84)$$

Where:

AGB	Oven-dry above-ground biomass of live trees, in kg d.m.
DBH	Diameter at breast height (1.30 m) or above buttress (30 cm), in cm

Considering that more than 96% of the AGB of tropical forests is found in trees with a diameter of ≥ 10.0 cm, the biomass of trees with a diameter of < 5.0 cm and the non-tree biomass (except for bamboos and arborescent palms, which are also included in the Philippine forest definition) is not key and will not be accounted for in the inventory.

Below-Ground Biomass of Live Trees

The below-ground biomass (BGB) is based on the AGB of sampled live trees. It can be calculated in two ways:

a. Using the root-to-shoot ratio (R) of the 2006 IPCC guidelines for national GHG inventories – AFOLU Table 4.4.

$$BGB = AGB \times R$$

Where:

BGB	Oven-dry below-ground biomass of live trees, in kg d.m.
AGB	oven-dry above-ground biomass of live trees, in kg d.m.
R	root-to-shoot or BGB to AGB ratio; default value is 0.37

b. Using the ratio developed by Mokany et al. (2006) which offers specific ratios based on forest type and climate zone, and applicable when the above-ground biomass is reported at the stand level.

Geography	Above-ground Biomass	Ratio to AGB
Tropical/Subtropical moist forest/ Plantation	AGB > 62.5 t C/ha	BGB = 0.235 x AGB
	AGB ≤ 62.5 t C/ha	BGB = 0.205 x AGB
Tropical/Subtropical dry forest/ Plantation	AGB > 20.0 t C/ha	BGB = 0.275 x AGB
	AGB ≤ 20.0 t C/ha	BGB = 0.563 x AGB

The equation that provides the most conservative value of BGB should be used.

Dead Wood

- ### *Biomass of Standing Dead Wood*

  The biomass of standing dead wood (SDW) can be calculated through:

  1. Calculation of the merchantable volume (V) of sampled standing dead wood based on the diameter at breast height or above buttress (DBH/DAB) and the merchantable height (MH) of sampled dead wood with $DBH \ or \ DAB \geq 5.0 \ c.m.$ using the Philippine regional volume equations for dipterocarps and non-dipterocarps.

  2. Conversion of V into biomass (SDW) using the Biomass Conversion and Expansion Factor (BCEFs) of merchantable growing stock volume to AGB of the 2006 IPCC Guidelines, and divided by 2 to account for decay.

  $$SDW = V \times BCEFs/ \ 2$$

  where:

SDW	Biomass of Standing Dead Wood, in t d.m.
V	Merchantable volume inside bark of Standing Dead Wood, in m³
BCEFs	Biomass Conversion and Expansion Factor of merchantable growing stock volume to AGB for humid tropical natural forests, in t/m3, depending on the growing stock level. See Table 4.5 of Chapter 4 (Forest Land) of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories - Volume 4: Agriculture, Forestry and Other Land Use.

- ### *Biomass of Lying Dead Wood*

  The biomass of lying dead wood (LDW) can be calculated through:

  1. Calculation of volume (V) of sampled lying dead wood sections up to a minimum diameter of 5.0 c.m. based on the mid-diameter (D) and the length (L) using the cylindrical formula:

$$V = \pi \times D^2 / 40{,}000 \times L$$

where:

  V volume of Lying Dead wood section, in m^3

  D mid-diameter of Lying Dead wood section, in cm

  L Length of Lying Dead wood section within the sample plot, in m

2. Conversion of V into biomass (LDW) using the average wood density for Asia (FAO, 1997), divided by 2 (Thiele et al., 2010)

$$LDW = V \times D / 2$$

where:

  LDW biomass of Lying Dead wood, in t d.m.

  V volume of Lying Dead wood section, in m^3

  D average wood density for Asia: 0.57 t d.m./m^3

Litter Biomass

The biomass of litter (LI) can be calculated through:

1. Calculation of the volume (V) of sampled litter based on the ground coverage percentage (C) and the average depth (DPT) of the litter:

$$V = C \times DPT \times 10{,}000$$

where:

  V volume of litter, in m^3/ha

  C ground coverage percentage of litter, in %

  DPT average depth of litter, in m

2. Conversion of V into biomass (LI) using the average density of litter.

$$LI = V \times D$$

where:

  LI biomass of litter, in kg d.m./ha

  V volume of litter, in m^3/ha

  D average density of litter: 40 kg d.m./m^3

Carbon Fraction of Dry Matter

The Carbon Fraction (CF) shall be used for the calculation of the carbon equivalent of the various carbon pools calculated in terms of dry matter.

- Carbon Fraction of Dry Matter for Living Biomass

$$CF = 0.47 \ t \ C \ / \ t \ dry \ matter \qquad \text{IPCC, 2006: Table 4.3}$$

- Carbon Fraction of Dry Matter for Dead Organic Matter

$$CF = 0.37 \ t \ C \ / \ t \ dry \ matter \qquad \text{IPCC, 2006: Equation 2.19}$$

Quality Control

It is recommended that at least ten percent (10%) of the tracts should be chosen at random and subjected to an independent re-measurement. The independent team from the Forest Management Bureau shall conduct the re-measurement. All the data of the re-measured tracts shall once again be acquired, recorded and processed. The field measurement error (in % of the difference of the total biomass per hectare between the measured and the re-measured tract, with reference to the re-measurement) shall be computed and documented.

Data encoding shall likewise be checked through the limitation of data entry ranges, the sorting of data to spot oddly small and large numbers, and the use of programmed plausibility checks revealing implausible data. If the data is filled with gross mistakes, ten percent (10%) of the encoded data shall be chosen at random and compared with the field data forms.

Reporting

The Forest Resources Assessment reporting cycle shall be every five (5) years. The Forest Management Bureau shall develop a progressive reporting program identifying the number of tracts to be validated and timeline of activities every reporting cycle.

Regional Field Assessment Teams shall conduct field data gathering at the first part of the reporting cycle. The Team Leader shall prepare the Regional Accomplishment Report. The Regional Executive Director shall submit a hardcopy and electronic copy of the approved report to the Undersecretary for Field Operations through the Forest Management Bureau and concerned Assistant Secretary for Field Operations.

The Forest Management Bureau shall consolidate and analyze the submitted regional reports and conduct the necessary quality control activities. It shall then prepare the national report for submission to concerned national and international agencies (e.g., Food and Agriculture Organization of the United Nations).

Glossary

Forest

DENR Memorandum Circular No. 2005-005 defines forests as "land with an area of more than 0.5 hectare and tree crown (or equivalent stocking level) of more than 10 percent. The trees should be able to reach a minimum height of 5 meters at maturity in situ. It consists either of closed forest formations where trees of various storeys and undergrowth cover a high portion of the ground or open forest formations with a continuous vegetation cover in which tree crown cover exceeds 10 percent. Young natural stands and all plantations established for forestry purposes, which have yet to reach a crown density of more than 10 percent or tree height of 5 meters, are included under forest. These are normally forming part of the forest area which are temporarily unstocked as a result of human intervention or natural causes but which are expected to revert to forest. It includes forest nurseries and seed orchards that constitute an integral part of the forest; forest roads, cleared tracts, firebreaks and other small open areas; forests within protected areas; windbreaks and shelter belts of trees with an area of more than 0.5 hectare and width of more than 20 meters; plantation primarily used for forestry purposes, including rubber wood plantations. It also includes bamboo, palm and fern formations (except coconut and oil palm)."

Land Cover

For Land Cover, the following classes and definitions shall be used to conform with the national land cover maps developed by the National Mapping and Resources Information Authority.

- *Closed Forest* – Formations where trees in the various storeys and the undergrowth cover a high proportion (>40 percent) of the ground and do not have a continuous dense grass layer.

- *Open Forest* – Formations with discontinuous tree layer with coverage of at least 10 percent and less than 40 percent and areas with woody vegetation resulting from the clearing of natural forest for shifting agriculture. They either are managed or unmanaged forests, in initial state of succession.

- *Mangrove Forest* – Forested wetland growing along tidal mudflats and along shallow water coastal areas extending inland along rivers, streams and their tributaries where the water is generally brackish and composed mainly of *Rhizopora, Brugiera, Ceriops, Avicenia, Aegiceras,* and Nipa species.

- *Brush/Shrub* – Combination of the former shrub and wooded grassland. It includes areas where: (1) the dominant woody vegetation are shrubs, generally of more than 0.5 meter and less than 5 meters in height in maturity and without a definite crown; and (2) predominantly vegetated with grasses, such as *Imperata, Themeda, Saccharum* and where the tree cover is between 5 to 10% of area and their height may reach 5 meters at maturity. It is an intermediate class between forest and non-forest land uses.

