UN-REDD
PROGRAMME

The United Nations Collaborative Programme
on Reducing Emissions from Deforestation and
Forest Degradation in Developing Countries

PARTICIPATORY CARBON MEASUREMENT
GUIDELINES FOR LOCAL PEOPLE AND FIELD STAFF

2010

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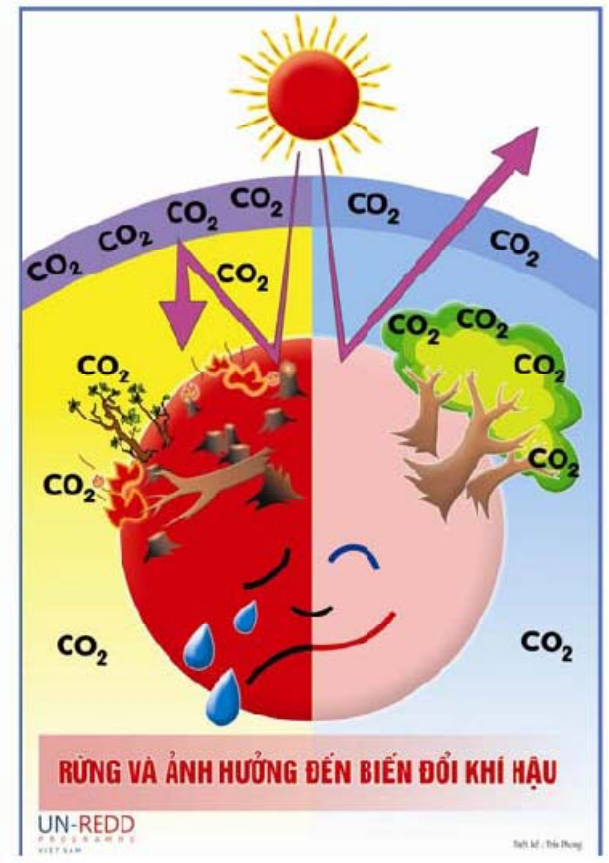
Part I : Introduction on the Participartory Carbon Measurement

1.1 Why participatory carbon measurement?

Climate change and forest role:

Climate change has being happened, including floods, droughts, unusual storms which cause unexpected consequences for people, of which Vietnam is considered as a heavily influenced country. Climate change has affected us everyday, everywhere that we can see. Thus reducing climate change is very important, of which includes to better manage the forests



Source: UN-REDD Vietnam

Forest-related climate change on both sides: positive and negative

i) **Positive:** forests can store carbon and absorb CO_2 and as a main gas causing climate change.

ii) **Negative** (due to human activities): deforestation, burning of forests, conversion of forest into other lands, and so on have made carbon emissions in the trees turn back again into the air under term of CO_2 which increase climate change. In recent years, particularly deforestation and forest degradation have contributed 20% of the gas causing the greenhouse effect and climate change.

Therefore monitoring of forest and forest carbon resources along with finding the causes of forest loss and degradation to better manage and protect are very necessary.

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REDD program to reduce deforestation – to mitigate climate change

Program "Reducing from Deforestation and Forest Degradation - REDD" is being launched in Vietnam as well as around the world. The program aims at reducing deforestation which is cause of loss of biodiversity, reduction of the protective function of forests, and cause of gas emissions including CO_2. Reduction of CO_2 emissions from forest degradation and deforestation will be compensated through the protection and sustainable forest management. This will help to store carbon well as to increas CO_2 absorpted by forests thank to biomass growth.

Why forest carbon needs to be inventoried:

For selling carbon credits forest owners, community, and local people should have database of information on forest resources, biomass, stored carbon, and CO_2 absorpted by their forests over time. Update this data should be periodically managed, monitored and measured.

Why participation of local people, local officials in forest carbon credits inventory is necessary:

Approach of inventory, monitoring biomass and forest carbon stocks in national REDD programs will be divided into two main levels:

i) **Baseline level:** At local level, households, community forest, households protecting forest under constract, and forest management agencies are the implementing people. Inventory at local level aims to provide original data of forest area and forest attributes to management agencies. This data will then be converted into carbon stored by the forest over time.

ii) **Management level:** At the provincial, regional and national levels, the appropriate agency tasked to consolidate the data from the local level, and determine changes in forest area and forest carbon stocks for each ecological region. They will prove emission reduction from forests to negotiate with international organizations. This will help to attract back payment for people who have protected, managed the forest and inventoried forest carbon.

Participatory forest carbon is conducted at the local level, in which the role of people who manage and protect forests and forest owners play the central part. This is of the following reasons:

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- **Human resources:** Data on changes in forest area and forest carbon pools of all forests throughout the country should be provided regularly. The workload is huge, thus, the management agency and forest inventory agencies will not have enough resources to do this. Consequencetly, attracting the participation of households, communities and forest owners in monitoring and measurements should be high considered.
- **Benefit:** Households, communities, forest owners will be paid and compensated, hence, they are also people that provide information area and carbon in forests under their management.
- **Transparency of information and data**: In order to sell forest carbon credits in the forests are well managed, the original data must come from people who have protect and manage. Through intermediate is not accepted.

It is the major reasons that needs to involve the community and forest owner in forest carbon inventory when joining the national REDD program.

1.2 What are forest factors measured

Two objects should be measured and monitored:

i) Monitoring changes in forest area under their management:
Including:

- Forest area under management boundaries
- Area of deforestation, afforestation

ii) Inventory factors to estimate forest carbon storage and CO_2 absorption:

There are 6 carbon sinks in the forest, including:

i) Above ground tree,
ii) Shrubs – herbs grass – NTFPs;
iii) Litter;
iv) Dead wood;
v) Root and
vi) Soil.

