ラオス人民民主共和国
ラオス国持続可能な森林経営及びREDD+のための国家森林情報システム構築に係る能力向上プロジェクト
（第2年次）

業務完了報告書

添付資料10：次期NFIマニュアル

Lao PDR National Forest Inventory

Standard Operating Procedures (SOP) Manual for Terrestrial Carbon Measurement

July 2015 Version

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INTRODUCTION AND HOW TO USE THIS DOCUMENT

Through the JICA funded program "Capacity Development Project for Establishing National Forest Information System for Sustainable Forest Management and REDD+", the Department of Forestry is working with Kokusai Kogyo Co and Asia Air Survey to assist in the design of an updated National Forest Inventory. Kokusai Kogyo Co has provided the support of Winrock International to adapt the field measurement methods[1] developed and field tested by Winrock over the last 20 years for use in the proposed Lao PDR NFI.

This document contains the recommended standard operating procedures for designing and implementing a NFI for Lao PDR. This document was designed to be used in conjunction with a number of companion products:

- National Forest Inventory for Forest Carbon Sampling – Guidance Document[2]
- A tablet based 'app' has been developed by Forest Carbon for field data collection
- Winrock Sample Plot Calculator Excel Tool, provides estimate of number of plots based on variability of preliminary data
- "Module C-CS: Calculations for Estimating Carbon Stocks. Leaf technical guidance series for the development of a forest carbon monitoring system for REDD+[3]" which describes the calculations to conduct to estimate carbon stocks
- R script developed by Forest Carbon to transform field data collected on tablets into analyzed data
- "Allometric Equation Evaluation Guidance Document[4]" which provides information on how to develop allometric equations for use in the NFI.

Using these products together will allow standing carbon stocks to be measured and estimated within sampled strata. This document shall be seen as a living document. As specific decisions are made in the NFI development, they need to be reflected in this document.

The purpose of this document is to provide standard field measurement approaches to assist in quantifying the amount of carbon stored within the various organic pools found within a landscape.

The SOPs are grouped by purpose. The first set of SOPs are general and can be used for many field measurement goals. A set of SOPs are also presented on the measurement of the carbon pools to be measured in the proposed Lao PDR NFI. These can be used to estimate the standing stock of a carbon pool within a stratum.

The SOPs should not be conducted without receiving extensive field training in the measurement methods performed by a qualified forester or ecologist.

For the Lao PDR NFI, data collection can take place either using field datasheets or a tablet using Open Data Kit (ODK) synchronized with a secure on-line data aggregation service (www.ona.io). This ODK SOP forms dataset was developed by Forest Carbon Partners.

For navigation purposes, it is recommended that tablets download OruxMaps, which makes use of satellite imagery (2015 Landsat 8, 2012/2013 RapidEye) and a variety of GIS data layers to make inventory points, backup points, roads, rivers, villages and other access points easily visible to the teams while in the field.

Following data collection, ODK data is exported into tab delimited files. For paper datasheet collection, a ab delimited template has been developed (See Appendix II). These tab delimited files can then be used as input for a companion R script that has been developed.

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[1] Walker, SM, TRH Pearson, FM Casarim, N Harris, S Petrova, A Grais, E Swails, M Netzer, KM Goslee and S Brown. 2014. Standard Operating Procedures for Terrestrial Carbon Measurement: Version August 2014. Winrock International.

[2] Walker, SM, KM Goslee, G Eickhoff, Y Morikawa. 2015. National Forest Inventory for Forest Carbon Sampling – Guidance Document. Winrock International, Forest Carbon Partners, KKC on behalf of Lao PDR FIPD

[3] Goslee, K, SM Walker, A Grais, L Murray, F Casarim, S Brown. 2013. Module C-CS: Calculations for Estimating Carbon Stocks. Leaf technical guidance series for the development of a forest carbon monitoring system for REDD+. USAID LEAF.

[4] Walker, SM, T Tepe. 2015. Allometric Equation Evaluation Guidance. Winrock International on behalf of KKC

GENERAL SOPS:

The following Standard Operating Procedures are used for a variety of purposes and studies. They provide general guidance or provide guidance on the use of a specific measurement tool.

SOP FIELD SAFETY

No matter what activities are engaged in or where they are carried out, *safety is the first priority* and all precautions must be well thought out in advance and then strictly adhered to. Planned field activities must remain flexible and allow for adjustments in response to on-the-ground assessments of hazards and safety conditions. Accordingly, field personnel must be vigilant and always avoid unnecessary risks.

Field crew members in particular must be well prepared. It is recommended that personnel engaging in field activities hold general first aid training and if possible training in CPR.

The following guidelines will apply to all field-based activities:

- Mandatory buddy system. Field crews will include no less than two people who must be directly accompanying each other for the entire duration of field work. Ideally field crews should include a minimum of three people; in case of an accident resulting in injury one person may leave to seek help while another person stays with the injured crew member.
- For each day in the field, specific location and scheduling information must be logged in advance with a point person who can be reached at any time during the anticipated duration of field work. While in the field, crews should check in with their designated point person once per day.
- Each independent crew must carry a radio, satellite phone or cell phone provided by the institution. Crews should make sure to check batteries each time before entering the field.
- Trip planning will include identification of the nearest medical facility and specific directions to reach that facility. When in areas with poisonous snakes, advance communication should be made to verify that appropriate antivenins are available. Where applicable, hunting regulations should be checked with local state agencies prior to field work.
- Personnel will carry personal and institutional insurance cards with them at all times. As well, personnel will carry identification and, if possible, institutional business cards at all times.
- Field crews will carry a first aid kit with them at all times. First aid kits should contain Epinephrin/Adrenalin or an antihistamine for allergic reactions (e.g. bee/wasp stings). Sun block and insect repellent should be carried in the field.
- Where poisonous snakes are common, snake chaps are recommended. In the event of snake bite, the victim should be taken immediately to a medical facility. Conventional "snake bite kits" (e.g. suction cups, razors) have been proven ineffective or even harmful and should not be used.
- Basic field clothing should be appropriate for the range of field conditions likely to be encountered. This will include: sturdy boots with good ankle support or rubber boots, long sleeves and pants, rain gear, and gloves. Blaze orange (vest or hat) is recommended when and where hunting may be taking place. Where necessary, to avoid extended contact with plant oils, ticks, and/or chiggers, a change of clothes should be made at the end of each day in the field and field clothes should not be reworn without first laundering.
- Ensure personnel stay sufficiently hydrated and carry enough clean water for the intended activity. Carry iodine tablets or other water purification tablets in case there is a need to use water from an unpurified source.
- Heightened caution should be given while operating any motor vehicle, particularly on backcountry roads where conditions are unreliable and rights-of-way are often not designated or adhered to. ATVs should always be operated at low speeds (<15 mph).
- Some plots may be too hazardous to sample. Situations include: plot center on a slope too steep to safely collect data (i.e., >100% slope or on a cliff); presence of bees; volcanic activity; illegal activities; etc. When hazardous situations arise, a discussion should be conducted among the team members to assess the situation.

SOP LABELING SAMPLING POINTS

Proper labeling of sampling points is important because it provides a unique signature to sampled locations as well as information about the sampling conducted. Experience has shown that sample points should be named with multiple characters defining the type of sampling conducted, the area, the number of the sample point and any other relevant information.

All sample points must be numbered with a unique name and number. The labeling system must be finalized prior to data collection. The character denoting the number should include at least as many digits as total numbers of plots expected to be sampled. In other words, if the number of sample points is expected to be greater than 1000 but less than 10000, the number characters must be at least four integers eg 0001 to 9999.

The following is the labeling format

- Inventory Year
- Province code
- District code
- Land Cover code
- Stratum
- The last four numbers should be a UNIQUE number to identify the specific sample point

***standard GIS province and distritct codes will be used + standard land cover code + stratum name **

All sample points should be given a UNIQUE number. The reason for this is that if after the field phase a plot is found to be in the wrong stratum, the letter and stratum number can be changed but the plot will still have a unique number based on the last three digits.

As an example, assume there will be three strata and less than 100 plots will be sampled in each stratum then the below sampling scheme could be used:

Stratum 1 sample point names: 2015-01-23-DD-01-1001 ***add stuff***

SOP QUALITY ASSURANCE/QUALITY CONTROL

Those responsible for aspects of data collection and analysis should be fully trained in all aspects of the field data collection and data analyses. Standard operating procedures should be followed rigidly to ensure accurate measurement and remeasurement. It is highly recommended that a verification document be produced and filed with the field measurement and calculation documents that show that QA/QC steps have been followed.

Quality Assurance

Data collection in field:

During all data collection in the field, the crew member responsible for recording must repeat all measurements called by the crew member conducting the measurement. This is to ensure the measurement call was acknowledged and that proper number is recorded on the data sheet. In addition, all data sheets should include a 'Data recorded by' field with the name of the crew member responsible for recording data. If any confusion exists, the transcribers will know which crew member to contact.

After data is collected at each plot and before the crew leaves the plot, the crew leader shall double check to make sure that all data are correctly and completely filled. The crew leader must ensure the data recorded matches with field conditions, for instance, by verifying the number of trees recorded.

Data sheet checks:

At the end of each day all data sheets must be checked by team leaders to ensure that all the relevant information was collected. If for some reason there is some information that seems odd or is missing, mistakes can be corrected the following day. Once this is verified and potential mistakes checked, corrected data sheets shall be handed over to the person responsible for their safe keeping while the crew is still in the field. Data sheets shall be stored in a dry and safe place while in the field. After data sheets have been validated by crew leaders, the data entry process can commence.

Field data collection Hot Checks:

After the training of field crews has been completed, observations of each field crew and each crew member should be made. A lead coordinator shall observe each field crew member during data collection of a field plot to verify measurement processes and correct any errors in techniques. It is recommended that the crew chiefs switch to a different crew to ensure data collection procedures are consistent across all field crews. Any errors or misunderstandings should be explained and corrected. These types of checks should be repeated throughout the field measurement campaign to make sure incorrect measurement techniques have not started to take place.

Data Entry checks:

To ensure that data is entered correctly, the person entering data (whether during fieldwork or after a return to the office) will recheck all of the data entered and compare it with the original hard copy data sheet before entering another sheet. It is advised that field crew leaders either enter the data, or participate in the data entry process. Crew leaders have a good understanding of the field sites visited, and can provide insightful assistance regarding potential unusual situations identified in data sheets. Communication between all personnel involved in measuring and analyzing data should be used to resolve any apparent anomalies before final analysis of the monitoring data can be completed. If there are any problems with the plot data (that cannot be resolved), the plot should not be used in the analysis.

Quality Control

Field measurement error estimation

A second type of field check is used to quantify the amount of error due to field measurement techniques. To implement this type of check, a complete remeasurement of a number of plots by people other than the original field crews is performed. This auditing crew should be experienced in forest measurement and highly attentive to detail. A total of 10% of sampling locations should be randomly or systematically chosen to be remeasured. Where clustered tree-plots are used, all tree-plots withinc a selected cluster shall be measured. All trees shall be remeasured in each plot. Field crews taking measurements should not be aware of which plots will be remeasured whenever possible.

After remeasurement, data analysis is conducted and biomass estimates are compared with estimates from the original data. Any errors discovered could be expressed as a percentage of all plots that have been rechecked to provide an estimate of the measurement error.

For all the verified plots:

$$\text{Measurement Error (\%)} = \left| \frac{(\text{t C/ha of measured plot - t C/ha of remeasured plot})}{\text{t C/ha of remeasured plot}} \text{ x } 100 \right|$$

This error level will be included in the carbon stock reporting.

Data Entry quality control check:

After all data has been entered into computer file(s), a random check shall be conducted. Sheets shall be selected randomly for re-checks and compared with data entered. Ten percent of all data sheets shall be checked for consistency and accuracy in data entry. Other techniques such as data sorting and verification of resulting estimates shall be employed to ensure data entered properly corresponds to field sites visited. Personnel experienced in data entry and analysis will be able to identify errors especially oddly large or small numbers. Errors can be reduced if the entered data is reviewed using expert judgment and, if necessary, through comparison with independent data.

QA/QC of Laboratory Measurements

Standard operating procedures (SOPs) should be created and rigorously followed for each part of all laboratory analyses. All instruments should be calibrated.

For example, all combustion instruments for measuring total C or C forms should be calibrated using commercially-available certified C standards. SOPs should include steps to calibrate and check analyses. Blanks can be analyzed, or analytical runs can include a check sample of known C concentration. One standard per batch/run should be included in the samples sent to a remote lab as an additional check of the quality of the instruments and lab procedures.

All balances for measuring dry weights should be calibrated against known weights. Where possible, 10-20 % of samples could be reanalyzed/reweighed to produce an error estimate.

SOP DATA STORAGE AND ARCHIVING

Field equipment:
Android Tablet
Protective tablet casing
Computer
Connection to network server

This SOP describes the methods for storing and archiving data in a simple yet safe and retractable way, so data can be accessed whenever necessary. Data storage and archiving is a very important and final component of the data collection process. The basic framework involving data storage and archiving follows.

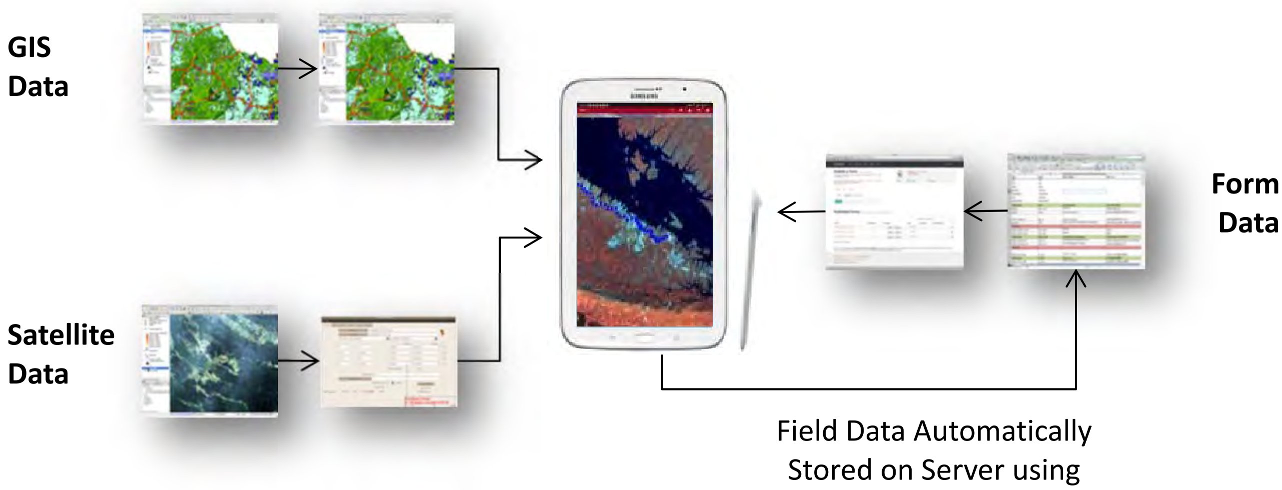

Figure 1: Data Storage Flow

Data storage in the field

In the field one person is responsible for carrying, operating and recording field data into a tablet computer such as a Samsung Android or Apple iPad. The tablet and data collection form will automatically record many types of data, including start time, stop time, GPS position other features of the data collection process. Once the field team has finished the plot, the tablet will automatically send data to the cloud-based data aggregation server or any other server designated by the inventory team.

Two freely available and secure cloud-based servers are: www.formhub.org and www.ona.io

If a 3G connection is not available at the locaiton of the plot, the tablet will automatically send data to the server once the field team comes within a 3G signal later in the day. Where field teams will be outside of a 3G connection for multiple days, teams should take special care and syncronize field data with a computer whenever possible. Keeping the tablet in a waterproof case when traveling between plots or overnight is recommended.

Data storage in the office

Once the field team has returned to the office or laboratory, data should be downlaoded from the server in all available formats (.xlsx, .csv, .pdf) and stored electronically.

Hard copy

Two copies fo the the .xlsx version of the data should be printed in hard copy and kept in separate locations in a special jacket folder in the filing cabinet with the location name and date written on the label. Inside of these jackets there are folders with the different types of data collected. After all data has passed through a Quality Assurance / Quality Control process to detect errors, the final data set should be printed and stored in secure fireproof filing cabinets in two separate locations.

Soft Copy

The exported data is stored on a computer in the office, along with all tools used for entering data. These data files are backed up on a server. All digital data collected and compiled (photos, proposal and report for exercise) are also stored in the archive file on both the desktop in the office and on the server. On the server there are a few folders in which all data are placed as follows:

1. '*Field Data'*, in which sub folders are created and are named the same way (Location) as the hard copy folder so as to have a uniform filing system. In each sub folder there are two folders; pictures and scanned data sheets in which the respective information are placed;
2. '*Data Analysis*' in which all completed tools are placed after the data entry has been completed;
3. '*Template*' in which all tool templates and field data sheets used in the data analysis are placed;
4. '*Documents*' in which all documents related to the project are placed; and
5. '*Field Proposal & Report'* in which all field exercise proposals and report are placed.

Procedure for Compiling and Managing Field Log Book or Electronic Log Book

This log book will be both of an electronic form and of the traditional book keeping format (a book). Both log forms will be updated simultaneously and twice for each field venture, before and after each trip. Log books will be used for recording the logistics of the field exercise, and providing explanation about field campaigns (e.g. date of departure to the field and date of returning, number of plots, location, field crew, challenges etc.). Each field inventory will be given a unique reference number and each report will also be given a reference number related to that of the inventory. This is to facilitate cross-referencing processes.

Upon returning to the office after field records are entered, the log books will be stored in a secure filing cabinet or placed on the network server via desktop computers respectively, after being updated. Upon the completion of field reports of which each report will be given a unique reference number, the log books will be revisited and the report number will be inserted for future references.

It is important to restrict access to log books and information only to users, as they alone are responsible for making changes.

SOP CALIBRATION OF HAGLÖF DME 201 CRUISER

This equipment may be used to establish the boundaries of permanent or temporary circular plots. Please see the SOP Plot Design for more information. The Haglöf Distance Measuring Equipment (DME) 201 Cruiser[5] contains two components: the measuring unit and the transponder. The DME uses ultrasound waves to calculate distance between the measuring unit and the transponder. However, the speed that sound waves travel through air is slightly influenced by humidity and temperature. If the DME is being used in a desert the sound waves will travel slightly faster than in a tropical humid environment. Therefore it is important to calibrate the device prior to data collection in each plot.

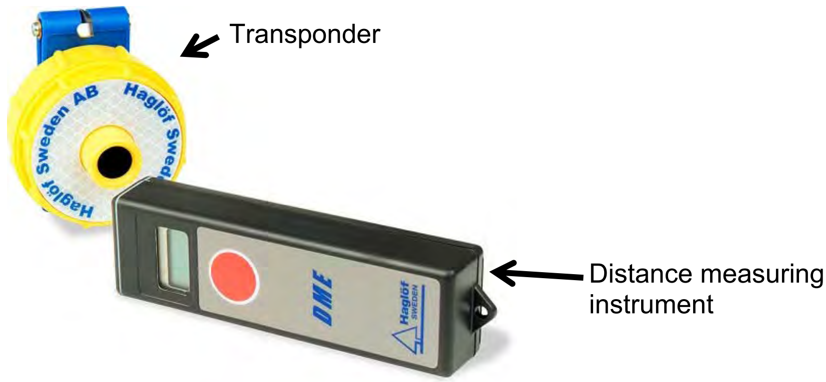

Figure 2: Haglöf DME 201 Cruiser[6]

1. Before the crew arrives in the field, the crew chief should have already taken the measuring instrument (grey rectangular box) out of the box. This instrument needs a minimum of 10 minutes to adjust to local temperature conditions. Therefore it should not be in its box or in someone's pocket immediately prior to use. It needs to be in contact with the open air for at least 10 minutes before it is used, if not, it can cause inaccurate readings. It is allowable for this instrument to be carried using a neck strap.
2. After the DME has had a chance to adjust to local temperature and humidity conditions, it is ready to be calibrated. One person should hold the transponder in their hand while the crew chief takes the measuring instrument and a measuring tape and proceeds to a clear point 10 m away. The measuring tape should be pulled tight and should not be draped on the ground. The measuring tape and the transponder and measuring instrument must be parallel to each other.
3. The crew chief should hold the measuring instrument in one hand and the end of the measuring tape in the other. The second person at the other end of the tape should do the same with the transponder. The crew chief should then point the measuring unit at the transponder and press the red button nine times. Hold the measuring unit very still until 10 m is displayed on the screen. If it does not, repeat.
4. The DME can display in metric or English units, i.e. feet or meters, make sure for field work that the DME is set to measure in meters. To change the DME to display in meters or feet click the red button on the measuring unit five times. Meters display with two decimal places but only one decimal place when it is set for feet.
5. Place the transponder on the tripod so that it is placed directly over the plot center.

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[5] For example: www.forestry-suppliers.com

[6] Photo source: http://www.forestry-suppliers.com/product_pages/View_Catalog_Page.asp?mi=1378&title=Hagl%F6f+DME+201+Cruiser)

SOP FIELD WORK WITH THE GPSMAP 60CSX

The following SOP describes how to use a specific GPS unit model, the Garmin GPSMAP 60CSX. However, many GPS units, especially Garmin models, work in similar ways and therefore this SOP can be used generally to assist with a variety of models.

Basic requirements

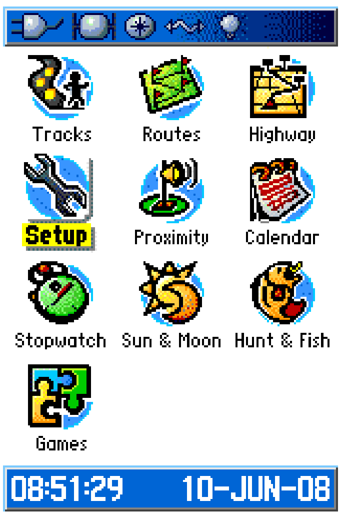
- The same coordinate system and measurement units should be used for all fieldwork.
- An advanced user can pick a projected coordinate system appropriate for the study site location. A novice should use a geographic coordinate system based on WGS84 geodetic datum (usually the default datum on GPS units) and record the coordinate pairs in decimal degrees or longitude and latitude coordinates.
- The coordinate system and datum used must be recorded on the field notes.
- The data should be collected using metric units not English units.
- Remove batteries when the unit is not in use for more than a week.
- Calibrate the electronic compass every time you install new batteries (see below for directions).

GPSMAP 60CSx Main pages

This section describes the most important functions available from the main pages of the GPS unit. Field members are advised to consult with the GPSMAP 60CSx manual for more detailed information on all functions.

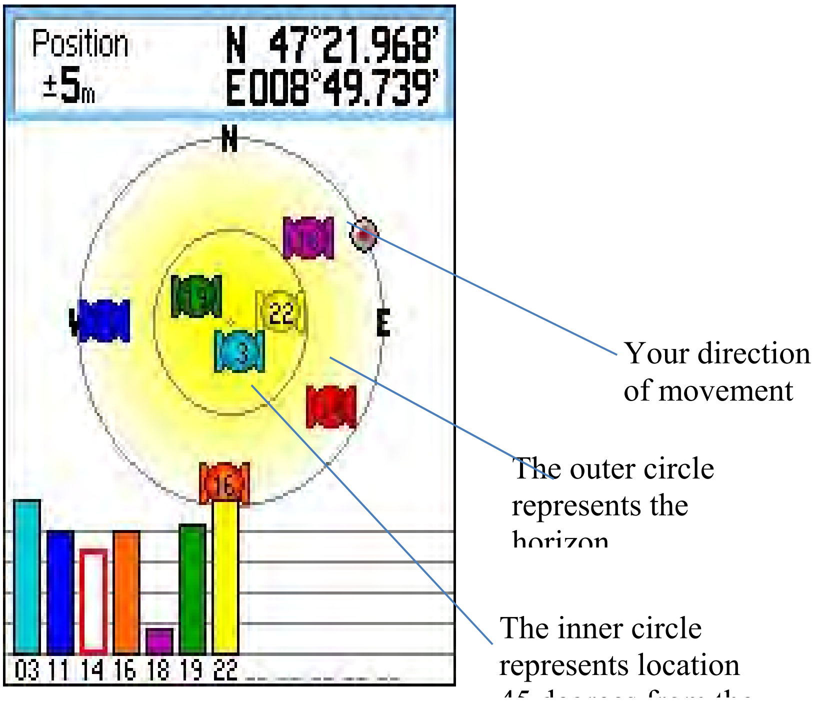
To navigate between pages press PAGE button.

Main menu



- The **MAIN menu** is accessible from any page by pressing the **MENU** twice
- To select an item from the **MAIN menu**, highlight the menu item and press **ENTER**

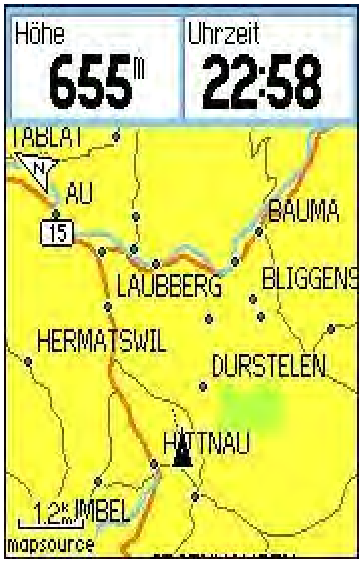
Satellite page



Satellite page shows:

- Current position (coordinates)
- Accuracy of current position information.
- Constellation of the satellites.
- Strength of satellites' signals.

Map page



A standard map with basic information comes with the GPS software. Additional GIS layers can be uploaded to the unit. The **Map page** contains field data and a map.

To show data field on the Map Page (or any other page):

- Press **MENU,** select **Data Fields** to see the Map page option menu. Select the number of data fields desired and press **ENTER.**

To change a data field display:

- Press **MENU**, select **Change Data Fields** and press **ENTER**.
- The field is selected; press **ENTER** to open the list of data field options.
- Use **ROCKER** key to select an option and press **ENTER**.

Compass page

The **Compass page** guides the user to a selected destination with a graphic compass display and a bearing or course pointer.

The compass should be calibrated in following occasions:

- When you first use the GPS unit.
- After installing new battery.
- After moving more than 160 km from the previous location.
- When there is temperature change > 20°C from the last calibration.

How to calibrate GPSMAP 60CSx

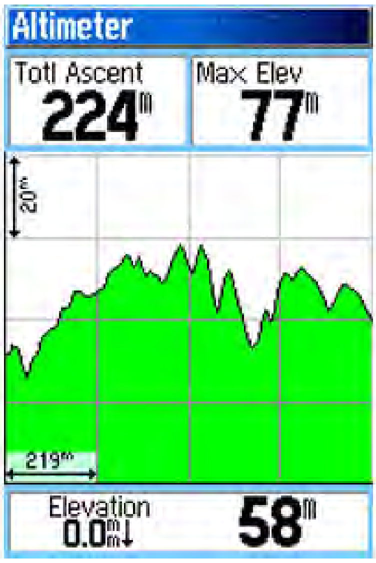
1. Press **MENU** while on the Compass page
2. Highlight **Calibrate Compass** to open the compass calibration page.
3. With the **START** button highlighted, press **ENTER** and follow on-screen directions for holding and turning the unit.

The unit must be held level and turned slowly clockwise.

Messages appear on the screen for guidance and indicate the success or failure of the calibration.

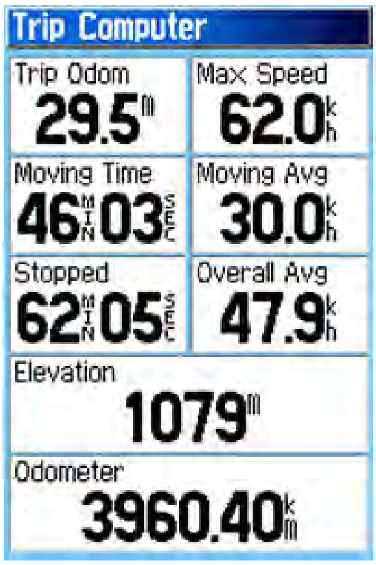
When the **on-screen button "STOP"** appears on the screen, press **ENTER** to return to the Compass page.

Altimeter page



The **Altimeter page** shows the user a profile of elevation changes over distance or time, or a profile of pressure changes over time.

Trip computer page



Trip computer page shows eight types of navigation data. Each field is selectable and can contain one of many data information options. The trip computer page can be reset before every new trip.

Waypoints

Waypoints are sets of coordinates –longitude and latitude that identify a point in physical space. Waypoints can **be used to select the location of any point important to the user.**

To mark a waypoint:

From the **Map page:**

1. Press and hold **MARK** until the Mark Waypoint page appears.
2. To accept the waypoint with default information, highlight **OK** and press **ENTER**.
3. To change any name of the waypoint, select the appropriate field and press **ENTER** to open on-screen keypad. After selecting each character of the name press **ENTER**; when finish typing the new name highlight the **OK on-screen button** and press **ENTER**. The new name will appear in the name field.

4. Navigate to the **AVG** on-screen button to average the location; press **ENTER**.
5. Once in the averaging page, wait until the accuracy error drops to ~5m and press **ENTER**.
6. Select **OK** and confirm your changes by pressing **ENTER**.

To search for waypoint:

If you want to navigate to a waypoint that is stored in the GPS unit, use the **FIND menu**:

1. Press **FIND** key to open the **FIND menu**.
2. Select the icon for the type of item you want (usually the **Waypoints** icon) to find and press **ENTER** to open the waypoint page.
3. Use the **ROCKER** to navigate to the name of the waypoint you want to find. The arrow symbol will point you to the direction of the point you want to find.

Track

A track log records a line along a set of points, which the GPS unit records automatically at a set time or distance interval chosen by the user.

To set up a track log:

From any page:

1. Press **MENU** twice to open the **Main page**.
2. Select **Tracks** and press **ENTER** to open the **Tracks page**.
3. Highlight the **Setup** button and press **ENTER**.
4. Select **AUTO** as the collection method, **0.01** as the interval and select the desired **colour** of the track.
5. Make sure that **On** is highlighted for the **Track Log**.
6. Press the **Page** button and navigate to the **Map page**. On this page you will see the map and the progression of your track.

To save a track log:

1. Press **MENU** twice navigate to the **Tracks** icon and press **ENTER**.
2. A message will prompt "*Do you want to select the entire track*" Select **NO** if you want to save the last track you have collected as separate track.
3. The map screen will appear and at the bottom of the page a message will appear saying "*Please select the beginning of the track*"; navigate with the arrow to the beginning point of the last track you collected and press **ENTER**; a list of points for the last track will appear. Select the beginning point of the track. When selecting the beginning and ending point of the track the user should make sure that the scale on the map page is 1:20m or 1:30m.
4. Press **ENTER** to save the track.

To calculate the area of a track:

1. With the **Track Log page** open and the **Track Log** on, press **MENU** to open the Options Menu.
2. Select "Area Calculation", and press **ENTER**.
3. Press **ENTER** to start the area calculation. As you move and define the area's boundaries, a **STOP** button appears on the page.
4. When finished defining the area, press **ENTER** and select **SAVE**.

Route

A route creates a sequence of waypoints that lead to a final destination.

To create a route:

1. Press **MENU** twice to open the main Menu.
2. Highlight the **Routes** icon and press **ENTER**.
3. Select **New** and press **ENTER**.

4. With **Select Next Point** highlighted, press **ENTER**.
5. Use **Find Menu** to select a route waypoint.
6. Select **USE** and press **ENTER** to add it to the route.
7. To add more points to the route, repeat steps 4 through 6.

To navigate to a route:

1. Press **MENU** twice and select **Route**.
2. Highlight a saved route, and press **ENTER** to open the Route page.
3. Highlight the **Navigate** button and press **ENTER**.
4. To stop navigating, press **MENU** -> **Stop Navigation** ->**ENTER**.

Downloading and uploading data

Data can be viewed and transferred to and from the GPS unit using either the Garmin MapSource program (manufacturer software) or the DNR Garmin extension software.

Garmin MapSource provides the user with geographic data that can be viewed on your PC and added to the base map of your compatible Garmin GPS device. With MapSource, the user can:

1. Transfer saved waypoints, routes, and tracks from your GPS device and save them to your PC. (MapSource transfer data as an .gdb .mps, .txt, .gpx, or .dxf file)
2. Create, view, and edit waypoints, routes, and tracks.
3. Find items, addresses, and Points of Interest included in the map data.
4. Transfer map data, waypoints, routes, and tracks to your GPS device.

DNR Garmin integrates GIS Software (ESRI's ArcView 3.x and ArcMap, ArcExplorer, MN DNR's Landview, Google Earth) with all types of Garmin brand GPS units. It uses a Visual Basic program that interacts with Garmin GPS via a serial/USB port allowing GIS users to transfer Waypoints, Tracks, and Routes from a Garmin GPS to ArcView, ArcMap, Landview, ArcExplorer, or Google Earth and store them as points, lines or polygons. Information can also be uploaded from ArcView/ArcMap/Landview graphics or shapefiles to the GPS unit and used as tracks or waypoints.

DNR Garmin can also be used to perform real-time tracking with your GPS and GIS. Connected to a laptop computer with ArcView, ArcMap or Landview a Garmin GPS can be a valuable tool for locating oneself and for interactive data collection.

The extension can be downloaded from:

http://www.dnr.state.mn.us/mis/gis/DNRGPS/DNRGPS.html.

Please follow instructions for software installation. DNR Garmin tool will be added as a toolbar to ArcGIS if that is the GIS program installed.

Downloading data from the GPS Unit into the PC

There are two steps to downloading data from a GPS to the PC:

Download data from the GPS

1. Select the download option from one of the following menus: Waypoint, Track, or Route. The data will be downloaded from your GPS into the data table.
2. Once the data is downloaded you may edit it prior to saving. Edits include modifying cell values or converting between waypoints/tracks/routes.

Save data to a file or GIS graphic from the DNRGarmin Data Table

1. Go to **File => Save To** and choose a destination (File, ArcView, Landview, ArcMap, ArcExplorer).

Note: You can only save to Arcview/Landview/ArcMap/ArcExplorer if that software is running.

Notes:

Each waypoint, track point, and route point has one or more attributes associated with it depending on the type of GPS unit used. Extra columns can be turned off if not needed. Individual route points can also be deleted if desired.

Data is downloaded in Lat/Long WGS84 coordinates. When the download is complete this spatial information is projected to the user-specified projection. The projected Y and X coordinates are stored in the Y_Proj and X_Proj fields.

Once the GPS information is stored in the Data Table, it can be saved as a text file, DBF Table, Shapefile, GPX file, KML file, ArcView Graphic, ArcMap Graphic, or Geodatabase Feature Class.

When the GPS unit is connected to the computer it shows up as a mass storage device (a Drive in Windows Explorer). When you download data using DNRGarmin, the program is pulling data from a GPX file on the storage device called CURRENT.GPX (possibly located at GARMIN/GPX or GARMIN/GPX/CURRENT).

Uploading data to a GPS Unit

There are two steps to uploading data from a PC to a GPS unit:

1. Load data from a file or GIS software into the DNRGarmin Data Table.
2. Go to File => Load From and choose a source (File, ArcView, Landview, ArcMap, etc).

Notes:

ArcView/Landview/ArcMap must be running in order to load to those programs.

For track logs, each Garmin Unit has a different amount of memory to store coordinates. If you are loading lines or polygons from ArcView or ArcMap, the program will check to see how many vertices are in the selected shapes. If the number of vertices is greater than the number of points it will generalize the shapes.

Once the data is loaded you may edit it prior to upload. Edits include modifying cell values or converting between waypoints/tracks/routes.

SOP USE OF A CLINOMETER AND MEASUREMENT OF SLOPE

A clinometer is a piece of equipment used to measure angles. This equipment is widely used in the field for multiple reasons, among them: measuring slope of the terrain, and measuring tree height. Usually a clinometer has two sets of units for measuring angles:

Right side: percent (%)

Left side: degrees

The Clinometer will indicate the units. For example, if using a Suunto® Clinometer, look into the clinometer and tilt your head back to look all the way up. The right side will say %.