- *Grassland* – Areas predominantly vegetated with grasses such as *Imperata, Themeda, Saccharum* spp. among others.

- *Perennial Crop* – Land cultivated with long term crops that do not have to be replanted for several years after each harvest; harvested components are not timber but fruits, latex and other products that do not significantly harm the growth of the planted trees or shrubs; orchards, vineyards and palm plantations, coffee, tea, sisal, banana, abaca, etc.

- *Annual Crop* – Land cultivated with crops with a growing cycle under one year, which must be newly sown or planted for further production after harvesting.

- **Built-Up** – Composed of areas of intensive use with much of the land covered by structures. It includes cities, towns, villages, strip developments along highways, transportation, power, and communication facilities, and areas occupied by malls, shopping centers, industrial and commercial complexes, and institutions that may, in some instances, be isolated from urban areas.

- **Open/Barren** – Land not covered by (semi-) natural or artificial cover. These include, among others, sand dunes, riverwash, lahar laden areas and rocky or stony areas.

- **Marshland/Swamp** – Natural area usually dominated by grass-like plants such as cattails and sedges which are rooted in bottom sediments but emerge above the surface or the water. It contains emergence vegetation and usually develops in zones progressing from terrestrial habitat to open water.

- **Fishpond** – A land-based facility enclosed with earthen, stone or concrete material to impound water for the growing of fish.

- **Inland Water** – Bodies of water surrounded by land (e.g., rivers, lakes, streams, ponds/fishponds, dams, and reservoirs).

Forest Condition

For Forest Condition, the following classes and definition shall be used to conform with the Lawin Forest and Biodiversity Protection System patrolling data.

- **Old Growth Forest** – Forests with predominantly large and very large trees (more than 50-centimeter diameter at breast height (DBH) and more than 30 meters in height), without significant disturbance.

- **Advanced Secondary Growth_Forest** – Forests that were previously disturbed and show an advance level of recovery, which have a less dense understory (a layer of vegetation under the main forest canopy) and are dominated by medium to large trees (above 30- to 55-centimeter DBH and about 30 meters in height).

- **Early Secondary Growth Forest** – Areas of newly regenerating forest after disturbance, dominated by saplings and other small to medium-sized trees (up to 30-centimeter DBH and up to 25 meters in height).

- **Industrial Forest Plantation** – Areas planted mainly to timber producing species, including rubber, and/or non-timber species such as rattan and bamboo, primarily to supply the raw material requirements of existing and proposed wood processing plants and related industries.

- **Open, Uncultivated Area** – Areas with abandoned farmland, grasslands, and brushlands.

- **Open, Cultivated Area** – Areas with farmland, agricultural plots, and small orchards with fruit trees.

Fire Type

- **Underground Fire** – Fire propagating under the surface through the roots or any other underground means.

- **Surface Fire** – Fire propagating on the ground cover of the forest where it consumes the dead cover and small vegetation without reaching the crown of trees.

- **Crown Fire** – Fire propagating through the crown of woody vegetation, a tree crown or nearby population.

Stand Structure

- **Single Layer** – Stand with one layer of trees (only one well-defined level, formed by the crown cover).

- **Two-layer Vegetation** – Stand with two distinct layers of trees, an upper level (or dominant layer where the crown cover is two-thirds above the first one, forming a clearly defined layer with at least 20% cover) and a lower layer (understory).

- **Three-layer Vegetation** – Stand with three distinct layers of trees: an upper layer (or dominant layer where the crown cover is two-thirds above the others, forming a clearly defined layer with at least 20% cover), an intermediate layer (of trees where the crown cover is from one to two-thirds above the lower layer, forming a clearly defined layer with at least 20% cover), and a lower level (understory, or group of trees growing at a maximum height of one third of the dominant layer, forming a clearly defined layer with at least 20% cover).

- **More than Three Layers** – Stand consisting of three distinct layers of trees (more than three well defined layers, forming a crown cover at different heights).

Silvicultural Practices

- **Timber Stand Improvement** – Operation that reduces the tree density or deficiency with the aim of improving the yield and quality of the commercial use stand volume. It also includes regeneration by natural or artificial seeding.

- **Release of Desirable Superior Trees** – Extraction of higher and larger, and intermediate diameter trees. It also includes selective cutting.

- **Release of Lianas and Tropical Plants** – Intervention aimed at clearing trees of harmful climbers.

- **Enhancement** – Plantation by seeding of indigenous species to improve natural regeneration.

- **Sanitary Cutting** – Elimination of dead, damaged, or vulnerable trees with the aim of stopping the propagation of predators or diseases.

Carbon Pools

- **Above-Ground Biomass (AGB)** – All biomass of living vegetation, both woody and herbaceous, above the soil including stems, stumps, branches, bark, seeds, and foliage. In cases where forest understory is a relatively small component of the above-ground biomass carbon pool, it is acceptable for the methodologies and associated data used in some tiers to exclude it, provided the tiers are used in a consistent manner throughout the inventory time series. It can be further divided into:

    - **Above-ground Tree Biomass** – it includes trees with ≥5 cm diameter at breast height (1.3 m above ground).

    - **Above-ground Non-Tree/Woody Biomass** – it includes all living matter above-ground excluding trees. In some cases, also referred to as shrubs.

- **Below-Ground tree Biomass (BGB)** – All biomass of live roots. Fine roots of less than (suggested) 2 mm diameter is often excluded because these often cannot be distinguished empirically from soil organic matter or litter.

- **Dead Organic Matter (DOM),** composed of:

  - **Dead Wood (DW)** – Includes all non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil. Dead wood includes wood lying on the surface, dead roots, and stumps, larger than or equal to 10 cm in diameter (or the diameter specified by the country). For the Forest Resources Assessment project, the inventory threshold/minimum diameter for dead wood is set to 5.0 cm.

  - **Litter (LI)** – Includes all non-living biomass with a size greater than the limit for soil organic matter (suggested 2 mm) and less than the minimum diameter chosen for dead wood (e.g., 10 cm), lying dead, in various states of decomposition above or within the mineral or organic soil. This includes the litter layer as usually defined in soil typologies. Live fine roots above the mineral or organic soil (of less than the minimum diameter limit chosen for below-ground biomass) are included in litter where they cannot be distinguished from it empirically.

- **Soil Organic Matter (SOM)** – Includes organic carbon in mineral soils to a specified depth chosen by the country and applied consistently through the time series. Live and dead fine roots and DOM within the soil that are less than the minimum diameter limit (suggested 2 mm) for roots and DOM, are included with soil organic matter where they cannot be distinguished from it empirically. The default for soil depth is 30 cm. The World Reference Base (WRB) soil classes are taken from the 2013 FAO soil map of the Philippines prepared by the Bureau of Soils and Water Management (BSWM, 2013: Updating the Harmonized World Soil Database [HWSD]: Correlation of Philippine Soils into FAO's WRB for Soil Resources).

References

Chojnacky D. et al. 2009. Separating duff and litter for improved mass and carbon estimates.

DENR-FMB & USAID/B+WISER. 2018. The Lawin Forest and Biodiversity Protection System Manual. Module 2: Purpose-driven Patrolling.

DENR-FMB. 2014. FMB Technical Bulletin No. 3: Measurement Standards and Procedures in the Conduct of Inventory for Standing Trees (Timber)

DENR-FMB. 2020. Carbon Stock Assessment: Inventory Methodology.

FAO. 1997. Estimating biomass and biomass change of tropical forests - a Primer: Chapter 3.1.2

IPCC. 1996. Revised Guidelines for National Greenhouse Gas Inventories - Reference Manual.

IPCC 2003. Good Practice Guidance for Land Use, Land Use Change and Forestry.

IPCC. 2006. Guidelines for National Greenhouse Gas Inventories, Volume 4 - Agriculture, Forestry and Other Land Use (AFOLU).

IPCC. 2013. 2013 Revised Supplementary Methods and Good Practice Guidance arising from the Kyoto Protocol.

Lennertz, R. & J. Schade. 2014. Methodology of the Forest Resources Assessments in the selected Project Sites. National REDD+ System Philippines Component 4: Forest Land Use Planning and REDD+ Implementation in Selected Areas.

Mokany, K., Raison, R.J. & Prokushkin, A.S., 2006. Critical Analysis of Root: Shoot Ratios in Terrestrial Biomes. Global Change Biology, 11, 1-13.