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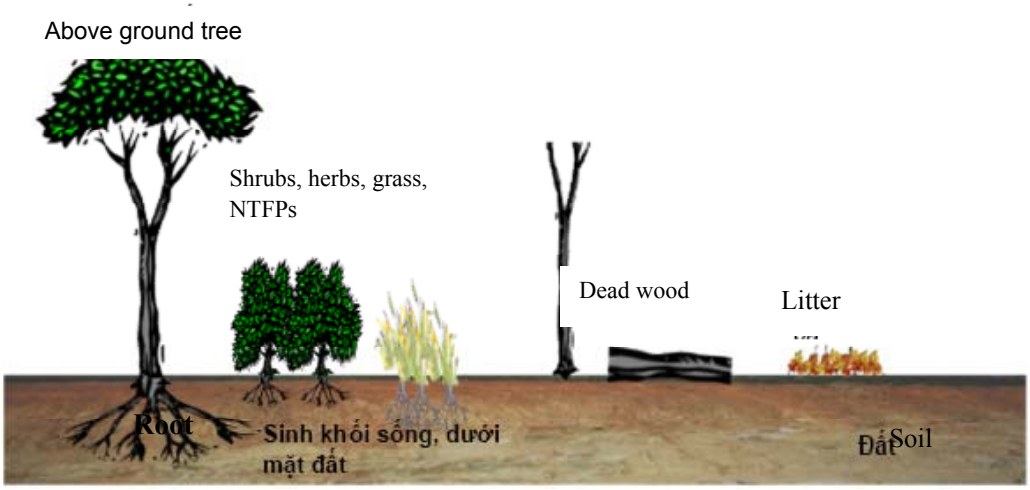

Source: WinRock, 2010

Threfore monitoring forest carbon should be measured by periodic changes of 6 carbon pools.

For measuring carbon at local level, measurement of simple indicators for every pool is required. This facilitates the local people and forest owner can easily measure and calculate. Nevertheless, it is the importance to provide background information for calculating carbon stocks for the nationwide through the transformation mathematical models

- ✓ **Above ground tree and bamboo:** DBH, species or adding tree height (H) measured to specify biomass of woody tree above ground and carbon. For bamboo, DBH, average of H and density should be recorded to predict biomass and carbon.
- ✓ **Shrub, herb, grass and NTFPs:** The factor for measurement is fresh biomass which are brought to the laboratory to determine moisture content, from which total dry mass and carbon can then be calculated.
- ✓ **Litter:** The factor for measurement is litter, and is brought to the laboratory to determine moisture content, from which total dry mass and carbon can then be calculated.
- ✓ **Dead tree:** The factor for measurement is their weigh and volume. Their sample is used to determine dry biomass and carbon.
- ✓ **Root of tree and bamboo:** It is impossible to directly measure biomass of the root, thus, this factor is not measured. However below biomass and carbon in root can be calculated by two ways: i) through the models or ii)

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Through rate of 20% of above ground tree biomass (AGTB).

- ✓ **Forest soil:** To inventory carbon in soil (Soil organic carbon-SOC), soil bunk density should be defined (ρ), soil thickness layer (d) and soil sampling to analysis rate % carbon in soil.

With the measured simple criterion above in 6 carbon pools, it is possible for local people and forest owners to conduct at the local. Furthermore, it is sufficient database to provide professional and management institutions to convert into forest carbon over time.

1.3 How to measure forest carbon?

The methodology and procedures to be used to estimate carbon stocks and their changes over time in forests are simple step-by-step procedures using standard carbon inventory principles and techniques.

Accordingly, forest carbon is calculated with participation of commnity, forest ownners. This procedure provides only basic data such as area changes of forest status, forest owners, households. Additionally, data to conver to carbon for monitoring forest carbon changes in the sinks is involved.

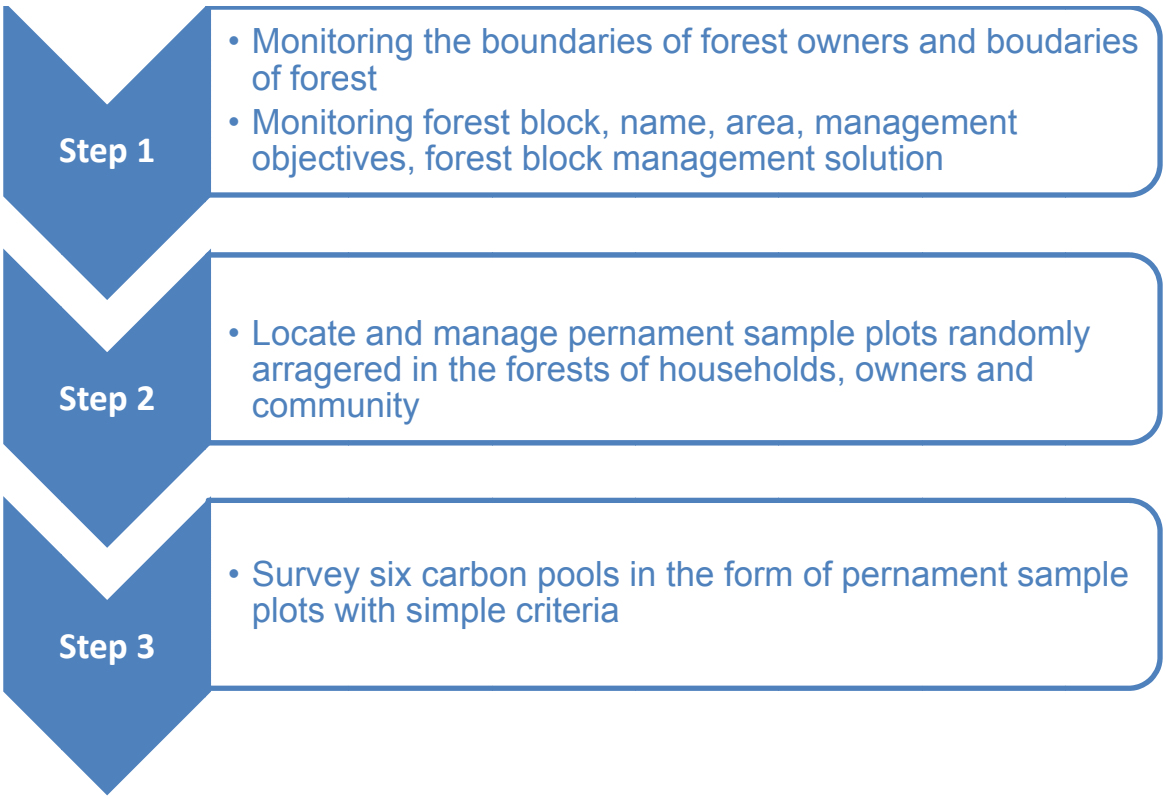

Figure 1: Process of data collection at the local level for monitoring carbon stocks

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Part II: Procedure of Participatory Carbon Measurement at local level

Step 1: Monitoring boundaries of forest owners, foresl block, setting management objectives and solution

Objectives

- To monitor deforestation and degradation at forest management units.
- To stratify the forests into homogeneous forest blocks (stratum) in order to easily inventory and assess forest recourses, carbon, band to plan forest management.