To measure an angle using a clinometer:

1. Holding the clinometer string, bring it up to your dominant eye (the string on the clinometer should be below the eye piece, stretching downward)

2. Keep both eyes open and simultaneously aim at the object you want to measure in the distance and look at the numbers through the clinometer

3. Record the % or degrees at the point that crosses what you are measuring.

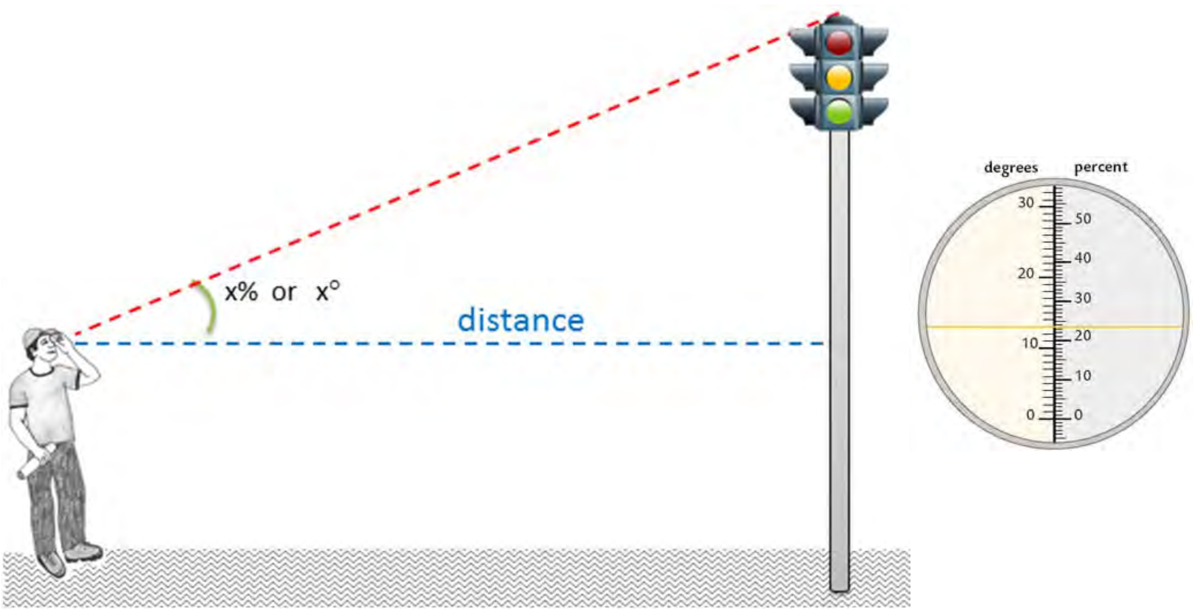


Figure 3: Measuring angle degrees or % using clinometer

Measurement of slope

Slope is measured using a clinometer and two people.

To measure slope, the person using the clinometer must be equal or shorter in height than the partner. The person holding the clinometer shall identify where on the partner's body is equivalent to his/her eye-height. The person holding the clinometer should stand at in the center of the tree-plot and the partner should walk at least 25 m upslope. The person with clinometer shall then aim at the eye-level location of the partner and record the angle reading displayed in the clinometer. This angle is the slope angle and should be recorded as percent (in the cases of very steep slopes, it can be recorded as degrees, making sure to note the unit used in the data sheets.

SOP MEASUREMENT OF HEIGHT

Field equipment:

Clinometer

Laser Range Finder or >50m measuring tape

The height of trees, palms, and other things is usually done by creating two right triangles. The distance from the object and the person measuring is measured and two angles are measured. The actual height is then calculated using trigonometry during data analysis.

1. Walk around the tree and find the best location to view the top of the tree.
2. Stand far enough away from the tree so that the top of the tree is less than 90 degrees above the line of sight.
3. Measure total tree height (see Figure below):
   a. Always stand up-slope of the tree. Standing down-slope of the tree should only take place when no other option exists.
   b. Using clinometer, measure the angle in % to top of the canopy of the tree (a%)
   c. Using clinometer, measure the angle in % to base of the tree (b%)
   d. Using Laser Range Finder or measuring tape, measure distance from eye of person measuring tree to the tree (dis_{tree}) in meters. Be certain that the distance measured is horizontal and not along the slope. Record the horizontal distance to the nearest 0.01 meter
4. Repeat measurements in another location, thus measuring tree height in two locations.
5. If you are not able to stand far enough from the tree so that the top of the tree is less than 90% above you, then take the measurements (a) and (b) in degrees (units on left side of clinometer). CAREFULLY NOTE ON THE DATA SHEET THE CHANGE IN UNITS! Tree height must be calculated differently if degrees are used!

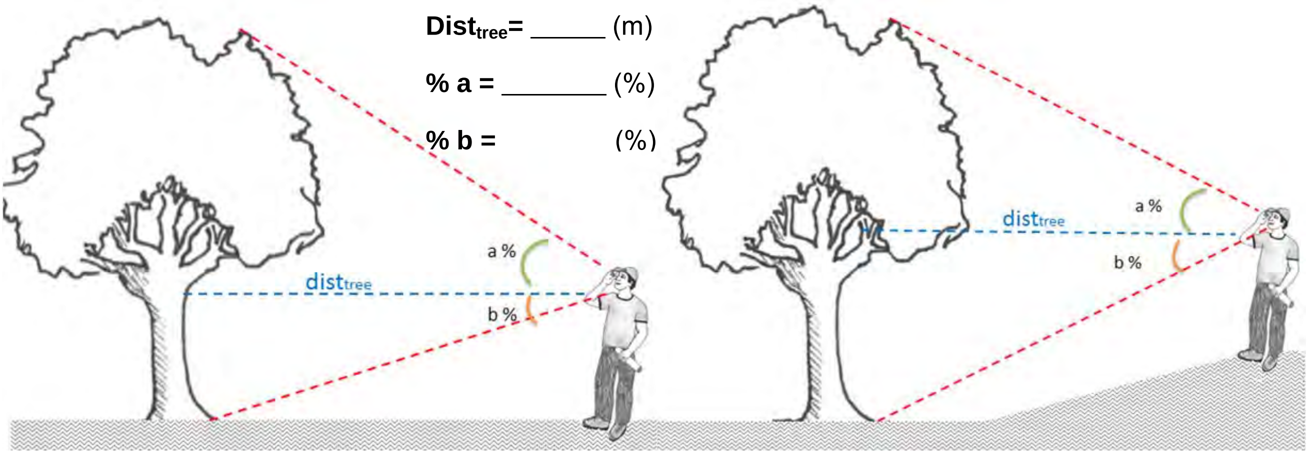


Figure 4 Tree height field measurements

Data collection to develop relationship between Height and DBH

Often the height of trees in the field can be difficult to measure and take a long time to conduct with high accuracy. However, many allometric equations include Height as a variable to estimate biomass. Therefore, as an alternative to measuring the tree heights of all trees, select measurements of tree heights and DBH can be used to develop a relationship between Height and DBH.In Lao, Allometoric equation development project has been implemented under the support of JICS. Relationship between Height and DBH will be developed by this project.

STOCKS OF CARBON POOLS SOPS:

The following set of SOPs can be used to establish plots to estimate the standing carbon stock of the various carbon pools. These SOPs will need to be altered based on the specific methods used by the field campaign.

SOP Sampling Design and Layout

SOP Establishment of Sampling Plots

SOP Measurement of Trees

SOP Measurement of Palms, Lianas, and Bamboo

SOP Measurement of Non-tree Woody Vegetation

SOP Measurement of Non-woody Vegetation (herbaceous)

SOP Measurement of Litter Layer

SOP Measurement of Standing Dead Wood

SOP Measurement of Lying Dead Wood

SOP SAMPLING DESIGN AND LAYOUT

This SOP describes the methods to determine the locations where sampling will take place along with the sampling layout and shape of sampling plots for all vegetation types and carbon pools. This SOP must be implemented prior to field data collection and requires operations in a GIS environment.

Prior to implementing this approach, the strata must have been chosen and a separate GIS shapefile created for each stratum. In addition, the minimum mapping unit must also have been determined and all locations within all forest land cover layers must meet the definition of a forest (e.g. all forest polygons must meet the definition of a forest).

This SOP must be repeated for *each* stratum separately.

Determine Sampling Locations using stratified two-stage sampling.

For the estimation of carbon stocks in the tree, non-tree woody, non-woody vegetation, litter, and deadwood pools, sampling should take place across a stratum in an unbiased way. Sampling layout and the design for determining sampling locations can differ for each stratum, however, the below approach is recommended for all stratum included in the expected Lao PDR NFI. The following method should be implemented for one stratum at a time.

This sampling design consists of selecting primary sampling units (PSUs) at the first stage and then selecting secondary sampling units (SSUs) at the second stage of sampling. The approach described ensures that any location has an equal probability of being sampled. The initial sampling units are chosen by using a systematic sampling with a random start approach. A 'grid' is placed across the area to be sampled in a randomly selected orientation. The grid cells will then serve as the 'primary sampling unit' (PSUs). Once the PSUs are chosen, a particular location within the PSU is randomly chosen to initiate field sampling. This is referred here to as the SSU1.

Thus, the definition of these terms is:

- **PSU-grid** cell: an individual grid cell of a known and defined size (e.g. 5 x 5 km square) within the grid that has been superimposed across the area to be sampled. PSU-grid cell is given a unique ID. This ID number will then be used within the identification of a PSU.
- **PSU_i** – this is the spatial extent of the stratum *i* within a given PSU-grid cell. The label of the PSU shall correspond to the PSU-grid ID and include stratum notation (here denoted as *i*).
- **$SSU1_i$** – this is a point, representing the starting point of the sampling at this location. The $SSU1_i$ is located within selected PSU_i.

Methods and Procedures

The following steps 2 to 4 to implement two-stage list sampling design shall be repeated for each stratum separately. The entire gridded area shall be used to determine selected PSUs for each stratum and thus each PSU-grid cell shall have an equal probability to be selected during the list sampling selection for all stratum. (If one PSU-grid happens to be selected for both strata A and B, this is allowable. There will then a PSU_A for stratum A and a PSU_B for stratum B, and thus two SSU points located within the boundary of this PSU, one for stratum A and one for stratum B.)

STEP 1: Create PSU-grid (3 x 3 km)

First, the size of the grids needs to be defined (Figure 1). The size of the grid cells takes into consideration other field surveys that may occur in Lao PDR; or align with the size of other REDD+ systematic sampling taking place elsewhere within Laos (i.e. PAREDD, CliPAD and others) to facilitate a future national forest monitoring system (NFMS) for the country. The PSU-grid cell size shall be small enough so that a sufficient quantity of PSU-grid cells will be available for sampling yet large enough to ensure both that the field cluster plot design can fit within a PSU selected and that sample plots are well distributed across the landscape.

To create a PSU-grid across the area to be sampled, a grid polygon shape file with desirable cell size (3 km) needs to be created in ArcGIS through function of Create Fishnet . If the grid layout does not need to be aligned with other sampling grids taking place in Laos, then the orientation of the grid shall be chosen randomly. The shape file has a unique identification number (ID) for each PSU-grid (PSU_ ID).

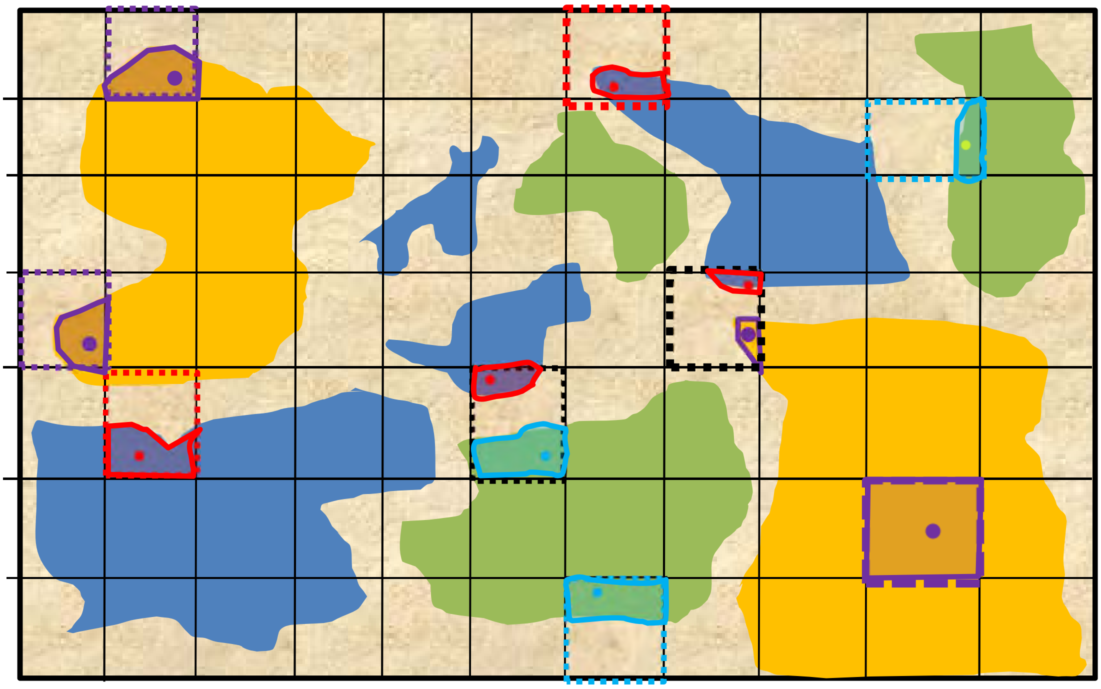


Figure 5: Example of selected PSU-grids in dashed lines and selected PSUs (polygons) with SSUs (dots) assigned within. Note, some PSU-grids may randomly be selected for two different stratum.

STEP 2: Create a list of PSUs for the stratum of interest

To create PSU_is for each stratum, use Intersect function in ArcGIS to combine the PSU-grid shapefile with the stratum shapefile. Next calculate the area of each PSU_i for each stratum in ArcGIS. If the area of the PSU_i is less than the minimum area in the Lao forest definition, exclude that PSU_i in the two stage list sampling procedure (The reason for this is that we are respecting the minimum threshold area for defining forest in Lao PDR, thus only PSUs with area greater than such threshold should be included in the PSUs grid list.). A list of all PSUs should be created and the attribute table exported as DBF table, maintaining record of PSU_i_ID and area in hectares.

STEP 3: Select PSUs with probability proportional to size

To ensure all locations within a stratum have an equal probability of being measured, the probability that a given PSU_i will be selected must be made proportional to its area. To select PSU_is with probability proportional to their size, use the list of PSUs from Step 2 and calculate the cumulative area of each stratum associated with each PSU. Cumulative area is defined as sum of all PSUs in the list up to and including the PSU itself. Once the cumulative areas are calculated, a random number between the smallest and the largest cumulative area should be generated. To select a PSU for forest sampling, the random number should be less than PSU's cumulative area and larger than the cumulative area for the previous PSU in the list.

All of the operations conducted in Excel are explained below:

1. After opening the DBF file in Excel, calculate the cumulative area for each PSU in a new column.
2. In the next column, create a list of random numbers between the minimum and maximum cumulative area of the PSUs grid list shall be generated created using following formula:
   =RAND ()*(B - A) + A

Where:

B is the maximum cumulative area, and

A is the minimum cumulative area for the list of PSUs

Once the random numbers have been created, convert the formula in each cell into a number to prevent new random numbers from being generated.

To select a PSU_i for sampling, the random number should be compared to the cumulative PSU area. The PSU_i shall be selected when the random number is smaller than the PSU cumulative area and greater than the previous PSU in the list cumulative area. For example, if the random number is 26,446.42 and the cumulative area for PSU_i with ID=1151 is 32,689.23 ha and the cumulative area for the previous PSU is equal to 22,758.71 ha, the PSU ID=1151 will be selected, because 26,446.42 (random number) < 32,689.23 (PSU_i cumulative area) and 26,446.42>22758.71 (cumulative area of the previous PSU in the list)

A table of selected PSU_is following the order of random number generated shall be created containing information on PSU ID, PSU_i area, PSU_i cumulative area, the order of the generated random number and random number itself.

STEP 4: Assign secondary sampling unit ($SSU_{n,i}$)

The table of selected PSUs in Excel shall be imported to ArcGIS and joined to the stratum PSUs shapefile to identify the selected PSUs. Generate a random point which will serve as the $SSU_{n,i}$.

STEP 5: Create two potential sampling location points

In ArcGIS, generate 1 points in association with the $SSU_{n,i}$. One additional point shall be randomly placed within 1000 m of the $SSU_{n,i}$ and must be within the same stratum. It is allowed to include a rule that excludes all areas within 500 m of District boundaries. They shall be allocated as ‘primary’ and ‘backup’ options for field sampling locations. Field crews will first navigate to the ‘primary’ option. If this point is not suitable for sampling because it does not fulfill the criteria described in SOP Establishment of Sampling Plots, then the ‘backup’ option will be used as the sampling location. For the point chosen for sampling, this will serve as the ‘Anchor Point’ for that sampling point.

Sampling Layout

Sampling Point Layout

For each stratum, all sampling will take place in association with the Anchor Point. For live trees, dead trees, and bamboo, sampling will use a ‘floating’ clustered design with four nested tree-plots. Where sampling for non-tree pools will be included, lying dead wood and clip-plot measurements (square boxes) shall be conducted for each plot. Sampling locations for these pools is described below.

In the ‘floating’ cluster nested tree-plot design, all sampling at each sampling point takes place only in locations under the same stratum. The location of the ‘anchor point’ and of each nested tree-plots is determined prior to field sampling and in a GIS environment. Due to the highly fragmented landscape and the terrain causing some locations to require significant time to access, a set of four potential subplot locations are chosen in GIS. In GIS, for a given stratum an Anchor Point is placed using the two-staged sampling design described above. The first tree-plot center (tree-plot A) is then placed on this Anchor Point. Three additional points (B, C, D) are then randomly placed within the given stratum within a 300 m radius of the Anchor Point, but no closer than 50 m from each other, the Anchor point, or the edge of the stratum to avoid overlap between tree-plots and tree-plots spanning more than one stratum. These serve as the center of four potential tree-plots.

When crews are in the field and have reached the anchor point, based on the accessibility of the tree-plots, the field teams will select which three additional points will serve as the tree-plots. See SOP establishment of Sampling Plots for more details.

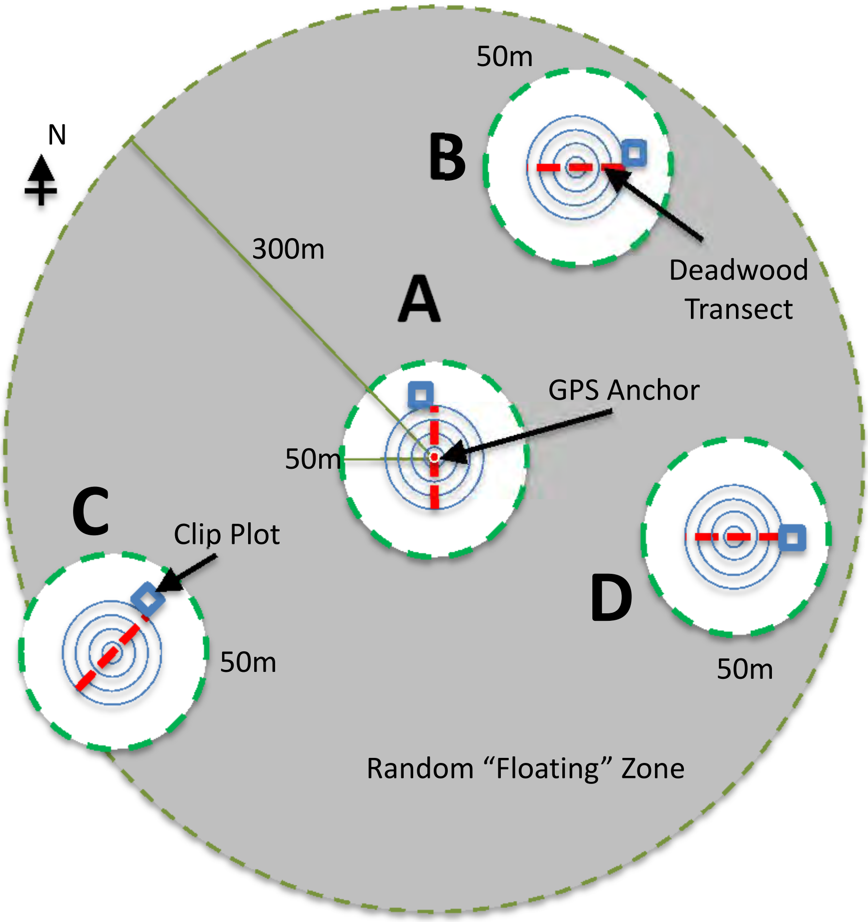


Figure 6: A “floating” cluster plot with a fixed center subplot. Red lines represent 40 m lying deadwood transects while blue boxes represent clip plots

Nested Tree-plots

The following circular nest sizes are recommended for each stratum as below.

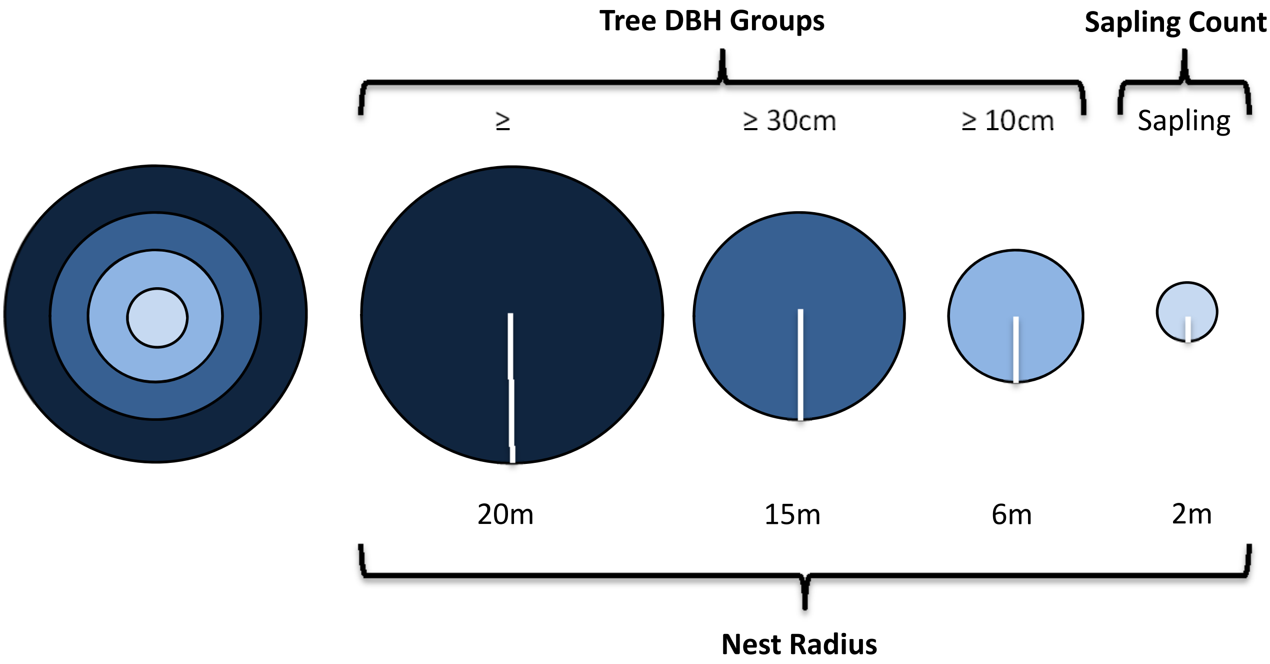


Figure 7 Nest radii (when slope <10% and size classes for each nest. Sapling defined as tree with height >1.3 m and DBH of <10 cm.

Other Vegetation and carbon pools

Each team will also measure standing and lying deadwood, non-tree vegetation in clip plots, and litter in clip plots. The location of sampling should follow the above sampling point layouts. Field measurement procedures should follow the relevant SOP.

SOP SAMPLING PLOT PLANNING

-permissions

-looking at on tablet maps

-meeting w dafo, donre, village head

-planning walking route

-recording track from car to plot

SOP ESTABLISHMENT OF SAMPLING PLOTS

Required equipment:
GPS
Flagging tape
Rope
Clinometer (to measure slope)
>10 m measuring tape (to calibrate DME)
Distance Measuring Equipment (DME)
Additional Items for Permanent Plots
Aluminum tags
Metal (usually iron) bar about 1-2 cm in diameter and 30 cm long
PVC tubing (1 m) and caps
Hammer
Fluorescent paint
Duct tape
Permanent marker

Establish Anchor Point

Navigate to predetermined latitude and longitude of the primary sampling location using a GPS. Walk an additional 10 steps in the direction of travel. These additional steps reduce bias in choosing the anchor point.

At the anchor point, mark a 'waypoint' on GPS and record GPS coordinates, accuracy, elevation, and waypoint number on data sheet. To record a GPS location, place the GPS at the plot center/corner and let it record for > 5 minutes prior to marking a 'waypoint'. The minimum precision level should be ±5 m. Leaving the GPS at one location for several minutes allows the GPS to get a more accurate location by averaging many location acquisitions. The longer the GPS acquires locations the more accurate the final location. The accuracy of the location is estimated and is displayed by the GPS. If there is heavy vegetation cover, it may take a longer time to acquire an accurate location. In some cases, it may be necessary to move slightly or devise a way of getting the GPS higher in the air to acquire satellite signals. For more information, see SOPs on the use of GPS and the manual of the GPS being used[7] .

Label the Anchor Point plot based on SOP Labeling Plots.

Establish Clustered Nested Tree-plots

A cluster of 3 circular nested tree-plots will be sampled at each Sampling Location.

At the anchor point, evaluate the stratum at "tree-plot A". If the GIS determined stratum is not the same as the stratum found on the ground at the Anchor Point, the sampling location shall be moved to 100m east

[7] If a Garmin GPS Map60 is being used, the following steps can be used: a) prior to saving new waypoint, press MENU. b) Highlight 'Average Location' and press ENTER. c) Let GPS sit for many minutes until 'Estimated Accuracy' stabilizes. d) press ENTER to save location. (see manuals at www.garmin.com for more information)

from original Anchor point. If moved point is not still the same with GIS determined stratum, move to 100m south from original Anchor point. Shift to west and north in the same policy.

If all of the tree-plot still would fall in a different stratum than determined in GIS, then no sampling shall take place at this 'tree-plot'. **even if supblot a no wor, just go to b' sampling location. Note on datasheet or tablet reason why sampling did not occur.

Navigate to the 'back-up' sampling location. If all or a portion of the tree-plot would fall in a different stratum than determined in GIS, then no sampling shall take place at this sampling location. Note on datasheet or tablet reason why sampling did not occur. Navigate to next $SSU_{n,i.}$

If an entire tree-plot would fall within the GIS allocated stratum at this location, then establish 'tree-plot A'.

For 'tree-plot B' and 'tree-plot C' this same procedure shall be repeated. If tree-plot A,B and C would fall in a different stratum than determined in GIS, then no sampling shall take place at this sampling location. Not necessary to conduct tree-plot D. At least, two of plots have to be surveyed for calculation the biomass.

In the nested tree-plots, the following vegetation types will be sampled: Trees; Saplings; Standing Dead Trees and Bamboo. The methods for sampling each of these vegetation types in the subplots are described in the respective SOP.

The dimensions and vegetation types sampled in each nest is presented in SOP Sampling Design and Layout. Based on the Sampling Layout determined in SOP Sampling Design and Layout, walk to the subplot center point.

At the subplot center point, mark a 'waypoint' on GPS and record GPS coordinates, accuracy, elevation, and waypoint number on data sheet. To record a GPS location, place the GPS at the plot center/corner and let it record for > 5 minutes prior to marking a 'waypoint'. The minimum precision level should be ±5 m. Leaving the GPS at one location for several minutes allows the GPS to get a more accurate location by averaging many location acquisitions. The longer the GPS acquires locations the more accurate the final location. The accuracy of the location is estimated and is displayed by the GPS. If there is heavy vegetation cover, it may take a longer time to acquire an accurate location. In some cases, it may be necessary to move slightly or devise a way of getting the GPS higher in the air to acquire satellite signals. For more information, see SOPs on the use of GPS and the manual of the GPS being used[8] .

1. Label the subplot based on SOP Labeling Plots
2. Measure the slope using a clinometer following the 'SOP Use of a Clinometer and Measurement of Slope'. If the slope is greater than 10% record the exact slope.
3. Correct for the size of the tree-plot area to account for the slope. (see below 'Tree-plot Area correction'), record the sizes of each of the nests for that tree-plot on the data sheet and inform all crew members.
4. Describe land and vegetation conditions of plot and if there is anything unique or unusual in the plot or directly surrounding the plot. This could include things such as small streams, trails, large boulder or termite nest, and proximity to a paved road.
5. Mark center of the plot with wooden stake wrapped with flagging tape. This plot center mark will be used to identify the plot center during any third-party verification or quality checks.

A wooden stake shall be placed at the plot center in circular plots and at each corner in square/rectangular plots. This will be used to facilitate verification of plot measurements where required.

When using Distance Measuring Equipment (DME) the only requirement is to place the DME stand in the center point of the plot. In areas with dense vegetation, it is recommended that a piece of bright colored flagging be placed on branches above the DME stand to increase visibility. Because the DME is essential for establishing circular plots, extra batteries should always be carried into the field. Alternatively, a rope/cord and/or a tape measure may be used to identify the boundary of circular plots. If a rope is used, the length of the rope must be measured prior to each plot establishment with a tape measure as many ropes are made out of material that stretches over time or when wet.

[8] If a Garmin GPS Map60 is being used, the following steps can be used: a) prior to saving new waypoint, press MENU. b) Highlight 'Average Location' and press ENTER. c) Let GPS sit for many minutes until 'Estimated Accuracy' stabilizes. d) press ENTER to save location. (see manuals at www.garmin.com for more information)

Establish Lying Deadwood Transect

For the NFI Pilot, the lying deadwood line transect will lie across the tree-subplot. (Please note: for permanent plots, line transects must be located outside the tree-plot. This prevents damage inflicted on plot area through measurement from impacting lying dead estimates.)

1. Starting at the tree-plot center, walk in a north direction 20 meters. If the plot is on a slope of >10%, walk 20 meters in the upwards direction of the slope.
2. Walk 5 more steps (These additional steps reduce bias in choosing the sampling location).
3. Correct for the length of the line transect to account for the slope.
4. Layout transect along the slope through the plot center.

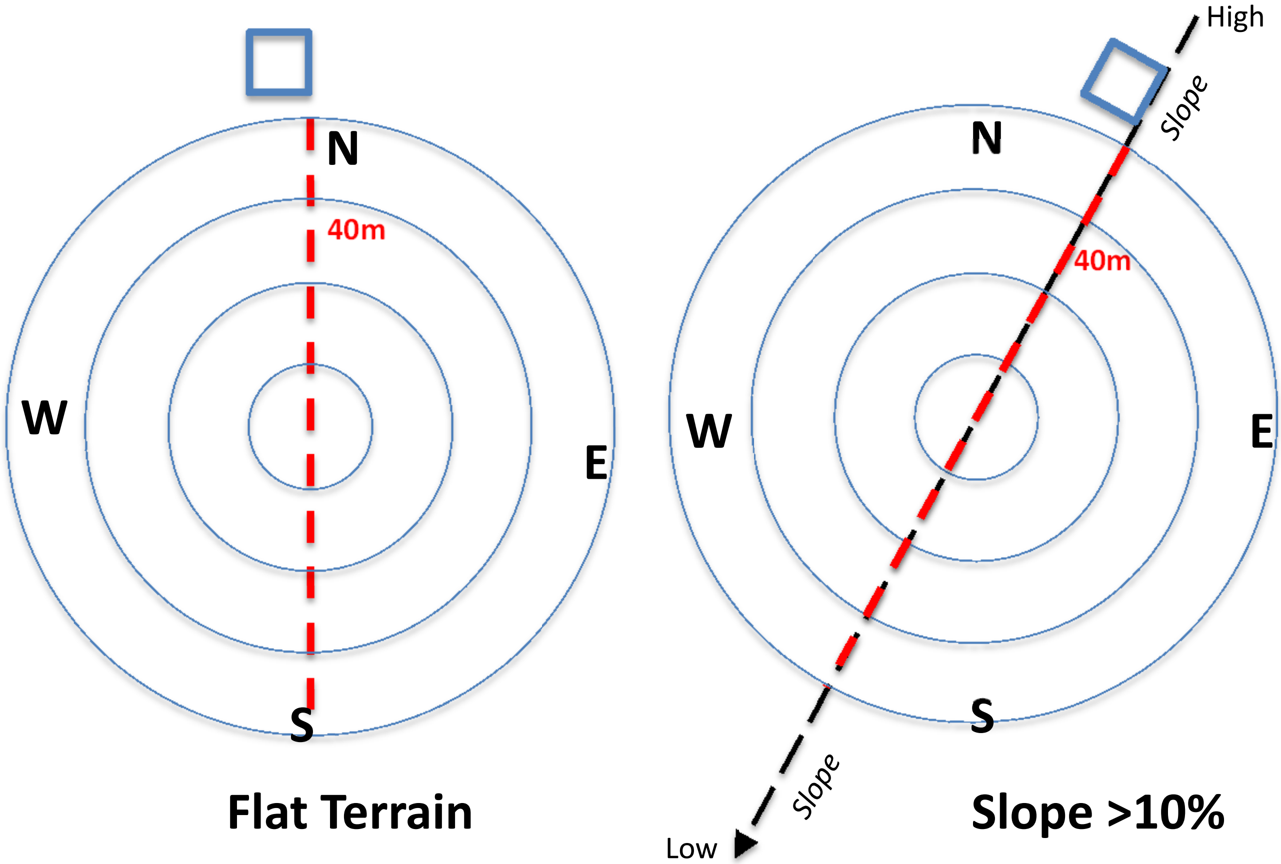


Figure 8: Positioning of lying deadwood transects (in red) located at subplot.

Establish Clip-plots

Clip-plots can be used to sample non-tree vegetation along with litter. Soil can also be sampled at the same location. In this example, 2 clip-plots are measured per anchor point.

Figure 9: Examples of clip-plots used for Non-tree vegetation and Litter collection

1) Starting at the tree-plot center, walk in a north direction 20 meters. If the plot is on a slope of >10%, walk 20 meters in the upwards direction of the slope.
2) Walk 5 more steps (These additional steps reduce bias in choosing the sampling location).
3) Place clip plot frame immediately to your left at this location (see Figure below). Clip plot frame may need to be placed around existing vegetation and then constructed. For example, a tree may be located within the clip plot location.
4) Follow SOPs for:
   a) Non-tree woody and herbaceous vegetation
   b) Litter
5) Repeat three more times, starting at the center of each tree-plot

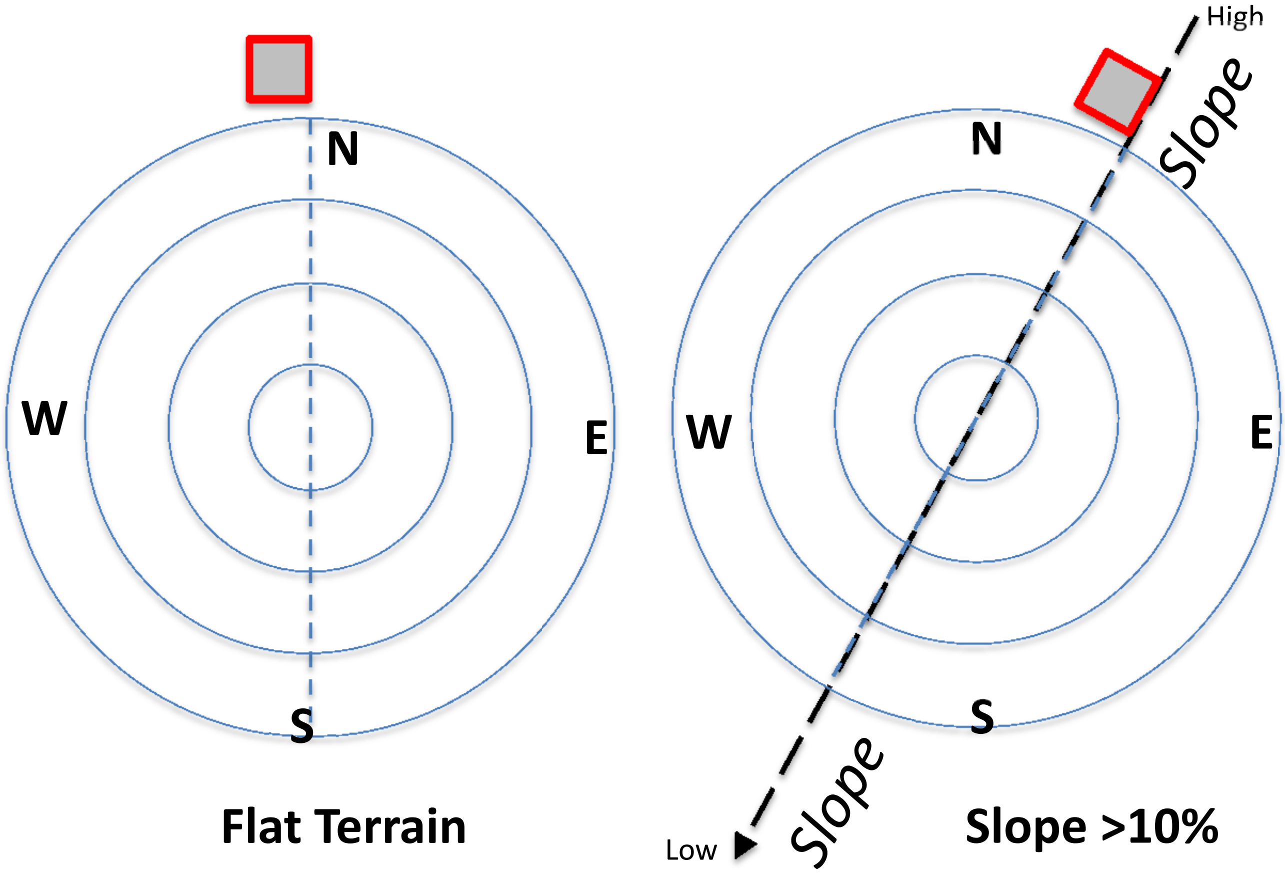


Figure 10: Position of Clip Plots (in red) located at subplot.

Slope Corrections - Conducted in the field

If the sampling location area falls on a slope that is greater than 10%, then slope angle should be measured using a clinometer so that an adjustment can be made to the location sampled. If slope is less than 10%, correction is not required.