Pearson, T., Walker, S.M., Brown, S. 2006. Sourcebook for Land Use, Land Use Change, and Forestry Projects. BioCarbonFund, Winrock International.

Thiele T. et al. 2010. Monitoring, assessment and reporting for sustainable forest management in Pacific Island Countries: Chapter 4.3.2.2

List of Annexes

List of Philippine Tree Species and their Wood Specific Gravity

Field Form 1: Field Assessment Team and Tract Center Information

Field Form 2: Plot Center Information and Subplot (5-m radius) Inventory

Field Form 3: Subplot (5-m radius) - Inventory of Saplings

Field Form 4: Plot (20-m radius) - Inventory of Trees

Field Form 5: List of Interviewees and Tract Land Status and Management

Field Form 6: Forest Management Structure and Forest Threats

List of Philippine Tree Species and their Wood Specific Gravity

Common Name	Scientific Name	Wood Density g/cm³	Source
Abuab	*Lophopetalum javanum* Turcz.	0.40	1
Adina	*Pertusadina multifolia* (Havil.) Ridsdale	0.57	3
African Tulip	*Spathodea campanulata* P. Beauv.	0.31	1
Afu	*Anisoptera thurifera* (Blanco) Blume	0.59	1
Agoho	*Casuarina equisetifolia* L.	0.80	1
Agoho del Monte	*Gymnostoma rumphianum* (Miq.) L.A.S. Johnson	0.86	1
Agosip	*Symplocos cochinchinensis* (Lour.) S. Moore	0.54	1
Akle	*Albizia acle* (Blanco) Merr.	0.51	1
Akleng-parang	*Albizia procera* (Roxb.) Benth.	0.51	1
Alahan	*Guioa koelreuteria* (Blanco) Merr.	0.57	3
Alim	*Melanolepis multiglandulosa* (Reinw. ex Blume) Rchb. & Zoll.	0.34	1
Almaciga	*Agathis philippinensis* Warb.	0.45	1
Almon	*Shorea almon* Foxw.	0.39	1
Alupag	*Dimocarpus longan* subsp. *malesianus* Leenh.	0.70	1
Alupag-amo	*Litchi chinensis* Sonn.	0.80	1
Amayan	*Licania splendens* (Korth.) Prance	0.82	1
Amugis	*Koordersiodendron pinnatum* Merr.	0.61	1
Anabiong	*Trema orientalis* (L.) Blume	0.33	1
Anagap	*Archidendron scutiferum* (Blanco) I.C. Nielsen	0.57	3
Anang	*Diospyros pyrrhocarpa* Miq.	0.64	1
Anilao	*Colona serratifolia* Cav.	0.38	1
Anislag	*Flueggea flexuosa* Müll. Arg.	0.69	1
Antipolo	*Artocarpus blancoi* (Elmer) Merr.	0.43	2
Anubing	*Artocarpus ovatus* Blanco	0.61	1
Anuling	*Pisonia umbellifera* (J.R. Forst. & G. Forst.) Seem.	0.24	1
Apanit	*Mastixia pentandra* subsp. *philippinensis* (Wangerin) K.M. Matthew	0.50	1
Apauang	*Mallotus cumingii* Müll. Arg.	0.49	1
Api-api	*Avicennia officinalis* L.	0.61	1
Apias	*Ficus ampelas* Burm.f.	0.38	1
Apitong	*Dipterocarpus grandiflorus* (Blanco) Blanco	0.67	1
Arangga	*Homalium foetidum* Benth.	0.73	1
Ata-ata	*Diospyros mindanaensis* Merr.	0.65	1
Aunasin	*Ardisia paniculata* Roxb.	0.57	3
Bagalunga	*Melia azedarach* L.	0.46	1
Bagarilao	*Cryptocarya ampla* Merr.	0.57	3
Bagna	*Glochidion triandrum* (Blanco) C.B. Rob.	0.57	3
Bagras	*Eucalyptus deglupta* Blume	0.34	2
Bagtikan	*Shorea malaanonan* Blume	0.51	1
Baguilumbang	*Reutealis trisperma* (Blanco) Airy Shaw	0.43	2
Bahai	*Ormosia calavensis* Blanco	0.43	1
Bakan	*Litsea philippinensis* Merr.	0.57	3
Bakauan	*Rhizophora apiculata* Blume	0.85	1
Bakauan-gubat	*Carallia brachiata* (Lour.) Merr.	0.66	1
Balakat	*Ziziphus talanae* Merr.	0.53	2

Common Name	Scientific Name	Wood Density g/cm³	Source
Balakat-gubat	Balakata luzonica (Vidal) Esser	0.43	1
Balangua	Cryptocarya edanoii Merr.	0.57	3
Balanti	Homalanthus populneus (Geiseler) Pax	0.29	1
Balat-buaya	Fagraea racemosa Jack	0.64	1
Balete	Ficus balete Merr.	0.65	1
Balik	Hydnocarpus heterophylla Blume	0.57	3
Balikbikan	Drypetes longifolia (Blume) Pax & K. Hoffm.	0.62	1
Balinghasai	Buchanania arborescens (Blume) Blume	0.45	1
Balitbitan	Cynometra ramiflora L.	0.79	1
Balobo	Diplodiscus paniculatus Turcz.	0.63	2
Balu	Cordia subcordata Lam.	0.51	1
Balukang	Chisocheton cumingianus (C.DC.) Harms	0.55	1
Banaba	Lagerstroemia speciosa (L.) Pers.	0.55	1
Banai-banai	Radermachera pinnata (Blanco) Seem.	0.46	1
Banato	Mallotus philippensis (Lam.) Müll. Arg.	0.60	1
Bangkal	Nauclea orientalis (L.) L.	0.47	1
Bangkal, Kaatoan	Breonia chinensis (Lam.) Capuron	0.34	1
Bangkal, Southern / Hambabalud	Neonauclea formicaria (Elmer) Merr.	0.57	3
Bansalangin	Mimusops elengi L.	0.82	1
Banuyo	Wallaceodendron celebicum Koord.	0.56	2
Basikong	Ficus botryocarpa Miq.	0.43	1
Basilan Apitong	Dipterocarpus eurhynchus Miq.	0.63	1
Basilan-Yakal	Hopea basilanica Foxw.	0.74	1
Batete	Kingiodendron alternifolium (Elmer) Merr. & Rolfe	0.49	1
Batikuling	Litsea leytensis Merr.	0.34	1
Batino	Alstonia macrophylla Wall. ex G. Don	0.64	1
Batitinan	Lagerstroemia piriformis Koehne	0.50	2
Bayanti	Aglaia rimosa (Blanco) Merr.	0.69	1
Bayok	Pterospermum diversifolium Blume	0.57	1
Benguet Pine	Pinus kesiya Royle ex. Gordon	0.48	2
Betis	Madhuca betis (Blanco) J.F. Macbr.	0.58	1
Binggas	Terminalia citrina Roxb. ex Fleming	0.71	2
Binoloan	Syzygium acuminatissimum (Blume) DC.	0.63	1
Binuang	Octomeles sumatrana Miq.	0.30	2
Bitanghol	Calophyllum blancoi Planch. & Triana	0.46	1
Bitaog-Palomaria	Calophyllum inophyllum L.	0.60	1
Blanco Narig	Vatica umbonata Burck	0.79	1
Boga	Alseodaphne philippinensis (Elmer) Kosterm.	0.57	3
Bogo	Garuga floribunda Decne.	0.51	2
Bokbok	Xanthophyllum flavescens Roxb.	0.69	1
Bolon	Platymitra arborea (Blanco) P.J.A. Kessler	0.57	3
Bolong-eta	Diospyros pilosanthera Blanco	0.65	1
Brazilian fire Tree	Schizolobium parahyba (Vell.) S.F. Blake	0.30	1
Broad-winged Apitong	Dipterocarpus kunstleri King	0.60	1
Bugawak	Melicope confusa (Merr.) P.S. Liu	0.38	1
Bulala (Wild Rambutan)	Dimocarpus fumatus (Blume) Leenh.	0.57	3