Results

- Forest of forest owners are assessed boundary and reflected on map
- The forest blocks that homogeneous status is named according to local, status, the area of each block and management objectives

Preparation, materials

- Topographic map at scale 1:10,000 – 1:25,000
- Topographic map and forest maps are interpreted/classified at scale 1:10.000 - 1:25,000 using satellite imagery or air photos.
- GPS for checking boundary of forest boundary of the forest owners
- Transparency paper (enough to cover maps) with pin
- Pen writing table to write on transparency paper and permanent marker to delineate map; alcohol and cotton to wipe the wrong markings.
- Compass to orient the map

Implementation

Forest status map, the forest boundaries would be provided by specialized agencies to forest owners and community. Based on these, monitoring the boundary, and the area is performed periodically.

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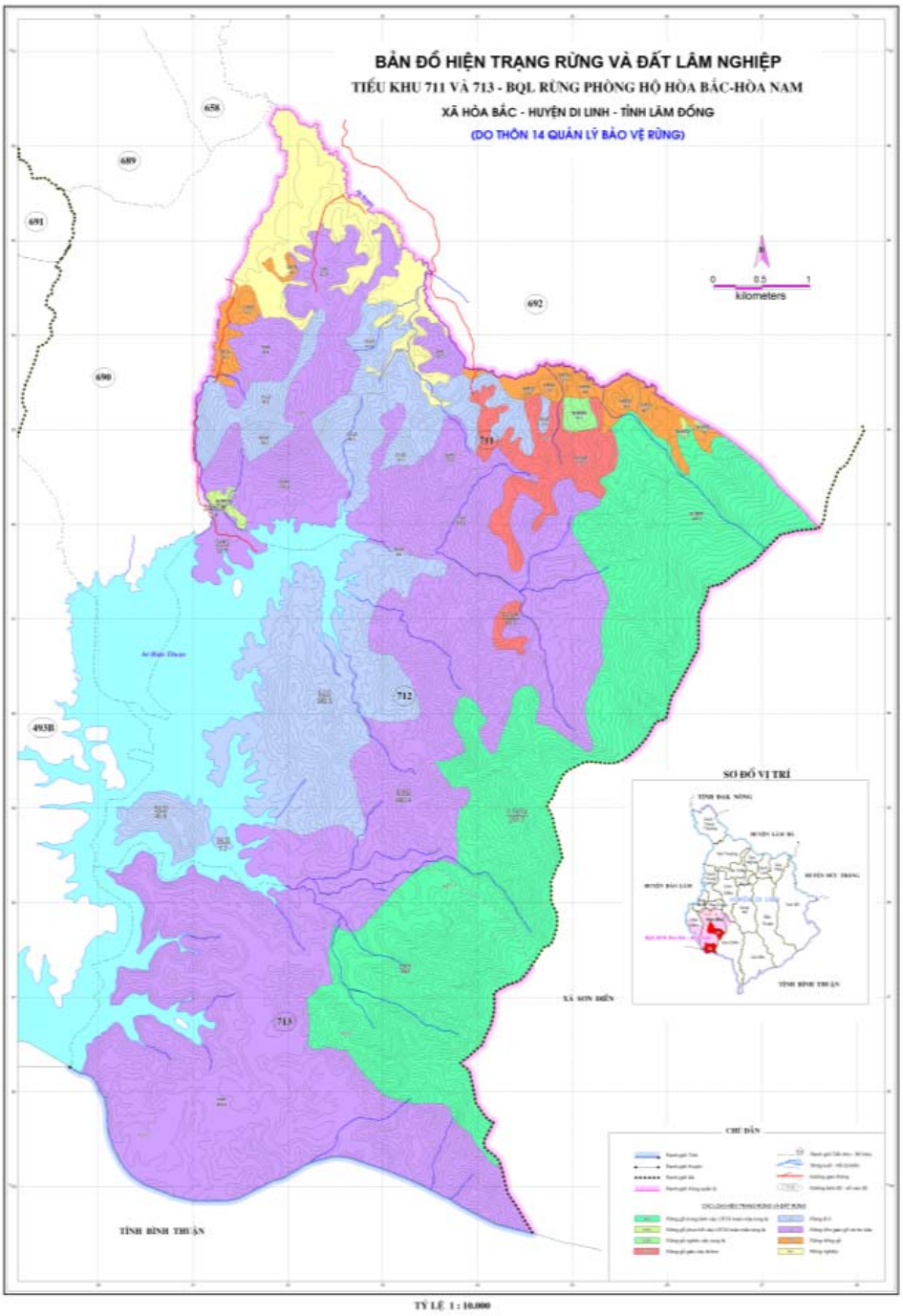

Figure 2: Forest status map referenced to Vn2000 in Village 14, Hòa Bắc – Hòa Nam commune (Hòa Bắc – Hòa Nam protective forest management board, Di Linh district)

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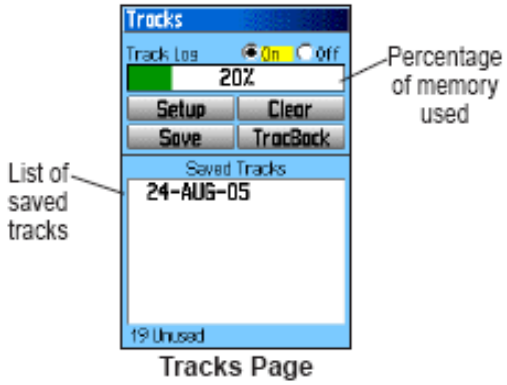
i) Checking and monitoring the forest boundary, the forest status, forest block

The forest boundaries of owners, forest status, and forest blocks are showed on the forest status map. However, in REDD program, the monitoring of forest area changes should be periodically performed by forest owners, local community who manage and protect the forests. The steps is detailed as following:

- Establish a key group of farmers along with member of management board of community forests, protective forest management board, and forestry companies with about 7-10 people
- Map oriented to north is asked. Place cellophane over the map and use pins to temporarily hold on a flat surface. Using the temporary marker pen redrawn roads, stream/river and forest boundaries of forest owners. The forest owner and local people are encouraged to delineate. They also are shown that their errors markings can be removed.
- Forest boundaries of owners are checked then. Forest status is defined based on experience of local people. If the forest boundaries of owners or forest status are different from the forest map, the delineation of the different areas is necessary. In this case, track function in GPS is used while DNR Garmin is employed for transferring data from GPS to GIS map. The forest areas which changed digitized afterward.