Tree-plot area correction

Where tree-plots are on sloped ground, tree-plot size has to be adjusted to reflect the true horizontal projection. When a tree-plot is to be established on sloped terrain, the radius for each of the nests within the tree-plot may need to be adjusted. That means the radii for the various nests will be slightly longer in the field to ensure the vertical projection of each of the nested subplots will yield the same area as if the tree-plot were established on flat terrain.

The slope must be measured for each of the clustered tree-plots.

To determine the corrected radius, the radius on the slope is first calculated, using the following equation:

$$Sloped\_Radius = \frac{Nest\_Radius}{Cos\theta}$$

Where:

Sloped_Radius = Length of radius (m) on slope that corresponds to horizontal radius

Nest_Radius = Length of radius agreed upon in flat terrain (m)

Cosθ = Cosine of the slope angle

The true horizontal projection of a circular plot on a slope is an ellipse, but because it is not possible to establish an ellipse in the field with accuracy, the plot is adjusted to be a circle having the same area as the ellipse. Therefore, after determining the corrected radius on the slope, the area is calculated as follows:

$$Corrected\_Area = \pi * Nest\_Radius * Sloped\_Radius$$

The corrected radius, to be used in the field, is then calculated as follows:

$$Corrected\_Radius = \sqrt{\frac{Corrected\_Area}{\pi}}$$

The correction of the subplot nests should be conducted in the field by the crew leader, based on the corrected radius for the appropriate slope as shown in the table below. Measured slope gradient should be approximated to the nearest slope gradient. A correction table is presented in the appendix. This should be printed and used by the crew leader.

Extrapolation to Hectare – Conducted during data analysis

Following field data collection, during data analyses, any measurements taken at the plot level are extrapolated to the area of a full hectare to produce carbon stock estimates on a 'per hectare' basis. Extrapolation is done by the use of scaling factors that are calculated as the proportion of a hectare (10,000 m^2) that is occupied by a given nested plot or clip plot:

$$Scaling\_factor = \frac{10{,}000m^2}{Horizontal\_Area\_of\_nest\_(m^2)}$$

SOP MEASUREMENT OF TREES

Field equipment:
Tree name list
Diameter tapes
Flagging tape
Tree poles: Small-diameter PVC piping cut the exact length of diameter measurements (eg 1.3 m if DBH will be measured)
Chalk sticks
For measuring height (see SOP Measurement of Height):
Clinometer
Laser Range Finder or >20m measuring tape

Please note: The 'SOP Destructive Sampling of Saplings' must be completed before estimates of total tree biomass can be made.

The design and establishment of plots shall be determined following SOP Plot Design and SOP Establishment of Plots. In the NFI Pilot, temporary tree-plots will be used.

1. Assign one person to record the data and all others should be measuring and marking trees. The recorder should stand in the center of the nested tree-plot being measured. He or she should track those measuring the trees and should try and ensure that no trees are missed.
2. To avoid either missed trees or double recording, measurement should begin to the North and the first tree should be flagged. After a tree is measured, a chalk mark facing the center of the plot should be placed on tree to allow the person recording the data to track measured and unmeasured trees.
3. Count the number of saplings (defined as trees <10 cm DBH and >1.3 m tall) in the smallest plot (e.g. 2 meter radius plot) and record on data sheet. (After field data collection, the number of saplings will be combined with the average sapling weight to estimate total sapling biomass (see 'SOP Destructive sampling of trees, saplings, palms, and bamboo')).
4. **Boundary trees:** Occasionally trees will be close to the border of the plots. The plots are relatively small and will be expanded to estimate biomass carbon on a per hectare basis. It is therefore important to carefully decide if a tree is in or out of a plot. To definitively determine whether the tree is in or out of the plot, use a DME to measure out from the plot center (or plot corner) to the base of the boundary tree. If the plot is on sloped ground, make sure the measurement follows the slope. If more than 50% of the base of the trunk is within the boundary of the nest, the tree is in. If more than 50% of the base of the trunk is outside of the boundary, it is out and should not be measured. If it is exactly on the border of the plot, flip a coin to determine if it is in or out.
5. Record the name of the tree, based on tree naming system developed prior to field data collection.
6. **Tree Pole placement**: For each tree, place the Tree Pole (e.g. 1.3 m plastic pole) against the tree to indicate the location of measurement (eg DBH). Placement of the Tree Pole depends on the slope of the ground, leaning angle of the tree, and shape of the tree bole (see Figure below for correct placement of diameter tape).
    a. **Slope:** Always place tree pole and measure diameter on the *upslope* side of the tree
    b. **Leaning tree**: Always measure the height of a measurement (e.g. 1.3 m) parallel with the tree, *not* perpendicular to the ground. Therefore, if the tree is leaning, measure underneath the lean, parallel with angle of tree. If a tree is not straight, a tape measure must be used to measure the bole distance from ground to location of measurement (e.g. DBH).
    c. **Dead tree**: If a tree is in dead class 1 (see SOP Measurement of Standing Dead Wood), mark as dead on data sheet. Trees are considered alive if there are green leaves present. Even if there are only one or two green leaves present the tree is considered alive. However, in deciduous forests during a season when trees drop their leaves (ie dry season) a branch or the stem must be cut to verify that the cambium is alive in order to determine if the tree is alive or dead.
    d. **Multi-stem tree**: If the tree is multi-stemmed with forking below the point of measurement (eg 1.3 m), measure the diameter on each stem and tag the stems that exceed the minimum diameter for the nest. Record it as if each stem were a different tree on the data sheet, but with a note that the stems make up one tree.

e. **Buttressed tree**

   i. If the buttress is shorter than the allometric equation's dictated measurement point (e.g. 1.3 m, measure the diameter at the standard (e.g. 1.3 m) height.

   ii. If the buttress is taller than 1.3 m, measure the diameter at 30 cm above top of buttress as shown in example D in the figure above, and above the top of the mangrove roots in the figure below. In cases where the buttress or mangrove roots are too tall and out of reach, the following procedure shall be followed:

      1. Taking into consideration the safety of field crew, climb the tree to take measurement 30 cm above the top of the buttress. In fluted buttress, it is possible to carve steps on the buttress itself to allow climbing to top of buttress. Extreme caution should be employed and climbing should only be performed when conditions are deemed safe by field crew leader.
      2. If climbing is considered unsafe, poles can be use. Mark 30 cm from the top of the pole. Attach DBH tape to the top of the pole and place this along the bole so that the 30 cm mark lines up with the top of the buttress. Use a series of other poles to move the DBH tape into position around the tree until it reaches the zero point on the DBH tape, ensuring the tape measure is perpendicular to the bole and does not flip upside down. Poles can be made from tall saplings found outside the sampling plot in the forest or by linking Tree Poles together (e.g. with pvc connectors)
      3. If no alternatives exist, poles shall be placed against the tree, at the edge of its circumference, projecting the diameter at exactly 30 cm above top of buttress down to the ground. An observer is required to ensure poles are properly placed at the very edge of tree's circumference in a way that linear distance between poles represents the diameter of tree at 30 cm above end of buttress. The **linear distance** (e.g. use regular tape measure NOT DBH tape measure) between the two poles shall be measured. At least two measurements shall be taken on opposite sides of tree using this method, and then averaged to estimate tree DBH. Poles can be made from tall saplings found outside the sampling plot in the forest or by linking Tree Poles together (e.g. with pvc connectors).

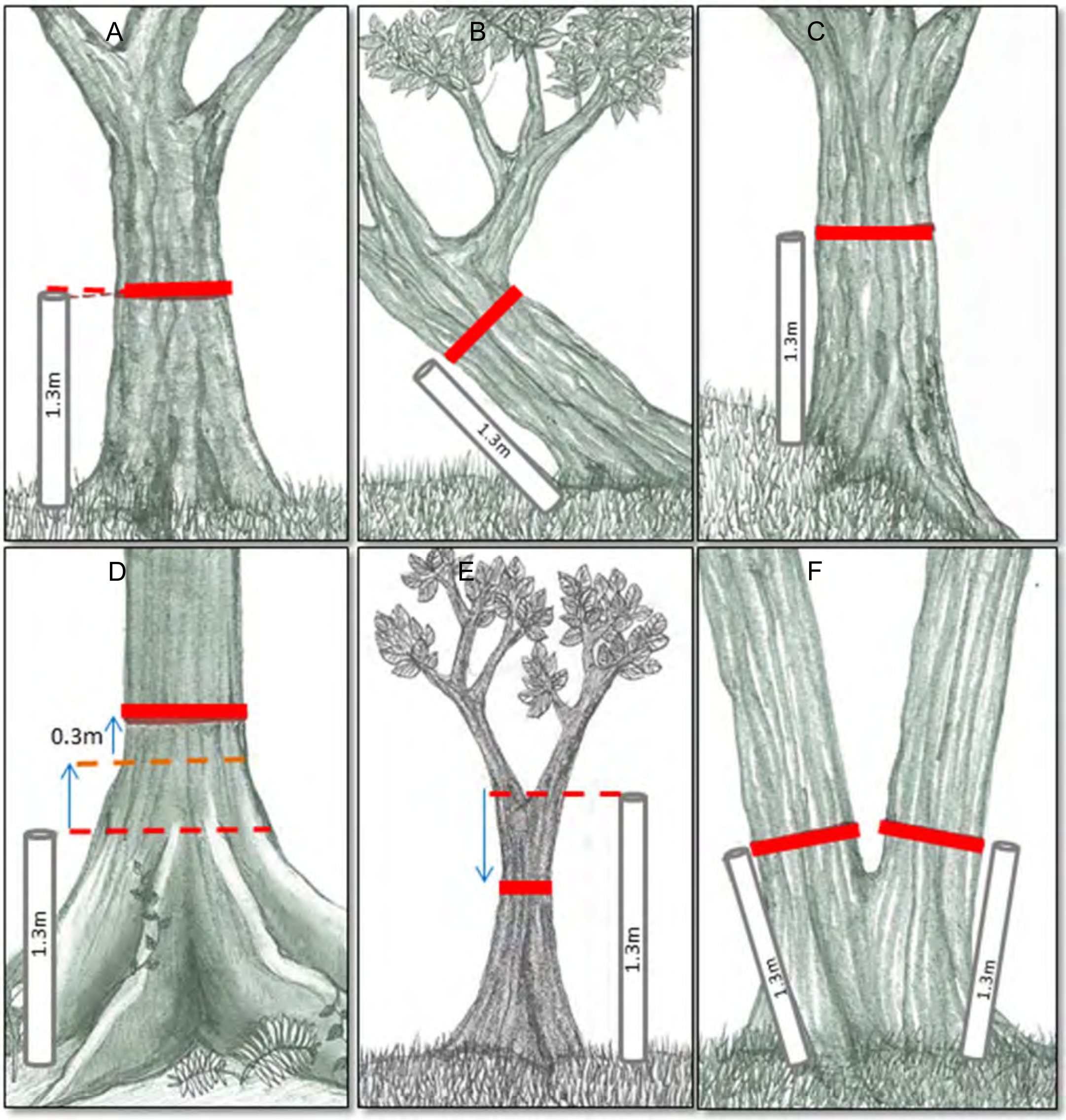


Figure 11: Proper placement of diameter tape when allometric equation used requires measurement at DBH (1.3 m)

f. **Diameter measurement:** Tree diameter should be measured to the nearest 0.1 cm (eg diameter of 10.2 cm *not* 10 cm).

   i. If the diameter tape has a hook, push the hook into the bark of the tree slightly to secure it and pull the tape to the right. The diameter tape should always start left and be pulled right around the tree, even if the person taking the measurement is left-handed. As the diameter tape wraps around the tree and returns to the hook the tape should be above the hook. The tape should not come around the tree below the hook. The tape should not be upside down; the numbers must be right side up. (see Figure below)

   ii. If a liana or vine is growing on a tree that is going to be measured, do not cut the liana to clear a spot to measure the tree's diameter. If possible, pull the liana away from the trunk and run the diameter tape underneath. If the liana is too big to pull away from the trunk, estimate the diameter of the liana and subtract from total tree diameter. Cutting a liana from a tree should only be done if there are no other options. The same standard should be followed for any other type of natural organisms (mushrooms, epiphytes, fungal growths, termite nests, etc.) that are found on the tree.

   iii. Place chalk mark on the tree to indicate to crew members that the tree has been measured.

Figure 12: Measurement of diameter using a diameter tape and tree pole

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When all of the trees in the tree-plot have been measured, there should be a double-check by the team leader to see that all of the appropriate trees have been measured.

SOP MEASUREMENT OF PALMS, LIANAS, AND BAMBOO

Field equipment:

Tree name list
Diameter tapes
Flagging tape
Tree poles: Small-diameter PVC piping cut the exact length of diameter measurements (eg 1.3 m if DBH will be measured)
Chalk sticks
Clinometer
Laser Range Finder or >20m measuring tape

Prior to Field Sampling

The biomass of palms, lianas, and bamboo varies significantly between land cover types. Prior to data collection initial field research should be undertaken to determine the distribution and dominance of these vegetation types within a land cover type. If such a vegetation type is common and dominant, field measurements methods are described below. If the vegetation type (palm, liana, bamboo) is not common and it is conservative to underestimate forest biomass, it is recommended that the vegetation type not be measured. This SOP must be altered to describe the approach that must be used for the measurement of palms, lianas, and bamboo.

The biomass of palms, lianas, and some types of bamboo is usually estimated using a previously created regression equation that relates biomass with one or more specific vegetation parameters such as species, diameter, height, and/or number of stems. Prior to plot establishments and measuring, the regression equations to be used to estimate the palm, liana, and bamboo biomass must be selected from existing equations and field verified for applicability or newly developed for the land use type of interest. See 'SOP Destructive sampling of trees, saplings, palms, and bamboo' for more information on how such equations are created and/or verified.

Prior to field data collection, a standard list of palm, liana, and bamboo names shall be developed. Depending on the biomass regression equations used, the names may relate to actual tree species, tree genus, or tree family. A standard name list and name abbreviation list shall be created and brought to the field for reference and for filling out data sheets.

The size classes to be measured in each nest will need to be determined prior to initiation of fieldwork. Measurement will only occur for individuals that meet the size class requirements for a given nest. For permanent plots, only individuals measured shall be tagged with an aluminum numbered tag and nail.

The biomass of individuals below a certain size threshold can be estimated by counting the number of individuals within a certain area and multiplying that by the average weight of an individual sapling. This 'sapling count' method is often used for trees (see SOP Measurement of Trees). To estimate the average weight of an individual, the sapling portion of 'SOP Destructive sampling of trees, saplings, palms, and bamboo' must be implemented prior to field data collection. In the field, such individuals should be counted in a 2-m radius plot but should not be tagged. Alternatively, the biomass of individuals below a size threshold can be included in the non-tree biomass measurements ('SOP Measuring non-tree vegetation'). However, only one approach can be taken for each stratum.

This SOP must be altered to describe the approach used for the measurement of palms, lianas, and bamboo. This will aid in field data collection initially allow future measurements to be completed efficiently and accurately.

Field Measurements

The design and establishment of plots shall be determined following SOP Sampling Design and Layout and SOP Establishment of Sampling Plots. The instructions here assume these SOPs have already been followed.

The following are the steps to be used in collecting measurements in the field. Often, these field measurements are taken at the same time as the measurement of trees.

Measuring Palms

Note: Palms will not do not be measured as part of the NFI in Lao PDR. The following guidance is given only as background:

The specific field measurements taken will be dependent on the allometric equation used, therefore, the below description offers only general guidance. A size threshold of 1.3 m height is usually used. All smaller palms should be measured either using the 'sapling count' method or with non-woody vegetation. Only one method can be used.

In tree-plots, only palms with a stem taller than 1.3 m should be measured. Smaller palms will be measured either as non-tree woody vegetation or herbaceous vegetation.

1. Measure palms at the same time as trees.
2. Measure all palms taller than 1.3 m within the medium nested plot.
3. Measure the required palm variable (often this is Height of the palm from the base to the top of the stem).
4. For permanent sample plots, tag the palm in the same location as for trees.

Measuring Lianas

Note: Lianas will not be measured as part of the NFI in Lao PDR. The following guidance is given only as background:

1. Lianas can be measured at the same time as trees. It is recommended that lianas be measured within the smallest nest.
2. The only lianas that should be measured are those originating from the nest (e.g. liana emerges from ground within nested plot where measurements taking place). Measure the liana variables (eg DBH) required by the allometric equation that will be applied.
3. Take care that the same liana is not measured more than one time.
4. If using permanent plots lianas should also be tagged in the same location as for other trees.

Measuring Bamboo

Allometric equations can be used to estimate the biomass of a bamboo patch. Usually the equations relate basal diameter and height to biomass. If no appropriate allometric equations exist, one must be created. See 'SOP Destructive sampling of trees, saplings, palms, and bamboo'. The specific field measurements taken will be dependent on the allometric equation used, therefore, the below description offers only general guidance.

1. The nest size within which bamboo will be measured will be dependent on the prevalence of bamboo. If highly prevalent, then the smaller nest size can be used. Otherwise, all bamboo patches should be measured in the medium nested plot.
2. Measure the bamboo parameters required in the biomass regression equation developed. This would include things such as height (using a clinometer), the basal diameter (using DBH tape), and the number of culms in a patch. Note: the exact measurements made will be dependent on the factors included in the allometric equation used.

SOP MEASUREMENT OF STANDING DEAD WOOD

Field Equipment:
DBH tape
Clinometer
Laser range finder (OPTIONAL)
Measuring tape

Other:
'Sound dead wood' density estimate (see SOP 6 Measurement of dead wood density)

Standing dead wood refers to trees that have died but are still upright. Usually the minimum size class of dead trees measured is the same as the minimum live tree measured (for example trees greater than 5 cm DBH and taller than 1.3 m). However, standing dead wood generally also includes dead wood stumps from trees that were greater than 5 cm DBH when alive but have a current height of less than 1.3 m, thus all standing dead wood with a diameter greater than 10 DBH or at stump height shall be measured.

This SOP must be done in conjunction with the SOP Measurement and Estimation of Dead Wood Density.

Standing dead wood can be measured within the permanent or temporary plots used to measure live trees. Generally, measurements of standing dead wood take place concurrently with live tree measurements. Standing dead trees shall be measured in the 15 radius tree nest size. Each standing dead trees should be classified into two classes (see Figure below):

Class 1: Dead tree with branches and twigs and resembles a live tree except for absence of leaves (make sure tree is dead and not deciduous)

Class 2: Dead trees containing large branches or no branches at all, including stumps.

By classifying trees into these two simplified classes, a conservative estimate of biomass will be taken.

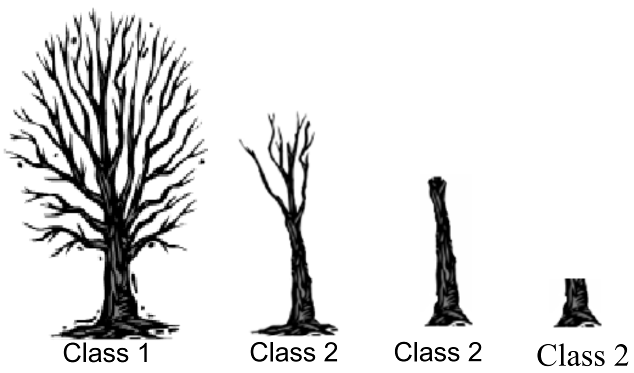

Figure: Example of trees in Class 1 and Class 2

Field Measurements

The design and establishment of plots shall be determined following SOP Plot Design and SOP Establishment of Plots. The instructions here assume these SOPs have already been followed.

Class 1 trees:

1. Follow the same measurement protocols as for the measurement of live trees, including the measurement of tree variables (eg DBH, H) (see SOP Measurement of Trees). If species/genus specific allometric equations require different field measurements, rules must be included in this SOP stating which field measurements will be made for which type of dead tree (for example – for all Class 1 dead trees, the 'other' tree allometric equation will used and DBH of dead trees will be measured.) If nested plots are used, it is recommended that dead trees be measured in the medium nest. Mark tree as 'Dead' on datasheet.

Class 2 trees (see Figure below):

1. The biomass of these trees is based on estimating the volume of the remaining tree and multiplying the volume by the wood density.
2. Measure DBH using methods for live trees. Measure all dead trees in medium nest.
3. Measure the diameter at the base of the tree. (**D_{base}**)
4. Measure height of stem (H) either using a clinometer and measuring tape or laser range finder (see SOP Measurement of tree height) or through direct measurement using tape measure (eg when dead wood is less than 2 m high)
5. Measure diameter at top of stump (**$D_{top,}$**) either through direct measurement (e.g. when diameter at top can be reached directly) or through the use of a relascope. Alternatively, do not take a measurement at the top of the stump and write 'None' or 'NA' on datasheet.

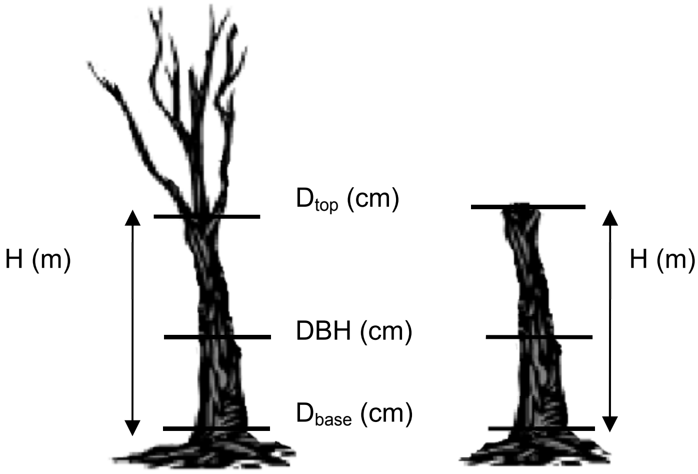

Figure2 Standing dead tree measurement locations

Volume Equations

A full description of the steps required to estimate standing dead wood biomass per hectare are not included here. However, equations are provided to estimate the volume of an individual standing dead tree. Different approaches can be used for different trees, depending on whether it is possible to measure the diameter at the top of a given dead tree.

To estimate the biomass of an individual standing dead tree, the estimated volume is multiplied by the average density calculated for 'sound wood' (see SOP Measurement of Deadwood Density).

Option 1: Diameter at top (Dt_{op}) was measured directly:

Volume estimated assuming tree is a truncated cone:

$$Volume = \left(\frac{\pi * Height}{12}\right) \cdot \left(D_{base}^2 + (D_{base} \cdot D_{top}) + D_{top}^2\right)$$

Option 2: Diameter at top (Dt_{op}) was measured using a Relascope:

Volume estimated assuming tree is a truncated cone:

$$Volume = \left(\frac{\pi * Height}{12}\right) \cdot \left(D_{base}^2 + (D_{base} \cdot D_{top}) + D_{top}^2\right)$$

Option 3: Diameter at top (Dt_{op}) estimated using taper equation:

$$D_{top} = D_{base} - \left[H \cdot \left(\frac{D_{base} - DBH}{130 \cdot 100}\right)\right]$$

Volume estimated assuming tree is a truncated cone:

$$\text{Volume} = \left(\frac{\pi * Height}{12}\right) \cdot \left(D_{base}^2 + (D_{base} \cdot D_{top}) + D_{top}^2\right)$$

Option 4: Diameter at top (Dt_{op}) is assumed to be zero.

Volume estimated assuming tree is a cone.

$$\text{Volume} = \frac{1}{3} \cdot \pi \cdot \left(\frac{D_{base}}{2}\right)^2 \cdot H$$

SOP MEASUREMENT OF LYING DEAD WOOD

Field Equipment: Calipers (preferred) or DBH tape Measuring tape Two 50 m long ropes (with 25 m marked) or two 25 m long ropes Machete **Other:** Dead wood density estimates (see SOP Measurement of dead wood density)

Lying dead wood is measured using the line-intersect method outlined in Harmon and Sexton (1996)[9]. Lying dead wood is defined as all woody material on the ground with a diameter ≥10 cm. Smaller diameter pieces of wood are sampled as part of the litter pool (see SOP of Litter Layer).

This SOP must be done in conjunction with the SOP Measurement and Estimation of Dead Wood Density.

Prior to Field Sampling

Using the following method, dead wood is grouped into three dead wood classes: sound, intermediate, and rotten. Prior to field measurements, samples of each dead wood class shall be collected for demonstration purposes. So that consistent measurements are made throughout sampling, all field members must be trained on what type of dead wood will be considered in each class.

Field Measurements

Follow the SOP Sampling Design and Layout and SOP Establishment of Sampling Plots to determine location of lying dead transect

1. Along the length of the line, measure the diameter of each intersecting piece of coarse dead wood (> 10 cm diameter) (see Figure below). Calipers work best for measuring the diameter.

Figure 13: Use of calipers to measure the diameter of lying deadwood along line transect

When measuring the diameter of dead wood it is not always possible to place a tape around the log. It can also be dangerous because logs are usually home to snakes, spiders, etc. If you are going to measure the diameter of the piece of dead wood with a diameter tape, make sure the route is clear before placing your hand underneath the log.

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[9]Harmon, M. E. and J. Sexton. 1996. Guidelines for measurements of woody detritus in forest ecosystems. Publication no. 20. U.S. Long-term Ecological Research (LTER) Network Office, University of Washington, Seattle, Washington, USA

2. A piece of dead wood should only be measured if: (a) more than 50% of the log is aboveground, and (b) the sampling line crosses through at least 50% of the diameter of the piece—see figures below. Some examples are displayed in the Figure below.

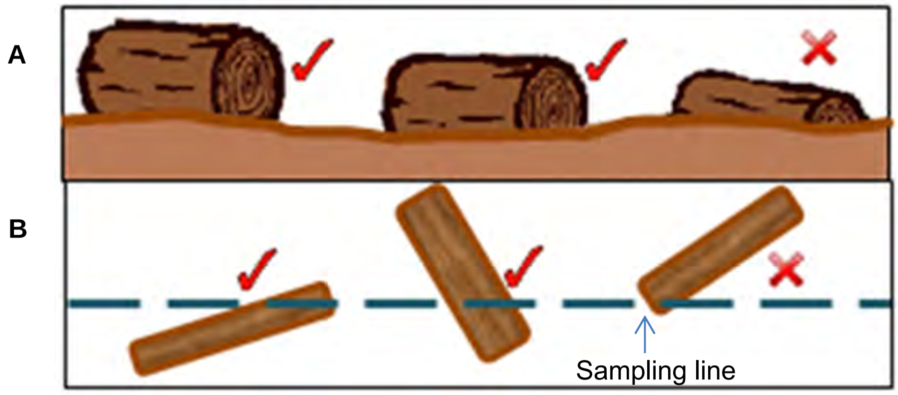

Figure 14: (A) Schematic of which dead wood should be measured. The first two logs should be measured because the log is more than 50% above ground, but the third log should not be measured. The horizontal line represents the soil surface. (B) Schematic of which dead wood should be measured. The first two logs should be measured because the sampling line crosses more than 50% of the diameter of the logs. Conversely, the third log should not be measured because the sampling line does not cross more than 50%.

3. If the log is hollow at the intersection point, measure the diameter of the hollow portion in two directions; the hollow portion in the volume estimates is excluded.

Figure 15 Hollow Log. Two measurements of the diameter of the hollow shall be taken

4. Assign each piece to one of three density states: sound, intermediate, or rotten. To determine what density class a piece of dead wood fits into, each piece will be struck with a machete. If the machete does not sink into the piece (bounces off), classify it as sound. If the machete sinks partly into the piece, and there has been some wood loss, classify it as intermediate. If the machete sticks into the piece, if there is more extensive wood loss, and the piece is crumbly, classify as rotten. Record on data sheet.
5. The volume of lying dead wood and then carbon stocks will be estimated using the diameters of each piece of wood and the length of the line transect.

SOP MEASUREMENT OF NON-TREE VEGETATION

Field Equipment:
Clip plot frame (see below for explanation)
Measuring tape
Clippers and hand saw to remove vegetation
5 kg hanging scale (for destructive sampling, appropriate size dependent on size of non-tree woody vegetation)
300 g hanging scale (for subsample)
Hanging scale
Durable plastic sheeting
Durable plastic tarp
Cloth or paper sample bags
Compass
Calibration weights (see below)

Laboratory Equipment:
Drying oven
Laboratory scale

Prior to Field Sampling

Create Clip plot frames: Clip plot frames can be made out of various materials and can be circular or rectangular. A square clip plot frame made of PVC pipe 50 cm x 50 cm is usually sufficient for sampling (see Figure below). The clip plot frame should ***not*** be one continuous piece of material. The pieces of PVC piping should ***not*** be glued together into a permanent square. Instead it must remain in pieces so that it can be constructed around existing vegetation. The 'elbows' used to connect two pieces of piping together may be glued to one piece of piping. This step is only required where the 'clip plot' method is to be used.

Create 'calibration weights' to calibrate hanging scales: Prior to going into the field, the scales that will be used to weigh samples must be calibrated. The ideal approach is to calibrate the hanging scales that will be used in the field with the laboratory scale that will be used to measure the dry weight of subsamples. Only required if 'clip plot' method will be used.

1. Ensure the laboratory scales are calibrated
2. Medium hanging scale (5 kg):
    a. Find an item that weighs about 3 kg and does not change weight when wet (metal tool of some sort). Weigh this item using the laboratory scale 5 times. Record weights and take average weight.
    b. Calibrate hanging field scale using this item and the average recorded weight. This can take place at a base camp and therefore does not have to take place at the site of the destructive sampling. Do this every day prior to weighing items in field.
3. Small hanging scale (~500 g):
    a. Find an item that weighs 100-250 g and does not change weight when wet (metal tool of some sort, stack of coins taped together). Weigh this item using the laboratory scale 5 times. Record weights and take average weight.
    b. Calibrate hanging field scale using this item and the average recorded weight. This can take place at a base camp and therefore does not have to take place at the site of the destructive sampling. Do this every day prior to weighing items in field.

Field Measurements

For the NFI Pilot field sampling, all non-tree biomass will be measured in clip plots. This includes shrubs, and herbaceous vegetation but will not include bamboo. Bamboo will be measured separately.

1. Follow the SOP Sampling Design and Layout and SOP Establishment of Sampling Plots to determine clip plot locations
2. Place clip plot frame at this location (see Figure below). Clip plot frame may need to be placed around existing vegetation and then constructed. For example, a tree may be located within the clip plot location.
3. Identify which non-tree vegetation individuals have stems originating from inside the area of the clip plot. This non-tree vegetation shall be cut at ground level. Any non-tree vegetation which have branches hanging into the plot but whose stem base is located outside the area of the clip plot shall ***not*** be clipped and measured.
4. Weigh clipped non-tree vegetation. If other types of non-tree vegetation (eg non-woody, bamboo, palms) are being sampled separately from the non-tree woody vegetation, do not include these other types of vegetation when weighing the non-tree woody vegetation. Record the total fresh weight of non-tree woody vegetation within the clip plot.
5. If there is no non-tree vegetation within the clip plot area, the clip plots should *not* be moved. Instead the non-tree woody vegetation biomass shall be recorded on the data sheet as 'zero'.
6. Take a sub-sample of vegetation. This should be representative of the total sample and shall be made up of a mix of species and vegetation found within the total sample. Place vegetation temporarily in a sample bag.
7. Repeat steps 1-6 for the remaining clip-plot locations.
8. Combine the sub-samples into one sub-sample bag.
    a. Weigh the subsample bag empty. Record weight.
    b. Combine the subsamples from all 3 clip plots into one subsample bag.
    c. Weigh the subsample bag with the subsample inside. The weight should be between 100-300 g. Record the actual weight.
    d. Label the subsample bag with the plot identification number, subsample identification number, and weight of subsample.
    e. Take the subsample bag and the subsample from field. Bring them to the laboratory and dry the subsample. Reweigh subsample. This subsample will be used to create a wet-to-dry ratio. This ratio will then be used to estimate the total dry weight of non-tree woody vegetation found within the clip plot.
9. It is allowable for there to be a delay between field data collection and laboratory analysis. However, cloth sample bags must be placed in a location that allows air drying to occur.

Figure 16: Clip plot on forest floor

SOP MEASUREMENT OF LITTER LAYER

Field Equipment:
Clip plot
Machete or knife
Clippers to remove vegetation and cut litter along edge of plot
2 kg hanging scale (appropriate size dependent on density of non-tree vegetation)
300 g hanging scale (for subsample)
Durable plastic sheeting
Durable plastic tarp
Cloth or paper sample bags
Permanent marking pen
Compass
Calibration weights (see below)

Laboratory Equipment:

Drying oven
Laboratory scale

Note: Litter do not need to be measured as part of the NFI in Lao PDR. The following guidance is given only as background:

The litter layer is defined as all dead organic surface material on top of the mineral soil. Some of this material will still be recognizable (dead leaves, twigs, dead grasses, and small branches) and some will be unidentifiable decomposed fragments of organic material.

Note: Deadwood with a diameter < 10 cm is included in the litter layer.

Clip plots should be used to sample litter and the clip plots can be the same as the ones used for non-woody vegetation material (see SOP for Non-woody Vegetation).

Sampling of litter may occur in a known small area in which all litter within the area is removed and weighed. The average carbon stock of litter within the land use area is then extrapolated based on the average weight found within the areas sampled and the assumed percent carbon of litter. This SOP must be altered to describe the approach that must be used for the measurement of litter.

Sampling can take place at the same location as sampling for non-woody vegetation (see SOP Measurement of Non-woody Vegetation).

Prior to Field Sampling

Create clip plot frames: The small areas within which litter is measured are called ‘clip plots’. Clip plot frames can be made out of various materials and can be circular or rectangular (see Figure below). A square clip plot frame made of PVC pipe 50 cm x 50 cm is usually sufficient for sampling. The clip plot frame should ***not*** be one continuous piece of material. The pieces of PVC piping should ***not*** be glued together into a permanent square. Instead it must remain in pieces so that it can be constructed around existing vegetation (such as trees and saplings). The ‘elbows’ used to connect two pieces of piping together may be glued to one piece of piping.

Create ‘calibration weights’ to calibrate hanging scales: Prior to going into the field, the scales that will be used to weigh samples must be calibrated. The ideal approach is to calibrate the hanging scales that will be used in the field with the laboratory scale that will be used to measure the dry weight of subsamples.

1. Ensure the laboratory scales are calibrated
2. Medium hanging scale (2-5 kg):
    a. Find an item that weighs about half the maximum weight of the scale and does not change weight when wet (metal tool of some sort). Weigh this item using the laboratory scale 5 times. Record weights and take average weight.

    b. Calibrate hanging field scale using this item and the average recorded weight. This can take place at a base camp and therefore does not have to take place at the site of the destructive sampling. Do this every day prior to weighing items in field.
3. Small hanging scale (~300 g):
    a. Find an item that weighs 100-250 g and does not change weight when wet or over time (metal tool of some sort, stack of coins taped together). Weigh this item using the laboratory scale 5 times. Record weights and take average weight.
    b. Calibrate hanging field scale using this item and the average recorded weight. This can take place at a base camp and therefore does not have to take place at the site of the destructive sampling. Do this every day prior to weighing items in field.

Field Measurements

1. Follow the SOP Sampling Design and Layout and SOP Establishment of Sampling Plots to determine clip plot locations
2. Place clip plot frame at this location (see Figure below). Clip plot frame may need to be placed around existing vegetation and then constructed. For example, a tree may be located within the clip plot location.
3. If needed, remove all vegetation to allow litter to be collected.
4. Collect all litter inside the clip plot frame. A knife can be used to cut pieces that fall on the border of the sampling frame. Place the litter on the plastic sheeting or tarp.
5. Weigh litter. Record the total weight of litter within the clip plot.
6. If there is no litter within the clip plot area, the clip plots should *not* be moved. Instead the litter shall be recorded on the data sheet as ‘zero’.
7. Take a sub-sample of litter. This should be a representative subset of the total sample and shall be made up of a mix of litter types found within the total sample. Place subsample temporarily in a sample bag.
8. Repeat steps 1-6 for the remaining locations.
9. Combine the sub-samples into one sub-sample bag.
    a. Weigh the subsample bag empty. Record weight.
    b. Combine the subsamples from all 4 clip plots into one subsample bag.
    c. Weigh the subsample bag with the subsample inside. The weight should be between 100-300 g. Record the actual weight.
    d. Label the subsample bag with the plot identification number, subsample identification number, and weight of subsample.
    e. Take the subsample bag and the subsample from field. Bring them to the laboratory and dry the subsample. Reweigh subsample. This subsample will be used to create a wet-to-dry ratio. This ratio will then be used to estimate the total dry weight of litter found within the clip plot.
10. It is allowable for there to be a delay between field data collection and laboratory analysis. However, cloth sample bags must be placed in a location that allows air drying to occur.

SOP MEASUREMENT AND ESTIMATION OF DEAD WOOD DENSITY CLASSES

Field Equipment:
Measuring tape
Chainsaw or handsaw
Cloth bags
Cling wrap (plastic wrapping that you would use for food storage)
Permanent marking pen

Laboratory Equipment:
Drying oven
Laboratory scale
1L Graduated cylinder with milliliter markings and wide mouth

Very fine elongated rod/needle

Note: To be conducted during sampling for establishment of allometric equations.

In the field, dead wood is classified into three dead wood density classes. This SOP provides the field measurement, laboratory measurements, and data analysis methods that shall be used to estimate the average density that will be assigned to each dead wood density class.