Common Name	Scientific Name	Wood Density g/cm³	Source
Bulalog	*Parishia maingayi* Hook.f.	0.51	1
Buntan	*Engelhardtia rigida* Blume	0.42	1
Busain	*Bruguiera gymnorhiza* (L.) Lam.	0.71	1
Cana-Fistula	*Cassia fistula* L.	0.75	1
Caribbean Pine	*Pinus caribaea* Morelet	0.48	2
Dagang	*Anisoptera aurea* Foxw.	0.56	1
Daha	*Macaranga caudatifolia* Elmer	0.57	3
Dalingdingan	*Hopea foxworthyi* Elmer	0.51	1
Dalinsi	*Terminalia pellucida* C. Presl	0.57	3
Dangula (Sasalit)	*Teijsmanniodendron ahernianum* (Merr.) Bakh.	1.03	1
Dao	*Dracontomelon dao* (Blanco) Merr. & Rolfe	0.40	1
Dapdap	*Erythrina variegata* L.	0.57	3
Dita	*Alstonia scholaris* (L.). R. Br. var. scholaris	0.39	1
Duguan	*Myristica philippinensis* Gand.	0.36	1
Duklitan	*Planchonella duclitan* (Blanco) Bakh.f.	0.51	1
Dulit	*Canarium hirsutum* Willd.	0.49	1
Dungon-late	*Heritiera littoralis* Aiton	0.87	1
Durian	*Durio zibethinus* L.	0.52	1
Duyok-duyok	*Manilkara fasciculata* (Warb.) H.J. Lam & Maas Geest.	0.82	1
Earpod	*Enterolobium cyclocarpum* (Jacq.) Griseb.	0.35	2
Ebony	*Diospyros vera* (Lour.) A. Chev.	0.85	1
Gatasan	*Garcinia venulosa* (Blanco) Choisy	0.57	3
Gisihan	*Aglaia leptantha* Miq.	0.64	1
Gisok-Gisok	*Hopea philippinensis* Dyer	0.67	1
Gubas	*Endospermum peltatum* Merr.	0.30	1
Guijo	*Shorea guiso* Blume	0.71	1
Hagakhak	*Dipterocarpus validus* Blume	0.54	1
Hagimit	*Ficus minahassae* (Teijsm. & Vriese) Miq.	0.32	1
Hairy-Leafed Apitong	*Dipterocarpus alatus* Roxb. ex G. Don	0.60	1
Hamindang	*Macaranga bicolor* Muell. Arg.	0.30	1
Haras / Ituman	*Garcinia ituman* Merr.	0.57	3
Hasselt Panau	*Dipterocarpus hasseltii* Blume	0.56	1
Hawili	*Ficus septica* Burm.f.	0.42	1
Highland Panau	*Dipterocarpus hasseltii* Blume	0.56	1
Himbabao	*Broussonetia luzonica* (Blanco) Bureau	0.50	1
Hogs Plum	*Spondias mombin* L.	0.57	3
Igem	*Dacrycarpus imbricatus* (Blume) de Laub.	0.41	1
Ilang-ilang	*Cananga odorata* (Lam.) Hook.f. & Thomson	0.29	1
Ilo-ilo	*Aglaia iloilo* (Blanco) Merr.	0.53	2
Ipil	*Intsia bijuga* (Colebr.) Kuntze	0.72	1
Ipil-ipil	*Leucaena leucocephala* (Lam.) de Wit	0.64	2
Is-is	*Ficus ulmifolia* Lam.	0.38	1
Jatoba	*Hymenaea courbaril* L.	0.59	1
Kaburo	*Phoebe sterculioides* (Elmer) Merr.	0.41	1
Kakawete	*Gliricidia sepium* (Jacq.) Walp.	0.74	1
Kalamansanai	*Neonauclea calycina* (Bartl. ex DC.) Merr.	0.63	1
Kalantas	*Toona calantas* Merr. & Rolfe	0.29	2

Common Name	Scientific Name	Wood Density g/cm³	Source
Kaliantan	*Leea guineensis* G. Don	0.57	3
Kalingag / Cinamomon	*Cinnamomum mercadoi* S. Vidal	0.43	1
Kalios	*Streblus asper* Lour.	0.52	1
Kalulot	*Artocarpus rubrovenius* Warb.	0.57	3
Kalumala	*Rosenbergiodendron longiflorum* (Ruiz & Pav.) Fagerl.	0.57	3
Kalumpang	*Sterculia foetida* L.	0.45	1
Kalumpit	*Terminalia microcarpa* Decne.	0.53	2
Kalunti	*Shorea hopeifolia* (F. Heim) Symington	0.49	1
Kamagong	*Diospyros discolor* Willd.	0.88	1
Kamandiis	*Garcinia rubra* Merr.	0.57	3
Kamatog	*Sympetalandra densiflora* (Elmer) Steenis	0.76	1
Kamiring	*Semecarpus cuneiformis* Blanco	0.57	3
Kamuning	*Murraya paniculata* (L.) Jack	0.87	1
Kanapai	*Ficus magnoliifolia* Blume	0.28	1
Kangko	*Aphanamixis polystachya* (Wall.) R. Parker	0.54	1
Kansulud	*Aglaia argentea* Blume	0.63	1
Karaksan	*Chionanthus ramiflorus* Roxb.	0.67	1
Katagpo	*Psychotria luzoniensis* (Cham. & Schltdl.) Fern. -Vill.	0.57	3
Katap	*Trigonostemon longipes* (Merr.) Merr.	0.57	3
Katmon	*Dillenia philippinensis* Rolfe	0.63	1
Katmon-kalabaw	*Dillenia reifferscheidia* Fern. -Vill.	0.57	3
Kato	*Aglaia cucullata* (Roxb.) Pellegr.	0.60	1
Katong-matsin	*Chisocheton pentandrus* (Blanco) Merr.	0.51	1
Kayatau	*Dysoxylum oppositifolium* F. Muell.	0.76	1
Kayugalo	*Sindora inermis* Merr.	0.57	3
Kubi	*Artocarpus nitidus* Trécul	0.48	1
Kubili	*Cubilia cubili* (Blanco) Adelb.	0.49	2
Kulasi	*Lumnitzera racemosa* Willd.	0.71	1
Kulatingan	*Pterospermum obliquum* Blanco	0.57	3
Kulilisiau	*Cinnamomum philippinense* (Merr.) C.E. Chang	0.57	3
Kuling-manok	*Aglaia luzoniensis* (Vidal) Merr. & Rolfe	0.65	1
Kulispakatan	*Dimorphocalyx luzoniensis* Merr.	0.57	3
Kupang	*Parkia timoriana* (DC.) Merr.	0.34	1
Kusibang	*Sapindus saponaria* L.	0.58	2
Lago	*Prunus grisea* (Blume ex Müll. Berol.) Kalkman	0.55	1
Laloi	*Turpinia sphaerocarpa* Hassk.	0.57	3
Lamio	*Dracontomelon edule* (Blanco) Merr. & Rolfe	0.40	1
Lamog	*Planchonia spectabilis* Merr.	0.58	1
Lanete	*Wrightia pubescens* subsp. laniti (Blanco) Ngan	0.57	3
Langarai	*Bruguiera parviflora* (Roxb.) Wight & Arn. ex Griff.	0.76	1
Lanipau	*Terminalia copelandi* Elmer	0.46	2
Lanutan	*Mitrephora lanotan* (Blanco) Merr.	0.57	3
Lanutan-baguio	*Gonystylus macrophyllus* (Miq.) Airy Shaw	0.47	1
Lanzones	*Lansium parasiticum* (Osbeck) K.C. Sahni & Bennet	0.71	1
Leaf-Tailed Panau	*Dipterocarpus caudatus* Foxw.	0.69	1
Libas	*Spondias pinnata* (L. f.) Kurz	0.34	1