The following is introduction of GPSmap 60CSx for use of area delineation

GPSmap 60CSx



Track function of GPS

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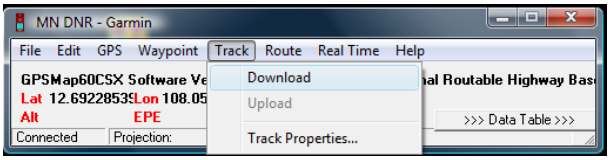
- Press Menu twice to assess Tracks and press Enter
- Using Clear button to delete all existing old tracks
- Record the path by travelling with GPS around the area which needs to delinate
- Press Save button to store the result, to name the delinated area

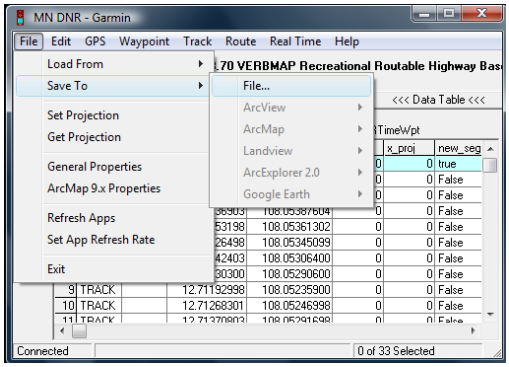
Saved Track Page

Technical staffs wil use DNRGarmin to download track data from GPS in GIS map (possible for both coordinates of UTM and Vn2000)

- Connect GPS and GIS through DNRGarmin: GPS/Auto Connect to GPS
- Download Track (Delineate variable areas in GIS): Track/Download
- Save in shape file format to be compatible with GIS software like Mapinfo, ArcGIS: File/Save to (select type of file in *shape file). This file is opened in GIS to modify the changes of forest area.



Download tracks from GPS through DNR



Save the tracks in shape file in DNR

In this step: local people, forest owners delineate changed areas of forest status. They then transfer the data to management level for updating.

ii) Determine objectives of management, issues in management of forest blocks in the location, and statistic of area of forest blocks

REDD is not only calculating and monitoring area and sinks of carbon stocks but also showing risks of forest degradation and disappearance along with specific solutions from the local level. Thus prior to inventory and monitor in each forest block, discussion should be done so that the community and forest owners can perceive and co-agreement within the community and owners on solutions in coming time to better manage and protect the forest.

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- Based on delineations of forest boundaries and blocks are completed, the forest owners and local people are asked to name their forest blocks on the maps map of the line drawing, line the entire forest and the forest plot; ask people, forest owners to discuss the naming of each lot up on the map. Use of place names familiar to local people as names of rivers, streams, mountains, hills, common local names are encouraged. Since then the forest blocks in management and monitoring areas of carbon stock are calculated.

Table 1: Statistics of forest blocks in homogeneous status

No.	**Sun-zone**	**Sub-sub-zone**	**Block name**		**Forest status**		**Area (ha)**	**Objective management of forest owner**
			Technicians	Local	Technicians	Local		
Total	**Number of sub-area**	**Number of sub-subarea**	**Number of blocks**				**Area**	

- On the basis of each block with its name, status, area, position on the map, discussion of key famers and forest owners is taken place to descript and specify their management objectives of the forest blocks such as: for timber?, firewood?, NTFPs?, shoot bamboo?, protection of water? or Sacred Forest? and so forth. The problems, orportunity, and solution for their forest blocks should be discussed.

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Table 2: Identify management objective for the forest block

Block name/Block code			
Management objective			
Problem/difficulty			
Opportunity			
Solution			

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Step 2: Locate and manage system of randomly arranged permanent sample plots

Objectives

- Forest owners, local people can identify and manage the system of randomly arranged permanent sample plots for measuring carbon

Results

- The permanent sample plots will be presented and managed on map and field for long time
- Randomly arranged permanent sample plots will be indentified in the field

Preparation, materials:

- Map of permanent random sample plots in forest status of the forest management unit
- Coordinates of random sample plots are uploaded in GPS

Implementation

i) Management of system of random plots by the forest status on the map

To ensure objectivity in the monitoring of carbon storage, sample plots in each forest status should be randomly arranged on a map with coordinates of every known plot. They are considered as a basis for determining positions in the field where forest tree and biomass are measured to estimate and monitor changes of forest carbon. The arrangement of random sample plots for each area are performed by specialized agency. Then they have to provides forest owners, local people. Arrangement of pernament sample plot for individual area is done by specialized agencies. The result will furnished to local people and forest owner.

The number of permanent sample plots is dependent on the size and types of forest stratum. Plots used must be of the same size as those used in the pilot survey. A map with coordinates of random sample plot is provided to all forest units for using in the management of permanent sample plots.

i) Locate the random sample plots to determine in the field

The results will give a random sample plot system on the map and their point has

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been transferred to GPS. Thence, use of function of “goto” of GPS to go right position of each plot in the field.