This field work and analysis needs to take place one time during a field sampling effort. This must take place for each stratum where dead wood will be measured. If only the standing dead wood pool is being measured, then only the density of 'sound wood' needs to be estimated. After the densities are determined, this SOP does not need to be repeated unless a new stratum is identified and measured.

Prior to Field Sampling:

1. Determine which type(s) of dead wood will be measured (standing and/or lying) during the NFI.
2. Determine where samples will be collected. The location where samples are collected should be representative of the stratum, however it is not necessary for samples to be collected in a random distribution throughout the stratum.
3. Randomly collect a small amount of around 30 samples of dead wood at various stages of decomposition from each of the stratum. These pieces will only be used to agree upon density classes and therefore can be collected close to any base camp directly prior to field measurements taking place.
4. All dead wood will be classified into three density classes: sound, intermediate, and rotten. These classes can be determined using the 'machete test'. The 'machete test' consists of raising the machete up to shoulder height and allowing it come down to the dead wood piece with the force of gravity. No additional force should be applied to the motion of the machete.
    a. **Sound**: : Machete does not sink into the piece (bounces off)—this does not necessarily mean the wood shows no sign of decomposition—lying dead wood can lose all the sapwood and bark but yet the heartwood is still sound—this would be classified as sound
    b. **Intermediate**: Machete sinks partly into the piece, and there has been some wood loss
    c. **Rotten**: Machete sticks into the piece, there is more extensive wood loss, and the piece is crumbly—the key here is that the dead wood is decomposed throughout and very soft and crumbly
5. Agreement shall be made on which pieces of wood fit into which dead wood density class. All field team members must be trained on how to classify dead wood so that there is consistency across field teams.

Field measurements:

Collect wood samples for each density class for density determination (dry weight per green volume). The number of wood samples will depend on the variability between tree species within the forest. A minimum of 10 samples should be collected for each density class of each species group. For example, for a forest containing mixed broadleaf and palm species, a minimum of 10 samples of dead wood from each tree group should be collected per density class—for a total number of 30 samples for broadleaf species and 30 for palms.

For sound class of dead wood:

1. Using a chainsaw or a handsaw, cut a complete disc from the selected piece of dead wood.
2. Measure the diameter (L1 and L2) and thickness (T1 and T2) of the disc to estimate volume (Figure below). The dimensions of the sample should be recorded on data sheet. The fresh weight of the disc does not have to be recorded.
3. All samples shall be placed in a labeled cloth bag.
4. Samples shall be stored in location in manner that allows for air drying to take place prior to laboratory measurements.
5. This sample will then be taken to the laboratory

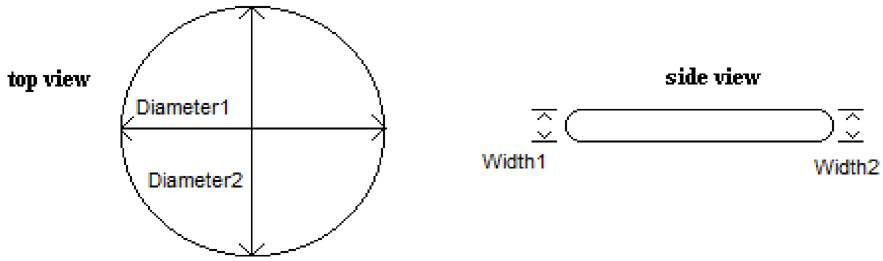

Figure 17: Measurements to be taken on disc cut from coarse dead wood samples

For intermediate and rotten classes:

1. Collect a contiguous sample of the dead wood that is not too small nor too large (i.e. that fit in the graduated cylinder).
2. Place sample in a bag, label the bag. Make sure sample doesn't break into smaller pieces when transporting it. If the sample is very crumbly, it can be placed on a piece of clear plastic wrap (e.g. cling wrap as used in food storage), and tightly wrapped around the piece of wood.
3. This sample will be taken to the laboratory. Carefully transport sample to laboratory where it volume will be measured.

Train all field crew members on how different pieces of dead wood are should be classified, based on the sampling that was conducted.

Laboratory Measurements and Data Analysis:

Dry Weight: Place samples in drying oven at 70°C until sample reaches constant weight (i.e. all moisture is evaporated). Record the dry weight (g).

Volume: If the wood disc sampled from the field is a regular shape (eg circular disk) the 'calculated volume' method below can be used. If the wood disc is an irregular shape, the 'water displacement volume' method shall be used.

Calculated Volume Estimate Method:

1. Calculate the volume using the measurements taken in the field:

$$Volume = \pi * \left(\frac{Diameter_1 + Diameter_2}{2} \Big/ 2 \right)^2 * \left(\frac{Width_1 + Width_2}{2} \right)$$

Where:

Volume = Volume of sample;cm^3

Diameter$_1$ = First diameter of sample; cm

Diameter$_2$ = Second diameter of sample; cm

Width$_1$ = First width of sample; cm

Width$_2$ = Second width of sample; cm

2. Calculate density using the following formula:

$$\text{Density} = \frac{Dry\_weight}{Volume}$$

Where:

Density = Density of sample; g/cm^3

Volume = Volume of sample; cm^3

Dry Weight = measured dry weight of sample; g

3. Calculate the mean the density for that wood density class:

Water Displacement Method: The most commonly used technique to measure the volume of irregularly shaped objects.

1. Create a subsample from the wood sample brought from the field. This subsample must fit inside the graduated cylinder to be used.
2. Weigh the subsample created and record weight.
3. Fill the graduated cylinder to a known volume (e.g. 1L). Make sure there is enough water to submerge the piece and enough empty room in the graduated cylinder to allow water to rise without spilling over.
4. Place dead wood sample inside the graduated cylinder.
5. Using the very fine elongated needle, push sample under the water until completely submerged. Make sure water doesn't spill over or rise above the last milliliter marking on the graduated cylinder.
6. On the data sheet, record the volume of water displaced by submerging the sample. That is the volume of the sample collected.
7. Calculate density using the following formula:

$$\text{Density} = \frac{Dry\_weight}{Volume}$$

Where:

Density = Density of sample; g/cm^3

Volume = Volume of sample; cm^3

Dry Weight = measured dry weight of sample; g

Calculate the mean the density for that wood density class.

SOP DESTRUCTIVE SAMPLING OF SAPLINGS

Field Equipment: Handsaws Machetes DBH tape Clinometer 5 kg scale ~300 g scale Durable, but thin plastic sheeting ~2 m x 2 m Durable plastic tarp ~2 m x 2 m Cloth or paper sample bags for subsamples Flagging tape Marker (to label bags and samples) 'Calibration weights' (see below) **Laboratory Equipment:** Drying oven Laboratory scale

The biomass of saplings can be estimated by counting the number of saplings in each tree-plot and then using an estimate of the 'weight of the average sapling' to estimate total sapling biomass. Therefore, the weight of an average sapling must also be estimated through destructive sampling. The same definition of sapling as presented in 'SOP Measurement of Trees' shall be used.

Prior to Field Sampling

Create 'calibration weights' to calibrate hanging scales: Prior to going into the field, the scales that will be used to weigh samples must be calibrated. The ideal approach is to calibrate the scales that will be used in the field with the laboratory scale that will be used to measure the dry weight of subsamples.

1. Ensure the laboratory scales are calibrated
2. Medium hanging scale (5 kg):
   a. Find an item that weighs about 3 kg and does not change weight when wet (metal tool of some sort). Weigh this item using the laboratory scale 5 times. Record weights and take average weight.
   b. Calibrate hanging field scale using this item and the average recorded weight. This can take place at a base camp and therefore does not have to take place at the site of the destructive sampling. Do this every day prior to weighing items in field.
3. Small hanging scale (~300 g):
   a. Find an item that weighs 100-250 g and does not change weight when wet (metal tool of some sort, stack of coins taped together). Weigh this item using the laboratory scale 5 times. Record weights and take average weight.
   b. Calibrate hanging field scale using this item and the average recorded weight. This can take place at a base camp and therefore does not have to take place at the site of the destructive sampling. Do this every day prior to weighing items in field.

Field Measurements

At the beginning of the fieldwork campaign, saplings must be harvested and weighed to calculate the weight of an 'average' sapling. Saplings harvested should span a range of typical sapling types (species, diameters, heights, etc.). At least 30 individual saplings must be weighed. If saplings vary significantly from one land cover type/stratum to another, weights should be measured for each stratum.

1. Randomly select 10 plots per strata in which to collect saplings. Alternatively, a field campaign can take place specifically to collect saplings, however care shall be taken to ensure the sapling sampled span the range of typical sapling types.
2. Calibrate hanging scales at start of each day with 'calibration weights'.
3. At each of selected locations:

a. If at tree plot, outside the plot boundary randomly select three (3) saplings
b. Cut sapling at base
c. Weigh empty piece of plastic sheeting. Record weight of plastic sheeting.
d. Place all of harvested sapling on plastic sheeting and weigh. Record weight of sapling.
e. Select a representative subsample of sapling.
f. Weigh the subsample bag empty. Record weight.
g. Weigh the subsample bag with the subsample inside. Record weight.
h. Label the subsample bag with the sapling name, identification number, subsample identification number, and weight of subsample
i. Until samples are taken to the laboratory, place samples in location that allows air drying to occur.
j. Later, the subsample will be oven dried to constant weight at 70C, weighed, and the ratio of dry weight to fresh weight will be calculated.

APPENDIX I: EXAMPLE DATASHEETS

1. Nested Tree-plot Radius Correction Table

2. Carbon stock measurements (Includes: trees, saplings, standing dead wood, lying dead wood, non-tree vegetation and litter)

3. Dead wood density datasheet

4. Sapling weight datasheet

Nested Tree-plot Radius Correction Table – to correct area of plot based on slope

Slope (%)	Corrected Radii (m)																												
0	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
10	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.1	22.1	23.1	24.1	25.1	26.1	27.1	28.1	29.1	30.1
15	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.1	10.1	11.1	12.1	13.1	14.1	15.1	16.1	17.1	18.1	19.1	20.1	21.1	22.1	23.1	24.1	25.1	26.1	27.2	28.2	29.2	30.2
20	2.0	3.0	4.0	5.0	6.1	7.1	8.1	9.1	10.1	11.1	12.1	13.1	14.1	15.1	16.2	17.2	18.2	19.2	20.2	21.2	22.2	23.2	24.2	25.2	26.3	27.3	28.3	29.3	30.3
25	2.0	3.0	4.1	5.1	6.1	7.1	8.1	9.1	10.2	11.2	12.2	13.2	14.2	15.2	16.2	17.3	18.3	19.3	20.3	21.3	22.3	23.4	24.4	25.4	26.4	27.4	28.4	29.4	30.5
30	2.0	3.1	4.1	5.1	6.1	7.2	8.2	9.2	10.2	11.2	12.3	13.3	14.3	15.3	16.3	17.4	18.4	19.4	20.4	21.5	22.5	23.5	24.5	25.5	26.6	27.6	28.6	29.6	30.7
35	2.1	3.1	4.1	5.1	6.2	7.2	8.2	9.3	10.3	11.3	12.4	13.4	14.4	15.4	16.5	17.5	18.5	19.6	20.6	21.6	22.6	23.7	24.7	25.7	26.8	27.8	28.8	29.9	30.9
40	2.1	3.1	4.2	5.2	6.2	7.3	8.3	9.3	10.4	11.4	12.5	13.5	14.5	15.6	16.6	17.6	18.7	19.7	20.8	21.8	22.8	23.9	24.9	25.9	27.0	28.0	29.1	30.1	31.1
45	2.1	3.1	4.2	5.2	6.3	7.3	8.4	9.4	10.5	11.5	12.6	13.6	14.7	15.7	16.8	17.8	18.8	19.9	20.9	22.0	23.0	24.1	25.1	26.2	27.2	28.3	29.3	30.4	31.4
50	2.1	3.2	4.2	5.3	6.3	7.4	8.5	9.5	10.6	11.6	12.7	13.7	14.8	15.9	16.9	18.0	19.0	20.1	21.1	22.2	23.3	24.3	25.4	26.4	27.5	28.5	29.6	30.7	31.7
55	2.1	3.2	4.3	5.3	6.4	7.5	8.5	9.6	10.7	11.8	12.8	13.9	15.0	16.0	17.1	18.2	19.2	20.3	21.4	22.4	23.5	24.6	25.6	26.7	27.8	28.8	29.9	31.0	32.0
60	2.2	3.2	4.3	5.4	6.5	7.6	8.6	9.7	10.8	11.9	13.0	14.0	15.1	16.2	17.3	18.4	19.4	20.5	21.6	22.7	23.8	24.8	25.9	27.0	28.1	29.2	30.2	31.3	32.4
65	2.2	3.3	4.4	5.5	6.6	7.6	8.7	9.8	10.9	12.0	13.1	14.2	15.3	16.4	17.5	18.6	19.7	20.7	21.8	22.9	24.0	25.1	26.2	27.3	28.4	29.5	30.6	31.7	32.8
70	2.2	3.3	4.4	5.5	6.6	7.7	8.8	9.9	11.0	12.2	13.3	14.4	15.5	16.6	17.7	18.8	19.9	21.0	22.1	23.2	24.3	25.4	26.5	27.6	28.7	29.8	30.9	32.0	33.1
75	2.2	3.4	4.5	5.6	6.7	7.8	8.9	10.1	11.2	12.3	13.4	14.5	15.7	16.8	17.9	19.0	20.1	21.2	22.4	23.5	24.6	25.7	26.8	28.0	29.1	30.2	31.3	32.4	33.5
80	2.3	3.4	4.5	5.7	6.8	7.9	9.1	10.2	11.3	12.4	13.6	14.7	15.8	17.0	18.1	19.2	20.4	21.5	22.6	23.8	24.9	26.0	27.2	28.3	29.4	30.6	31.7	32.8	33.9
85	2.3	3.4	4.6	5.7	6.9	8.0	9.2	10.3	11.5	12.6	13.7	14.9	16.0	17.2	18.3	19.5	20.6	21.8	22.9	24.1	25.2	26.3	27.5	28.6	29.8	30.9	32.1	33.2	34.4
90	2.3	3.5	4.6	5.8	7.0	8.1	9.3	10.4	11.6	12.8	13.9	15.1	16.2	17.4	18.6	19.7	20.9	22.0	23.2	24.4	25.5	26.7	27.8	29.0	30.2	31.3	32.5	33.6	34.8
95	2.3	3.5	4.7	5.9	7.0	8.2	9.4	10.6	11.7	12.9	14.1	15.3	16.4	17.6	18.8	20.0	21.1	22.3	23.5	24.7	25.8	27.0	28.2	29.4	30.5	31.7	32.9	34.1	35.2
100	2.4	3.6	4.8	5.9	7.1	8.3	9.5	10.7	11.9	13.1	14.3	15.5	16.6	17.8	19.0	20.2	21.4	22.6	23.8	25.0	26.2	27.4	28.5	29.7	30.9	32.1	33.3	34.5	35.7
105	2.4	3.6	4.8	6.0	7.2	8.4	9.6	10.8	12.0	13.2	14.4	15.7	16.9	18.1	19.3	20.5	21.7	22.9	24.1	25.3	26.5	27.7	28.9	30.1	31.3	32.5	33.7	34.9	36.1
110	2.4	3.7	4.9	6.1	7.3	8.5	9.8	11.0	12.2	13.4	14.6	15.9	17.1	18.3	19.5	20.7	21.9	23.2	24.4	25.6	26.8	28.0	29.3	30.5	31.7	32.9	34.1	35.4	36.6
115	2.5	3.7	4.9	6.2	7.4	8.6	9.9	11.1	12.3	13.6	14.8	16.0	17.3	18.5	19.8	21.0	22.2	23.5	24.7	25.9	27.2	28.4	29.6	30.9	32.1	33.3	34.6	35.8	37.0
120	2.5	3.7	5.0	6.2	7.5	8.7	10.0	11.2	12.5	13.7	15.0	16.2	17.5	18.7	20.0	21.2	22.5	23.7	25.0	26.2	27.5	28.7	30.0	31.2	32.5	33.7	35.0	36.2	37.5
125	2.5	3.8	5.1	6.3	7.6	8.9	10.1	11.4	12.7	13.9	15.2	16.4	17.7	19.0	20.2	21.5	22.8	24.0	25.3	26.6	27.8	29.1	30.4	31.6	32.9	34.2	35.4	36.7	38.0
130	2.6	3.8	5.1	6.4	7.7	9.0	10.2	11.5	12.8	14.1	15.4	16.6	17.9	19.2	20.5	21.8	23.1	24.3	25.6	26.9	28.2	29.5	30.7	32.0	33.3	34.6	35.9	37.1	38.4
135	2.6	3.9	5.2	6.5	7.8	9.1	10.4	11.7	13.0	14.3	15.6	16.9	18.1	19.4	20.7	22.0	23.3	24.6	25.9	27.2	28.5	29.8	31.1	32.4	33.7	35.0	36.3	37.6	38.9
140	2.6	3.9	5.2	6.6	7.9	9.2	10.5	11.8	13.1	14.4	15.7	17.1	18.4	19.7	21.0	22.3	23.6	24.9	26.2	27.5	28.9	30.2	31.5	32.8	34.1	35.4	36.7	38.0	39.3
145	2.7	4.0	5.3	6.6	8.0	9.3	10.6	11.9	13.3	14.6	15.9	17.3	18.6	19.9	21.2	22.6	23.9	25.2	26.5	27.9	29.2	30.5	31.9	33.2	34.5	35.8	37.2	38.5	39.8
150	2.7	4.0	5.4	6.7	8.1	9.4	10.7	12.1	13.4	14.8	16.1	17.5	18.8	20.1	21.5	22.8	24.2	25.5	26.9	28.2	29.5	30.9	32.2	33.6	34.9	36.3	37.6	38.9	40.3

LIVE BIOMASS AND SOIL MEASUREMENT AND SAMPLING DATA SHEET

Plot ID #:____________ Location:______________ Land cover type:_______________ Crew chief:___________ Data recorded by:________ # people in crew: _________

Date:_________/________/________Start Time:_________________ End time:_________________ Total Time: _____________________
GPS Datum: _________GPS Waypoint:______ Lat:______________ Long:_____________ Precision: ________ Elevation: _______
Slope (%): ____________ Photo Number(s):________________
Notes:

Saplings:
# of Saplings: __________ Sapling Plot dimensions (m): __________
LIVE TREE MEASUREMENTS.

TREES
Nested Plot radius (m): small:__________ medium:_________ large:_________
Nested plot tree diameter sizes (cm): small:____________ medium:____________ large:_____________

Tree #	Species	DBH (cm)	Tree #	Species	DBH (cm)	Tree #	Species	DBH (cm)

Plot ID #:______________

CLASS 2 STANDING DEAD WOOD MEASUREMENTS:

Diam at base (at 0.1 m) (cm)	DBH (at 1.3 m) (cm)	Diameter at top (cm) (if measured directly)	Height (m) (if measured directly)	Height Measurement 1				Height Measurement 2			
				Clinometer angle (%) +	Clinometer angle (%) -	Distance from eye to tree (m)	Height of eye (m)	Clinometer angle (%) +	Clinometer angle (%) -	Distance from eye to tree (m)	Height of eye (m)

NON-TREE VEGETATION (CLIP PLOTS)

Clip-plot dimensions: __________ (if clustered tree-plots, only 1 measurement per plot)

Weight of bag or sheet (g)	Weight of bag + material (g)	Clip-plots subsample ID #	Weight of subsample bag (g)	Weight of subsample bag + subsample material (g)

LITTER CLIP PLOTS

Clip-plot dimensions: __________ (if clustered tree-plots, only 1 measurement per plot)

Weight of bag or sheet (g)	Weight of bag + material (g)	Clip-plots subsample ID #	Weight of subsample bag (g)	Weight of subsample bag + subsample material (g)

LYING DEADWOOD MEASUREMENTS:

(wood greater than 10 cm diameter) Transect length (m) = ______

Diam (cm)	Density Class (S,I,R) S=Solid, I=Intermediate, R=Rotten	Hollow diam (cm)

DEAD WOOD DENSITY DATA SHEET

Stratum: ___________ Location:______________________

Date: _______/_______/_______ Data recorded by:______________

Notes:

A minimum of 10 samples should be collected for each density class at the beginning of the field sampling effort. Diameter and width should be recorded for each sample. Empty bag weight should be recorded.

Photo #	Dead Wood ID	Wood Density Class: S, I, R*	Diameter2 (cm)	Diameter2 (cm)	Width1 (cm)	Width2 (cm)	Volume (cm^3)	Bag weight (g)

* S = sound, I = intermediate, R = rotten

DATA SHEET FOR SAPLINGS

Stratum:___________ Location:______________________
Date:___________ Data recorded by:_________________
Notes:
At least 30 saplings must be cut and weighed.

Plot ID	Sapling ID	Total Wet Weight (g)	Weight of empty subsample bag (g)	Subsample Wet Weight + Bag (g)

APPENDIX II: FIELD EQUIPMENT REQUIREMENTS PER FIELD TEAM

Equipment	Quantity	Crew Member	SOP	Use/Info
NFI Sampling Coordinator				
Tablet				
Tablet cord				
GPS				
GPS memory card				
AA batteries for GPS				
Field Sampling Crew				
Machete	2/team	Village guides	All	
Whistles	1/person		All	one per team member
First Aid Kit	1/team		All	
Chalk sticks	many		Tree plots	to mark measured trees
1.3 m poles	2/team	DME Person1 and 2	Tree plots	make from PVC piping
Durable plastic tarp ~2 m x 2 m	1/team		All	to put equipment on while measuring plot
Two-way radios	1/team	Crew Chief	All	
Tablet		Crew Chief	All	
Tablet cord		Crew Chief	All	
Camera (or use Tablet)	1/team	Crew Chief	All	
GPS	1/team	Crew Chief	All	
GPS Waterproof case	1/GPS	Crew Chief	All	
GPS memory		Crew Chief	All	
AA batteries for GPS	many	Crew Chief	All	
clip board	1/team	Crew Chief	All	
Compass	1/team	Crew Chief	Navigation, safety	
Bright colored spray paint	many	Crew Chief	temporary mark tree-plot center	
DME			Tree plots	Haglof DME 201 Cruiser
DME pole	1/team	DME Person1	Tree plots	
DME transponder (yellow piece)	1/team	DME Person1	Tree plots	
DME distance measuring unit (grey box)	2/team	DME Person1 and 2	Tree plots	
AA batteries for transponder	many	DME Person1	Tree plots	

9V batter for DME grey box	many	DME Person1 and 2	Tree plots	
Clinometer	1/team	DME Person 2	Slope, tree heights, standing dead trees, palms	*Note: must have clinometer that measures slope. If have height specific clinometer, then MUST also purchase slope clinometer*
Clinometer case		DME Person 2	Slope, tree heights, standing dead trees, palms	
Measuring Tape - 50 m	2/team	LDW Person 1	LDW	
biodegradable Flagging tape	2/team		All	
diameter tape measure	2/team	DME Person1 and 2	tree plots	Lufkin Chrome-Clad 3/8" Wide line is chrome-clad steel with black graduations. Claw hook, hand crank rewind and vinyl covered steel case. Case dimensions: 3-1/2" x 1"
Work gloves	1/person		All	for people doing clip plots, and weighing vegetation
Equipment backpacks	3+/team		All	to carry equipment, lunch, and water into field
Small backpack or hipsack	1/person		All	to carry small equipment while in field
Sturdy backpacks, bags	2/team		All	to carry soil samples + subsamples **from** field. must be additional to above backpacks
Water bottles	1/person		All	
Lunch containers	1/person		All	reusable containers to carry lunch into field
Permanent Marker	5/team		All	
Pens	many		All	
Pencils	many		All	
Pencil sharpeners	many		All	
Erasers	many		All	
Stapler	1/team		All	staple datasheets together
Staples			All	staple datasheets together
small notebooks	1/person		LDW	
NTV, litter, bamboo, and soil sampling (must be edited dependent SOPs used):				
calipers (see Bamboo SOP for size)	2/team	LDW Person 1	Bamboo	
hanging scale - 300 g	1/team		Subsamples - non-tree veg, shrubs, litter, dead wood density, saplings	weigh subsamples
hanging scale - 1 kg	1/team		non-tree veg, shrubs, litter, dead wood density, saplings	weigh saplings, shrubs, non-tree vegetation. Size needed depends on how large understory vegetation is
hanging scale - 2 kg			non-tree veg, shrubs, litter, dead wood density, saplings	weigh saplings, shrubs, non-tree vegetation. Size needed depends on how large understory vegetation is
hook - for hanging scale	1/scale			accessories for scales

case - for hanging scale	1/scale		accessories for scales
clip - for hanging scale	1/scale		accessories for scales
hanging scale - 50 kg	1/team	Destructive sampling of trees, palms	weigh large things during destructive sampling for trees, palms, etc
Cloth bags. Can buy professional ones OR make locally		subsamples: non-tree veg, shrubs, litter, dead wood density, saplings	for subsamples. Need to be around 20 cm x 30 cm. have cloth bags made at market. must be closable - If cloth, can make with draw string or maybe able to staple
Clip Plot (pvc)	1/team	non-tree veg, shrubs, litter	For clip plots: non-tree veg., shrubs, litter. get PVC piping and cut into 50 cm long sets, and 25 cm long sets. Also get elbows to put together. Piping can be very narrow. DO NOT GLUE together! Using four pipes and four elbow connectors, we will make a square frame that can be assembled and disassembled in the field.
Clippers	2/team	non-tree veg, shrubs, litter	to cut understory vegetation for clip plots, litter
Lightweight plastic sheeting		non-tree veg, shrubs, litter, dead wood density, saplings	to weigh vegetation on
Hand Saw	1/team	shrubs, dead wood density, destructive sampling	cut dead wood density samples, cut shrubs
Soil sampler	1/team	Soil sampling	soil sampling, bulk density sampling
Cloth bags. Can buy professional ones OR make locally	3/site	Soil sampling	Soil bags.Can buy professional ones, or have made locally w/ draw string. Make at least ~40 cm long x 15 cm wide (so easy to put soil probe into bag)
If doing permanent tree sample plots:			
Tree tags - for perm sample plots	1	Permanent tree plots	1-1/4" D Tags, 1-100
Tree tags - for perm sample plots	1	Permanent tree plots	1-1/4" D Tags, 101-200
Tree tags - for perm sample plots	1	Permanent tree plots	1-1/4" D Tags, 201-300
Tree tags - for perm sample plots	1	Permanent tree plots	1-1/4" D Tags, 301-400
Tree tags - for perm sample plots	1	Permanent tree plots	1-1/4" D Tags, 401-500
Tree tags - for perm sample plots	1	Permanent tree plots	1-1/4" D Tags, 501-600
Tree tags - for perm sample plots	1	Permanent tree plots	1-1/4" D Tags, 601-700
Tree tags - for perm sample plots	1	Permanent tree plots	1-1/4" D Tags, 701-800
Tree tags - for perm sample plots	1	Permanent tree plots	1-1/4" D Tags, 801-900
Tree tags - for perm sample plots	1	Permanent tree plots	1-1/4" D Tags, 901-1000
Aluminum Nails - for tree tags	2	Permanent tree plots	1 lb. Box. Approx. 575 nails per pound
Iron bars about 1-2 cm in diameter and 30 cm long		Permanent Plots	
PVC tubing (1 m) and caps		Permanent Plots	

Hammer	2/team	Permanent Plots
Piece of wood to place over hammer	2/team	Permanent Plots
Electrical tape/duct tape		Permanent Plots
Bright colored paint (orange)		Permanent Plots

ラオス人民民主共和国
ラオス国持続可能な森林経営及びREDD+のための国家森林情報システム構築に係る能力向上プロジェクト
（第2年次）

業務完了報告書

添付資料11：NFI for forest carbon sampling -Guidance Document

National Forest Inventory for Forest Carbon Sampling – Guidance Document

4 July 2015

Prepared on behalf of Lao PDR by:

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1 Scope and Audience

A national forest inventory (NFI) for forest carbon sampling can have many objectives, one of which can be to develop an estimate of the standing stock of carbon in various forest types within the country. This information can be used to develop emission factors, and ultimately the estimation of carbon emissions from land use change. Through the JICA funded program "Capacity Development Project for Establishing National Forest Information System for Sustainable Forest Management and REDD+", the Department of Forestry is working with Kokusai Kogyo Co and Asia Air Survey to assist in the design of an updated National Forest Inventory.

This document provides the overall framework for Lao PDR to complete a forest inventory. This includes information on the information required prior to initiating a forest inventory and a description of a recommended sampling design. The sampling approach and field measurement methods are based on the initial National Forest Inventory for Lao PDR conducted from 1991-1999 and guidance within Winrock International's standard operating procedures guidance that has been field tested and refined since 1995. In addition, the field sampling methods and analysis approaches described in this guidance document were piloted through the CLiPAD funded project where sampling took place in Houaphan Province in 2014 (Eickhoff et al 2014), were then refined, and then tested again within the province of Khammouane in early 2015.

This document should be used in association with several companion components:

- "Standard Operating Procedures for Terrestrial Carbon Measurement", provides the field methods for data collection,
- Winrock Sample Plot Calculator Excel Tool, provides estimate of number of plots based on variability of preliminary data,
- A tablet-based data collection form has been developed by Forest Carbon for field data collection using "ODK",
- R script developed by Forest Carbon to transform field data collected on tablets into analyzed data,
- "Module C-CS: Calculations for Estimating Carbon Stocks. Leaf technical guidance series for the development of a forest carbon monitoring system for REDD+" (Goslee et al 2014) which describes the calculations to conduct to estimate carbon stocks, and
-
- "Allometric Equation Evaluation Guidance Document" (Walker and Tepe 2015) which provides information on how to develop allometric equations for use in the NFI.

This document is targeted at the Forest Inventory and Planning Division (FIPD) of the Department of Forestry of Lao PDR. The guidance in this document can be implemented by these staff to conduct a forest inventory for Lao PDR. This document along with its companion components can also be adapted for use in subnational inventories for carbon stock assessment.

At the end of this guidance document are several appendices, including an overview of previous forest biomass data that has taken place in Lao PDR, an overview of NFIs conducted by other countries, and another that provides some background information on sampling design.

2 Overview of National Forest Inventories

Many countries use the approach of developing a National Forest Inventory (NFI) as a way to understand the current conditions of the forests and other land types. The forest (and sometimes non-forest) lands are sampled by taking field measurements at different locations across the country. These field measurements are combined with land cover mapping and land use information to summarize different aspects of the forest land. Often, NFIs are designed to have a wide array of purposes but often the goal is to have an independent estimate of forest resources such as timber or woodfuel, to examine the forest condition, and to estimate standing carbon stocks. A review of National Forest Inventory programs in select countries can be found in Appendix A.

NFIs tend to require a substantial amount of resources and commitment, and thus should be constructed in a practical manner to serve a number of purposes. The goals of NFIs can range from simple timber stock inventories to comprehensive surveys of a range of biophysical characteristics of entire landscapes. Historically, NFIs served the largely economic purpose of informing decision makers and industry stakeholders about the supply of timber resources within a geographic area. Over time, NFIs expanded to collect additional data to support broader land use planning and policy development goals. Examples of the types of information NFI's produce include:

- Estimates of standing timber volume for each land cover class
- Estimates of carbon stocks in each land cover class
- Other information on trees: number per hectare, basal area, size distribution of trees in forest types, species distribution
- Dominance of shrubs and other non-tree pools
- Degradation state of forest type
- Forest health – disease, drought/water stress, natural disturbances, degradation status, Invasive species
- Habitat
- Land use

NFIs can serve to collect valuable data to allow stakeholders and decision makers to make informed decisions about a variety of functions within a landscape, including watershed assessment, protection and management; biodiversity assessment and management; and carbon stock assessment for GHG inventories.

In this document, NFI for Forest Carbon Sampling Guidance Document, it is assumed that the main objective of the NFI is the creation of estimates of the standing carbon stocks within the various forest types and across the country of Lao PDR.

Box 1. Information NFI will not provide

Although the NFI can be designed to collect a wide array of information, there is some information that would not be efficiently measured using an NFI approach.

REDD+: Although the NFI will provide information to create deforestation emission factors (EF), the NFI will unlikely provide direct emission factors for forest degradation (logging, fuelwood, fire) or emission factors for enhancements due to tree planting. In addition, the NFI alone will not provide any 'activity data' (AD) (Table 1). Instead, Lao PDR will need to set up a system to monitor activities. This will include creating successive land cover maps and monitoring the quantity of other activities such as degradation.

UNFCCC National Communications: There are only a selection of parameters that the NFI will need to provide for UNFCCC National Communications (NFI). Again, it will not be sufficient for EF from degradation or generate estimates of land areas in different categories (AD).

Table 1 Information on whether the NFI will provide data needed for REDD+ and National Communications

	Activity Data (e.g. area change per year)		Emission Factors (t CO2e/ha)	
	Historical	2015-2020	Historical	2015-2020
Forest – Nonforest / Deforestation				
--> Non forest	No	No	Yes	Yes
--> Slash and burn	No	No	maybe	Maybe
--> Rice paddy	No	No	maybe	Maybe
--> Agri plantation	No	No	maybe	Maybe
Forest-Forest / Degradation				
Nat forest to Plantation	no	No	maybe	Maybe
Fuelwood	no	No	No	No
Legal logging	no	No	No	No
Illegal logging	no	No	No	No
Fire	no	No	No	No
Enhancement				
Forest growth	no	No	No	No
Afforestation	no	No	No	Maybe

Timber volume: Although a NFI can be used to provide a general understanding of the timber availability in the country, the density of sample points will NOT allow estimates of timber volume at a local level. It will also not be suitable for monitoring overall degradation from logging through time.

Biodiversity: Although the main tree species composition will be known from the NFI, the NFI is not designed to find rare species. In addition, it will not provide information on non-tree species (eg other plants, birds, animals, insects) or define the 'High Conservation Value'.

2.1 Previous Forest Inventories in Lao PDR

In Lao PDR, various field measurements of the forest have taken place over time (Table 2). This includes the first NFI conducted in 1991-1999 and whose focus was on estimating timber volumes. Additional details of these field surveys can be found in Appendix B.

Table 2 Brief summary of previous and current project related to the forest inventory and biomass in Laos

Project	Implementation Period	Focal Area	Implementation Agencies	Finance	Main Objective
First NFI	1991-1999	National	Forest Inventory and Planning Center (FIPC)	Sweden	Timber Estimate
SUFORD (phase I~I I I)	2003-2017,	Khammoune, Savanakhet, Salavan, Champasak, Xekong, Attepue, Bolikhamxay, Vientiane Province and Xayabouli	DoF, DOFI, NAFES, NAFRI, Provincial and District Forest Offices, Village Forestry Organisations/Units	World Bank USD 10 million, Government of Finland USD 12 million (Phase II)	Timber Estimate
Timber plantations	2006	Bolikhamxay,Champassak Salavan,Savannakhet and Vientiane Province	ADB Industrial Tree Plantation Project (ITPP)	N/A	Timber Estimate
CliPAD	2009-2018	Sayaboury and Houaphan Provinces	MAF, DoF, Provincial and District Agriculture and Forestry Offices	GIZ (4.0 million EUR), KfW (10.0 million EURO)	Biomass Stocks
PARRED+	2009-2014	Luang Prabang	National Agriculture and Forestry Extension Service, Provincial and District Forest Offices	JICA(4 million USD)	Biomass Stocks
FIM	2010-2013	Whole Provinces (National Level) but Luang Prabang for feasibility study with PAREDD	DOF/FIPD	JICS(5.5 million USD)	Biomass Stocks

Although the main goal of the 1st NFI was to estimate potential timber and other forest resources, this data was also reanalyzed using the same allometric equations used for Khamouane and Houaphan data to create an estimate of carbon stocks. The biomass stocks of the first NFI, the recently completed field work in Houaphan province under CliPAD, and the pilot data from Khammouane provide an initial estimate of the carbon stocks within certain land cover types, along with the amount of variance (Table 3). The carbon stocks between these surveys are quite similar and the uncertainty values are relatively low, even for the province level piloting surveys with only limited sample sizes.

Table 3 Mean aboveground live tree carbon stocks by land cover class estimated within 1st NFI, CLiPAD funded work in Houaphan Province, and the pilot field work completed as part of this study in Khammouane Province. Biomass calculated using the Moist Forest biomass equation from Chave et al 2005 and assumed average wood density for Asia from Reyes et al 1992. (sources: Eickhoff, G. 2015. Technical Summary Report. 2015 National Forest Inventory Piloting NFIS Project, Lao PDR, Eickhoff, G. 2015. Technical Summary Report. 2014 CliPAD Houaphan Biomass Inventory.)