Common Name	Scientific Name	Wood Density g/cm³	Source
Ligas	*Semecarpus cuneiformis* Blanco	0.57	3
Lingo-lingo	*Vitex turczaninowii* Merr.	0.49	2
Lipang-kalabaw	*Dendrocnide meyeniana* (Walp.) Chew	0.57	3
Lokinai	*Dacrydium beccarii* Parl.	0.61	1
Loktob	*Duabanga moluccana* Blume	0.34	1
Ludek	*Ludekia bernardoi* (Merr.) Ridsdale	0.66	1
Luisin	*Maranthes corymbosa* Blume	0.83	1
Lumarao / Apitong baboi	*Swintonia foxworthyi* Elmer	0.62	2
Lumbang	*Aleurites moluccana* (L.) Willd.	0.30	1
Lumbayao	*Heritiera javanica* (Blume) Kosterm.	0.62	1
Lumuluas	*Ziziphus hutchinsonii* Merr.	0.57	3
Lunas	*Lunasia amara* Blanco	0.57	3
Mabunot	*Gomphandra luzoniensis* (Merr.) Merr.	0.57	3
Magabuyo	*Celtis luzonica* Warb.	0.55	1
Maguilik	*Premna cumingiana* Schauer	0.57	3
Mahogany	*Swietenia mahagoni* (L.) Jacq.	0.51	1
Makaasim	*Syzygium nitidum* Benth.	0.74	2
Malaanonan	*Shorea polita* S. Vidal	0.51	1
Malabatino	*Alyxia concatenata* (Blanco) Merr.	0.57	3
Malabayabas	*Tristaniopsis decorticata* (Merr.) Peter G. Wilson & J.T. Waterh.	0.91	2
Malabitaog	*Calophyllum pentapetalum* var. *cumingii* (Planch. & Triana) P.F. Stevens	0.57	3
Malabuho	*Sterculia oblongata* R. Br.	0.22	1
Malabulak	*Bombax ceiba* L.	0.28	1
Malabunga	*Alseodaphne malabonga* (Blanco) Kosterm.	0.57	3
Malaguijo	*Shorea plagata* Foxw.	0.70	2
Malaikmo	*Celtis philippensis* Blanco	0.69	1
Malakadios	*Dehaasia cairocan* (Vidal) C.K. Allen	0.57	3
Malakalumpit	*Terminalia calamansanay* Rolfe	0.50	1
Malakamias	*Ailanthus triphysa* (Dennst.) Alston	0.30	1
Malakapa	*Gymnacranthera farquhariana* var. *paniculata* (A. DC.) R.T.A. Schouten	0.58	1
Malakatmon	*Dillenia luzoniensis* (Vidal) Merr.	0.69	1
Malakauayan	*Podocarpus rumphii* Blume	0.46	1
Malak-malak	*Palaquium philippense* (Perr.) C.B. Rob.	0.46	1
Malalumbaga	*Aglaia elliptica* (C. DC.) Blume	0.66	1
Malamala	*Hancea penangensis* (Müll. Arg.) S.E.C. Sierra, Kulju & Welzen	0.54	1
Malanangka	*Parartocarpus venenosa* Becc.	0.35	1
Malapanau	*Dipterocarpus kerrii* King	0.61	1
Malapapaya	*Polyscias nodosa* (Blume) Seem.	0.32	1
Malapinggan	*Trichadenia philippinensis* Merr.	0.70	1
Malaruhat / Panglomboyen	*Syzygium claviflorum* (Roxb.) Wall. ex A.M. Cowan & Cowan	0.64	1
Malasaging	*Aglaia edulis* (Roxb.) Wall.	0.71	1
Malasantol	*Sandoricum vidalii* Merr.	0.45	1

Common Name	Scientific Name	Wood Density g/cm³	Source
Malatabako	*Solanum verbascifolium* L.	0.57	3
Malatibig	*Ficus congesta* Roxb.	0.57	3
Malayakal	*Shorea seminis* Slooten	0.72	1
Malugai	*Allophylus cobbe* (L.) Raeusch.	0.58	2
Mamalis	*Pittosporum pentandrum* (Blanco) Merr.	0.54	1
Manggachapui	*Hopea acuminata* Merr.	0.54	1
Manggasinoro	*Shorea assamica* var. *philippinensis* (Brandis ex Koord.) Y.K. Yang & J.K. Wu	0.46	1
Manggasiriki	*Lithocarpus ovalis* (Blanco) Rehder	0.57	3
Manggis	*Koompassia excelsa* (Becc.) Taub.	0.69	1
Mangkas	*Planchonella obovata* (R.Br.) Pierre	0.81	1
Mankono	*Xanthostemon verdugonianus* Náves ex Fern. -Vill.	0.57	3
Mapilig	*Xanthostemon bracteatus* Merr.	0.57	3
Marang	*Litsea perrottetii* (Blume) Fern. -Vill.	0.45	2
Maranggo	*Azadirachta excelsa* (Jack) Jacobs	0.51	1
Margapali	*Dehaasia incrassata* (Jack) Kosterm.	0.46	1
Matamata	*Aglaia elaeagnoidea* (Juss) Benth	0.63	1
Matang-araw	*Melicope triphylla* (Lam.) Merr.	0.39	1
Matang-hipon	*Breynia vitis-idaea* (Burm.f.) C.E.C. Fisch.	0.57	3
Matang-usa	*Litsea euphlebia* Merr.	0.57	3
Mayapis	*Shorea palosapis* Merr.	0.42	1
Miao	*Dysoxylum alliaceum* (Blume) Blume	0.57	1
Mindanao Narek	*Hopea brachyptera* (Foxw.) Slooten	0.57	3
Mindanao Narig	*Vatica odorata* (Griff.) Symington	0.79	1
Mindanao Palosapis	*Anisoptera costata* Korth.	0.55	1
Mindoro Pine	*Pinus merkusii* Jungh. & de Vriese	0.54	2
Molave	*Vitex parviflora* A. Juss.	0.70	2
Moluccan sau	*Falcataria moluccana* (Miq.) Barneby & J.W. Grimes	0.37	1
Mt. Tapinag	*Sterculia cordata* Blume	0.32	1
Nangka	*Artocarpus heterophyllus* Lam.	0.49	1
Narek	*Hopea cagayanensis* (Foxw.) Slooten	0.74	1
Narig	*Vatica mangachapoi* Blanco	0.75	1
Narra	*Pterocarpus indicus* Willd.	0.53	1
Nato	*Palaquium luzoniense* (Fern. -Vill.) Vidal	0.55	1
Niog-niyogan	*Ficus pseudopalma* Blanco	0.57	3
Pagatpat	*Sonneratia alba* Sm.	0.51	1
Pagsahingin-bulog	*Canarium asperum* Benth.	0.47	1
Paguringon	*Cratoxylum sumatranum* (Jack) Blume	0.59	1
Pahutan	*Mangifera altissima* Blanco	0.59	1
Pahutan / Malipajo	*Mangifera monandra* Merr.	0.45	1
Paitan	*Syzygium costulatum* (C.B. Rob.) Merr.	0.57	3
Palosapis	*Anisoptera thurifera* (Blanco) Blume	0.59	1
Pamitaogen	*Calophyllum whitfordii* Merr.	0.57	3
Panau	*Dipterocarpus gracilis* Blume	0.60	1
Pandakaking-gubat	*Tabernaemontana pandacaqui* Lam.	0.57	3
Pangi	*Pangium edule* Reinw.	0.50	1
Para Rubber	*Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg.	0.39	1
Philippine Ash	*Fraxinus griffithii* C.B. Clarke	0.60	1

Common Name	Scientific Name	Wood Density g/cm³	Source
Piagau	*Xylocarpus moluccensis* (Lam.) M. Roem.	0.57	3
Pili	*Canarium ovatum* Engl.	0.57	3
Piling-liitan	*Canarium luzonicum* (Blume) A. Gray	0.31	1
Pototan	*Bruguiera sexangula* (Lour.) Poir.	0.74	1
Pulahan	*Lansium parasiticum* (Osbeck) K.C. Sahni & Bennet	0.71	1
Puso-puso	*Neolitsea vidalii* Merr.	0.57	3
Putian	*Alangium javanicum* (Blume) Wang. var. *jaheri* Bloem.	0.73	1
Rain Tree (Acacia)	*Albizia saman* (Jacq.) Merr.	0.49	1
Rarang	*Erythrina subumbrans* (Hassk.) Merr.	0.23	1
Red Lauan	*Shorea negrosensis* Foxw.	0.51	1
Red Nato	*Palaquium obovatum* (Griff.) Engl.	0.55	1
Round-Leafed Apitong	*Dipterocarpus orbicularis* Foxw.	0.57	3
Saguimsim	*Syzygium brevistylum* (C.B. Rob.) Merr	0.57	3
Sakat	*Terminalia nitens* C. Presl	0.58	2
Salakin	*Aphanamixis polystachya* (Wall.) R. Parker	0.54	1
Salinggogon	*Cratoxylum formosum* (Jacq.) Benth. & Hook.f. ex Dyer	0.72	1
Salingkugi	*Albizia saponaria* (Lour.) Miq.	0.57	1
Sandit	*Magnolia philippinensis* P. Parm.	0.57	3
Sangilo	*Pistacia chinensis* Bunge	0.57	3
Santol	*Sandoricum koetjape* (Burm.f.) Merr.	0.43	1
Sinaligan	*Sterculia rubiginosa* Vent.	0.57	3
Spanish Cedar	*Cedrela odorata* L.	0.38	2
Sudiang	*Ctenolophon parvifolius* Oliv.	0.74	1
Supa	*Sindora supa* Merr.	0.56	1
Taba	*Tristaniopsis littoralis* (Merr.) Peter G. Wilson & J.T. Waterh.	0.57	3
Tabau	*Lumnitzera littorea* (Jack) Voigt	0.69	1
Tabigi	*Xylocarpus granatum* J. Koenig	0.57	3
Tabon-tabon	*Atuna racemosa* Raf.	0.67	1
Tagatoi	*Palaquium foxworthyi* Merr.	0.57	3
Tagpo	*Ardisia elliptica* Thunb.	0.57	3
Taingang-baboi	*Gonocaryum calleryanum* (Baill.) Becc.	0.67	1
Takip-asin	*Macaranga grandifolia* (Blanco) Merr.	0.57	3
Taklang-anak	*Garcinia dulcis* (Roxb.) Kurz	0.72	1
Talisay	*Terminalia catappa* L.	0.46	1
Talisay-gubat	*Terminalia foetidissima* Griff.	0.60	1
Taluto	*Pterocymbium tinctorium* Merr.	0.25	1
Tamayuan	*Strombosia philippinensis* S. Vidal	0.70	1
Tambalau	*Myristica glomerata* (Blanco) Kudô & Masam.	0.52	1
Tambis / Malatambis	*Syzygium aqueum* (Burm. f.) Alston	0.57	3
Tan-ag	*Kleinhovia hospita* L.	0.39	1
Tangal	*Ceriops tagal* (Perr.) C.B. Rob.	0.77	1
Tanghas	*Myristica elliptica* Wall.	0.40	1
Tangile	*Shorea polysperma* Merr.	0.51	1
Tanglin	*Adenanthera intermedia* Merr.	0.78	1
Tanguisang-bayawak	*Ficus variegata* Blume	0.31	1