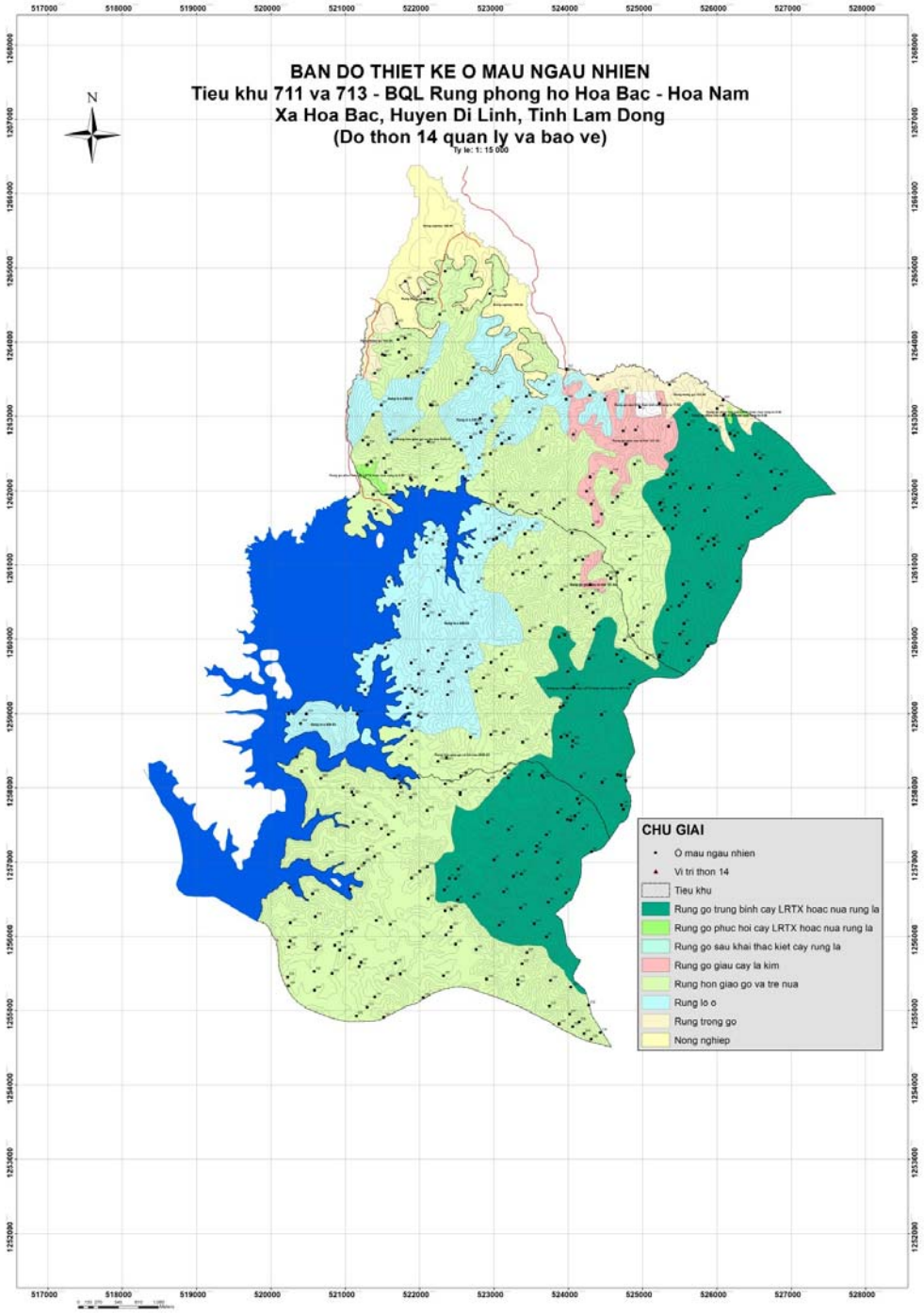

Figure 3: Map located random sample plots belong to forest startum in Village 14, Hòa Bắc commune (Hòa Bắc – Hòa Nam protective forest management board, Di Linh district)

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Step 3: Permanent Pilot Measurement

Objective:

Set up a system of random sample plot which fixed on the field to collect relevant data to convert to forest stored carbon and absorbed CO_2 periodically

Result:

- The random permanent plots are fixed landmark to periodically inventory.
- Data on forest resources are obtained to be able to convert to biomass, carbon in the sample plots according to the forest status, forest blocks and are repeated periodically.

Preparation, materials

- Establish key groups of farmers and technical staff of the forest management agencies (especially those who know the forest). Each group has five people, 4 farmers and one technical staff.
- Forest status maps, topographical maps and forest block map at 1:10.000 scale.
- Transparency paper (enough to cover maps) with pin
- Pen writing table to write on transparency paper and permanent marker to delineate map; alcohol and cotton to wipe the wrong markings
- Ruler 50cm to make the grid cell for permanent plots
- Compass to orient the map
- GPS for locating sample plots
- Tape for making sample plot
- Diameter measuring tape
- Sununto clinometer
- Chalk for marking on the tree
- Iron board for recording number sign of tree
- Iron board for recording number sign of sample plot
- Hammer, nails to hammer board on the tree
- Paint to paint the number sign of sample plots
- Frame of 50x50cm to establish sub-sample to measure litter, grass, herb, and shrubs
- Tool for soil bunk density
- Packaging for containing fresh branches to weight

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- Scales 12 - 20 kg to weight biomass of grass, shrub, herb, litter, and branches
- Electronic scale 200 g, accurate to 0.1g to weight sample of fresh and rotten carpet, and soil
- Knife for cutting foliage
- Shovel to dig the soil sample
- Packaging for soil sample, biomass specimen
- Color carr
- Nilon bags
- Spreadsheet for recording inventory factors

Performance

i) Arrangement of sample plot in the field

The plots' coordinates are loaded into the GPS. Use navigation function of GPS along with compass to determine centre position of the sample plots which are randomly chosen in individual forest status. Cemented or wooden pillars marked with permanent paint are used to fix the centre of each plot permanently, on the pillars are written Vn2000 coordination of the sample plot, number code of sample plot. The marking in the centre of the plots has proved to be very valuable in annual monitoring as GPS alone could give a few meters of difference in locating the centre of the permanent plot for subsequent measurements.

Use of GPS: Press button Find/Waypoint, then select plot number sign which needs to access and select Go to

ii) Design sample plot (shape, size) according to forest types:

The shape and size of plot depend on density of forest trees and forest type.

Forest carbon measurement can be carried out in both rectangular and circular plots. Nevertheless, circular samples are recommended for the study because they are relatively easy to establish. The radius of plot is dependent on the density of the forest and each of diameter.

In addition some sub-plots are divided to measure trees of different sizes according to principle of the larger diameter trees, the lower density and size of sub-plots should be larger and vice versa. This will reduce labour but still ensure a number of trees per area unit of the sample according to the principles of statistics.

Below is the form and size of the permenant sample plot suggested for participatory

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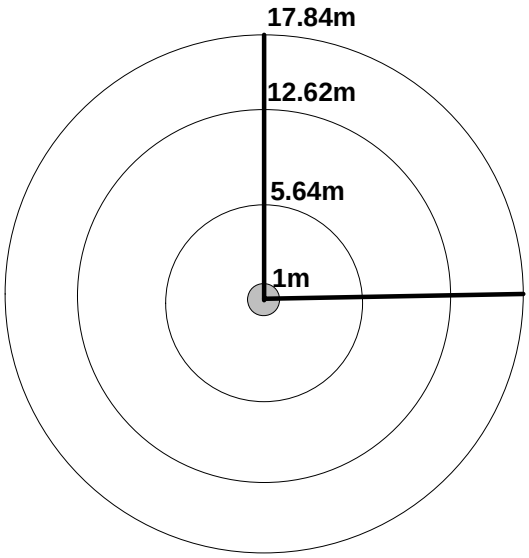
carbon measurement in Vietnam:

- ***Type of evergreen, semi-deciduous, dipterocarp, and pine forest:***



17.84m radius plot to measure tree ≥ 50cm DBH

12.62m radius sub-plot to measure tree 30 cm ≤ DBH < 50cm

5.64m radius sub-plot to measure tree 6 cm ≤ DBH < 30cm

1m radius sub-plot to measure tree DBH < 6 cm

Figure 4: Sampling design of circular plot with 1000m^2 of plot size

Note the sign survey factors:

- DBH: Diameter at breast height in 1.3m high position from the foot of tree; unit is centimeter (cm)
- H: tree height, unit is meter (m)
- A: tree age (year)
- N: tree density (tree/ha)

Using circular plot divided into sub-plots with different sizes depending on the tree diameter classes:

- ✓ 17.84m radius circle plot with an area of 1000m2: Measurement of timber trees ≥ 50 cm DBH
- ✓ 12.62m radius circle sub-plot with an area of 500m^2: Measurement of the tree with 30 ≤ DBH <50 cm
- ✓ 5.64m radius circle sub-plot with an area of 100m^2: Measurement of the tree with 6 cm ≤ DBH <30 cm
- ✓ 1m radius circle sub-plot with an area of 3.14m^2: Measurement of the tree with DBH ≤ 6 cm and record of dead wood
- ✓ 4 sub-plots 50x50cm square with an area of 0.25m^2:

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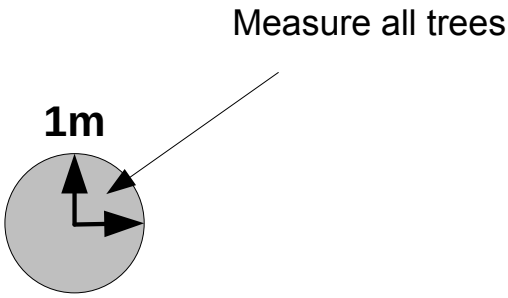
How to design circular sample plot and sub-plot:

- Prepare a knotted rope in the range of colors in the radius of the sub-plots, respectively, 1m, 5.64m, 12.62m and 17.84m. So there are 4 positions determined by the band of colors, each color for each location. To conduct a sub-sample, it needs at least two such ropes, preferably 4 ropes.
- One by one set of sub-plot from small to large: sub-plot with radius of 1m, 5.64m, 12.52m and 17.84m
- The center position of the plot is identified and marked. A fixed-suspended table is used to indicate the number sign and coordinates referencing to Vn2000.



- For first sub-plot, there are at least 4 positions, respectively to 4 segments, is specified. The first is the knot with a radius of 1 meter; landmarks and tie the color band at that position and record the radius. Then the second rope is pulled in a clockwise direction at an angle from 45 to 90^0 and also mark the position of the radius of the sub-plots and color band that is uniform with the same sub-plot radius size. Landmark and the radius of sub-plot are shown. All woody trees from the smallest to largest are measured in the first segment in 1m radius sub-plot. Moving the first rope in a-clockwise by 45 to 90^0 and marked with colored strips; landmarks, recording radius. Keep doing this until the circle is closed.

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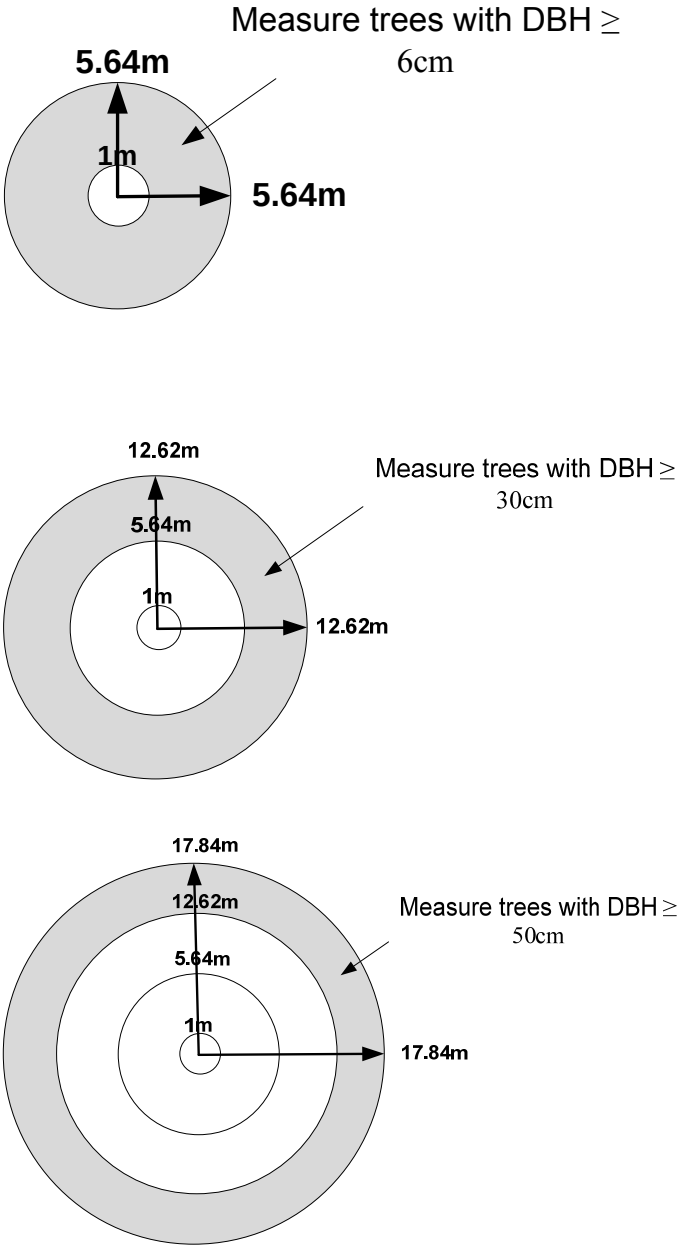
- The remaing sub-plots with radius of 5.64m, 12.62m, and 17.84m are done in a similar way. However, measurements are done only in the area extending from a radius of 1m - 5.64m; 5.64m - 12.62m, and 12.62m - 17.84m, respectively. Trees in each sub-plot are separately recorded in individual segments within the sub-plot:

  - For 5.64m radius sub-plot, only trees with DBH ≥ 6 cm are measured.
  - For 12.62m radius sub-plot, only trees with DBH ≥ 30 cm are measured.
  - For 17.84m radius sub-plot, only trees with DBH ≥ 50 cm are measured.



Note:

- The radius locations of the all sub-plots from small to large are fixed landmarks and tied with different color bands. Radiuses of the sub-plots are inscribed so that later surveys can be repeated.
- Slope correction: While placing a permanent sample plot, care must be taken to do a correction for any slopes in the area. A Clinometer can be used to measure slope angles. A chart with horizontal distances calculated according to the slope angle could be taken to the field. (Attached in Annex). Slope is defined by Clinometer Sunnto.