Survey	Stratum Name	Number of Plots Surveyed	Mean AG Tree Carbon (t C ha^{-1})	Std Dev (t C ha^{-1})	Uncertainty (expressed as 90% CI as percent of mean)
1st NFI	EF	56	110.1	50.4	22%
Khammouane	EF	2	185.5	31.4	76%
1st NFI	MD	805	60.0	41.2	6%
Houaphan	MD	82	92.1	63.5	16%
Khammouane	MD	33	114.4	51.5	13%
1st NFI	DD	636	43.5	26.4	7%
Khammouane	DD	13	48.5	15.7	16%
1st NFI	CF	27	32.4	26.1	33%
1st NFI	MCB	74	80.5	48.5	19%
Houaphan	RV	1	39.3		
Houaphan	SC	16	12.2	16.4	72%
Khammouane	SC	2	22.0	8.6	175%
Houaphan	SHBB	7	11.7	12.0	94%
1st NFI	RV	102	7.1	10.4	20%

2.2 IPCC Technical Background

The IPCC (Good Practice Guidance 2003, and Guidelines for National Greenhouse Gas Inventories Agriculture, Forestry, and Other Land Uses [AFOLU] 2006) provides the framework for estimating emissions and removals of CO_2 in the AFOLU sector and was used to design the NFI for Forest Carbon Sampling Guidance Document. The IPCC framework is based on estimating the carbon stocks in five IPCC recognized carbon pools (aboveground biomass, belowground biomass, soil organic matter, litter, and dead wood) caused by changes in forest cover. Depending on country circumstances, all carbon pools do not need to be included in the design, but significant pools must not be excluded[1]. A key-category-type analysis must be conducted to determine which carbon pools should be included to accurately capture the emissions and removals from changes in forest cover, taking into account their magnitude and the cost effectiveness to monitor.

For the purposes of this sampling design, the analysis will use the guidance applicable to the IPCC GPG/AFOLU category of Forest Land converted to other lands (Cropland, Grassland, Wetlands, Other,

[1] SBSTA Decision, UNFCCC COP 17

Settlements), which is equivalent to deforestation. Another category, Forest Land remaining Forest Land, captures forest degradation and enhancement of carbon stocks (and also includes the activities of forest conservation and sustainable management of forests as part of the "plus" in REDD+), and will not be fully addressed in this sampling design. It must be noted that the forest inventory sampling guidance provided here will allow for the calculation of standing carbon stocks. In order to convert such stocks to GHG net emission estimates resulting from land cover change, additional analysis would need to be conducted. This is outside the scope of this guidance document.

Box 2. IPCC Approach to estimating net GHG emissions

The Intergovernmental Panel on Climate Change (IPCC) is an international scientific body that reviews and evaluates information relevant to the understanding of climate change. The IPCC has produced two key currently relevant documents on methodologies for conducting GHG inventories for assessments of land use/land cover change that provide a framework for GHG inventories in the agriculture, forests, and other land use (AFOLU) sector. These are the 2003 Good Practice Guidance for Land Use, Land Use Change and Forestry and the 2006 IPCC Guidelines for National GHG Inventories (Volume 4 Agriculture, Forestry and Other Land Use). The IPCC present five general principles that guide the reporting of estimates of national emissions and removals of greenhouse gases (GHGs), and these are equally applicable to the preparation of RLs.

Transparency: assumptions and methodologies should be clearly explained to facilitate replication and assessment.

Consistency: an inventory should be internally consistent;

Comparability: estimates of emissions and removals reported should be comparable with the national communications from other nations, and apply standard methodologies (those agreed by the COP[2]) for estimating and reporting inventories.

Completeness: full geographic coverage of sources and sinks.

Accuracy: estimates should be accurate (systematically neither over or under true emissions or removals), and uncertainties must be reduced as far as practicable.

The IPCC Guidelines refer to two basic inputs with which to estimate greenhouse gas emissions and removals: activity data and emissions factors. "**Activity data**" refer to the extent of a category, and in the case of deforestation, activity refers to the change in areal extent of forest land, presented in hectares over a known time frame (usually per year). "**Emission factors**" refer to emissions/removals of greenhouse gases per unit area, e.g. tonnes of carbon dioxide emitted per hectare of deforestation. Emissions/removals resulting from land-use conversion are manifested in changes in ecosystem carbon stocks, and for consistency with the IPCC framework, we use units of carbon dioxide, specifically tonnes of carbon dioxide per hectare (t CO_2 ha^{-1}), to express emission factors (multiply t C by 44/12 to convert

[2] Revised 1996 Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Inventories

to CO_2). "**Activity data**" combined with "**emission factors**" estimates the total amount of emissions/removals taking place in a given year as a result of that activity.

Three Approaches (Approaches 1-3) are presented as options in the IPCC guidance documents for obtaining activity data, and three **Tiers** (Tiers 1-3) are presented as options for obtaining emission factors (Table 1). The IPCC refers to three general tiers for estimating emissions/removals of GHGs. Tier 1 is a basic method, using default values for broad continental forest types and default values such as the IPCC Emission Factor Data Base. This Tier has low cost and high uncertainty. Tier 2 uses country-specific data for key factors, and has medium costs and uncertainty. Tier 3 is regional- or forest-specific, and is based on comprehensive field sampling repeated at regular intervals. This Tier has high costs and low uncertainty. IPCC encourages use of higher tiers for the measurement of significant carbon pools.

Table: Comparison of IPCC Approaches and Tiers[3]

Approach for activity data: Area change
1. Total area for each land use category, but no information on conversions (only net changes) 2. Tracking of conversions between land-use categories 3. Spatially explicit tracking of land-use conversions
Tiers for emission factors:
1. IPCC default factors 2. Country specific data for key categories 3. Detailed national inventory of carbon stocks for key categories, repeated measurements of through time or modeling

While moving from Tier 1 to Tier 3 increases the certainty of GHG estimates, it also increases the complexity and costs of measurement and monitoring. Likewise, achieving greater completeness and certainty in a measurement and monitoring system means higher costs as it is likely that more carbon pools would need to be monitored and that the monitoring would need to result in accurate and precise estimates of emissions and removals.

2.3 Comparison between FAO Forest Resource Assessments and an NFI

2.3.1 Review of FAO FRA

The Food and Agriculture Organization of the United Nations has a mandate to undertake periodic assessments of global forest resources through the Global Forest Resource Assessment (FRA). The FRA involves close collaboration between the FAO and its 197 member countries who submit country reports prepared by National FRA Correspondents. The country reports are combined with remote sensing data collected by the FAO and Global FRA is published every 5 years.

FAO member countries are encouraged to submit FRA country reports every 60 months to the FAO. National Correspondents are expected to use the FRA Country Report template which follows a

[3] IPCC. 2006. Chapter 1 Overview. Guidelines for National Greenhouse Gas Inventories.

standardized format and ensures reporting on consistent categories and topics using the same definitions and classifications.

Both global and country FRAs cover four main categories: (1) estimation of areas defined as forest, other wooded land, and other land; (2) estimation of areas under forest designation and management categories; (3) characterization of forest areas (4) quantification of forest stocks. In this way, the FRA attempts to comprehensively describe the world's forest resources in a way that is comparable across countries.

Given the fact that countries have varying resources and capacities for conducting forest assessments, FRA information can be collected using a wide range of methodologies and sources. Although not required for use, the FAO has developed a manual that can be used to develop and implement a FRA[4]. This includes a generic example of institutional arrangements and organizational structure, global land cover class definitions that can be used, GIS methods, and field methods. The elements of a FRA are summarized in Box 2.

Box 3. Components of a FRA

Areas defined as forest, other wooded land and other land

To maintain consistent metrics across countries, the FRA applies consistent definitions of Forest, Other wooded land, and other land. Forest is defined as land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10percent, or trees able to reach those thresholds in situ. It does not include land that is predominantly under agricultural or urban use. Other wooded land includes areas that have trees, shrubs, and bushes, but do not meet the definition of forest. Other land includes agricultural and urban areas, but are not predominantly wooded and do not meet the definition of forest.

Forest designation and management

The FRA also attempts to capture how forests are delineated and managed within countries. It estimates the area for forest designated for production, protection, conservation, social services, and multiple use. The FRA also estimates the forest area under management regimes including forest areas that are under permanent forest estate, protected, under sustainable forest management, and areas with a management plan.

Forest Characteristics

The FRA characterizes the state of forests by placing them into two broad categories: naturally regenerated forests and planted forests. Naturally regenerated forests include primary forests as well as other types of natural forests with varying degrees of disturbance and human impact. Planted forests are those which include native and non-native introduced species.

[4] http://www.fao.org/forestry/14727-072b68bcfa49334202f1586889517ce24.pdf

Forest stocks

Forest stocks are also accounted for in the FRA, which includes estimating the volume, biomass, and carbon stocks within forests. The biomass stock includes both above and belowground biomass and the carbon stock combines the biomass stocks with estimates of the carbon in dead organic matter and soil. To maintain consistency in methods for estimating biomass and carbon stocks, the 2006 IPCC Guidelines are followed.

2.3.2 Difference between FRA and NFI

National forest inventories (NFI) are typically separate from the FAO FRA, although information collected with the NFI may contribute to FRA Country Reports. While NFIs also provide regularly updated information on the state of a given country's forest resources, and collect and process such information in a systematic manner, NFIs may collect different information than the FRA and may use different forest definitions and categorizations. The frequency, extent, and focus of NFIs are defined by a nation's priorities and resources, whereas the FAO FRA's scope is standardized across all participating countries.

NFIs are typically more comprehensive than the FRA. In addition to quantifying areas of forest, categorizing forest, and quantifying forest stocks, NFIs may involve collecting information about geology, site conditions, tree health, and biodiversity information.

National FRA Correspondents often must adjust NFI data to be compatible with FRA standards and definitions. For example, the total land/country area must match the official UN statistics in FAOSTAT, and if there are slight discrepancies, the total land/country data must be adjusted to match the FAOSTAT[5] figure. Countries may also have different national forest definitions than what is stipulated by the FAO, as the FAO follows a forest definition with a low threshold of just 10% canopy cover over 0.5 ha. This low threshold allows for areas of relatively open forest to be considered forest, whereas a higher threshold would mean that only denser, more closed tree stands could be considered forest. As the forest definition adopted for NFIs has as broad implications for how forests are classified and quantified, adopting a differing forest definition to that used by the FRA may present complexities in using NFI data for FRA reporting.

2.4 Comparison between a forest inventory and GHG emission estimation

Normally a NFI is developed and implemented by the government as an independent assessment of the forest resources. Often a NFI is a permanent established function of the government that is repeated overtime. In many countries, field measurements are taken across the country over time with measurements at all sampling points taking place within often 5 years. These measurements are then repeated over time and thus permanent forestry staff are assigned to field measurement, analysis, and reporting. The field measurements are combined with land cover maps, and other GIS layers to provide an overall picture of the forests of the country.

[5] FAO Statistics Division (faostat.fao.org)

A forest inventory itself provides a current status report, for example, the current standing carbon stocks or the volume of timber and firewood. However, the creation of GHG emission estimates is based on estimating the quantity of various activities across the landscape along with the emissions results per unit of that activity.

Therefore, a traditional forest inventory alone will not generate GHG emission estimates. Instead, this needs to be combined with a system to monitor activities taking place within Lao PDR. Lao PDR will need to determine the classes of activities that are taking place, and the monitoring system that will be used to monitor the existence of these activities. This type of information could be used as inputs in the Lao PDR's UNFCCC National Communications and its REDD+ National Forest Monitoring system.

A core component of any REDD+ program is a National Forest Monitoring System (NFMS) that serves to estimate historical emissions from REDD+ activities and track their emissions over time. Under a system where a REDD+ proponent receives results-based payments for implementing measures that reduce emissions from deforestation and forest degradation, the NFMS system is the mechanism that quantifies those results. Under a REDD+ program, monitoring has to occur at regular intervals, remote sensing technologies must be applied, carbon stocks from all significant pools must be estimated within defined precision and accuracy parameters, and results must be carefully scrutinized and verified.

3 Decisions informing NFI development

The overall spatial and inventory design of the NFI is largely influenced by two principle technical definitions: forest definition and land cover classes used by the national classification system.

3.1 Forest Definitions

The nationally communicated UNFCCC forest definition of Lao PDR includes land areas meeting the following minimum criteria[6]:

- **Tree crown cover value:** 20% (defined as 10% under FAO FRA 2015)
- **Land area value:** 0.5 ha
- **Minimum DBH:** 10 cm
- **Includes palm:** No
- **Includes bamboos:** No

It has recently been discussed however that the national forest definition may be changed to also include bamboo. If this is altered in the future, the area defined as 'forest' can be updated later.

3.2 Land cover types included within NFI

The NFI field standard operating procedure and measurements are designed for a variety of land cover types in Lao PDR. These are anticipated to include:

- Forest classes

[6] http://cdm.unfccc.int/DNA/index.html

- Non-forest natural land cover classes (eg savanna, grassland)
- Post-deforestation land uses: agricultural and fallow land, plantations

The detailed land use/land cover types include the "Level 2" classes identified in Table 4 below[7]. The definitions of each of these land cover classes is taken from the 1st NFI (See Appendix D). These definitions are used in the field to determine the actual land cover at the sampling point.

3.3 Stratification

3.3.1 Background

Due to the spatial variability of land-use change drivers as well as the spatial variability of forest carbon stocks, **a stratified sampling design** is often useful in a carbon sampling design. Stratification of land cover types can reduce sampling effort while maintaining accuracy and precision in estimates of carbon stocks.

The goal of stratification is to reduce within stratum variance and improve the precision of each stratum, thereby minimizing the number of samples required to achieve an overall level of certainty. A stratified sampling design also allows flexibility in designing a sampling protocol within each stratum that is tailored to the desired level of precision (targeted at a 90% confidence interval of ±10%) as well as the time and resources available to collect the data. Potential criteria to be used in determining strata include:

- Forest type/species composition
- Land use and past management practices, including age of vegetation
- Various environmental conditions (precipitation, drainage, soil, slope elevation)
- Proximity to access points

Existing data can be used to identify and divide sampling units into relatively homogenous strata with regard to the factor of interest. Land within each stratum should be similar with respect to its carbon stocks, with different strata having different carbon stocks. Each stratum may be comprised of one large block of land or several small blocks of land, provided that all of the blocks are similar with respect to carbon stocks.

3.3.2 Strata for NFI

The minimum strata level during sampling will equate to "Level 2" of the forest land cover types and "Level 1" for the non-forest land cover types (Table 4). If deforestation emission factors will be made based on the results of the NFI, at least limited sampling needs to take place in the dominant non-forest classes following deforestation. Land cover classes with likely low carbon stocks and covering a very small portion of the country can be estimated using IPCC defaults if resources are not available for sampling.

[7] Certain classes are pending final decision and approval by the Ministry of Agriculture and Forestry (MAF) and the Ministry of Natural Resources and Environment (MoNRE)

Table 4: Breakdown of land cover classes to be targeted for the 2nd NFI

National Level Classification System for Lao PDR			
Level 1	**Level 2**	**Included in NFI**	**Target Precision**
Current Forest	Evergreen Forest	Yes	Yes
	Mixed Deciduous Forest	Yes	Yes
	Dry Dipterocarp Forest	Yes	Yes
	Coniferous Forest	Yes	Yes
	Mixed Coniferous and Broadleaved Forest	Yes	Yes
	Forest Plantation	Yes	Limited sampling only, or existing inventory data
Regenerating Vegetation	Bamboo	Yes	±10% at 90% CI
	Regenerating Vegetation	Yes	Yes
Other Vegetated Areas	Savannah	Yes	Limited sampling only
	Scrub	Yes	Limited sampling only
	Grassland	Yes	Limited sampling only
	Swamp	Yes	IPCC default
Cropland	Upland Crop	Yes	IPCC default
	Rice Paddy	Yes	IPCC default
	Other Agriculture	Yes	IPCC default
	Agriculture Plantation	Yes	IPCC default
Non Vegetated Areas	Urban	No	
	Barren Land and Rock	No	
Other Land	Other Land	No	
Water	Water	No	

It is recommended that some areas of the country be defined as 'Unmanaged Forest' and 'Unmanaged Grassland'[8] and hence excluded from the NFI and GHG accounting. This can include the areas with some vegetation, but with high slopes or otherwise very inaccessible. It is assumed that logging or other anthropogenic use will be rare in such areas and are hence ignored in the NFI. As recommended by the IPCC, the area of these strata shall be monitored overtime.

Table 5 Stratum NOT included in National Forest Inventory and national GHG AFOLU accounting

Stratum not included in the Inventory:	Area (ha)	Notes
Unmanaged Forest		Delineated in GIS

[8] As allowable and defined by 2006 IPCC Guidelines for National GHG Inventories, Chapter 4.

Defined as: Areas with a slope >65%, forest areas <2 ha completely surrounded by the land class 'barren land and rock'	
Unmanaged Nonforest	Delineated in GIS
Defined as: Areas with a slope >65%, savannah/scrub/grassland areas <2 ha completely surrounded by the land class 'barren land and rock'	
Urban	
Barren Land and Rock	
Other Land	
Water	

In a previous study[9], it was determined that differences in latitude, elevation or precipitation did not result in statistical differences in carbon stocks within a forest class. Thus, it was decided that these environmental features would not be used as potential options for stratification.

However, it is recommended that the main forest types be further stratified based on historical and expected future land use (Table 6). It is recommended that the PFAs for each forest type be stratified separately from forest areas outside these location as selective logging has taken place in the past and will continue into the future. It is recommended that the data from the SUFORD funded study on PFAs should be assessed to determine if the field data collection is sufficient for the NFI itself in that stratum or if additional field measurement sampling still must take place in this stratum.

It is also recommended that the main forest strata be stratified by historical and expected future land use by using 'accessibility' as a proxy for delineating areas more and less degraded (See Box 4 for suggested methodological approach). It is expected that more accessible areas will have lower carbon stocks than areas more difficult to access. This type of stratification is a common and well accepted stratification method.

Table 6 Recommended Strata for the Lao PDR 2nd National Forest Inventory

Proposed Stratum Name	Area (ha)	Precision Target?	Notes
EF			
EF - High Accessibility		±10% at 90% CI	
EF - Low Accessibility		±10% at 90% CI	
EF – PFA		±10% at 90% CI	Use PFA data instead?
MD			
MD - High Accessibility		±10% at 90% CI	
MD - Low Accessibility		±10% at 90% CI	
MD – PFA		±10% at 90% CI	Use PFA data instead?
DD			

[9] The Capacity Development Project for Establishing National Forest Information System for Sustainable Forest Management and REDD+(Phase Ⅱ) Work Completion Report, 2015.

DD - non PFA	±10% at 90% CI	
DD - PFA	±10% at 90% CI	Use PFA data instead?
DF	±20% at 90% CI	
MCB	±20% at 90% CI	
Forest Plantation	TBD	Use existing plantation inventory?
Bamboo	±20% at 90% CI	
Regenerating Vegetation	TBD	
Upland Crop		
Savannah / scrub /grassland	at least 20-30 plots	

Box 4. Overview of approach to stratification by 'accessibility':

This approach assumes that areas that are easier to access will be more likely to have undergone previous degradation from selective logging for local or export sale, local building supply, fuelwood, and or home use. It has been used by both voluntary market REDD projects and in national REDD+ programs

1. Create updated Key Features village, road shapefile layers across time series

   Currently not all district level roads are mapped across Lao PDR. Therefore, it is highly recommended that the remote sensing imagery used to develop the 2015 Land Cover Map could also be used to digitize all roads within Lao PDR. This would create a District Road shapefile for all of Lao PDR which would extremely useful for additional purposes beyond the NFI. This road delineation can be conducted by FIPD staff. It is recommended that delineation of roads first be done using the 2014 RapidEye data and roads be classified into 'types' if possible. Once this road layer is created, this process can be repeated for 2010 RapidEye and 2005 SPOT data.

   Prior to conducting this study, it is recommended that other government sectors be consulted to compile any spatial road and village data ensure t

2. Create 'accessibility' shapefile
   Following the development of such a data layer, it is recommended that an 'accessibility' map be developed by combining slope and distance to roads.[10]
3. Determine 'accessibility cut off point'
   Whether an area is considered 'accessible' to a local population will be dependent on a number of factors, including the distance and length of time an average person would walk to selectively log an area. It is recommended that a small household survey take place asking local community members to estimate this length of time.

[10] See Eickhoff 2015b and Drigo et al 2014 for example of methods to develop accessibility spatial layer

It will also need to be determined whether further stratification will take place by provincial boundary. Sampling would then occur across each province and allow for province-level carbon stock estimates. See Section 5.1.1 for further discussion on this point.

3.4 NFI Frequency

The temporal frequency of data collection will need to be determined. This will be decided upon when the forest inventory is to be initiated and will be dependent on the availability of resources. National Forest Inventories are implemented by countries in a number of different ways for a wide range of purposes globally. In some countries the NFI is a permanent component of the government and role of the national Department of Forestry. In such instances, permanent fulltime staff are assigned to designing the sampling, conducting the fieldwork, and analyzing the results. In such instances, the order of field sampling at different points will need to be decided as different plots will be sampled in different years. However, in Lao PDR it is expected that the National Forest Inventory will be completed within 1-2 years and then repeated again after five years. In such a situation, the spatial order of sampling should be done to ensure efficiency of resources.

3.5 Allometric equations

The **aboveground biomass** of live trees is usually estimated using an allometric equation that relates tree biomass with one or more specific tree variables such as tree species, diameter at breast height (DBH) diameter at stump height (DSH), total tree height, and/or wood density. The tree variable(s) measured in the field are then used to calculate biomass during data analysis.

Prior to field data collection, the allometric equation(s) that will be applied to trees must be determined. The companion document: "Allometric Equation Evaluation Guidance Document" should be referenced for additional information on the allometric equations to be used in the NFI. The JICS(Japan International Cooperation System) funded 'The Forest Preservation Programme In Lao People's Democratic Republic, Technical Assistant : Allometric Equation Development' project will implement this guidance document to create Lao-specific allometric equations. The results of this work shall supply the allometric equations to be used by this NFI. It must be noted that the vegetation parameters listed in these equations are those to be measured in the field and thus following this work, the SOP Manual will need to be updated. This will be especially true for bamboo and for regenerating vegetation. Documentation on the equation should list the minimum and maximum sized tree applicable to the equation (e.g. Trees with a DBH ≥5 cm and ≤60 cm).

The above allometric equation study will focus on either developing new equations or verifying the applicability of existing equations for the following land cover classes:

- Mixed Deciduous
- Dry Diptocarp
- Evergreen
- Regenerating vegetation
- Bamboo

However, this Allometric Equation study will also recommend the existing biomass equation to be used for:

- Coniferous Forest
- Mixed Coniferous and Broadleaved Forest
- Forest Plantation

3.6 Carbon Pools

To estimate the emission factors for deforestation the following carbon pools can be included in a Forest Carbon Monitoring system: aboveground live tree biomass, belowground live tree biomass, lying and standing dead wood, litter and herbaceous vegetation.

For the Lao NFI, it has been decided that field sampling will take place for aboveground live tree, standing dead wood, live bamboo, and lying dead wood (Table 5). Palms are not dominant in Lao PDR and will therefore be ignored in sampling. The biomass of shrubs and herbaceous vegetation will be sampled in a subset of sampling points for specific stratum. These will then be used to create a default value for these carbon pools. For litter, the IPCC default will be used. Soil carbon stocks will not be sampled but instead the IPCC default emission factors will be applied when calculating net emissions from land cover changes.

Table 7 Inclusion of vegetation and carbon pool in NFI for each stratum

Vegetation type and carbon pool	EF Low Access, High Access, PFA	MD Low Access, High Access, PFA	DD Non-PFA, PFA	DF	MCB
Live Vegetation AG trees	Y	Y	Y	Y	Y
BG trees	IPCC default ratio	IPCC default ratio	IPCC default ratio	IPCC default ratio	IPCC default ratio
Palms	Ignore	Ignore	Ignore	Ignore	Ignore
Bamboo	Y	Y	Y	Y	Y
Shrubs	Lao default	Lao default	Lao default	IPCC default ratio	IPCC default ratio
Herbaceous	Lao default	Lao default	Lao default	IPCC default ratio	IPCC default ratio
Rattan	(Presence/ Absence)	(Presence/ Absence)	(Presence/ Absence)	(Presence/ Absence)	(Presence/ Absence)
Dead Wood Standing Dead Wood					
Stumps	Y	Y	Y	Y	Y
Natural Dead	Y	Y	Y	Y	Y
Lying Dead Wood	Y	Y	Y	Y	Y
Litter	IPCC default	IPCC default	IPCC default	IPCC default	IPCC default
Soil	IPCC default	IPCC default	IPCC default	IPCC default	IPCC default

	Forest Plantation	Bamboo	Regenerating Vegetation	Upland Crop	Savannah / Scrub /grassland
Live Vegetation AG trees	Y	Y	Y	Y	Y
BG trees	IPCC default ratio	IPCC default ratio	IPCC default ratio	IPCC default ratio	IPCC default ratio
Palms	Ignore	Ignore	Ignore	Ignore	Ignore
Bamboo	Y	Y	Y	Y	Y
Shrubs	IPCC default ratio	IPCC default ratio	IPCC default ratio	IPCC default ratio	Lao default
Herbaceous	IPCC default ratio	IPCC default ratio	IPCC default ratio	IPCC default ratio	Lao default
Rattan	(Presence/ Absence)	(Presence/ Absence)	(Presence/ Absence)	(Presence/ Absence)	(Presence/ Absence)
Dead Wood Standing Dead Wood Stumps Natural Dead	 Y Y	 Y Y	 Y Y	 Y Y	 Y Y
Lying Dead Wood	Y	Y	Y	Y	Y
Litter	IPCC default	IPCC default	IPCC default	IPCC default	IPCC default
Soil	IPCC default	IPCC default	IPCC default	IPCC default	IPCC default

4 Institutional Arrangements and Field Coordination

The forest inventory is the responsibility of the National FIPD. It is expected that an NFI Steering Committee will be created by FIPD and include members of DoF and DFRM.

The NFI will be managed by the National FIPD with provincial (PAFO and PONRE) and district level (DAFO and DONRE) staff actively engaged in the process. DFRM will be responsible for informing and coordinating all activities with PONRE and DONRE together with FIPD.

The following delineation of arrangements is expected:

National level FIPD: The national level is responsible for the overall design, implementation and completion of the NFI. The national level will create the sampling design and field SOP manual. It will be responsible for developing awareness raising materials and training materials for provincial and district level staff and then will conduct such trainings. The National staff will serve as 'team leads / crew chiefs' for all field data collection and serve as crew member responsible for entering data onto datasheets and/or tablets. The National staff will be responsible for compiling and analyzing all field data collected along with publishing the results.

Provincial and District Staff: The provincial and district level staff will be responsible for coordination and facilitation. This will include arranging for any and all permissions to conduct field sampling and planning route taken to reach sampling locations. This staff will also work form part of the field teams to conduct the field inventory itself. These staff may be responsible for specific components of the field data collection and potentially for the use of the GPS. It is expected no data analysis would take place at the provincial or district level, but provincial level staff would be responsible for developing summary reports on what field data collection took place.

4.1 Field Crew Composition

Field crews will be comprised of a combination of national FIPD staff, DAFO/PAFO staff and village guides. Based on piloting within Lao PDR[11], the following field crews composition is recommended:

- **Person 1:** Team Leader/Data Collector (FIPD staff member)
  - Responsible for Tablet and GPS
  - Directs all activities taking place
  - Determines if sampling location meets criteria
  - Inputs all data collected by team
  - Ensures Quality Assurance by monitoring and correcting as needed SOP implementation by field crew
- **Person 2:** DBH Measurement/DME Person 1 (FIPD staff member)
- **Person 3:** DBH Measurement/DME Person 2 (PONRE or PAFO staff member)
- **Person 4:** Lying Dead Wood Pool Person (DONRE or DAFO staff member)
- **Person 5:** Village Guide

It is recommended that the Team Lead and the DBH measurement crew members be from the National FIPD staff. Provincial level staff can be responsible for assisting in DBH measurements and either provincial or district staff may be appropriate for measuring lying deadwood. Adequate field training is required prior to involvement in field measurements. The accuracy of the data collected is dependent on the methods being applied correctly.

It should be noted that a significant portion of the costs for the NFI are for vehicle transportation. Thus field crews must be limited in size to allow for only one vehicle per team.

4.2 Data Collection Logistics, Permission, and Coordination

As stated, the National FIPD will be conducting the NFI in association with other departments such as DAFO, PAFO, MoNRE, PoNRE, and DoNRE along with village level participants.

Permission from both MAF and MoNRE (DFRM) for field data collection must be sought by National FIPD staff where plots are to be installed in National/Provincial Protection and Conservation Forest Areas. In addition, field support and logistical coordination support is needed by provincial and district staff.

Therefore, it is recommended that a 'NFI Sampling Coordinator' be assigned to each team. This staff member would be coordinating data collection with provincial, district, and village representatives. It is recommended that this staff person have the following responsibilities:

[11] Eickhoff, G. 2015. Pilot Technical Summary Report. National Forest Inventory Piloting NFIS Project, Lao PDR. Prepared for JICA funded NFIS by Forest Carbon Partners.

- Send out awareness raising materials to DAFO, PAFO, DFRM, PoNRE, DoNRE, and villages where sampling will occur in advance of inventory.
- Conduct NFI Sampling Coordination:
    - Travel at least one week ahead of the 'NFI Field Team'
    - Seek permissions from all relevant stakeholders
    - Coordinate with agencies to determine what district and provincial staff will assist with field data collection
    - Conduct training for provincial and district staff on 'lying dead wood' measurements
    - Coordinate at village level to determine village representative that will join in field data collection
    - Consult with village representative on potential access points and most appropriate route for field data collection
- Prepare for field sampling by field crew:
    - Travel to potential sampling location, determine if meets conditions. If not, travel to alternate location.
    - If one meets conditions, created temporary 'trail' using machetes. This can be done by hiring two or three village members to serve as guides and trail cutters.

To complete this task, this staff member would need:

- Tablet
- GPS
- Transportation (vehicle or motorbike?)

The use of such an NFI Sampling Coordinator may be flexible. In some locations where awareness and accessibility are higher, this person's responsibilities may not be as crucial. Therefore, FIPD would like to keep this arrangement flexible.

4.3 Awareness Raising and Training Materials

As stated, prior to the implementation of the NFI, an NFI Steering Committee will be created by FIPD. FIPD and this Steering Committee will be responsible for creating and implementing an awareness raising campaign. This would likely include standard information sheets and official memos requesting permission and coordination.

FIPD is responsible for maintaining training materials for FIPD itself. New staff may join FIPD and such staff will require both in classroom and field training prior to involvement with the NFI. In addition, the FIPD staff would be responsible for developing and implementing training to provincial and district level staff.

5 Forest Inventory Guidance

5.1 Sampling Design

The sampling design must address where sampling will be conducted, how it will be carried out, and what elements will be sampled. These items are addressed below, with initial recommendations for how best to address each item.

Many NFIs in other countries were developed prior to the technological advances in GIS and Remote Sensing and therefore use a very systematic sampling approach and are not optimized for any particular goal. However, now a variety of sampling designs are easy to create within a GIS environment.

For many NFIs using systematic sampling approaches, plots are laid out across the country (sometimes systematic, sometimes combination of systematic and random) irrespective of the land cover. Instead, during data analysis, each plot is placed in a certain strata depending on what type of land cover was actually in the plot. This is called 'post-stratification'. When the total number of plots is large, it will generally be sufficient to estimate any forest characteristic with good precision at a national level. Generally, the location of each sample point is fixed over time and permanent sample plots are installed.

However, if a very large number of plots are not taken, then there is a chance some forest types may be under-sampled. This will mean that for some forest classes there will be an insufficient number of data points resulting in low precision estimates.

Alternatively, the sampling design can be 'pre-stratified' by strata. The number of sample points can be based on the variability of that strata and a precision target. This would mean that the number of sample points would not be the same for all strata. This is an acceptable and standard approach to sampling. However, one important consideration in following this approach is that due to a dynamically changing landscape in Lao PDR, land cover will likely change over time. Thus, for each successive forest inventory, a new nation-wide land cover map and the location of sample points would also need to be updated.

5.1.1 Number of sample points

The number of plots can determined based on the targeted level of precision and preliminary field data or the expected standard deviation based on proxy data or knowledge. Commonly used precision levels are a 90% confidence level at 10% of the mean or a 95% confidence level at 15% of the mean.

A simple form of the equation for estimating sample size based on expected standard deviation and targeted confidence interval is developed as described below. It starts with the equation for calculating the confidence interval:

$$CI = \pm t * \frac{s}{\sqrt{n}}$$

Where:

CI:	*Confidence interval (e.g. 10% of the mean)*
t:	*Critical value from a two tail-test with n-1 degrees of freedom, based on confidence level (e.g. 90%)*
s:	*Standard deviation*
n:	*Number of samples*

This is then re-arranged as follows to calculate n, the sample size:

$$n = (t * \frac{s}{0.10 * x})^2$$

Where 0.10 * $x$equals the precision level of 10% of the mean, and t would be the critical value for 0.90, with n-1 degrees of freedom.

A companion Excel file, titled: Winrock_SamplePlot_Calculator_2014_Simplified.xlsx, has been developed to assist with the calculation of sampling points.

To use this equation, an initial estimate of the mean and standard deviation must exist. Data from previous studies in the same land cover types can be used or an initial survey can take place under a limited number of plots. This data would be most representative if the data is collected using similar field methods, and similar sized field plots.

Using such data allows users to get a general sense of the variability, however, the actual variance that will be found is unknown. Therefore it is recommended that at least 20% points than the minimum number of sample points should be sampled during the inventory. In addition, as a 'rule of thumb' if a land cover type is to be sampled, it is recommended that at a minimum 30 sampling points be located in each stratum.

The above equation was applied to mean and standard deviation data from the first NFI, the CLiPAD Houaphan data, and the pilot field data from Khammouane (Table 3) to create an estimate of the minimum number of plots required to reach various precision targets (Table 6).

Table 8 Minimum number of estimated plots required to reach various precision targets using 1st NFI, Houaphan, and Khammouane data

Survey	Stratum Name	Number of Plots in Survey	Min number of sampling points required <15% Error at 95% CI	<10% Error at 90% CI	<20% Error at 90% CI
1st NFI	EF	56	36	57	14
Khammouane	EF	2	5	8	2
1st NFI	MD	805	80	127	32
Houaphan	MD	82	81	129	32
Khammouane	MD	33	35	55	14
1st NFI	DD	636	63	100	25

Khammouane	DD	13	18	29	7
1st NFI	CF	27	111	176	44
1st NFI	MCB	74	62	98	25
Houaphan	SC	16	311	493	123
Khammouane	SC	2	26	41	10
Houaphan	SHBB	7	178	282	71
1st NFI	RV	102	368	583	146

Using the 'rule of thumb' to increase the number of plots by 20% and sample at least 30 plots per stratum, an initial estimate of the minimum number of plots was made (Table 7).

Table 9 Initial estimate of the minimum number of points to be sampled during NFI

Level 1	Level 2	# sampling points	Error Target
Current Forest	Evergreen Forest	70	<10% Error at 90% CI
	Mixed Deciduous Forest	200	<10% Error at 90% CI
	Dry Dipterocarp Forest	120	<10% Error at 90% CI
	Coniferous Forest	50	<20% Error at 90% CI
	Mixed Coniferous and Broadleaved Forest	120	<10% Error at 90% CI
	Forest Plantation	30	
Regenerating Vegetation	Bamboo	?	
	Regenerating Vegetation	200	<20% Error at 90% CI
Other Vegetated Areas	Savannah / Grassland / Scrub	30	
	Swamp	30	
Cropland	Upland Crop	30	
	Rice Paddy	30	
	Other Agr / Agr Plantation	30	

This previously collected field data provides a general understanding of the degree of variability, however, this data does not perfectly represent the actual variability currently found across Lao PDR in the various land cover types. The data from Houaphan and Khammouane represent the variability only across one province each where conditions will likely be relatively similar in comparison to the difference in conditions across the entire country. In addition, the historical land use across the country is more spatially variable currently than it was during the first NFI when less forest degradation had taken place.

In addition, this type of plot number would only allow national level carbon estimates of each land cover type to be created. This would not be sufficient to allow Provincial level carbon stock estimates to be developed as the number of plots in a given Province would be small, and thus the uncertainty would be high. Likewise, post-stratification, such as by historical land use, will also likely result in higher uncertainty.

If the main purpose of the NFI is as an input into the REDD+ estimates of net reference level and future actual emissions, then the error target for each of the stratum should be based at least in part on its expected contribution to total emissions. For example, if very small number of hectares of deforestation took place in the coniferous forest, and this trend is expected to continue in the future, then the emissions and associated uncertainty from deforestation in this land cover class will have only a small contribution to total emissions. Thus, it may be efficient to have a lower precision target for this land cover class. If the primary goal of the NFI is for use in estimating historical and future emissions from deforestation and degradation, the biomass stocks of natural land cover classes that have not historically undergone land cover change and are not expected to in the future are not needed. However, since this NFI has multiple goals, it is recommended that some limited sampling still take place in these land cover classes.

Therefore, it is recommend that the number of plots that will be distributed in each land cover class be reexamined once the historical time series of land cover maps has been created.

Since very little data has actually been taken in Regenerating Vegetation areas and Bamboo areas, it is recommended that some preliminary sample data be taken in these vegetation types to have a better estimate of the variability.

5.1.2 Temporary vs permanent sampling locations

In some countries, forest inventories are designed such that sampling takes place in the same exact locations on a regular time cycle. In such NFIs, the sampling area is clearly labeled, and all sampled trees are labeled with permanent numbered tags. During the next cycle, the same area is sampled. Such permanent sampling points can be an efficient way to monitor forest stocks and forest stock changes over time as well as develop an estimate of tree growth rates. The installation of such permanent sampling takes time.

If land cover change takes place in the sample point locations, and thus trees are removed then the permanent sample point is lost. If this happens to many points, there will not be an adequate number of sampling point locations remaining to reach precision target.