Common Name	Scientific Name	Wood Density	
		g/cm³	Source
Tara-tara	*Dysoxylum cumingianum*	0.72	1
Tawi-tawi Narig	*Vatica rassak* Blume	0.55	1
Teak	*Tectona grandis* L.f.	0.53	2
Thick-leafed Narig	*Vatica pachyphylla* Merr.	0.78	2
Tiagkot	*Archidendron clypearia* subsp. *clypearia* (Jack) I.C. Nielsen	0.32	1
Tiaong	*Shorea ovata* Dyer ex Brandis	0.64	1
Tibig	*Ficus nota* (Blanco) Merr.	0.57	3
Tiga	*Tristaniopsis micrantha* (Merr.) Peter G. Wilson & J.T. Waterh.	0.89	2
Tikas-pula	*Canna indica* L.	0.57	3
Tinaang-pantai	*Drypetes maquilingensis* (Merr.) Pax & K. Hoffm.	0.57	3
Tindalo	*Afzelia rhomboidea* (Blanco) S. Vidal	0.59	1
Tiri	*Gleditsia fera* (Lour.) Merr.	0.57	3
Toog	*Petersianthus quadrialatus* (Merr.) Merr.	0.54	1
Tuai	*Bischofia javanica* Blume	0.61	1
Tubling-kahoi	*Pterocarpus cumingii* (Benth.) Kuntze	0.57	3
Tukang-kalau	*Aglaia pachyphylla* Miq.	0.69	1
Tulo	*Alphitonia philippinensis* Braid	0.40	1
Tungkao	*Glebionis coronaria* (L.) Cass. ex Spach	0.57	3
Ulayan (Oak)	*Lithocarpus caudatifolius* (Merr.) Rehder	0.57	3
Unik	*Albizia philippinensis* Nielsen	0.57	3
Urung	*Fagraea fragrans* Roxb.	0.69	1
Usak	*Neonauclea media* (Havil.) Merr.	0.57	3
Vidal's Lanutan	*Thespesia campylosiphon* (Turcz.) Rolfe	0.48	1
White Lauan	*Shorea contorta* S. Vidal	0.43	1
White Nato	*Pouteria macrantha* (Merr.) Baehni	0.52	1
Whitford Narig	*Vatica whitfordii* Foxw.	0.57	3
Yabnob	*Horsfieldia costulata* Warb.	0.57	3
Yakal	*Shorea astylosa* Foxw.	0.73	2
Yakal-Gisok	*Shorea gisok* Foxw.	0.76	2
Yakal-Kaliot	*Hopea malibato* Foxw.	0.89	1
Yakal-Mabolo	*Shorea ciliata* King	0.89	1
Yakal-Magasusu	*Hopea mindanensis* Foxw.	0.57	3
Yakal-Malibato	*Shorea malibato* Foxw.	0.72	1
Yakal-Saplungan	*Hopea plagata* S. Vidal	0.71	1
Yakal-Yamban	*Shorea falciferoides* Foxw.	0.72	1
Yemane	*Gmelina arborea* Roxb.	0.43	2

1 = ZANNE A. et al., 2009: Global wood density database
2 = REYES G. et al., 1992: Wood densities of tropical tree species
3 = FAO, 1997: Estimating biomass and biomass change of tropical forests

Department of Environment and Natural Resources
Forest Resources Assessment

FORM 1: FIELD ASSESSMENT TEAM AND TRACT CENTER INFORMATION

Tract Number [   ]   **Date of Inventory** (mm/dd/yyyy) [   ]

Team Members	Name	Position	Office	Signature
Team Leader				
Assistant TL				
Team Member 1				
Team Member 2				
Team Member 3				

Additional Members/Local Hire *(write in separate sheet, if necessary)*

Name	Address	Contact No.	Signature

Tract Center Location

Region	[ ]	Barangay	[ ]
Province	[ ]	Sitio	
Municipality/City	[ ]	Elevation (masl)	

Coordinates	Northing (N)	Easting (E)
Target		
Actual		

Reference Points Surrounding the Tract Center

Description* (Tree, Rock, House, Body of Water, etc.)	Bearing/ Azimuth	Distance (m)	Diameter (cm)	Height (m)	Geotagged Photo No.

* Note: If the Reference Point is a tree, indicate the Species Name (in the description), diameter at breast height/ diameter above buttress and merchantable height

Land Cover *(select one)*

Forest	[ ]	Annual Crop	[ ]	Marshland/ Swamp	[ ]
Mangroves		Perennial Crop		Fishpond	
Brushland/Shrub		Open/Barren		Inland Water	
Grassland		Built-up			

Tree Crown Cover *(select one)*

Closed Forest (tree crown cover ≥40%)	[ ]	Open Forest (tree crown cover 10-39%)	[ ]	Non-Forest (tree crown cover <10%)	[ ]

Forest Condition *(select one)*

Old Growth Forest	[ ]	Industrial Forest Plantation	[ ]
Advanced Secondary Growth Forest		Open, Uncultivated Area	
Early Secondary Growth Forest		Open, Cultivated Area	

Remarks/Notes *(description of tract)*

[   ]

Department of Environment and Natural Resources
Forest Resources Assessment

FORM 2: PLOT CENTER INFORMATION AND SUBPLOT (5-m radius) INVENTORY

Tract Number		Plot Code*		Date of Inventory (mm/dd/yyyy)	

*N = Due North; E = Due East; S = Due South; W = Due West

Plot Center Information

Coordinates	N		E		Elevation	

Reference Points Surrounding the Plot Center

Description* (Tree, Rock, House, Body of Water, etc.)	Bearing/ Azimuth	Distance (m)	Diameter (cm)	Height (m)	Geotagged Photo No.

* Note: If the Reference Point is a tree, indicate the Species Name (in the description), diameter at breast height/ diameter above buttress and merchantable height

Land Cover *(select one)*

Forest		Annual Crop		Marshland/ Swamp	
Mangroves		Perennial Crop		Fishpond	
Brushland/Shrub		Open/Barren		Inland Water	
Grassland		Built-up			

Tree Crown Cover *(select one)*

Closed Forest (tree crown cover ≥40%)		Open Forest (tree crown cover 10-39%)		Non-Forest (tree crown cover <10%)	

Forest Condition *(select one)*

Old Growth Forest		Industrial Forest Plantation	
Advanced Secondary Growth Forest		Open, Uncultivated Area	
Early Secondary Growth Forest		Open, Cultivated Area	

Inventory of Standing Deadwood (with diameter of ≥ 5 centimeters)

No.	Species (if recognizable)	DBH (cm)	Height (m)	Azimuth	HD (m)	Remarks

Inventory of Lying Deadwood (with diameter of ≥ 5 centimeters)

No.	Species (if recognizable)	Mid-diameter (cm)	Length (m)	Azimuth	HD (m)	Remarks

Forest Litter

Ground Cover Percentage		Average Depth (cm)	