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- ✓ 4 sub-sample 50x50cm square with an area of 0.25m^2: Used to collect the volume of grass, herb, bushes, non-timber forest products, litter and soil samples in 30 cm thick layer. The 4 sub-plots should be placed outside the sample plot. In the first inventory, they should be placed in 4 directions of north, south, east, and west adjacent to the circular plot. In the latter survey, the directions will spin clockwise down under 45^0.

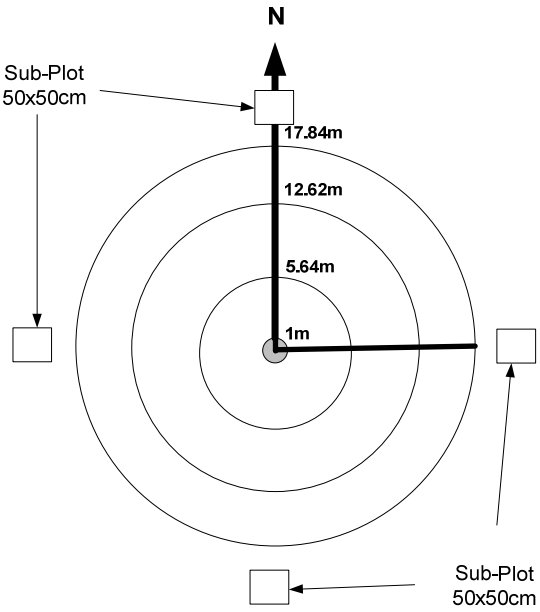

Figure 5: Location of 4 sub-plots 50x50 cm for measuring biomass of LHG and soil

The distributed diameter classes above are consistent with the diameter class of the in volume tables which used for statistics of volume of currently Vietnamese forest with 4cm in intervals of DBH. Tree diameter for measuring is ≥ 6cm; tree with DBH < 6 cm is considered as regeneration tree.

- ***Bamboo forest:***

For the bamboo forest, the sample size is 100m^2, a circle sample with a radius of 5.64m used to measure the bamboo and 4 sub-plots with 50x50cm employed to measure litter, grass, herb, and shrub biomass (LHG), soil samples are taken in soil layer of 30 cm depth like wood forest surveys.

- ***Mixed woody – bamboo forest:***

For this forest type, both two groups of wood and bamboo are measured. The measurement of woody tree in the circular plot with an area of 1000m^2 divided into sub-plots according to diameter classes. Bamboo is measured separately in the plot size of 100m^2 with a radius of 5.64m as bamboo forest only. Dead wood are measured in 1 meter radius circular sub-plot. Similar to 2 forest types above, 4 sub-plots 50x50cm employed to measure litter, grass, herb, and shrub biomass (LHG), soil samples are taken in soil layer of 30 cm depth like wood forest surveys.

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- ***Plantation forest:***

For this forest type, the measurement of the tree is done in 500m^2 circular plot with a radius of 12.62m as maximum diameter of the plantation forest is not exceeding 50cm. Dead trees, fallen branches were measured in the circle sub-plot with 1 meter radius while 4 sub-plots with 50x50cm are set to measure the fresh biomass such as grass, herb, shrub, and litter. Soil profile with 30cm deep is also collected.

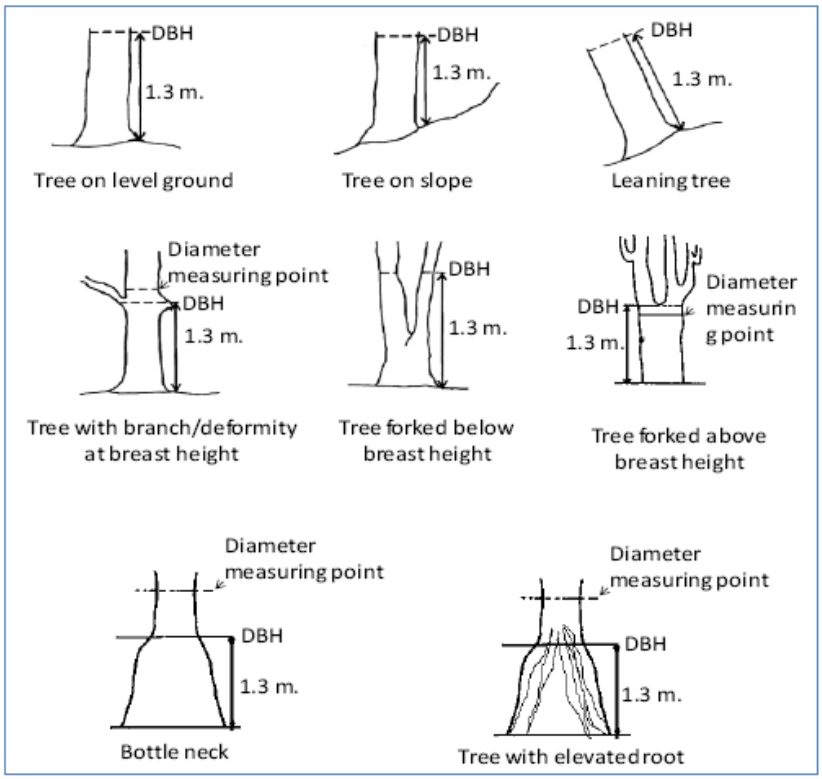
iii) Inventory in sample plot

Including 5 factors mentioned above (exception for tree root):

- **Measuring woody layer:** Recording from small to large plot: In the 1 m radius plot all trees are recorded with tree species and DBH, except for 6cm in DBH regeneration trees which only specified tree species and number of trees. For 5.64m radius plot, DBH is measured for only the DBH ≥ 6cm trees. For 12.62m radius, DBH is measured for only the DBH ≥ 30 cm trees, and for the largest radius plot with 17.84m, DBH is measured for only the DBH ≥ 50cm trees. The trees having DBH ≥ 6cm are fixed specific for monitoring in increment, death, or logged (recorded factors are DBH and tree species).

Diameter tape is used to measure DBH. This tape is already converted to diameter by producer, the accuracy reaches 0.1cm. Positions measured are presented at below

Figure 6: Measuring DBH tree (Source: Bhishma et al, 2010)



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If the tree which is located in the border at over 50% of the stem, then it will be measured, otherwise it is not measured.

- **Bamboo measurement:** Bamboo is measured in 5.64m radius plot with factors of age (A), individual DBH, and average height.