Thus, given the dynamic land cover change in Lao PDR, sampling will primarily take place at temporary sample point locations. The Anchor Point and tree-plot centers of each sample point is temporarily marked with a pole and flagging so that it can be located within a few months if re-measurement needs to take place, but a permanent marker is not installed.

Limited permanent sampling will take place within National Protected/Conservation Areas only. This will allow Lao PDR to gain some understanding of forest growth dynamics and tree growth rates while not devoting significant resources toward installing permanent plots in locations where there is a high probability of land cover/use change.

5.1.3 Distribution of sampling

Stratified two-stage sampling design

For the estimation of carbon stocks in the tree, non-tree woody, non-woody vegetation, litter, and deadwood pools, sampling should take place across a stratum in an unbiased way. Sampling layout and the design for determining sampling locations can differ for each stratum

A **stratified two-stage sampling design** is recommend to be employed in Lao PDR for several reasons, including: expected spatial variability of land-use change drivers as well as the spatial variability of forest carbon stocks, optimization of resource available for implementation of field surveys, data availability, and scientific integrity.

This two-stage sampling design consists of selecting primary sampling units (PSUs) at the first stage and then selecting secondary sampling units (SSUs) at the second stage of sampling. The approach described ensures that any location has an equal probability of being sampled. The initial sampling units are chosen by using a systematic sampling with a random start approach. A 'grid' is placed across the area to be sampled in a randomly selected orientation. The grid cells will then serve as the 'primary sampling unit' (PSUs). Once the PSUs are chosen as described below, a particular location within the PSU is randomly chosen to initiate field sampling. This is referred here to as the SSU1.

Thus, the definition of these terms is:

PSU-grid cell: an individual grid cell of a known and defined size (e.g. 5 x 5 km square) within the grid that has been superimposed across the area to be sampled. PSU-grid cell is given a unique ID. This ID number will then be used within the identification of a PSU. In Houaphan and Khammouane Provinces 3 x 3 km grids have been used in the past.

PSU_i – this is the spatial extent of the stratum i within a given PSU-grid cell. The label of the PSU shall correspond to the PSU-grid ID and include stratum notation (here denoted as *i*).

$SSU1_i$ – this is a point, representing the starting location of the cluster biomass plot. The $SSU1_i$ is located within selected PSU_i.

The exact methods to implement this sampling design method can be found in the companion SOP document under SOP Sampling Design and Layout.

Following the selection of sampling point locations in GIS, it is recommended that the points be overlaid with any existing higher resolution imagery and a visual inspection of the land cover at each point take place.

5.1.4 Sampling Layout

Background

Once the location of each sampling unit is chosen, the layout of sampling for each of the pools will need to be determined. Generally the specific location sampled for each of the vegetation and carbon pools can be distributed around an initial sampling location. Here we refer to this as the '**Anchor Point**'. Different pools are sampled differently because of the spatial distribution of different types of vegetation. The size and shape of the area to be sampled to estimate tree biomass is a trade-off between accuracy, precision, time, and cost for measurement. The sampled area should be large enough to sufficiently capture the small-scale spatial variability in the pool while still seeking to maximize sampling efficiency and reduce field errors. The most appropriate size and shape will be dependent on the vegetation type found in the sampling area.

For vegetation types where biomass will be estimated using allometric equations, such as trees, standing dead trees, palms, lianas, some bamboo, and some other woody vegetation, sampling generally takes place within relatively large areas (0.01 ha to 1 ha). Often different sizes of each vegetation type (e.g. small trees vs large trees) are sampled within different sampling areas, referred to as nested sampling. The sizes of the various nests will need to be adapted based on the vegetation in the stratum to be sampled. These sample areas can vary in shape, including circles, rectangles or squares. For vegetation types where sampling will be done through direct destructive sampling such as some non-tree woody vegetation, non-woody (herbaceous) vegetation, and litter, the area sampled is much smaller (4 m^2 – 0.25 m^2). In this document, this area is referred to as a '**clip-plot**'. Soil carbon and soil bulk density measurements will also sample much smaller areas. In this sampling guidance, it is recommended to sample lying dead wood using a line transect that can range from 50 to 100 m (see SOP Measurement of lying dead wood).

Sampling can take place within one area per sampling point or sampling can take place at within multiple areas associated with each other per sampling point or Anchor Point. This is often referred to as **clustered sampling**. The clustering of multiple subplots together at one sampling unit allows field crews to sample a larger area per sampling point. For vegetation types destructively sampled in clip-plots and for soil sampling, clustering of subplots is recommended for all vegetation types. For vegetation types estimated using allometric equations (trees etc), clustering of subplots at each sampling unit is recommended for natural forest areas and especially areas that have been selectively logged. Single-plots will be sufficient for stratum where the distribution of trees and the size classes of trees is expected to be relatively uniform and the whole area of interest is relatively accessible. For example, single plots are often used for measurements in areas where afforestation/reforestation is taking place.

Background - Nested tree-plots

Experience has shown that sample tree plots containing smaller sub-units varying in size (nested tree plots) are cost efficient and scientifically robust for most vegetation types with trees. Nested plots are composed of several plots (typically 2 to 4, depending upon forest structure) and each plot in the nest should be viewed as being a separate plot. The tree plots could take the form of nested circles or nested squares/rectangles. In each tree plot within a nest of plots, trees representing different diameter classes are measured. When trees attain the minimum size for one of the nested plots they are measured and included, and when they exceed the maximum size, measurement of that tree in that nest stops and begins in the next larger plot of the nest.

Plots can be circles, squares, or rectangles. Experience has shown that circular plots are more efficient because the actual boundary around the plot does not need not to be marked. The use of distance measuring equipment (e.g. the DME, Haglöf, Sweden) is the most recommended method for the establishment of circular plots.

Background - Saplings, standing deadwood, palms, lianas, bamboo, shrubs

If using an allometric equation method for standing deadwood, palms, lianas or bamboos (see SOP Measurement of Palms, Lianas and Bamboos for more explanation about methods), these vegetation types can be measured within the same area of the nested tree-plots. However, in Lao PDR, the amount of lianas and palms is very small, and thus it has been decided that these two vegetation types will be ignored in all field sampling.

- **Saplings:** using the 'average sapling technique', all saplings within a 2 m radius nest (sapling nest) around the tree subplot center shall be counted.
- **Standing Deadwood:** measure all standing dead wood within the medium tree plot. See SOP for sampling methods.
- **Bamboo:** The nest size within which bamboo will be measured will be dependent on the prevalence of bamboo. If highly prevalent, then the smaller nest size can be used. Otherwise, all bamboo patches should be measured in the medium nested plot. The study on Allometric Equation development will determine the method to be used for sampling this vegetation type.
- **Non-tree woody (using allometric equation)**: The nest size will be will be dependent on the prevalence of non-tree woody vegetation. If highly prevalent, then the smaller nest size can be used. Otherwise, all individuals should be measured in the medium nested plot.

Background - Non-tree vegetation and litter

A cluster of clip-plots placed in association with one Anchor Point will be used for sampling non-tree vegetation (NTV) and litter carbon pools. If tree-plots are being established, the location can also be in association with these tree-plots. Non-tree vegetation, litter, and soil can all be sampled in the same clip-plot location. First the non-tree vegetation is destructively sampled and then the litter. Finally the soil can be collected.

The location to place clip-plots can either be determined randomly, or a set protocol can be established. Generally, it is recommended to place the clip-plots outside of the nested tree-plots. This is because often the understory vegetation may get stepped on or cut by machete when collecting tree samples. If repeated sampling will take place over time at permanent anchor points, the protocol established must prevent the exact same clip-plot area from being sampled repeatedly.

Where clip-plots will be used to measure non-tree woody vegetation, it must be decided whether non-tree woody vegetation will be measured separately from non-woody vegetation and tree seedlings (trees smaller than a sapling) or if these will be measured together. Please note that certain regulatory and voluntary Standards (e.g. CDM, VCS, ACR) and Methodologies may provide explicit rules on how non-tree woody vegetation and non-woody vegetation may be measured. If non-tree woody, non-woody vegetation, and tree seedling vegetation will be measured separately, very clear rules will need to be created delineating what will be defined as a 'non-tree woody vegetation' and what will be defined as 'non-woody vegetation'. All field members must understand these definitions.

Clip-plot frames can be made out of various materials and can be circular or rectangular. A square clip plot frame made of PVC pipe 50 cm x 50 cm is usually sufficient for sampling (see Figure below). The clip plot frame should ***not*** be one continuous piece of material. The pieces of PVC piping should ***not*** be glued together into a permanent square. Instead it must remain in pieces so that it can be constructed around existing vegetation. The 'elbows' used to connect two pieces of piping together may be glued to one piece of piping.

Background - Lying Deadwood

As for clip-plots, lying deadwood transects can be placed in association to the Anchor Point. If tree-plots are being associated, the location can also be in association with these tree-plots. Generally, it is recommended to conduct lying deadwood transect outside of the nested tree-plots. This is because the deadwood may be disturbed by field crews measuring trees. If repeated sampling will take place over time at permanent anchor points, the protocol established must prevent the exact same line-transect location from being sampled repeatedly.

Sampling Layout for NFI

Sampling Point Layout

Sampling will use a clustered design with nested tree-plots. For locations where sampling for non-tree pools will be included, two lying dead wood and two clip-plot measurements shall be conducted for each sampling point. A 'floating' layout will be used in which for each sampling location, tree-plot placement is determined prior to field work in a GIS environment. The location of the tree-plots is determined using a set of rules that ensure each tree-plot sampled is in the same stratum and sampling is efficient.

See SOP manual for specific instructions on how to lay out sampling points in the field.

Nested Tree Plots

Circular nested tree plots will be used. Data from other locations in Laos need to be examined to determine what the appropriate tree plot size rules should be. The below table shall then be updated. Different size classes can be used for different strata.

Table: Example tree stem diameter classes and nested plot sizes

Stem diameter	Circular plot Radius
†Saplings	2 m
10 – 20 cm dbh	6 m
20 – 50 cm dbh	15 m
> 40 cm dbh	20 m

† Saplings are defined as: tree stems <10 cm dbh, height >1.3 m

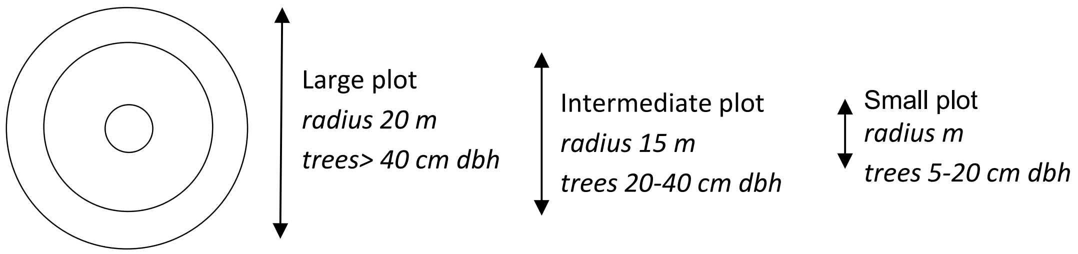

Figure: Schematic diagram of three-nest circular sampling plots

Table 10 Draft size classes per nest for each land cover class

		Forest Class					
	Radius	EF	MD	DD	CF	MCB	P
Sapling	2 m						
Small	6 m						
Medium	15 m						
Large	20 m						

		Regenerating and Other					
	Radius	B	RV	SA	SR	G	SW
Sapling	2 m						
Small	6 m						
Medium	15 m						
Large	20 m						

		Cropland			
	Radius	UC	RP	PA	AP
Sapling	2 m				
Small	6 m				
Medium	15 m				
Large	20 m				

Other Vegetation and carbon pools

One of the sampling teams will measure standing and lying deadwood, non-tree vegetation in clip plots, and litter in clip plots. The location of sampling should follow the above sampling point layouts. Field measurement procedures should follow the relevant SOP.

5.2 Field Measurements

The standard operating procedures for all field measurements are included in the companion SOP document.

[ADD to SOP manual – potential for regenerating vegetation – that if allometric equation is based on age – just collect this data

So also add doing the point sampling to determine proportion age]

5.3 Quality Control

Those responsible for aspects of data collection and analysis should be fully trained in all aspects of the field data collection and data analyses. Standard operating procedures should be followed rigidly to ensure accurate measurement and remeasurement.

The companion SOP manual provides details on QA/QC measures that shall be taken.

To estimate field measurement error, 10% of all sampling locations shall be remeasured. Field crews taking measurements should not be aware of which plots will be remeasured whenever possible.

The field measurement report shall include details on the QA/QC procedures that took place. In addition, the data analysis shall include an estimate of the field sampling error.

5.4 Calculation methods

A complete descriptions of the calculations required to estimate carbon stocks is provided in the LEAF Technical Guidance Series for the Development of a Forest Carbon Monitoring System for REDD+ (Goslee et al, 2014).

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7 Appendix A – National Forest Inventories in other countries

Many countries around the world have been conducting forest inventories over time. Generally these forest inventories are designed for multiple purposes – including understanding forest health and an estimate of forest resources. Many of these forest inventories were designed prior to the current advances in remote sensing technologies where it is relatively easy and inexpensive to understand changes in forest cover. In addition, some forest inventories exist in countries with relatively stable land use and thus permanent plots established in forested lands will likely remain forested over time. Below is an overview of a selection of countries and their NFIs.

7.1 USA - Forest inventory and Analysis

The USA National Forest Inventory is referred to as the 'Forest Inventory and Analysis (FIA)' [12]. The FIA operates as the nation's forest census and is a program of the U.S. Forest Service. The FIA is managed by the Research and Development organization within the USDA Forest Service in cooperation with State and Private Forestry and National Forest Systems. It has been operational since the early inventories beginning in 1930.

[12] http://www.fia.fs.fed.us/

Recently the Forest Service enhanced the FIA program by implementing an annual survey - moving away from the traditional periodic survey approach.[13] Capacity has also been increased to collect, analyse and publish data at a broader scope including soil and understory vegetation to name a few.

The Forest Inventory and Analysis National program has 5 main program features.

- Basic Forest Inventory[14]: This is a two-phase program where in phase one remote sensing classifies the land into forest and non-forest. Phase 2 implements field sampling where allocated plots measure a range of ecosystem data.
- Forest Health Indicators[15]: A subset of the phase 2 plots are then surveyed to collect an additional suite of ecological data.
- Timber Products Output Studies[16]: These studies estimate industrial and non-industrial uses of roundwood in a state.
- National Wood Owner Survey[17]: This is the official annual census of forest owners in the USA.
- National Assessment[18]: FIA currently provides updates of assessment data every five years. See reporting information below for more information.

As required by law a Forest Resources of the United States report is released every 5 years. The FIA delivers these assessment reports which include "an analysis of present and anticipated uses, demand for, and supply of the renewable resources, with consideration of the international resource situation, and an emphasis of pertinent supply, demand and price relationships trends."[19]

For the Basic Forest Inventory, The FIA program collects data from a number of sources including forest measurement plots (approximately one plot per 6,000 acres) and uses remote sensing for stratification to enhance precision. For the assessment of Forest Health Indicators, a subsample of forest sample plots are measured for a broader set of forest ecosystem indicators including soil, down woody material, plant species occurrence. A National Woodland Owner Survey is also conducted in the subsample to collect social data. To assess timber products, the FIA conducts Timber Products Output studies to estimate industrial and non-industrial uses of harvested timber.

7.2 Australia - National forest inventory

The National Forest Inventory (NFI) was established in 1988 as an entity that enabled the calculation of nationally consistent and comprehensive attributes describing Australia's forests.[20] Forest management agencies in Australia's states and territories undertake the on-ground collection of forest data. Key data are then supplied to a Federal level NFI management team within the Department of Agriculture. The

[13] http://www.fia.fs.fed.us/program-features/
[14] http://www.fia.fs.fed.us/program-features/basic-forest-inventory/
[15] http://www.fia.fs.fed.us/program-features/indicators/
[16] http://www.fia.fs.fed.us/program-features/tpo/
[17] http://www.fia.fs.fed.us/nwos/
[18] http://www.fia.fs.fed.us/program-features/rpa/
[19] http://www.fia.fs.fed.us/program-features/rpa/
[20] http://www.agriculture.gov.au/abares/forestsaustralia/australias-national-forest-inventory

NFI management team performs core activities, including the collection, compilation, analysis and management of forest data, and the public communication of forest information.

More information on the states and territory bodies responsible for data collection can be accessed at: http://www.agriculture.gov.au/abares/forestsaustralia/forest-agencies-and-organisations

Australia collects data against National Forest Inventory indicators established in accordance with the countries' commitment to the Montreal Process.[21] The National Forest Inventory team request data from the States and Territories on Seven Criteria and 44 indicators nested into the criteria. The seven criteria are as follows:

Criterion 1. Conservation of biological diversity.
Criterion 2. Maintenance of productive capacity of forest ecosystems.
Criterion 3. Maintenance of ecosystem health and vitality.
Criterion 4. Conservation and maintenance of soil and water resources.
Criterion 5. Maintenance of forest contribution to global carbon cycles.
Criterion 6. Maintenance and enhancement of long-term multiple socioeconomic benefits to meet the needs of societies.
Criterion 7. Legal, institutional and economic framework for forest conservation and sustainable management.

Information relating to the indicators can be accessed at:
http://www.agriculture.gov.au/abares/forestsaustralia/Documents/Forests_Australia_CandI_framework.pdf

Australia's NFI team collect mapped data from the state and territory departments. The states and territories largely follow the methods and procedures outlined in the National Vegetation Information System (NVIS)[22]. NVIS guides these departments towards consistency in the capture, interpretation and management of existing and new vegetation information into a Relational Database Management System. Information regarding data quality (e.g. update frequency and spatial coverage) is directly reported against all criteria and indicators.

At the NFI level, once all data is collated, any data gaps were then filled using best available data from Australian Government agencies, and research and industry institutions. To improve the accuracy of the forest area estimate, the NFI team then examines of a range of other, independent forest cover datasets, including remotely sensed data, in conjunction with the previously used state and territory data. These additional datasets are from advanced forest based programmes such as Queensland's *State-wide Landcover and Trees Study (SLATS)*. The combination of these aforementioned datasets form the high level NFI dataset and constitute Australia's new approach to NFI data composition, known as the *Multiple Lines of Evidence Process.*

21 http://www.agriculture.gov.au/abares/forestsaustralia/framework

22 http://www.environment.gov.au/land/native-vegetation/national-vegetation-information-system

The NFI data is presented in the State of the Forests Report (SOFR).[23] The SOFR is a series of reports released every five years and constitutes a system for reporting the state of Australia's forests, as well as the directions of change across a range of social, economic and environmental aspects of forests.

The SOFR details all NFI indicator information from a defined reporting period. For example, SOFR 2013 presents data for the five-year period between 01 July 2006 and 30 June 2011. The Report is released by the Australian Government Department of Agriculture, and coordinated by the National Forest Inventory Steering Committee and the Montreal Process Implementation Group for Australia.

7.3 Tanzania - National Forestry Resources Monitoring and Assessment

Tanzania's NFI is known as 'The National Forestry Resources Monitoring and Assessment (NAFORMA)' and was initiated around 2010. NAFORMA has been designed to provide forest resource related information for national policy, international programmes and general forestry planning in Tanzania. The programme is administered by the Forest and Beekeeping Division (FBD) of the Ministry of Natural Resources and Tourism. NAFORMA is structured to fulfill forestry, REDD+ MRV and international reporting needs with reasonable costs[24]

The NAFORMA project is a pilot initiative supported by the FAO. The project design will be replicated in Ecuador, Peru, Viet Nam and Zambia. The investment in Tanzania totaled US$5.6 million. NAFORMA is considered to be one of the largest efforts ever undertaken by a developing country to chart its forest-lands[25].

The NAFORMA project has established a system of collecting baseline information on forest & tree resources and related socio-economic data as well as developing a long-term monitoring system of Tanzania's forestry ecosystems.

Initially, a wall to wall satellite image mosaic was generated for the country using landsat 7 data to estimate and map forest & non-forest land units and to predict growing stock volumes within the forest land units[26]. Following this, a 2 year baseline programme was undertaken which involved 16 multidisciplinary teams collecting data at 3400 sites measuring and mapping the forest in accordance with the *Biophysical Survey Manual*[27] and collecting socio economic data in accordance with their *Socioeconomic Field manual*[28]. The multidisciplinary teams included specialists on tree species, soil, climate change, livelihoods and gender.

The Biophysical Survey Manual includes all information and procedures relating to the sampling design, Measurement practices, Biophysical parameters and Inventory field forms. The Socioeconomic field manual includes all information and procedures on the sampling design for socio-economic survey, socio-economic data collection and data collection field forms.

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[23] http://www.agriculture.gov.au/abares/forestsaustralia/sofr/sofr-2013
[24] file:///Users/simon/Downloads/4_tomppo-et-al-Tanzania-NAFORMA-design-morogoro-7-2011%20(1).pdf
[25] http://www.fao.org/in-action/tanzania-forest-inventory-provides-critical-baseline-data/en/
[26] file:///Users/simon/Downloads/4_tomppo-et-al-Tanzania-NAFORMA-design-morogoro-7-2011.pdf
[27] http://www.mnrt.go.tz/uploads/NAFORMA_BIOPHYSICAL_MANUAL.pdf
[28] http://www.mnrt.go.tz/uploads/NAFORMA_SOCIOECONOMIC_MANUAL.pdf

These baseline systems are currently being developed to structure the monitoring component of NAFORMA. The National Inventory will be undertaken every five years with a mid term review in 2019.

Information on methods/frequency of reporting is scarce outside of general commitments to prioritising domestic and international reporting requirements. A website dedicated to reporting NAFORMA data, and the official NAFORMA report was scheduled for Launch at the end of 2014 however both have been inaccessible.

7.4 Indonesia - Forest Monitoring and assessment system

From 1989 to 2006 Indonesia had a National Forest Inventory administered by the Forest Planning Agency within the Ministry of Forestry. The NFI was largely funded by the World Bank with support from the FAO. The objective of the National Forest Inventory (NFI) was to assess forest and forest conditions, stocks, growth rates and tree diversity across the landscapes of Indonesia. In 2006 the Indonesian Ministry of Forestry launched the Forest Monitoring and Assessment System (FoMAS). With the aim "to establish the conditions for transparency in the forest sector by making relevant, reliable, accurate and up-to-date forest sector information continuously available to decision makers and the general public".[29]

The National Forest Inventory, along with FoMAS have been integrated into the Forest Resource Information System (FRIS) which now represents Indonesia's formal NFI. FRIS is run by the Ministry of Forestry and provides a comprehensive and transparent information management system designed to support effective planning and forest management decision making for forest lands in Indonesia[30].

Initially Indonesia's forests were inventoried under the formal National Forest Inventory from 1989 to 1996. In 2003, a second phase known as the Recalculation of Forest Resources was undertaken. This was internally funded and included an assessment of Landsat 7 data from 1999/2000. The Third phase in 2005 was an additional Recalculation of Forest Resources which interpreted Landsat 7 data from 2002/2003.

Data was collected across a range of geophysical, biophysical, forest extent, forest type, Forest Use, Condition, Biodiversity and Legal Tenure categories. For all information remote sensing and field inventory designs see the FAO report referenced[31].

Within the current FRIS several programs exist for data collection and management. These are[32]:

- The remote sensing program - measuring forest extent condition and change
- Ground based measurement program – building off the National Forest Inventory dataset to proved greater information for the broader indicators in the FRIS
- Geodatabase – an store and archive spatial data to planning monitoring and management of forests.

[29] http://www.sekala.net/files/Fomas%20Dephut%20final.pdf
[30] file:///Users/simon/Downloads/FRIS%20draft%20design%20-%20March%2009%20(1).pdf
[31] http://www.fao.org/docrep/016/ap186e/ap186e.pdf
[32] file:///Users/simon/Downloads/FRIS%20draft%20design%20-%20March%2009%20(1).pdf

- Modeling program – spatial modeling to estimate a range of economic, biological and social variables.
- Data sharing and exchange program – development of a data disclosure policy
- Decision Support program – development of decision support tools and system for forest planning and management activities.

Three key reports were published under the National Forest Inventory. These are titled 'Final Forest Resources Statistics Report (of NFI) (1996), Recalculation of Indonesia Forest Cover (2003) and Recalculation of Indonesia Forest Cover (2006).

Formal annual reports are now published by the Ministry of Forestry in a series called: *Forestry Statistics of Indonesia*. The 2013 edition is the most recent report (published in 2014) and is "intended to provide data and information on forest resources and results of forestry development activities. The statistics present current information with some data covering the previous years"[33].

7.5 India – Forest Survey of India

Forest Survey of India (FSI) has been undertaking national forest assessments since 1965.[34] The forest characterization and land use data collected as well as their sources are described below:

- Government Records: Annual land use statistics (Ministry of Agriculture Records), legal status of forest areas – State Forest Department Records
- Remote Sensing: assessments of forest cover
- Field survey: Growing stock of forests and other non-forest tree cover

7.6 People's Republic of China

Since 1977, a national system of continuous forest resources inventory has been implemented at five year intervals and is based on 415,000 fixed ground sample plots.[35] RS has been used in NFIs since 1994, using NOAA and Landsat data. The forest characterization and land use data collected as well as their sources are described below:

- Government Records: legal status of forest areas and management (production/tourism/recreation etc.)
- Remote Sensing: Assessment of forest cover, other wooded land, and other land with tree cover
- Field Survey: geophysical and biophysical characteristics including altitude, topography, tree data (number, height, diameter, age class); forest health (insect/disease disturbance)

[33] http://www.dephut.go.id/uploads/files/2fba7c7da8536e31671e3bb84f141195.pdf
[34] http://www.fao.org/docrep/016/ap185e/ap185e.pdf
[35] http://www.fao.org/docrep/016/ap184e/ap184e.pdf

8 Appendix B – Overview of Previous forest biomass work in Laos

In Lao PDR, various field measurements of the forest have taken place over time (Table 3). This includes the first NFI conducted in 1991-1999 and whose focus was on estimating timber volumes.

Table 11 Brief summary of previous and current project related to the forest inventory and biomass in Laos

Project	Implementation Period	Focal Cite	Implementation Agencies	Finance
First NFI	1991-1999	National	Forest Inventory and Planning Center (FIPC)	Sweden
SUFORD (phase I~I I I)	2003-2017,	Khammoune, Savanakhet, Salavan, Champasak, Xekong, Attepue, Bolikhamxay, Vientiane Province and Xayabouli	DoF, DOFI, NAFES, NAFRI, Provincial and District Forest Offices, Village Forestry Organisations/Units	World Bank USD 10 million, Government of Finland USD 12 million (Phase II)
Timber plantations	2006	Bolikhamxay,Champassak Salavan,Savannakhet and Vientiane Province	ADB Industrial Tree Plantation Project (ITPP)	N/A
CliPAD	2009-2018	Sayaboury and Houaphan Provinces	MAF, DoF, Provincial and District Agriculture and Forestry Offices	GIZ (4.0 million EUR), KfW (10.0 million EURO)
PARRED+	2009-2014	Luang Prabang	National Agriculture and Forestry Extension Service, Provincial and District Forest Offices	JICA(4 million USD)
FIM	2010-2013	Whole Provinces (National Level) but Luang Prabang for feasibility study with PAREDD	DOF/FIPD	JICS(5.5 million USD)

Table 12 Carbon Pools collected in three of data collection projects

	1st NFI	FIM	CliPAD
Above Ground Biomass	×	×	×
Below Ground Biomass			
Dead Wood			×
Litter			x
Soil	×		x

※There are no data of soil survey which was implemented 1st NFI

8.1 Objectives and Outline of each Project

8.1.1 First NFI

The objectives of the NFI conducted in the 1990's were:

- To provide information about forest and land use, in particular about standing volume, but as far as possible also about cutting and site conditions in accessible areas of the concerned provinces.
- To collect data for elaboration of volume functions.
- To compile ground truth for soil, vegetation and land use maps.
- To improve the definitions for any variable when it is found necessary.

8.1.2 SUFORD (Phase II)

The Development Objective is to achieve the sustainable management of natural production forests to alleviate rural poverty. SUFORD provides support to forest policy formulation and reform, forest land classification and demarcation of natural production forests, investments in improving the management of production forests and village development on the ground, and broad technical advice, training, and capacity building. With respect to REDD+, the SUFORD project:

1. Facilitates intersectoral coordination and cooperation for equitable benefit sharing for local communities
2. Strengthens the impacts of PSFM through continued operational support to field implementation, improvements in forest management quality through better internal control and capacity building, and independent certification
3. Facilitates improved consultation with ethnic groups
4. Develops and implements a program on forest and wildlife law enforcement
5. Supports a REDD+ demonstration site in the Dong Sithuane PFA

8.1.3 Timber plantations

This report analyses inventory data collected between May and September 2006 from Eucalyptus camaldulensis plantations established in Laos under the ADB Industrial Tree Plantation Project (ITPP) between 1997 and 2001. In all, 309 inventory plots of 0.012 ha (10 x 12 m) were established in 65 villages in 5 provinces.

Several volume equations were tested from the data. The best was a simple form factor of 0.454, used to calculate all volumes overbark to a top diameter of 2 cm, as measured on 114 felled sample trees. These ranged in height from 6 to 19 m, and in diameter from 4 to 17 cm.

8.1.4 CliPAD

This subnational program was established to address the loss and degradation of its natural forests causing high levels of greenhouse gas emissions, as well as to improve the livelihood of rural communities and to conserve its precious biodiversity. The overall goal of the CliPAD focuses on the development of suitable framework conditions and pilot models for effective forest conservation in and around NPAs on the basis of the international discussion on REDD+.

8.1.5 PARRED+

PAREDD project aims not only to develop an approach for reducing deforestation and forest degradation based on participatory land and forest management at village level. Simultaneously, the project aims to register a GHG reduction project under VCS programme in order to generate carbon credits at the project level.

8.1.6 FIM

The objective of the program is to improve the system for forest information management in order to contribute to sustainable forest and land management as well as to mitigate climate change through establishing the ability for development and management of forest base maps using multiple satellite information. The program proposes several important tasks to achieve the program objective:

- Establishment and construction of Forest Resource Information Centre

- Procurement of equipment for Forest Information Management, such as satellite imagery analysis, database development and sampling field surveys

- Capacity building to establish the system for Forest Information Management, data collection/analysis with remote sensing, GIS/database and filed survey

The expected outcomes from the program include providing the forest base map and related database for the implementation of national REDD program, and enhanced capacity building opportunities and training for government officials to support a Lao led process on REDD.

8.2 More detailed review of first NFI

8.2.1 Inventory Design

The inventory design is a two-phased, stratified, systematic, cluster sampling.

In the first phase a large number of tracts are laid out on the Land Use Maps (based on the SPOT satellite images). The tracts are located in a systematic way according to the map grid net. The tracts are classified according to land use and accessibility. Based on this classification the tracts are assigned to five different strata.

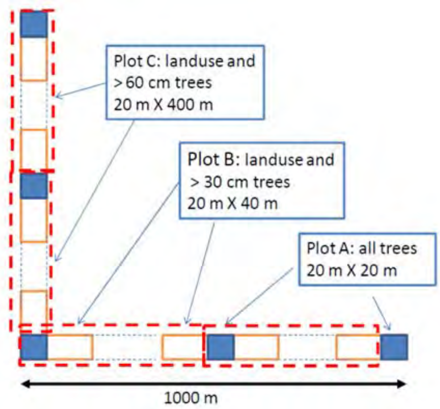
In the second phase a certain ratio of the tracts, different for different strata, are selected for field inventory. This selection is done systematically with random start. Plot type is non-permanent.

8.2.2 Plot Design

There are three types in one tract.

Type A: Square plots, 20 m x 20 m, located at the end and in the middle of each tract side.

Type B: Rectangular plots 20m x 40 m located directly before and after each plot of type A.



There are eight plots of type B in one tract.

Type C: Rectangular plots 20 m x 400 m located between the plots of type B covering the whole tract line that is not covered by plots of type A or B.

8.2.3 Survey Items

Plot type A

Plot; Land use and forest type, Regeneration quality for plot with crown density<40%, Crown density with 10% interval, Stand structure based on mean diameter, Stand damage, Altitude, Topographic position, Slope aspect (direction), Hauling distance to road, Slope conditions along hauling course,

Tree; All trees with a reference diameter (DBH) > 100 mm is enumerated within the whole plot.

Species, DBH, Diameter at stump height, Stem class (straight, knots, bent etc), Tree height, Crown point height, Upper diameters (diameters at crown point and half of bole point of sample trees),

Bamboo, Rattan and Stump are refer to “First National Forest Inventory_Summary”

8.2.4 Crew and Time

Concerning the survey crew, 1st NFI had a team of 8 staff excluding driver and so on and they included the team leader, reader of measurement, recording and species specialist. According to SUFORD analysis, on average 40 hours including transportation and walking to plots were necessary for one tract of first NFI.

8.2.5 Other

Control survey was implemented in exactly the same way as the ordinary inventory

Inventory crew re-checked field collected data.

8.3 More detailed overview of FIM

8.3.1 Type of Plot

Plot types are intended to be simple, non-permanent point samples measuring land cover classification and biomass only.

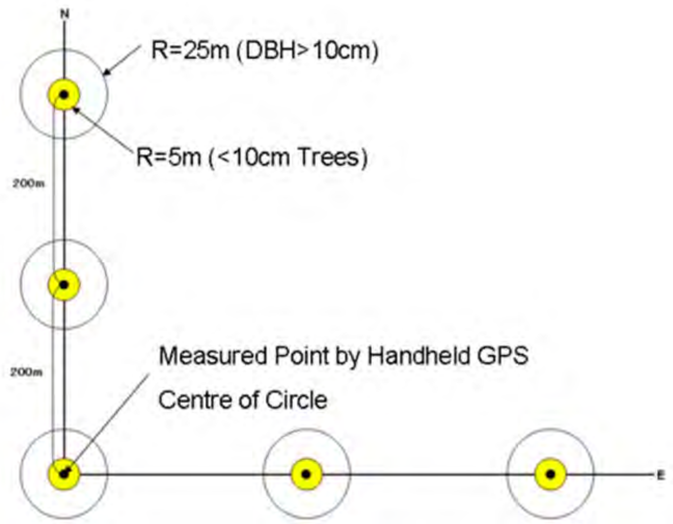
8.3.2 Plot Design

The FIM method uses a circular plot design and incorporates a nested 5m plot overlapping with a larger 25m plot.

A tract area has five plot areas. Each plot area consists of two circles with radii of 5m and 25m. DBH ≥ 10cm is recorded in the larger 25m-radius plot area, whereas the smaller 5m-radius plot samples the population falling within the 5cm-10cm DBH range.

The FIM approach situates a total of 5 plots along 400m West to East and South to North L-shaped cluster design. The central origin point of the starting plot is identified by GPS and always located within 500m of a road in order to ensure ease of access and alternative locations in cases of inaccessibly steep slope. A clustered approach was chosen based on the high levels of anticipated disturbance.

This plot design enables the teams to sample approximately 3 ha per 5-plot cluster. Following Figure illustrates the overall design of the FIM cluster plot.



8.3.3 Survey Items

Living Trees:

- **Diameter at Breast Height (DBH)**: using a centimeter DBH tape for trees ≥ 10cm
- **Tree Height**:
- **Tree Quality:** There were 3 categories such as Good, Normal and Poor.
- **Population of Saplings**: Ranging from height 1.3m and/or < DBH 5cm.
- **Canopy Density**: a 4-point cardinal direction average is established using a standard convex mirror densitometer at the center of each plot. These data were collected to further assist satellite remote sensing accuracy and the overall stratification process.
- **Forest Class:** Following the 8 categories defined based on land cover classification system.
- **Non-Forest Class:** Following the 16 categories defined based land cover classification system.
- **Forest Structure:** Divided between 4 classes for forest structure and calculated based on the average DBH of the plot.
- **Species Local Name:** Local names were recorded in the field
- **Direction of Slope Face:** Following the cardinal directions and defined using a compass.
- **Photographs**: showing forest conditions at the center of each plot, facing north, east, south, west, canopy directly overhead.

8.3.4 Crew and Time

The survey team consists of at least six (6) persons for the smooth implementation of the survey as follows :(1) Field surveyor (FIPD), (2) GIS engineer (FIPD), (3) Engineer for Data Entry (FIPD) (if possible), (4) Province staff, (5) District staff, (6) Local staff, (7) Driver

FIM measured one tract per day on average.

8.4 More detailed overview of CliPAD project[36]

The NFI plot design builds largely off of the CliPAD plot design first tested in Houaphan Province. The design of the CliPAD plots differs in the size of the floating survey area (set at 500m rather than 300m in the NFI pilot), used a slightly large radius of it's largest living tree plot nest (25m rather than 20m in the NFI pilot), and placed the location of Non-Tree Vegetation sample clip plots at a different location. The Inventory under CliPAD also chose not to make slope adjustments in the field, choosing instead to make those changes to the data post inventory.

8.4.1 Type of Plot

Temporary plots were used in order to establish carbon stock densities by forest ecological class across Houaphan Province

8.4.2 Plot Design

Living tree circular nested sub plots were broken into 3 nests of 6m, 15m and 25m radii. A 2m radius sapling nest was placed within the 6m living tree nest (. Circular nested cluster plots were installed in configurations of 3 sub-plots per cluster.