Remarks/Notes *(description of plot)*

Department of Environment and Natural Resources
Forest Resources Assessment

FORM 3: SUBPLOT (5-m radius) - INVENTORY OF SAPLINGS
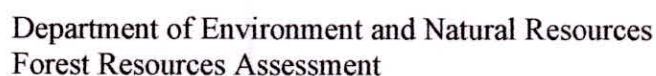
Tract Number		Subplot Code*		Date of Inventory (mm/dd/yyyy)	

*N = Due North; E = Due East; S = Due South; W = Due West

Inventory of Saplings (with diameter of 5-14 centimeters)

No.	Species	DBH (cm)	MH (m)	TH (m)	Azimuth	HD (m)	Stem Quality[1]	Health State[2]	Remarks[3]

[1] Stem Quality: H = high stem quality; M = medium quality; L = low quality
[2] Health State: SLT = slightly affected; STA = strongly affected; DT = dying tree; NA = not applicable
[3] Specify Disease/Damage Causing Element (if applicable)

Page ___ of ___

Department of Environment and Natural Resources
Forest Resources Assessment

FORM 4: PLOT (20-m radius) - INVENTORY OF TREES

Tract Number		Plot Code*		Date of Inventory (mm/dd/yyyy)	

*N = Due North; E = Due East; S = Due South; W = Due West
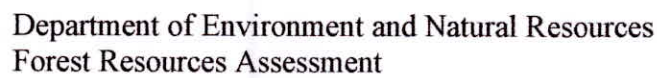
Inventory of Trees (with diameter of ≥ 15 centimeters)

No.	Species	DBH (cm)	MH (m)	TH (m)	Azimuth	HD (m)	Stem Quality[1]	Health State[2]	Remarks[3]

[1] Stem Quality: H = high stem quality; M = medium quality; L = low quality
[2] Health State: SLT = slightly affected; STA = strongly affected; DT = dying tree; NA = not applicable
[3] Specify Disease/Damage Causing Element (if applicable)

Department of Environment and Natural Resources
Forest Resources Assessment

FORM 5: LIST OF INTERVIEWEES AND TRACT LAND STATUS AND MANAGEMENT

Tract Number [   ]   **Date of Interview** (mm/dd/yyyy) [   ]

External Key Informants *(write in separate sheet, if necessary)*

Name	Address	Contact Detail	Affiliation & Position (if any)	Signature

Target Individuals/Groups *(write in separate sheet, if necessary)*

Name	Address	Contact Detail	Affiliation & Position (if any)	Signature

Land Classification *(select one)*

Forest Land [ ]   Mineral Land [ ]
National Park [ ]   Agricultural Land [ ]

Designation/Protection Status *(select one)*

NIPAS – Legislated [ ]   Production Forest [ ]
NIPAS – Initial Component [ ]   Not Applicable [ ]
Protection Forest (outside NIPAS) [ ]

Land Tenure *(select all that applies)*

Ancestral Land – Titled [ ]   Communal Forest [ ]
Ancestral Land – Claimed [ ]   Tenured Forest Land (specify): [ ]
Co-management Area [ ]   _____

Existing Forest Management Plans *(select all that applies)*

Forest Land Use Plan [ ]   Tenure Management Plan or [ ]
Watershed Management Plan [ ]   Other Plan/s (specify):
Protected Area Management Plan [ ]   _____

Remarks/Notes

[   ]

Page ___ of ___

Department of Environment and Natural Resources
Forest Resources Assessment

FORM 6: FOREST MANAGEMENT STRUCTURE AND FOREST THREATS

Tract Number [   ]   **Date of Interview** (mm/dd/yyyy) [   ]

Stand Origin *(select one)*

Natural Regeneration	[ ]	Coppice	[ ]
Planted/Artificial Regeneration	[ ]	Unknown	[ ]

Stand Structure *(select one)*

Single Layer	[ ]	More than three layers	[ ]
Two-layer vegetation	[ ]	Unknown	[ ]
Three-layer vegetation	[ ]		

Silvicultural Practices *(select all that applies)*

Timber stand improvement	[ ]	Enhancement	[ ]
Release of desirable superior trees	[ ]	Sanitary cutting	[ ]
Release of lianas and tropical plants	[ ]	Not applicable	[ ]

Technology for Tree Exploitation *(select all that applies)*

Manual	[ ]	Not applicable	[ ]
Chainsaw	[ ]	Others (specify):	
Mechanized tractors	[ ]	_____	

Disturbance Impact *(select one)*

Undisturbed forest	[ ]	Moderately disturbed forest	[ ]
Slightly disturbed forest	[ ]	Heavily disturbed forest	[ ]

Environmental Problems *(select all that applies)*

Water loss in rivers and other sources	[ ]	Erosion/landslides	[ ]
Drought/El Niño	[ ]	Storms	[ ]
Poor water quality	[ ]	Others (specify):	
Pests/diseases	[ ]	_____	
Earthquake	[ ]		

Fire Occurrence *(if applicable)*

	Year/s	Frequency	Area (in ha)
Underground Fire	_____	_____	_____
Surface Fire	_____	_____	_____
Crown Fire	_____	_____	_____

Anthropogenic Threats *(select all that applies)*

Land use conversion	[ ]	Overharvesting	[ ]
Construction of infrastructure	[ ]	Overpopulation	[ ]
Illegal logging	[ ]	Others (specify):	
Wildlife poaching	[ ]	_____	

Remarks/Notes

[   ]

# Comparison of Existing and Proposed Forest Resources Assessment (FRA) Guidelines

Particulars	Existing FRA Guidelines	Proposed FRA Guidelines
Sampling Design	Systematic and without stratification. The tracts are selected every fifteen (15) minutes latitude and fifteen (15) minutes longitude.	Systematic and without stratification. The tracts are selected every five (5) minutes latitude and five (5) minutes longitude.
Tract Design	The tract/sampling site consists of a square tract measuring 1km x 1km. Each sampling site contains a group of four observation plots. The plots are rectangles with each plot measuring 20m wide and 250 m long. Six (6) nested plots are identified within each plot corresponding to 2 different data collection levels: • Three (3) rectangular nested plots, identified as nested plot level 1, which measures 20m x 10m; and • Three (3) circular nested plots, identified as nested plot level 2, with a radius of 3.99m and used to measure regenerations and small diameter trees.	Each FRA tract consists of nested circular plots clustered on the sample point, i.e., Tract Center. The clustered plots include four (4) plots i.e., Plots North (N), East (E), South (S), and West (W), with their Plot Centers at 40 meters horizontal distance from the Tract Center in the four (4) cardinal directions (north, east, south, and west). The plots have a radius of 20 meters starting from the Plot Center and used for measuring large trees. Each plot consists of a circular subplot, i.e., Subplot North (N), East (E), South (S), and West (W), with a radius of 5 meters starting from the Plot Center and used for measuring small trees (saplings), dead wood, and litter.
Field Inventory Team	The Regional Field Inventory Team shall be composed by at least five people (two technicians and three forestry workers) with the following roles: • Team leader • Team leader assistant • Worker	The Regional Field Assessment Teams (RFATs) shall be composed of at least five people (two foresters and three forestry workers) with the following roles: • Team Leader • Assistant Team Leader • Extension Worker/Interviewer • Mapping Analyst/Geographic Information System Specialist • Data Analyst
Field Work Stages	Field Work Preparation 1. Bibliographic research 2. Contact with forestry services staff 3. Field form preparation 4. Map preparation and access schedule 5. Material preparation Field Work	Field Work Preparation 1. Bibliographic research 2. Preparation of maps 3. Initial site coordination 4. Preparation of printed field forms and maps. 5. Preparation of field tools and equipment. Field Implementation

Comparison of Existing and Proposed Forest Resources Assessment (FRA) Guidelines

| Particulars	Existing FRA Guidelines	Proposed FRA Guidelines

	1. Interviews
	    ■ Key external informants
	    ■ Target groups
	2. Measurement and field observations
	    ■ Access to the first plot
	    ■ Plot marking
	    ■ Variable measurements
	    ■ Access to the next plot
		1. Introductory meeting with site stakeholders
		2. Field socioeconomic and biophysical data gathering (interchangeable depending on the availability of interviewees and hired workers).
		3. Quality assurance
		
		Data Analysis and Processing
		1. Data encoding
		2. Volume computation
		3. Biomass computation
		4. Quality control