- **Shrub, herb, grass, NTFPs measurement:** In 4 50x50cm sub-plots, weighting fresh biomass and 100g of evenly mixed sub-samples are brought to the laboratory to determine moisture content, from which total dry mass/carbon can then be calculated.

Weighting to sample fresh

Weighting shrub, grass, herb

Frame 50x50cm to take fresh and litter

- **Litter measurement:** In 4 50x50cm sub-plots, weighting fresh biomass and 100g of evenly mixed sub-samples are brought to the laboratory to determine moisture content, from which total dry mass/carbon can then be calculated.

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- **Dead wood measurement:** in 1m radius sub-plot, quality and volume of dead wood are specified. A sample of 100g which mixed all components to carbon and dry biomass analysis is taken.

Soil sampling: in 50x50cm sub-plot, small soil profile with 30cm in deep is dug Soil color, soil bunk density are determined. A sample of 500g (mixed 4 samples of 4 sub-plots) is collected for laboratory working to figure out carbon storage.

Tool for soil bunk density: Plug the tool into the soil, the soil taken and weighed, then divided by tube volume (50cm3) to have soil bunk density

The sample plots should be clear signs to know the exact

The sample plot should be clearly and accurately signed to know origin and enable to aggregate data which can calculate the carbon at a higher level.

Symbol of plots should include information: forest owner, forest type, forest status, and number sign of plot. For example: **NB-TX-TB-10:** forest under management of Nam Ban forest protection board, evergreen forest, medium status, and number sign of plot (10).

Symbols of samples taken for analysis: including the information of the sample plot + sign of samples. For example: **NB-TX-TB-10–TT** (including: TT (fresh) or TM (litter), or CN (dead wood), or Đ (soil).

All sample plot data is numbered, referenced coordination and arranged according to forest block, forest status, forest ownner. These data will be submited to agency who has responsible to manage and analyse data to convert to biomass, carbon sequestration fro each ecological zone, in the whole country.

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Part III : Annex

Annex 1: Slope correction for the radius of the circle

Slope correction for the radius of the circle					
	Radius (m)				
Slope (Degrees)	0.56	1	5.64	12.62	17.84
0	0.56	1.00	5.64	12.62	17.84
2	0.56	1.00	5.64	12.63	17.85
4	0.56	1.00	5.65	12.65	17.88
6	0.56	1.01	5.67	12.69	17.94
8	0.57	1.01	5.70	12.74	18.02
10	0.57	1.02	5.73	12.81	18.12
12	0.57	1.02	5.77	12.90	18.24
14	0.58	1.03	5.81	13.01	18.39
16	0.58	1.04	5.87	13.13	18.56
18	0.59	1.05	5.93	13.27	18.76
20	0.60	1.06	6.00	13.43	18.98
22	0.60	1.08	6.08	13.61	19.24
24	0.61	1.09	6.17	13.81	19.53
26	0.62	1.11	6.28	14.04	19.85
28	0.63	1.13	6.39	14.29	20.21
30	0.65	1.15	6.51	14.57	20.60
32	0.66	1.18	6.65	14.88	21.04
34	0.68	1.21	6.80	15.22	21.52
36	0.69	1.24	6.97	15.60	22.05
38	0.71	1.27	7.16	16.02	22.64
40	0.73	1.31	7.36	16.47	23.29
42	0.75	1.35	7.59	16.98	24.01
44	0.78	1.39	7.84	17.54	24.80
46	0.81	1.44	8.12	18.17	25.68
48	0.84	1.49	8.43	18.86	26.66
50	0.87	1.56	8.77	19.63	27.75

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Annex 2: Data Sheet forms for pilot inventory

Form 1: Data Sheet form for timber plot inventory

Form 1.1: Data Sheet form for measuring DBH ≥ 6cm in sub-plots 5.64m and greater

Plot No.: Forest type:
Vn2000 coordination: Forest stratum/status
Forest Owner: Contractor:
Location (Village, Commune, District, Province)
Tiểu khu Altitude (m)
Khoảnh Canopy cover (%)
Forest Block Slope (degree)
Measurement conducted by:
Date:

No.	Species		DBH (cm)	Comment	No.	Species		DBH (cm)	Comment
	Local name	Popular				Local name	Popular		
1					26				
2					27				
3					28				
4					29				
5					30				
6					31				
7					32				
8					33				
9					34				
10					35				
11					36				
12					37				
13					38				
14					39				
15					40				
16					41				
17					42				
18					43				
19					44				
20					45				
21					46				
22					47				
23					48				
24					49				
25					50				

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Form 1.2: Data Sheet form for measuring DBH < 6cm in sub-plot with 1m radius

Plot no.:

No.	Species		Number of tree	Comment	No.	Species		Number of tree	Comment
	Local name	Popular				Local name	Popular		
1					26				
2					27				
3					28				
4					29				
5					30				
6					31				
7					32				
8					33				
9					34				
10					35				
11					36				
12					37				
13					38				
14					39				
15					40				
16					41				
17					42				
18					43				
19					44				
20					45				
21					46				
22					47				
23					48				
24					49				
25					50				

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Form 1.3: Data Sheet form for LHG 4 sub-plots 50x50cm

Plot no.:

No	Item	Fresh Biomass (kg)			
		1	2	3	4
1	Herb, grass,				
2	Litter				

Take specimen 100g per item

Form 1.4: Data Sheet form for dead wood in sub-plot inventory 1m radius

Plot No.:

No	Item	Biomass (kg)
1	Fallen stumps, dead wood	

Take specimen 100g

Form 1.5: Data Sheet form for Soil plot inventory in 4 phụ 50x50cm sub-plot

Plot no.:

No	Layer	Soil Bunk Desnity ρ (g/cm3)			
		1	2	3	4
1	0 - 30 cm				

Take specimen 500g

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Form 2: Data Sheet form for bamboo inventory in plot with 5.64m radius

Plot No.: Forest type:
Vn2000 coordination: Forest stratum/status
Forest Owner: Contractor:
Location (Village, Commune, District, Province)
Tiểu khu Altitude (m)
Khoảnh Canopy cover (%)
Forest Block Slope (degree)

Bamboo species: Height Average (m)

No.	DBH (cm)	Age	Comment	No.	DBH (cm)	Age	Comment
1				26			
2				27			
3				28			
4				29			
5				30			
6				31			
7				32			
8				33			
9				34			
10				35			
11				36			
12				37			
13				38			
14				39			
15				40			
16				41			
17				42			
18				43			
19				44			
20				45			
21				46			
22				47			
23				48			
24				49			
25				50			

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