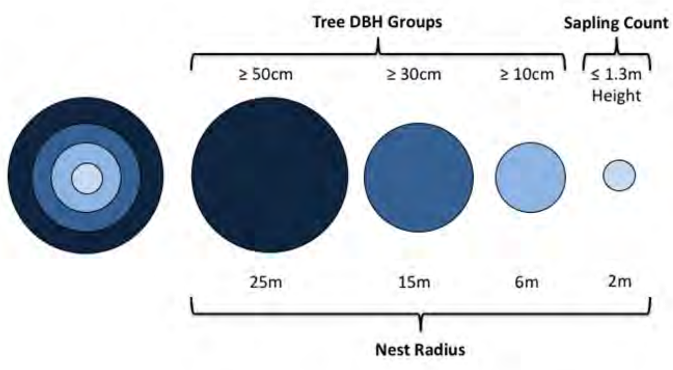


Figure: Nest and DBH size classes for the CliPAD Houaphan inventory.

[36] See Casarim, F., Eickhoff, G., and T. Pearson (2013) Harmonized Methods for Forest Carbon Assessment Standard Operating Procedures (SOPs) for Houaphan Province, Lao PDR. Joint Publication of the Climate Protection through Avoided Deforestation (GIZ) and the Lowering Emissions in Asia's Forests (LEAF) Project.

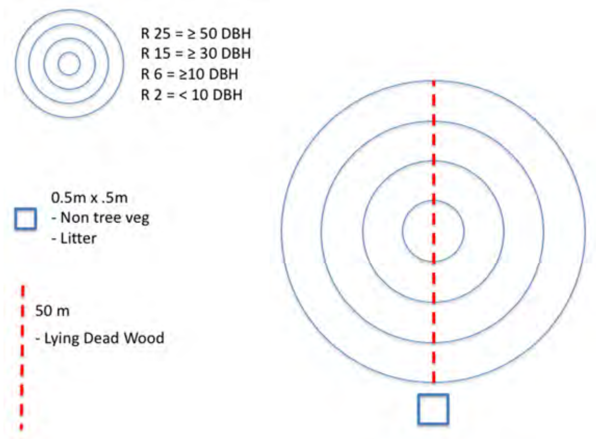


Figure: Location and layout of subplot carbon pool sampling areas.

Each cluster plot was an aggregation of 3 individual sub plots falling within a strata of interest. This "floating plot" approach was tested due to the high variability of the Houaphan forest landscape. Like the current NFI design, sub-plots were allowed to be randomly placed within a "floating zone" and constrained to ensure that they were not overlapping.

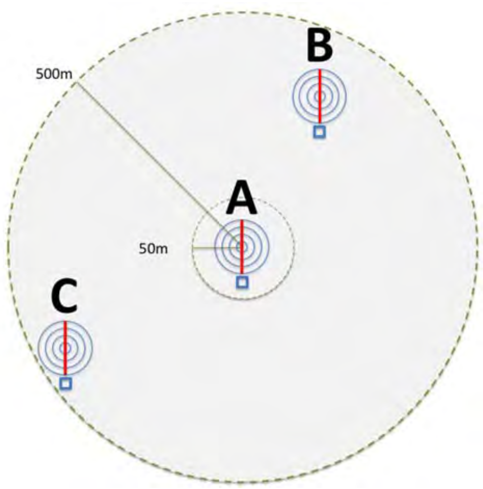


Figure: Cluster plot design.

8.4.3 Survey Items

The CliPAD method includes the following parameter measurements:

Living Trees:

- **Diameter at Breast Height (DBH)**: using a centimeter DBH tape for trees ≥ 10cm
- **Tree Height**: tree height was not measured. Chave et al 2005 was used to model total biomass per tree.
- **Species Local Name**: Species local name was collected as a reference but not used in biomass calculations.
- **Leaf Index**: describing the status of leaf fall of each deciduous trees (full leaf cover, partial fall,

complete loss of leaves).

- **Canopy Density:** teams were asked to estimate average canopy density in 10% density classes (e.g. 10-20% coverage, 20-30% coverage, etc…)
- **Forest Classes**: Forest and non-forest class; evergreen versus deciduous, ecological classification.
- **Photographs**: showing forest conditions at the center of each plot, facing north, east, south, west, canopy directly overhead and the datasheet ID#.
- **Slope**: Slope of each plot was measured and recorded using a clinometer.
- **"Deciduousness" –** Teams were asked to rate the state of leaf fall of deciduous species, (e.g. leaves fully on, leaves partially fallen, leaves totally fallen).

Stumps:

- **Diameter (at base):** Using a tape measure if measuring stumps.
- **Height:** Using a tape measure from top of stump to base.

Standing Dead Trees:

- **Diameter at Breast Height (DBH):** using a centimeter DBH tape
- **Tree Height**: % clinometer readings are made from a free (non-fixed) distance. Both % measurement to the visible top of the tree and the base of the tree are made. This is used in the calculation of tree height. Distance to tree is measured using a handheld laser distance measurement device from point where Clinometer Tree Height % reading is taken in order to calculate of tree height.

Lying Dead Wood:

- **Diameter of Lying Dead Wood**: Lying dead wood lying across the transect line is measured at the center of the lying log and recorded.
- **Dead Wood Decomposition Class**: Using the Solid/Intermediate/Rotten (SIR) machete decomposition test.

Non-Tree Vegetation

- **Clip Plots**: Used 0.5m x 0.5m clip plots

Litter:

- **Clip Plots**: Used 0.5m x 0.5m clip plots

9 Appendix C – Fundamental concepts in sampling designs

This annex is meant to provide a short primer on statistical concepts related to sampling designs. Much of the information was provided by Dr. Stephen Stehman, PhD, a biometrician at the State University of New York, College of Environmental Science and Forestry.

Basics of sampling designs

Probability vs. Non-probability sampling designs

Probability sampling is a term used to describe a sampling design that results in two key features:

1. The probability of an individual unit to become part of the selected sample (the "inclusion probability") is known and can be calculated. This probability depends on which specific sampling design is chosen, and may be determined before the actual sample is selected.
2. The inclusion probability of all sampling units in the population is greater than zero.

All probability sampling designs include a randomization component. Sampling designs are sometimes characterized as "equal probability" or "unequal probability" sampling designs. An *equal probability sampling design* (sometimes referred to as "self-weighting" designs) is one in which the inclusion probability for all potential sampling units is the same. Simple random, systematic (assuming a random start), and stratified random sampling with proportional allocation (described in Section 2.3 below) are all equal probability sampling designs. *Unequal probability sampling designs* are also valid, and are often used. A common example is stratified random sampling with equal allocation of sample size to all strata (see Section 2.3 below). Smaller strata are sampled with higher inclusion probabilities (i.e., a larger proportion of the rare stratum is sampled).

Nonprobability sampling designs are protocols in which judgement, rather than randomization, is used to select the sample units. This type of sampling should be used with caution. Examples of nonprobability sampling include convenience sampling, where sampling units are chosen based on their relative ease of access, or quota sampling, where a quota (e.g., 65% of total plots must come from Stratum A) is established and researchers are free to choose to sample any location within the stratum as long as the quota is met. Another example of nonprobability sampling is when sample selection protocols are so complex that it is not possible to determine the inclusion probabilities. Judgement sampling is a form of nonprobability sampling in which "expert" judgement is used to choose a representative sample. These "judgement" samples are sometimes justified when only a very small sample is possible. For example, a "judgement sample" of a lake is justified when a single location of the lake will be sampled to represent the lake in a larger "index" of some sort. That is, assuming a probability sample of lakes has been selected, and each lake will be visited just once in time, a nonprobability sample for a lake might be to visit the lake during a specific time window (e.g., mid-summer) and to select a water sample at the centroid of the lake's surface at a depth of 1 meter. Thus two levels of sampling are present, a probability sample of lakes, and within each sampled lake, a nonprobability sample to characterize the lake based on a fixed time and spatial location.

Types of Inference: Design-based vs. Prediction-based

A simple way to think about "inference" in a statistical sense is that it provides the context for how the variability of a sample-based estimate should be interpreted. Two common approaches to inference that apply to sampling are *design-based inference* and *prediction-based inference*.

Design-based inference requires a probability sampling design. All observations are assumed to be measured with negligible error, so that the variability in the estimate is associated only with which specific sampling units were included in the sample – a different sample will yield a different estimate. Thus, the variance is based on how large the range of variation among different samples is over the set of all possible samples. If different samples yield close to the same estimate, then the estimate will have a small variance and will therefore be very *precise*. Model-assisted estimators, such as regression estimators that link the response variable (y) to an auxiliary variable (x), can be used to improve precision and are still considered part of design-based inference.

Prediction-based inference does not require a probability sampling design, and is dependent upon a model of some sort. The measurements on each sample are assumed to be realizations of a random variable Y, and the model links the random variable Y to other observable variables. The modelling approach is based on predicting the values of Y for unobserved units of the population using the model as the basis of the predictions. Therefore, variability in prediction-based inference is not linked to the sampling units but is linked to the model. For example, the variance may be estimated based on the calculated difference between the observed and predicted values of Y. Because prediction-based inference is dependent on a model, it is necessary to validate the model for a particular application and the assumptions of the model must be verified as plausible.

Measurement Error

Measurement error refers to the situation in which data for a sampling unit cannot be measured with complete accuracy. Typically it is assumed that measurement error is negligible relative to sampling error (i.e., the variation due to taking a sample of the population is much larger than the variation attributable to inexact measurements). If measurement error is "random" (i.e., varies randomly about the true value of the measurement), then there will be no bias in the estimate. If measurement errors are "directional" (e.g., always tend to be too high or too low), then bias can result. The estimation of biomass using allometric equations entails "model" error, which consist basically of measurement error, in that an allometric equation might be used to estimate biomass from height and/or diameter data, but for a specific tree (or plot of trees), the true biomass is probably not exactly the same as the biomass derived from the allometric equation.

Non-response and Imputation Techniques

Non-response refers to an inability to obtain a measurement of interest. Non-response is often separated into *unit non-response*, meaning that no data were obtained for the sampling unit (e.g., the unit was not accessible when the field crews arrived), versus *item non-response*, meaning that one or a few observations for a particular sample unit were missing. Unit non-response is sometimes ameliorated by selecting "replacement" sampling units. Replacement sample units should be selected according to the same protocol used to select the initial random sample. Ad hoc protocols, such as moving the sample to a more convenient location or replacing a sample with its nearest neighbour or nearest similar looking location, should be avoided. In general, field crews should be cautioned not to move sample locations or look for replacements.

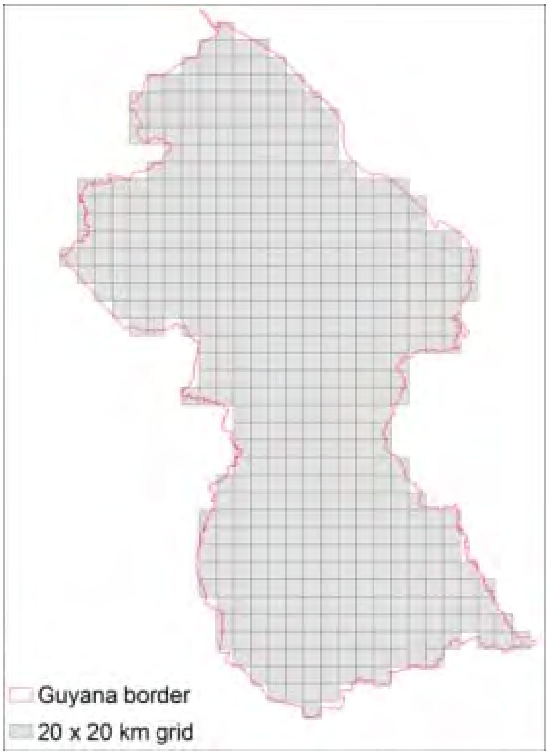
Imputation refers to procedures for replacing missing data due to non-response. For item non-response (missing data), it may be possible to use regression or other modelling approaches to predict the response for the missing variable based on the variables that were able to be measured. For unit non-response (no data) nearest neighbour approaches can be used. That is, the missing sampling unit is matched to its nearest neighbour (for which measurements were obtained) based on all auxiliary information available about the sampling unit. The data from the nearest neighbour then substitute for non-response sampling units.

Overview of common sampling designs

This section provides a broad overview of three commonly used sampling designs: **systematic**, **stratified**, and **cluster**. Choosing a sampling design typically involves weighing the advantages and disadvantages of different design options that address potentially competing objectives and design criteria. Advantages and disadvantages of each sampling design are outlined as tables within each sub-section. There is usually not a “perfect” choice, but rather one that has strengths for certain criteria and objectives but weaknesses for others.

Systematic Sampling

Systematic sampling is a sampling method in which sample plots are spaced at regular intervals throughout the study area using a grid pattern (Figure A-1). Systematic sampling should be implemented with a randomized start to the sampling grid. Once the initial randomization process specifies the starting point, all other sampling points are determined by the sampling interval, i.e., how far apart the points are from each other in space.



FigureA-1. Example of a systematic sampling grid over Guyana, South America where sample points are distributed at regular 20-km intervals.

The advantages and disadvantages of a systematic sampling design are given in Table A-1. Sampling points are spatially well distributed, ensuring that a representative sample is obtained. This design has a long history of use, particularly for forest inventory applications, and is easy for non-scientists to understand. A systematic sampling design is also advantageous when there is a spatial gradient in the variable of interest (for example, forest carbon stocks), **except** in the case where prearranged sampling points happen to coincide with a periodic pattern in the underlying data and cause the sample to be unrepresentative of the population as a whole (this situation can generally be avoided by judicious choice of the sampling interval). Advantages to this design diminish when applied as a stratified systematic design if each stratum is not spatially entire (e.g., stratum is fragmented into separate areas). Also, systematic designs are less flexible than simple random designs in terms of adjusting sample size once the sample selection process has started. Once the grid of a fixed number of points has been established, keeping the same grid layout of points while also adding or removing sample points to the design becomes challenging. Finally, estimating standard error is problematic for systematic sampling designs, as the approximations generally overestimate true standard error.

Table A-1. Advantages and disadvantages of systematic sampling.

Advantages	Disadvantages
Sampling points are spatially well distributed	Estimating standard error is problematic, usually approximate (conservative) value is used
Small standard errors result when there is a gradient in the spatial pattern of the response variable and when the variable shows a positive spatial correlation	Less flexible than simple random sampling to increase or decrease sample size once the sample selection process has started
Long history of use, particularly for forestry applications	Advantages diminish when applied within strata and each stratum is not spatially entire (e.g. stratum is fragmented into separate areas)
Intuitively appealing to non-scientists	If prearranged sampling points coincide with a pattern in the underlying data, then the sample is unrepresentative of the overall population

Stratified Sampling

When forest carbon stocks vary considerably across space, it is advantageous to sample each sub-population (stratum) independently using a stratified sampling design. The strata should be mutually exclusive, so that every spatial unit within the region (e.g., a pixel, a 20 km block, etc.) is assigned to only one stratum. The strata should also include the entire study region; no unit should be excluded from the stratification process.

Stratification serves two primary (but often competing) objectives: (1) estimation of the characteristics of each stratum individually (e.g., each stratum is a “subpopulation” of interest and it is desirable to provide a carbon stock estimate for each stratum) and (2) improvement of the precision (i.e., lower standard error) for the full population (e.g., estimating a mean carbon stock for Cross River State as a whole).

Stratified sampling is usually implemented using one of three options for allocating sample points to strata (Figure A-2):

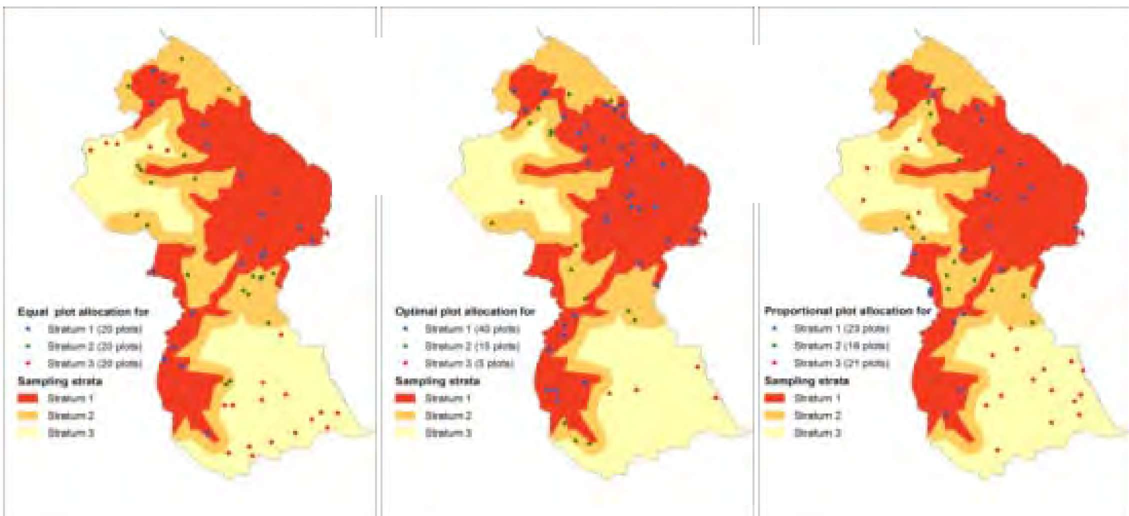
Equal allocation is used when the objective is stratum-specific estimation, for example estimating the mean carbon stock for each stratum. It is possible to deviate from equal allocation to account for expected differences in variability for different strata, with a higher variation stratum receiving a larger sample size.

Optimal allocation is used when the objective is to minimize the standard error of an estimate for an entire region (e.g., mean carbon stock for all of Cross River State). Optimal allocation specifies taking a larger sample size from strata that are large, have high variability, and are less costly to sample.

Proportional allocation is applicable when the survey targets multiple objectives (variables). In this case, optimal allocation may not be warranted but estimates are desired for the full region rather than for each stratum. Proportional allocation specifies that a stratum's sample size is proportional to the size of that stratum (i.e., a small stratum will receive a proportionally small sample size). Stratified sampling with proportional allocation is usually not advantageous, because the same outcome can be achieved by simple random or systematic sampling with post-stratified estimation. In other words, instead of stratifying the study region up front, it is just as effective to distribute plots and stratify at the end during the analysis stage.

When stratum-specific parameters are estimated (e.g., mean carbon stock per stratum), equal allocation is usually implemented to ensure a specified minimum sample size in each stratum. However, if the sole objective is to estimate a parameter across the whole study region (e.g. Cross River State), then optimal allocation should be implemented. Advantages and disadvantages of stratified sampling are listed in Table A-2.

In a stratified sampling design, each stratum is sampled separately and so a different design (random, systematic, clustered) can be used in each stratum if desired. For example, simple random sampling can be implemented in Stratum A while systematic sampling can be implemented in Stratum B. However, stratification is generally performed with respect to one variable of interest, and so if a study has several objectives, all of which are equally important, then stratification that is effective for one variable may be less effective for other variables.



FigureA-2. Examples of stratified sampling across Guyana, South America. (a) equal allocation, where 20 plots are distributed within each of three strata; (b) optimal allocation, where the largest stratum (Stratum 1) is sampled most intensively with 40

plots. Stratum 2, although smallest, may be most variable and thus may warrant higher sampling intensity at 15 plots compared to Stratum 3, which may be homogeneous and would not require a high distribution of plots; and (c) proportional allocation, where the number of plots in each stratum is proportional to the area of each stratum.

Table A-2. Advantages and disadvantages of stratified sampling.

Advantages	Disadvantages
Allows specification of sample size for specific strata. Therefore, can increase the sample size of a relatively rare subgroup.	Bad stratification decisions can lead to higher standard error than for simple random sampling.
Each stratum is sampled separately, so a different sampling design can be used in each stratum, creating flexibility in choice of sampling design.	Stratification that is effective for one variable may be less effective for other variables, so this design is less desirable for multi-objective analyses where all objectives are equally important

Post-stratification is an alternative to using strata as part of the sampling design protocol, instead using strata information at the end (during the analysis phase) rather than at the beginning. In this type of design, samples are selected and data are collected without regard to strata, but the statistical formulas themselves use the strata information. For example, a simple random sampling design could be selected and implemented, but the formulae for stratified random sampling would be used once the sample units are identified to strata.

Post-stratification requires that the entire region be stratified. This is because stratum weights are used in estimation formulas, and these weights are derived using information from the entire region. An advantage of post-stratification is that different stratifications can be used for different variables. This is beneficial in a multi-objective survey in which several variables are of interest. If one measured variable is not associated with the stratification, then the standard error for this attribute may be higher. For example, if the strata are defined by forest type but a variable of interest is unrelated to or unaffected by forest type, no improvement in precision would be expected from the stratification process.

If the objective is to estimate a parameter across an entire study region (e.g., forest carbon stock of Cross River State), then post-stratification usually results in standard errors that are about the same as would be obtained by proportional allocation but not as precise as optimal allocation. If the objective is to estimate a mean for each stratum, post-stratification will not be effective for small strata because the sampling design does not increase the sample size for these small strata.

Cluster Sampling

Cluster sampling involves grouping spatial units across a study region into manageable "clusters", after which specific clusters are chosen for more intensive sampling. A cluster is referred to as a primary sampling unit (PSU) and the objects within the cluster are referred to as secondary sampling units (SSU). For example, a cluster (PSU) could be a 20 km x 20 km block, and "plots" within the PSU could be SSUs.

A common motivation for cluster sampling is to reduce sampling costs. Given a fixed budget and/or timeline, cluster sampling can allow an increased sample size because sampling units are located close together in space, so sampling is conducted more efficiently. If a significant amount of time and resources involved in inventory work are dedicated to the time spent travelling among different sampling sites, it can be more efficient to implement a cluster sampling design. The number of PSUs and SSUs within each PSU to sample depends on the cost of sampling a PSU versus an SSU and also the relative variation of the two variance components (variance among different PSUs and variance among SSUs within an individual PSU). The drawback to cluster sampling is that standard errors are complex to calculate, and approximations of standard errors tend to be underestimated (Table A-3).

TableA-3. Advantages and disadvantages of cluster sampling.

Advantages	**Disadvantages**
Lower costs, because the sample units are spatially constrained	If the variable of interest is highly spatially correlated, the cost advantage of cluster sampling may not compensate for the increase in standard error resulting from sampling locations in closer proximity
Using a cluster of contiguous smaller units rather than a sample of separate small units sometimes provides better spatial information	Complex computation of standard errors (two variance components must be estimated); can result in underestimation of standard error if second-stage variance component is ignored

There are two types of cluster sampling: *one-stage* and *two-stage*. In one-stage cluster sampling, all SSUs are observed within each sampled PSU. In two-stage cluster sampling, only a subset of SSUs is selected from each sampled PSU (Figure A-3). Two-stage cluster sampling is a good “compromise” design between cost and precision when the variable of interest is expected to be positively spatially correlated. Instead of sampling every SSU within a sampled cluster (e.g., measuring the carbon stock across an entire 20 km x 20 km forested pixel), a subsample of SSUs within the cluster is obtained and the time and cost saved by subsampling is applied to sampling additional clusters (PSUs). The calculation of standard errors will differ depending upon whether one- or two-stage sampling is implemented.

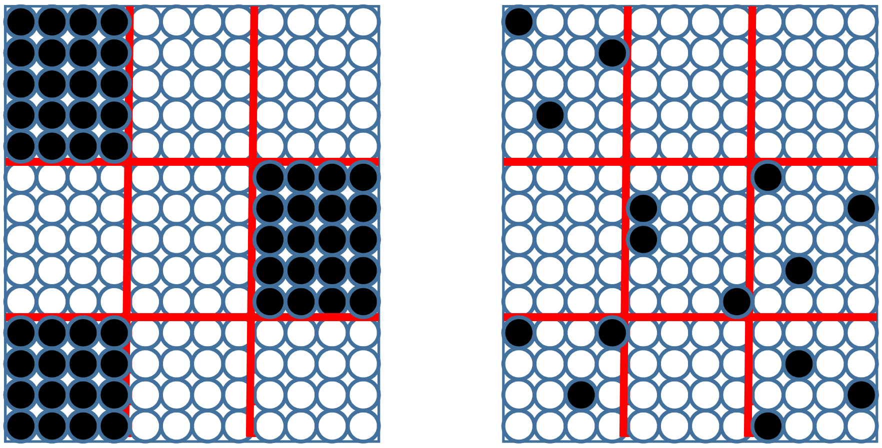


Figure A-3. One-stage and two-stage cluster sampling. In one-stage cluster sampling (left figure), a sample of clusters (primary sampling units, or PSUs) is chosen and all secondary sampling units, or SSUs, within each PSU are selected. In two-stage cluster sampling (right figure), a sample of clusters (PSUs) is chosen after which only a subset of SSUs is randomly selected from each sampled PSU.

Comparing alternative sampling designs for national forest monitoring: Finland as a case study

Tomppo and Katila (2008) compared the efficiencies of alternative sampling designs for national and regional forest monitoring in Finland from the perspective of both the standard errors of selected parameters and field measurement costs. The designs compared included 'dense' and sparse' variations of the FAO NFMA (with 'dense' and 'sparse' corresponding to different size sampling grids), a similar grid-based 'Eurogrid' design, and various cluster-wise designs (stratified and unstratified). Their results indicate that all designs performed similarly with respect to error estimates (although error estimates for total (m^3) and mean (m^3 ha^{-1}) growing stock were generally lowest for cluster designs), so the efficiency comparisons of the designs boiled down to sampling costs. When comparing costs, the cluster design, and in particular a stratified cluster design, was much cheaper, and thus more efficient, than the other grid-based designs (Figure A-4). The authors conclude that a design in which the density of the plots varies depending on the variation of the forests is the most efficient one, and the NFMA approach needs resources almost four times as much as the stratified cluster design. These results clearly favor cluster designs, particularly with stratification. It should be noted that these tests were carried out in Finnish forests, and the results could be somewhat different for a different vegetation zone such as tropical forests of Nigeria. However, it is reasonable to expect that somewhat similar conclusions would be obtained from other regions of the world.

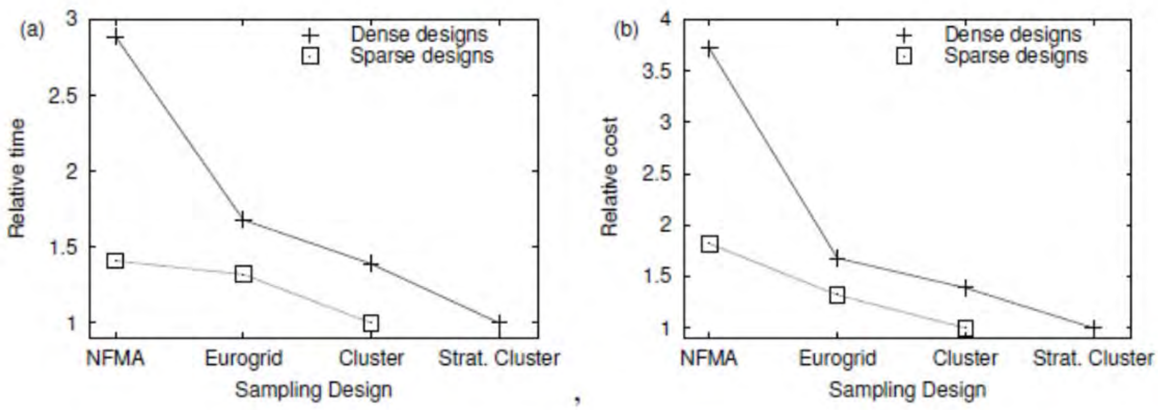


Figure A-4. The relative time consumption (a) and costs (b) to measure forests across Finland using different sampling designs. From Tomppo and Katila (2008)[37].

[37] Tomppo, E. and M. Katila. Comparing alternative sampling designs for national and regional forest monitoring. Appendix 4 in Tomppo, E. and K. Andersson, Technical review of FAO's approach and methods for national forest monitoring and assessment (NFMA), NFMA Working Paper No. 38, Rome, 2008.

10 Appendix D Land Use Classes and Forest Type Definitions

Below is an extract directly from the Lao National Forest Inventory Field Manual – 1993/94.

These forest definitions are still used as the standard definitions. However, the names of certain classes have changed:

Table 13 Land Use and Forest Class names in 1st NFI in comparison to current Land Cover Class names

1st NFI Land Use Class Name	Current Land Cover Class Name
Evergreen Forest (E) Dry Evergreen Forest (DE)	Evergreen Forest (EF)
Mixed Deciduous Forest (MD)	Mixed Deciduous Forest (MD)
Dry Dipterocarp Forest (DD)	Dry Dipterocarp Forest (DD)
Coniferous Forest (S)	Coniferous Forest (CF)
Mixed Broadleaved and Coniferous Forest (MS)	Mixed Broadleaved and Coniferous Forest (MCB)
Forest Plantation (P)	Forest Plantation (P)
Bamboo (B)	Bamboo (B)
Unstocked Areas (TL, TS)	Regenerating Vegetation (RV)
Ray (RA)	Upland Crop (UC)

APPENDIX 1 DEFINITION OF LAND USE CLASSES AND FOREST TYPES

Introduction

The definitions presented in this document originate from the classification system used in the Nation-wide Reconnaissance Survey of Laos which was performed by interpretation of aerial photos and satellite imagery. The system which was based upon FAO recommendations was worked out by Mr Jozsef Fidloczky in 1987.
Since the start of the National Forest Inventory the system has gradually been somewhat changed. The major modifications that have been made in comparison to the Reconnaissance Survey are as follows:

- Addition of the forest type Evergreen
- Integrating of the two forest types Lower and Upper Dry Evergreen into Dry Evergreen
- Integrating of the two forest types Lower and Upper Mixed Deciduous into Mixed Deciduous
- Excluding of the forest type Gallery Forest
- Dividing the land use class Unstocked into the classes Unstocked due to logging and unstocked due to shifting cultivation

Besides, some characteristics, such as species composition, and specification of the ratio between deciduous and evergreen species in various vegetation types have been added to the description of each vegetation type.

Another addition is that the land use classes have been put together into the following main land use groups:

1. Areas of Current Forest
2. Areas of Potential Forest
3. Other Wooded Areas
4. Areas of Permanent Agriculture
5. Areas with Other Land Use
6. Water

The main structure of the classification system is presented in the figure on next page. The different vegetation types and land use classes are further described on the following pages.

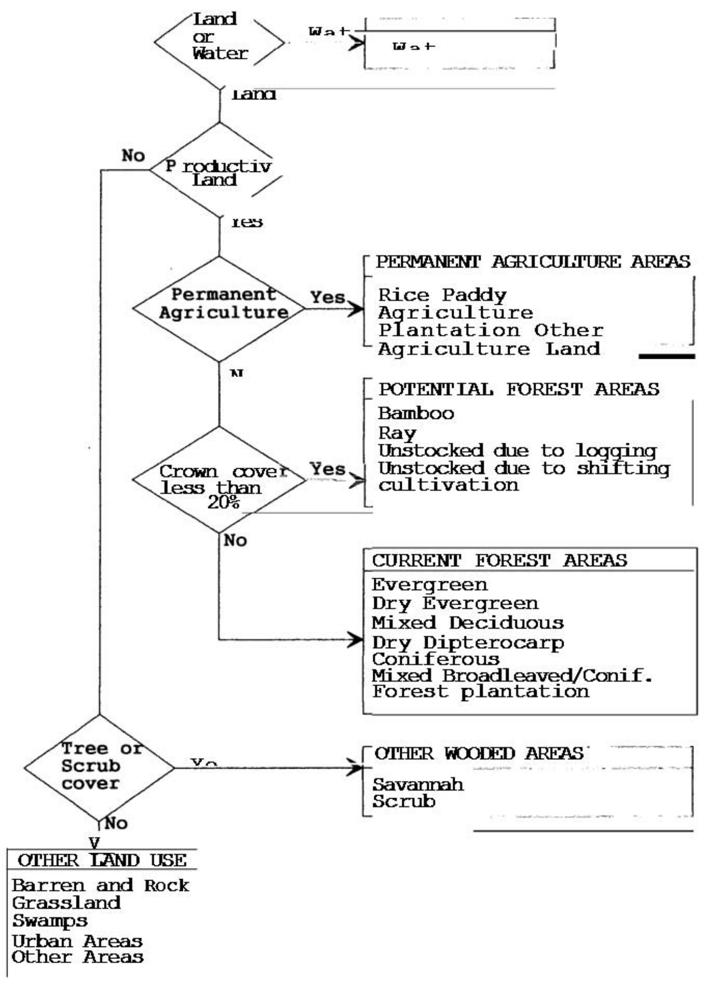
The detailed description of each vegetation type and land use class will be subject to continuous revisions and improvement.

<u>S^Pecification of land use classes and forest tviDes</u>

1 AREAS OF CURRENT FOREST

Areas of Current Forest are defined as areas being suitable for forest production and having a tree cover with a crown density of at least 20 %. Forest Plantations are excepted from the rule of a minimum crown density.

CLASSIFICATION OF LAND USE AND FOREST TYPES IN LAO PDR



11 Evergreen Forest (E)

The Evergreen Forest type is a multi storey forest consisting of more than 80% trees of evergreen species. Most of the trees have long and cylindrical boles, many of them with a big buttress. Usually, the height of the trees of the upper storey is more than 30 m. The dense second storey prevents most of the light from reaching the ground floor. Another typical characteristic of this forest type are climbers and lichen on the tree stems. Bamboo is usually not found except when the canopy has been opened.

12 Dry Evergreen Forest (DE)

The Dry Evergreen Forest type has a lower proportion of evergreen trees than the Evergreen type, 50% - 80%. Except for in disturbed stands there is very little bamboo. Soil is usually deep. The forest consists of a considerable number of species of which 2 to 3 species tend to be predominant.

Some characteristic species of this type are Mai Khen (Hopes spp), Mai Do (Pterocarpus pelatus), Mai Nhang (Dipterocarpus alatus) and Mai Bak (Anisoptera spp). The height of upper and second storey is usually less than in DE.

13 Mixed Deciduous Forest (MD)

In the Mixed Deciduous Forest type the deciduous tree species represent more than 50% of the stand. The forest storeys are not as dense as those of evergreen types and most of the seedlings and saplings are deciduous trees. Most often bamboo occurs in this type of forest.

In moist areas there might be a lot of climbers, and it could be difficult to distinguish this forest type from the Dry Evergreen type. In dry regions the difference can be clearly seen. There the type appears quite open with a considerable amount of bamboo and undergrowth.

14 Dry Dipterocarp Forest (DD)

The Dry Dipterocarp Forest occurs in open stands. The tree diameter is comparably small and the height of the stand varies from 8 to 25 m. The crowns do not spread out widely.

This type of forest is normally found in places with shallow soil, where the hard pan emerges above the ground, and on laterized soil. On the most poor and shallow soils the trees are crooked and do not exceed 10 m in height. If the crown cover is less than 20 % and the stand is undisturbed this vegetation type should be classified as Savannah.

Many species being characteristical for the Dry Dipterocarp forests are fire resistant and have a thick bark. Mai Sabeng (Dipterocarpus intricatus), Mai Chick (Shorea obtusa), Mai Sat (Dipterocarpus obtusifolius), Mai Suak (Terminalia tomen-tosa) and Mai Hang (Shorea siamensis) are such species.

15 Coniferous Forest (S)

The Coniferous Forest is usually single storied and open but the young growth may sometimes form a dense second storey. This forest type occurs in higher elevations with a cool climate. The characteristic species of this type are pines (Pinus kesiya or Pinus merkusii) but other coniferous trees such as i.e. Cunninghammia may also be predominant.

16 Mixed Broadleaved and Coniferous Forest (MS)

The Mixed Coniferous Forest is a transition type between the coniferous and the broadleaved forest types. The coniferous trees could be mixed with either deciduous or evergreen trees. It is also found in higher elevations.

17 Forest Plantation (P)

In Forest Plantations the planted trees could still be identified (i.e. by even height, even spacing or by species typical for plantations) although they may be mixed up with other non-cultivated plants. All sustainable plantations (including young ones with a crown density less than 20 %) should be classified as Forest Plantations.

Rubber plantations are also classified as Forest Plantations. Coffee, tea and shade providing trees for coffee and tea as well as fruit trees are not classified as Forest Plantations.

2 AREAS OF POTENTIAL FOREST

Areas of Potential Forest are defined as areas suitable for forest production having a crown density less than 20% and not permanently being used for other purposes (i.e. housing, agriculture etc.).

21 Bamboo (B)

If an area is covered with bamboo and the over storey has a crown cover less than 5% it should be classified as Bamboo.

Abandoned ray is often recovered by bamboo. Some species of bamboo may last for many years. Bamboo brakes may vary in height from 2 m to 25 m depending on their species. If the Bamboo represents less than 80% of the total vegetation cover of the under storey, the vegetation type should not be classified as Bamboo.

22, 23 Unstocked Areas (TL, TS)

Unstocked Areas are previously forested areas in which the crown density has been reduced to less than 20% because of logging or heavy disturbance. If the area is left to grow undisturbed it will become forest again.

Abandoned ray and old fallow lands are classified as Un-stocked Areas due to shifting cultivation (TS) and overlogged areas are classified as Unstocked Areas due to logging (TL).

Note that on land use maps these two classes also have a suffix giving information on the regeneration conditions.

24 Ray (RA)

Ray is an area where the forest has been cut and burnt for temporary cultivation of rice and other crops. The area should be classified as Ray from the time of clear-cut until one year after it has been abandoned. Areas being prepared for clear-cut but not yet clear-cut should be classified as Forest Area (if crown cover > 20 %) and areas that have been abandoned for more than 1 year should be classified as Unstocked Area (TS) (if crown cover < 20 %).