Inventoried Variables	Biophysical ■ Land Cover and land classification ■ Small trees/saplings (DBH/DAB of 5-14 cm) ■ Standing dead wood ■ Lying dead wood ■ Large trees (DBH/DAB of ≥15 cm) Socioeconomic ■ Land status and management ■ Forest management land structure ■ Potential forest threats ■ Forest products and forest services ■ Population ■ Proximity to Structure	Biophysical ■ Land Cover and land classification ■ Forest Condition ■ Tree Crown Cover ■ Small trees/saplings (DBH/DAB of 5-14 cm) ■ Standing dead wood ■ Lying dead wood ■ Litter ■ Large trees (DBH/DAB of ≥15 cm) Socioeconomic ■ Land status and management ■ Forest management structure ■ Potential forest threats
Field Forms	1. Information 2. Tract 3. Plot 4. Sub-plot (land use/forest type)/Trees and stumps ≥10 cm diameter 5. Edaphic and topographic measurement points/nested plots 2 6. Products and services	1. Field Assessment Team and Tract Center Information 2. Plot Center Information and Subplot (5-m radius) Inventory 3. Subplot (5-m radius) - Inventory of Saplings 4. Plot (20-m radius) - Inventory of Trees 5. List of Interviewees and Tract Land Status and Management 6. Forest Management Structure and Forest Threats

Comparison of Existing and Proposed Forest Resources Assessment (FRA) Guidelines
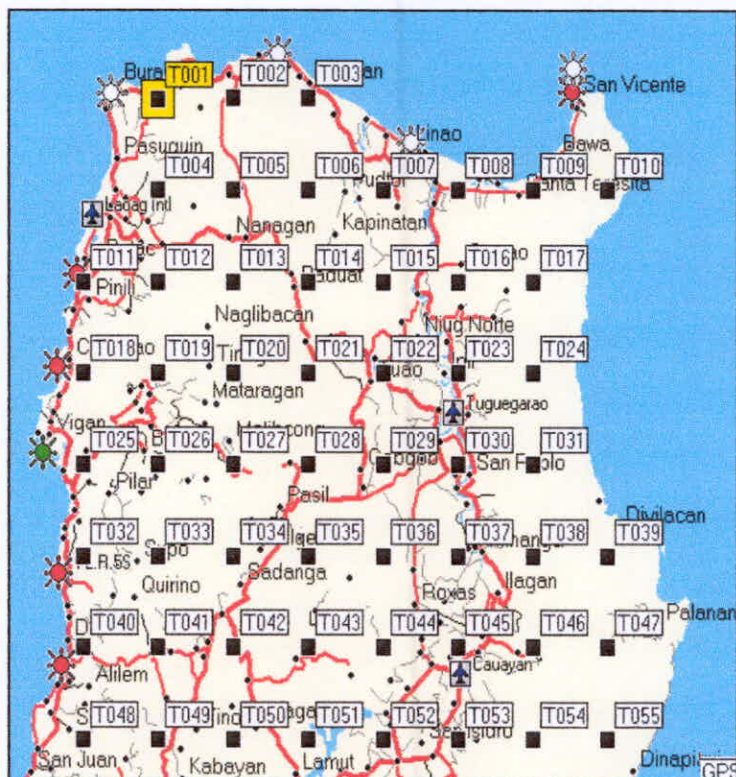
Existing Design:

Tracts are selected every fifteen (15) minutes latitude and fifteen (15) minutes longitudes.
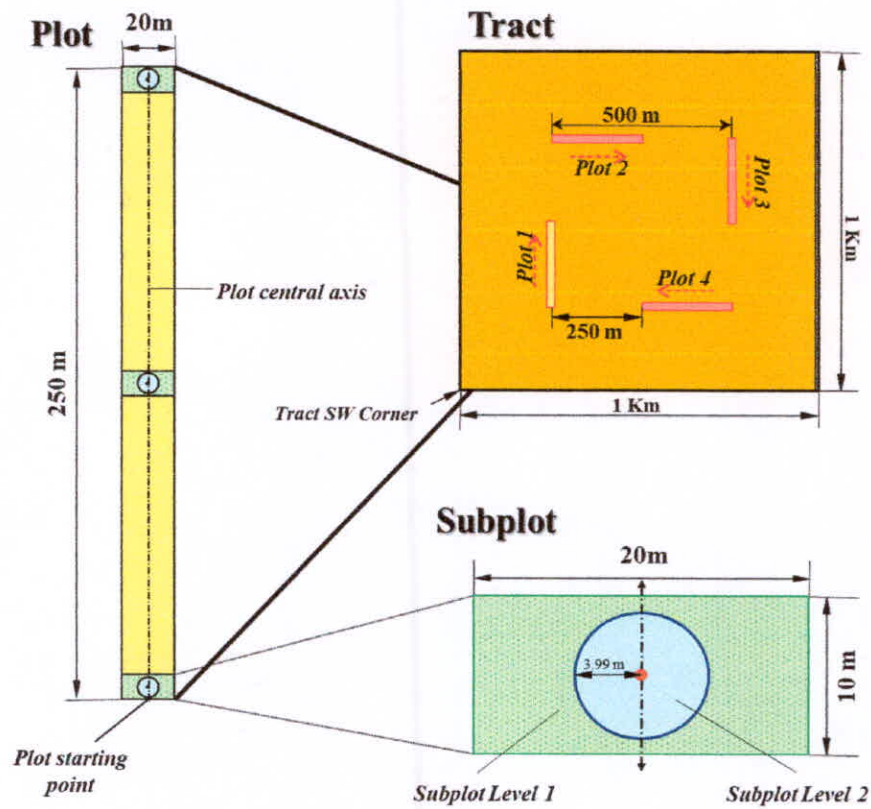
Total tracts: 395.
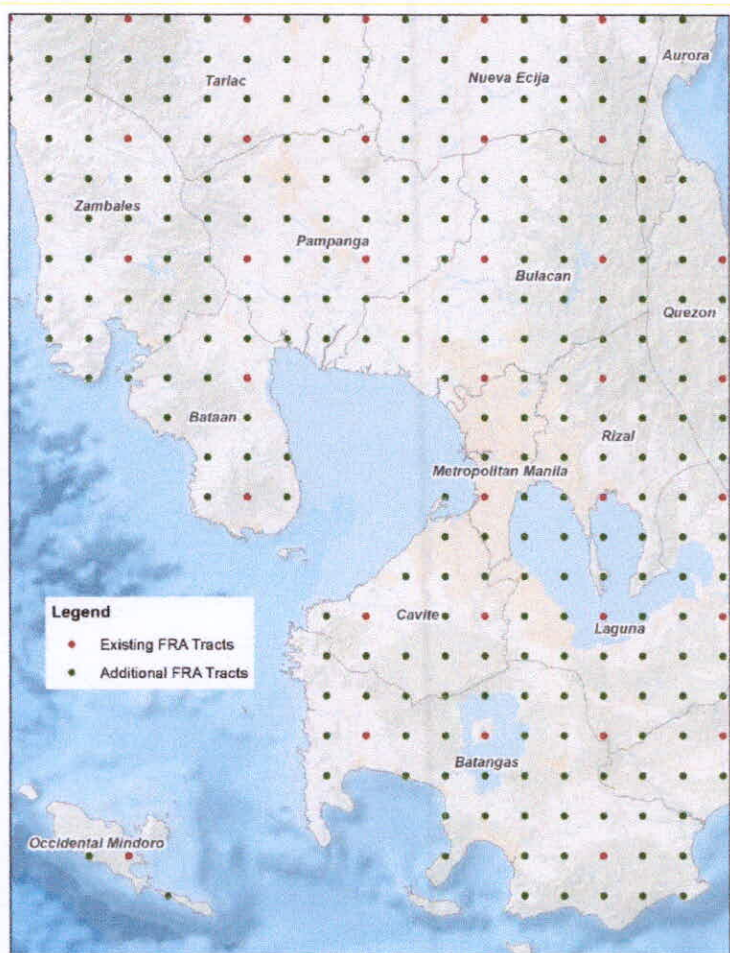
Proposed Design:

Tracts are selected every five (5) minutes latitude and five (5) minutes longitudes.

Total tracts: 17,550.

Comparison of Existing and Proposed Forest Resources Assessment (FRA) Guidelines

Existing Design: Rectangular nested plots.

Plot

20m

250 m

Plot central axis

Plot starting point

Tract

500 m

Plot 2

Plot 3

Plot 1

Plot 4

250 m

1 Km

1 Km

Tract SW Corner

Subplot

20m

3.99 m

10 m

Subplot Level 1

Subplot Level 2

Proposed Design: Circular nested plots.

N

W

40 m

40 m

E

TRACT CENTER

S

PLOT (20m radius)

SUBPLOT (5m radius)

5 m

20 m

PLOT CENTER