3 OTHER WOODED AREAS

Other Wooded Areas are defined as areas with a certain cover of trees or shrubs but being unsuitable (too poor) for forest production. The tree cover is less than 20% (if it would be more it should be considered as Current Forest).

31 Savannah (SH)

The Savannah is an area where the soil conditions are unsuitabie for tree growth as well as agriculture production. The tree cover in the Savannah should be at least 1% but less than 20%. The trees are drought resistant and mostly short with graminaceous and herbaceous plants forming an under storey.

Savannahs should not be mixed up with those grass covered areas that sometimes occur after shifting cultivation. Normally, the Savannah does not occur on steep slopes but in plain areas.

32 Heath, Stunted and Scrub Forest (SR)

This is an area covered with scrub and stunted trees. The soil is shallow and rocky. Inaccessible parts of lime stone formations with vegetation cover (also forest) should be classified as Scrub

4 AREAS OF PERMANENT AGRICULTURE

Areas of Permanent Agriculture include areas for production of crops, fruit trees etc. and areas permanently being used for grazing.

41 Rice Paddy (RP)

Areas permanently being used for rice cultivation. Old paddy that has been abandoned for more than one year should not be classified as Rice Paddy.

42 Agricultural Plantation (AP)

Areas of agricultural land being used for production of other crops than rice, i.e. various kinds of vegetables, for fruit tree cultivation etc. Plantations with cash crops, such as coffee, tea, cacao and cotton are also referred to this land use class.

43 Other Agricultural Land (OA)

Agricultural land being used for other agricultural purposes than agricultural crop cultivation, i.e. grazing of cattle, should be classified as Other Agricultural Land, unless the tree cover exceeds 20%. In that case it should be classified as some type of Current Forest depending on the tree species composition. Other Agricultural Land also includes Rice Paddy that has been abandoned for more than one year.

5 OTHER LAND USE

Areas with Other Land Use include land that for various reasons is non-productive from a forestry or agricultural viewpoint and also productive areas being used for other purposes than agriculture and forestry.

51 Barren Land and Rock (R)

Infertile or seriously degraded land on shallow soil and rocky areas on which neither trees nor grasses can grow. Inaccessible parts of lime stone formations with sparse or without vegetation cover should be classified as Rock. If the vegetation cover consists of trees with a crown cover exceeding 20 % it should be classified as forest area and the forest type should be decided upon.

52 Grass Land (G)

Infertile or degraded land on which no trees or shrubs grow. It might be an area that is too dry for tree growth that has been covered by grass. It could also be an area that has originally been covered by trees which has been heavily dis-turbed by cutting and fire and gradually depleted. One reason for the absence of trees could be that so big areas have been deforested that the seed supply from surrounding forest has ceased.

Areas being burnt over and over again (every year) for pro-duction of fodder, hunting purposes etc. could also be clas-sified as Grassland. That type of land could be found on higher elevations in the Northern part of Laos. Grassland could also occur on deep sand with a high moisture content.

53 Swamps (SW)

Swamps are areas where the soil is saturated with water. The soil may basically be fertile but the lack of oxygen limits its agriculture or forest-production capacity. The Swamp could have a high ecological or environmental value and the flora and fauna may be rich.

54 Urban Areas (U)

Urban Areas include all areas being used for permanent set-tlements such as villages, towns, public gardens etc. It also includes roads having a width of at least 5m and areas under electric high power lines. Any type of land under high power lines, except Rice Paddy, should be classified as Urban Areas.

55 Other Areas (0)

Any areas that cannot possibly be classified as any of the land use types 11-54 or 60 should be classified as Other Land. Examples of Other Areas could be cemeteries and some historical and cultural sites.

6 WATER

60 Water (W)

The land use class Water includes rivers, water reservoirs (i.e. ponds and dams for irrigation and hydro power) and lakes. Water reservoirs and lakes should have an area of 0.5 ha and rivers should be at least 10m wide to be classified as Water. In other cases it should be joined to adjacent land use class.

ラオス人民民主共和国
ラオス国持続可能な森林経営及びREDD+のための国家森林情報システム構築に係る能力向上プロジェクト
（第2年次）

業務完了報告書

添付資料12：パイロット調査報告書

Technical Summary Report

2015 National Forest Inventory Piloting NFIS Project, Lao PDR

FOREST CARBON

Report prepared for:	Kokusai Kogyo LTD/JICA – NFIS Project, Lao PDR
Date	20th July, 2015
Version:	3.0
About Forest Carbon:	Forest Carbon is a Southeast Asian-based firm that addresses the need for a regionally focused team capable of providing technical services for carbon forestry projects in tropical rainforest countries. Our team of experts works one-on-one with governments, non-profits and private sector clients across Asia, Africa and South America on the development of field-level projects and jurisdictional programs for reducing emissions from deforestation and degradation including reforestation, conservation and sustainable management of forests (REDD+). This work was undertaken in collaboration with members of Winrock International and Kokusai Kogyo Ltd.

1 TABLE OF CONTENTS

2 BACKGROUND

2.1 SUMMARY

Lao-Japanese National Forest Information System (NFIS) Project, supported by JICA, is a multi-year project being implemented in Lao PDR by Kokusai Kogyo Co., LTD(KKC) and Asia Air Survey Co., LTD. The NFIS Project supports a wide range of different activities in forest information management for Lao PDR, including the establishment of the procedures and piloting of the next (2nd) National Forest Inventory (NFI) of Lao PDR. The implementing team, KKC, has acquired the support of Forest Carbon Partners and Winrock International who have previously collaborated on subnational forest inventories in Lao PDR.

Under the NFIS project, KKC and partners have worked with the national counterpart to develop a Standard Operating Procedure (SOP) and Manual for the 2nd National Forest Inventory. Ahead of the full-scale implementation, KKC and partners have undertaken a piloting process to test major processes, equipment and the suitability of the SOP and overall Survey design for learning and final revisions of the SOP ahead of full-scale implementation. The draft version of the SOPs[1] and survey design were piloted in Khammouane Province in March 2015 with the following issues under study:

1. **SOP:** Test the usability of the proposed NFI SOP
    - Test suitability of the plot design in 3 unique but representative forest strata:
        - Dry Dipterocarp
        - Mixed Deciduous Forest
        - Evergreen Forest
    - Where sufficient plots numbers were possible to acquire, determine biomass stock densities and standard deviations of each forest strata.
    - Determine necessary points for technical improvements and efficiency in data collection
    - Determine estimate number of plots per day
2. **Inventory Design:** Test GIS-based plot placement assumptions of the inventory design
3. **Recommendations:** Provide recommendations on the pilot SOP design

This SOP manual builds off of the methods field tested by Winrock International for over 20 years and recently adapted for the Houaphan Province forest inventories under the Lao-German Climate Protection through Avoided Deforestation (CliPAD)[2] project and was proposed for consideration as the default SOP for the National Forest Inventory.

The piloting schedule corresponded to the following major benchmarks:

- **January-March 2015:** SOP and Inventory Design
- **March 9ht-13th:** SOP and Inventory Design Training, Vientiane
- **March 19th-April 7th:** Pilot Inventory
- **May 1st-May 10th**: Data Analysis

This report summarizes the data and results of the design and piloting phase of the NFI and proposes recommendations for changes and modifications ahead of the full NFI.

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[1] Walker, SM, TRH Pearson, FM Casarim, N Harris, S Petrova, A Grais, E Swails, M Netzer, KM Goslee and S Brown. 2015. Lao PDR - Draft NFI Standard Operating Procedures for Terrestrial Carbon Measurement. Prepared on the behalf of Lao PDR by Winrock International.

[2] Casarim, Proposed National Forest Carbon Assessment Standard Operating Procedures (SOPs) , LAO PDR, Ministry of Natural Resources and Environment (MoNRE), and Ministry of Agriculture and Forestry (MAF), **Submitted by:** Felipe Casarim, Gabriel Eickhoff and Timothy PearsonNeed citation

2.2 NOTES ON PILOT INVENTORY

2.2.1 TABLET EQUIPMENT

In addition to testing the SOP, the inventory tested the use of tablet technology to collect data. The tablets (Samsung Galaxy Note 8.0) are used both for data collection and navigation purposes. Data was collected using Open Data Kit (ODK) synchronized with a secure on-line data aggregation service (www.ona.io). For navigation purposes, tablets were also equipped OruxMaps, which makes use of satellite imagery of the province (2015 Landsat 8, 2012/2013 RapidEye) and a variety of GIS data layers to make inventory points, backup points, roads, rivers, villages and other access points easily visible to the teams while in the field.

2.2.2 LAND COVER BASE MAP

The inventory used a 2013 Rapid-eye landcover classification map based on cloud-free imagery taken during the dry season from February 2012 to January 2013. The map was generated by Forest Carbon Partners in 2013 while under contract and was openly distributed to the NFIS project, including the satellite imagery, by GIZ (CliPAD).

The land cover map was used as the basis determining which strata would be sampled, determining the total area of each strata for use in calculating the how many plots would be required and for determining the spatial distribution of the plot locations based on the inventory design rule set.

2.2.3 TEAMS

A total of 3 local teams participated in the NFI Pilot activity in Khammouane Province. Each team comprised between 2-3 staff from national level (FIPD), 1-2 staff from the provincial government (PAFO) and 1-2 staff from each district government (DAFO) where inventory plots were established. Given the remoteness of the inventory, every plot also required the consultation, approval and participation of one or two representative from the village where the plot was located. Often village participants were the Neiban (village head), village forest rangers or a member of the village militia.

Roles within each team were broken down as follows:

- **Role 1 - Team Leader**: Oversaw correct execution of other roles in the team and responsible for data entry and tablet operation. This role is also the main focal point of the team for discussions with village heads and with district staff.
- **Role 2 - Tree DBH Measurement:** One person who setup and operated the DME device, measured distances of trees from plot centers and took DBH measurements.
- **Role 3 - Lying Deadwood Transect and Clip Plots**: One to two persons were responsible for laying out the lying dead wood transects and taking LDW measurements where necessary. This person was also responsible for placing the clip plots and collecting non-tree vegetation and litter samples.
- **Role 4** – Village head/district staff, were often in charge of helping to navigate the team to the plot location.

2.2.4 ANALYSIS

Tables are provided in the "Tables" section. Below is a description of the biomass by strata (Dry Dipterocarp, Mixed Deciduous Forest and Evergreen Forest) as well as each carbon pool within each strata. Mean values are expressed in terms of tons of solid forest carbon stock per hectare (tC/ha). Statistical value is interpreted through the use of both a 90% and 95% Confidence Interval (CI) and an uncertainty threshold of 15%.

Living Tree biomass was calculated using Chave et al 2005[3] and Chave et al 2014[4]. For Chave et al 2005, the following equation for moist forest stands was used for all strata:

$$< AGB >_{est} = \rho \times \exp(-1.499 + 2.148\ln(D) + 0.207(\ln(D))^2 - 0.0281(\ln(D))^3)$$

Where:

ρ = a default wood density of 0.6 (g/cm^3)

D = measured diameter at breast height of the tree (cm)

For Chave 2015, the following equation was used for forest strata:

$$< AGB >_{est} = \exp[-1.803 - 0.976\,E + 0.976\ln(\rho) + 2.673\ln(D) - 0.0299\,[\quad]^2]$$

Where:

E = A measure of environmental stress factor from the Chave et al 2015 dataset, and determined as the average value of of *E* across each stratum.

Dry Dipterocarp, *E* = 0.2822

Mixed Deciduous Forest, *E* = 0.268

Evergreen Forest, *E* = 0.2357

Scrub/Shrub, *E = 0.2587*

ρ = a default wood density of 0.57 (g/cm^3)

D = measured diameter at breast height of the tree (cm)

All other biomass pools are considered identically consistent. Under Chave et al 2014, equations are considered through the use of an "environmental stress variable" (*E*). *E* was generated for each forest strata by "clipping" the extent of each strata to an "environmental stress" GIS raster file provided by Chave et al 2014, and taking the average *E* value across the extent of the strata. In total, 3 separate *E* values were derived and used for allometrically-derived biomass calculations.

2.3 PLOT LOCATIONS

Plots were placed using GIS software and the 2013 Rapid-Eye satellite land cover classification of Khammouane Province in central Laos. The survey design considered lessons learned from the CliPAD piloting experience in Houaphan Province about plot placement.

Plots were placed based on the following criteria:

1. **Strata**: All sub plots must fall within the strata of interest,
2. **Forest/Non-Forest**: Only forest strata were sampled, non-forest classes were excluded,
3. **Primary Plots Distances:**
    a. Roads:
        i. Maximum 5 km
        ii. Minimum 250 m

[3] Chave J, Andalo C, Brown S et al. (2005) Tree allometry and improved estimation of carbon stocks and balance in tropical forests. Oecologia, 145, 87–99.

[4] Chave J, Réjou-Méchain M, Búrquez A et al. (2014) Improved allometric models to estimate the aboveground biomass of tropical trees. Global Change Biology (2015), 20, 3177-3190.

   b. Greater than 250m from villages
   c. Greater than 250m from rivers
4. **Backup Plots**
   a. Placed within 3 km radius of the Primary Plot location, and
   b. Roads:
      i. Maximum 2.5 km
      ii. Minimum 250 m
   c. Greater than 250m from villages
   d. Greater than 250m from rivers
5. **Slope**: Excludes slopes of ≥35 degrees
6. **Minimum Mapping Unit:** Minimum continuous forest size: 0.5 ha
7. **Other**: No exclusion buffers were applied to the edges forest strata to account for assumed levels of degradation closer to a non-forest area.

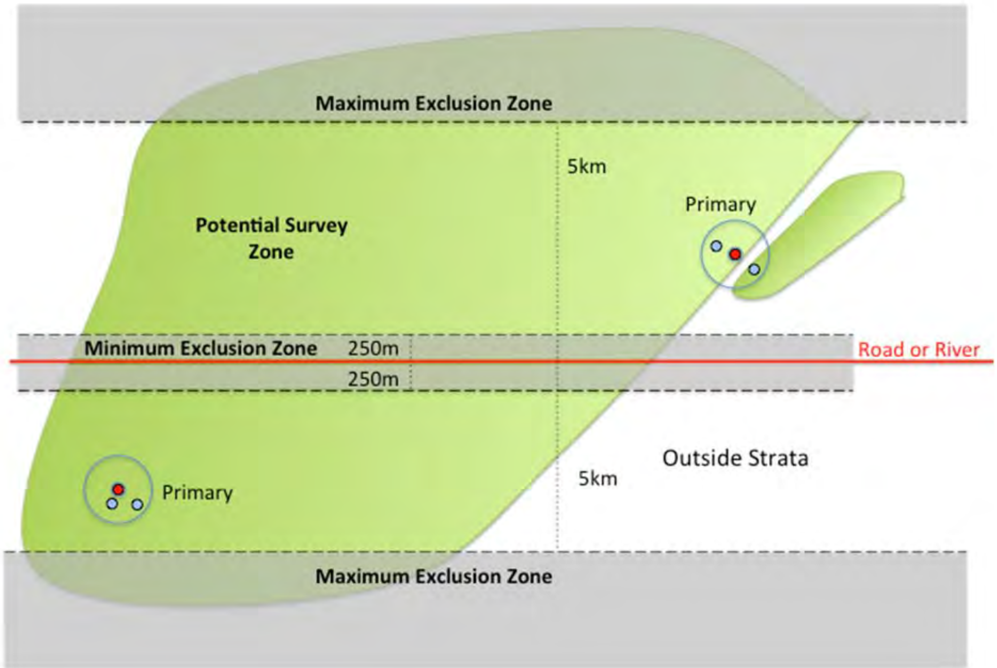

Figure 1: Schematic showing location rules for distance from roads of primary plots.

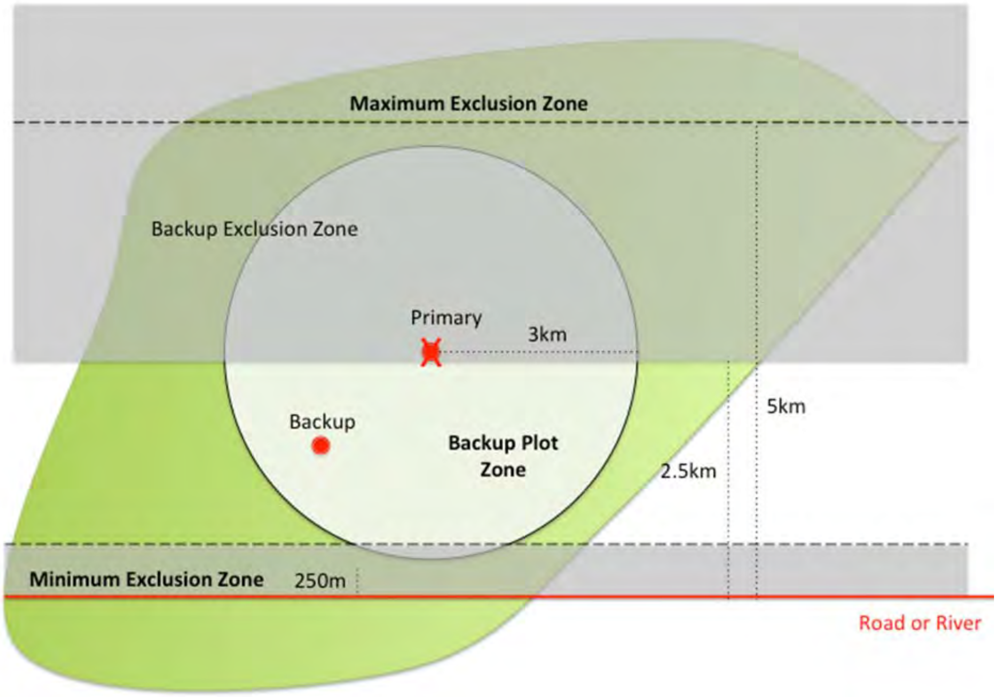

Figure 2: Schematic showing location rules for distance from roads of backup plots.

2.4 DISTRIBUTION OF SAMPLING LOCATIONS BY MANAGEMENT TYPE

Before departure, a total of 85-target cluster plots were randomly placed based on the Strata categories in Table 1. エラー! 参照元が見つかりません。. Based on the criteria discussed above, these locations were distributed across the Province based on land cover class and management type. Given that a limited number of plots were available and that primary purpose of the inventory was to test the plot design in a variety of locations, it was decided to distribute plots evenly across strata rather than scale them based on the proportion of the total area. Scaling by proportion should take place as part of the larger NFI process.

Table 1: Distribution of plots per strata: land cover class and management type combined together.

Strata	Land Cover Class	Land Management Class	Area (ha)	Plots Needed	Proportion	Plots Available
1a	DD	PFA	19,002	515	12%	10
1b	DD	Other (Non-Zoned and NPA)	29,521	515	12%	10
2a	MDF	NPA	123,615	545	12%	10
2b	MDF	PFA	115,625	545	12%	10
2c	MDF	Other (Non-Zoned and PPF)	191,445	545	12%	10
3a	EF	NPA	279,749	587	13%	11
3b	EF	PPF	32,483	587	13%	11
3c	EF	Other (Non-Zoned and PFA)	33,312	587	13%	11
Total				**4426**		**85**
Plots Avail				**85**		

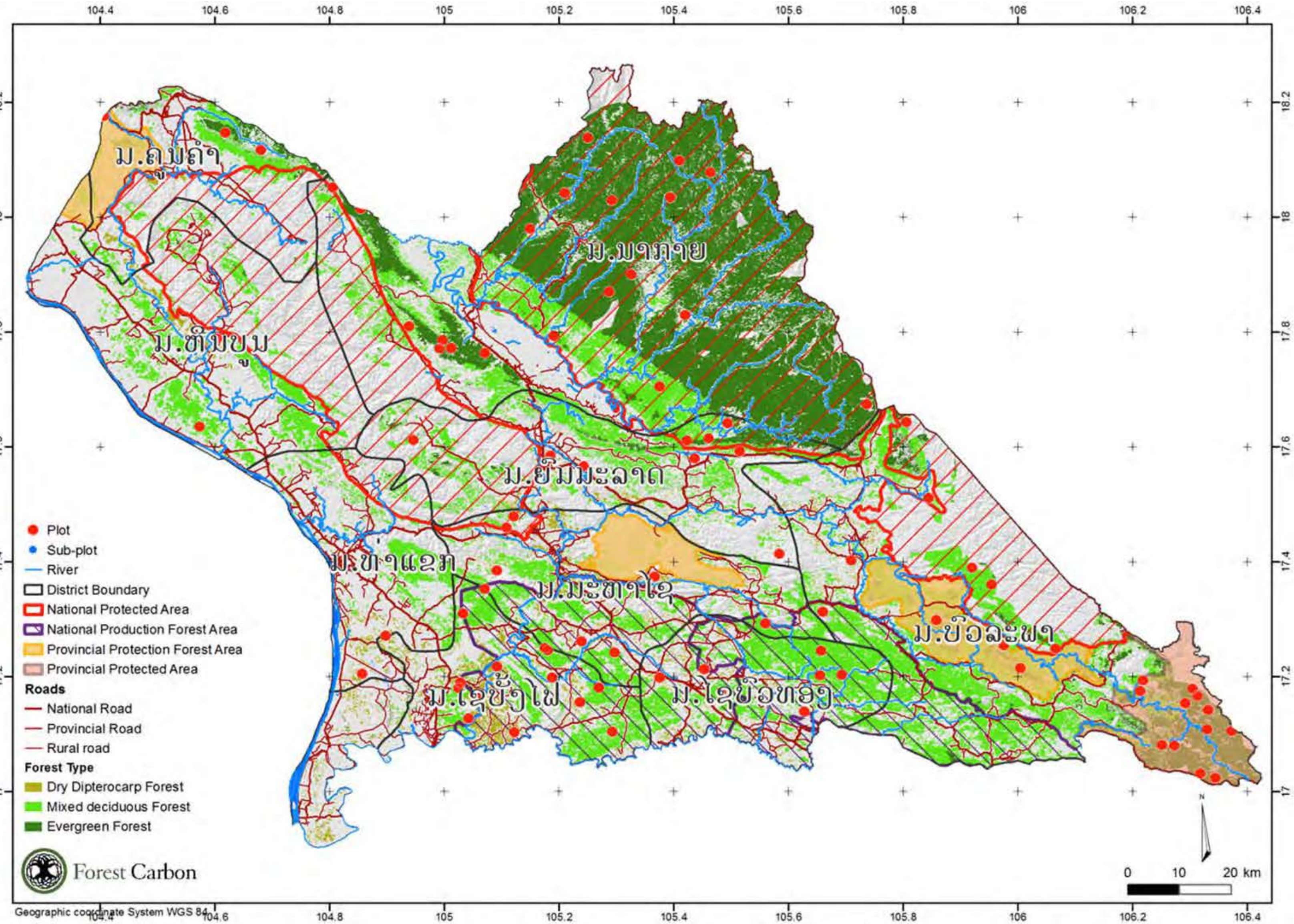

Figure 3: Survey Design: distribution of targeted primary plots across Khammouane Province.

2.5 SAMPLE PLOT DESIGN – SUB SAMPLE UNIT (SSU)

2.5.1 CLUSTERED PLOTS

It was determined that for trees, palms, and bamboo sampling would take place using nested cluster-plots. In this sampling layout a set of tree-plots are laid out around an 'anchor point'. Many options exist for the layout of these tree-plots. For more information see Winrock International's SOP Manual[5]. Two of the example sampling point layouts included within the WI SOP Manual were evaluated for use in the piloting inventory: a 4-sub plot "L-Shaped" cluster plot and a "Floating" plot. The L-Shaped cluster plot comprised 3-4 sub plots, each containing 4 nested tree plots within them. The L-Shaped design anchors the "corner" of a cluster plot in the strata of interest with fixed 100m straight distances West and North to the next subplot. This sampling design contains 'standard rules' that are implemented consistently, thus reducing subjectivity in the field. This design is appropriate for land cover types covering large contiguous areas. However, for areas where land cover types are highly fragmented, this approach may lead to different subplots landing in different land cover types, see Figure 4 for an illustrative example.

GIS and Remote Sensing teams experimented the placement of the L-Shape design in a number of landscapes as well reducing the number of sub plots to 3, rather than 4 to make it easier to place, but found similar difficulties in many locations. These findings echoed similar difficulties faced by the CliPAD Project in Houaphan Province, which has an intensely fragmented forest landscape.

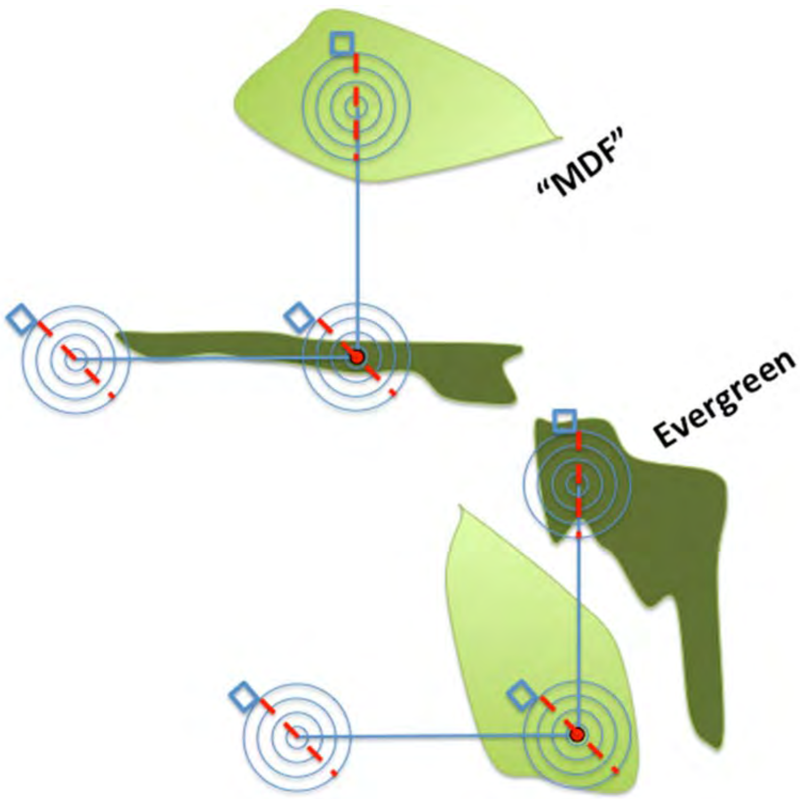

Figure 4: Challenges of the L-Shaped Plot Design in the highly fragmented forest class landscape of Lao PDR. The L-Shape Plot Design often could not avoid placing sub plots outside of the target strata, making it difficult or impossible to survey certain locations.

[5] Walker, SM, TRH Pearson, FM Casarim, N Harris, S Petrova, A Grais, E Swails, M Netzer, KM Goslee and S Brown. 2014. Standard Operating Procedures for Terrestrial Carbon Measurement: Version August 2014. Winrock International.

Based on piloting by CliPAD in Houaphan and additional analysis by the NFIS project, it was decided to consider a slightly modified version of the final "floating" design from the CliPAD project, taking into considerations lessons learned about the initial design piloted in Houaphan. The draft plot design tested during the piloting can be seen in Figure 5 and Figure 7 below. Each plot is comprised of a cluster of three identical sub plots. Sub-plot A is placed first using GIS software, while the centroid of sub plots B and C are randomly placed within a 300 m radius from the center of sub-plot A, and no closer than 50m from sub plot A, to avoid overlap in sampling. Each sub plot is comprised of i) a series of 4 nests (see Figure 5) for measuring living trees, bamboo, standing dead trees and stumps, ii) a 0.5m x 0.5m clip plot for measuring non-tree vegetation and litter, and iii) a 40m transect for measuring lying dead wood.

This design greatly reduced the number of erroneous sub-plot placements by forcing sub plots to be randomly placed with a strata of choice at a fixed distance (see Figure 8).

More information on the details of the plot design is available in the NFI Guidance Document.

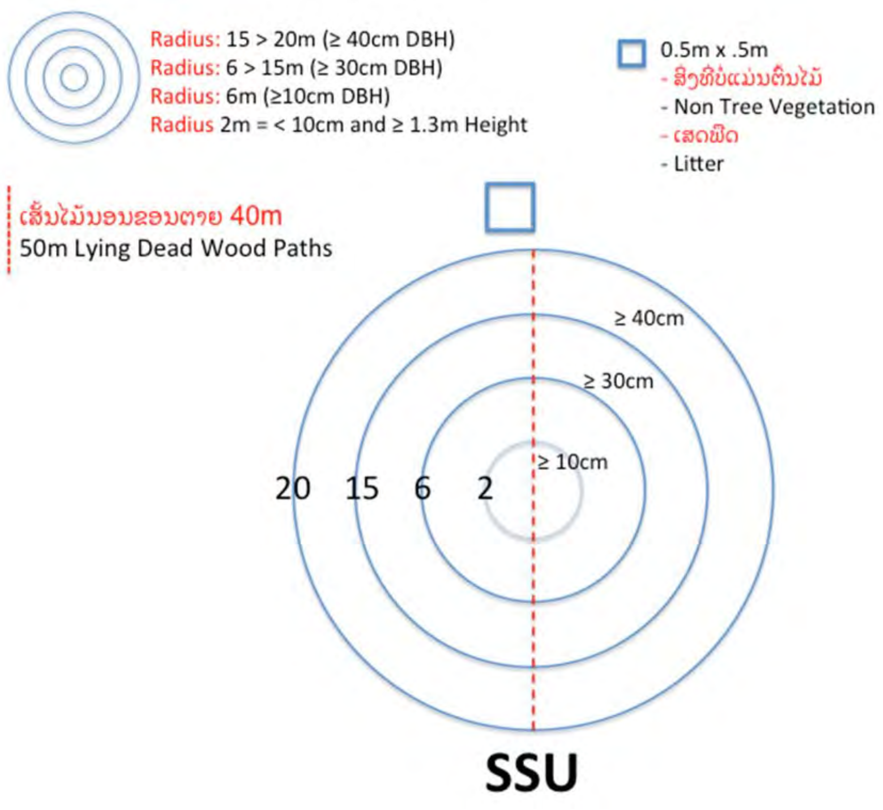

Figure 5: Example of a single cluster sub-plot.

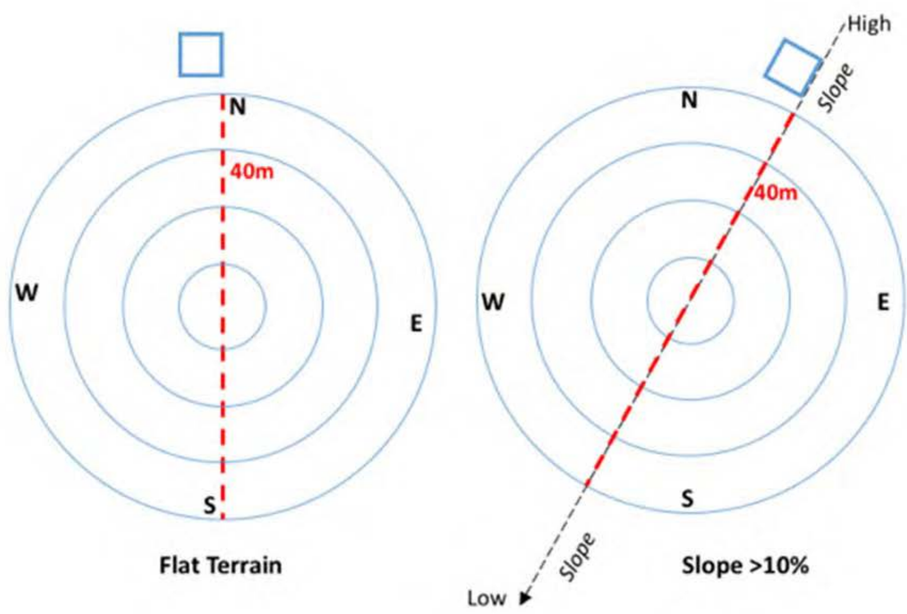

Figure 6: Example of adjustments for slope. Subplots found on sloping areas were rotated to follow the slope/contour of the terrain.

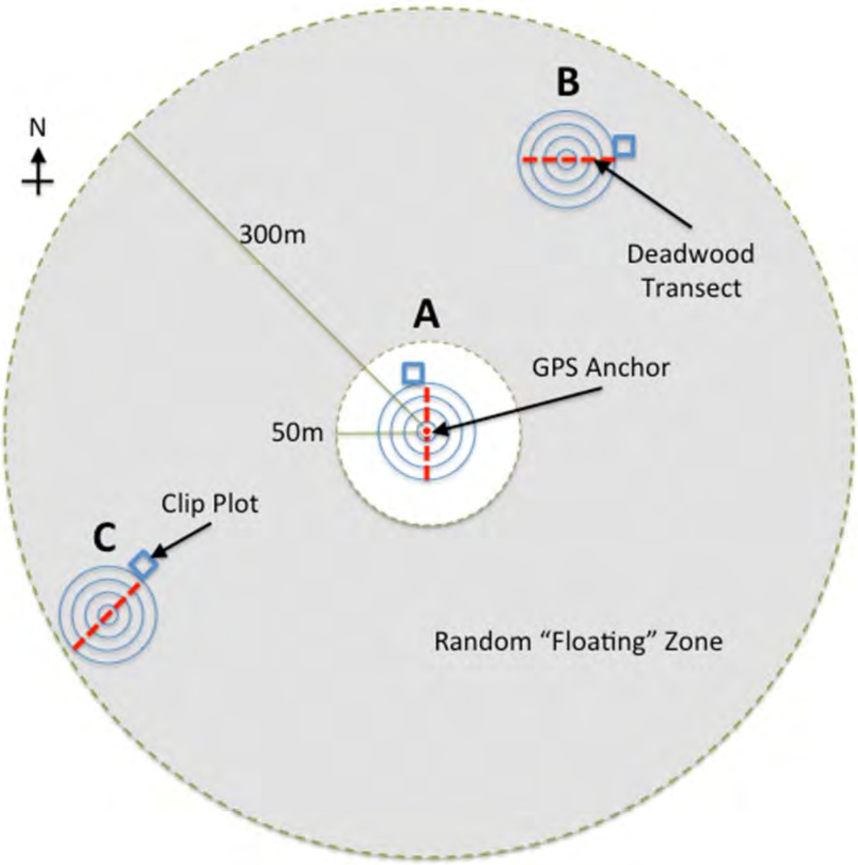

Figure 7: Example of a single cluster plot, comprised of three sub-plots.

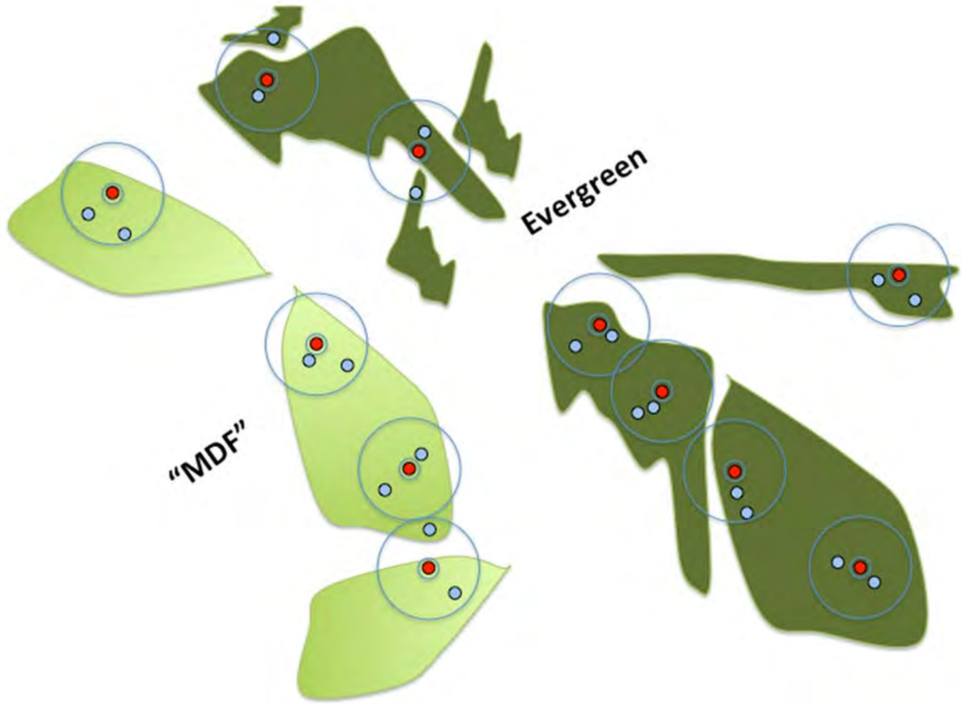

Figure 8: "Floating" Plot design, allowed for a flexible placement of plots within a 300m radius from the initial sub-plot anchor. Sub plots were constrained to only the strata of interest, based on a 5m resolution (RapidEye-based) classification.

2.6 CARBON POOLS SAMPLED

The biomass pools measured during the pilot NFI included all those anticipated pools to be measured under the full NFI. Namely, these included:

1. Aboveground Living Tree Biomass
2. Sapling Trees
3. Deadwood
    a. Standing
    b. Lying
    c. Stumps
4. Non-Tree Living Vegetation
5. Non-tree Litter

2.6.1 LIVING TREE POOL

For all stratum, four nested plots were included. The radius and tree size classes are described in Figure 5.

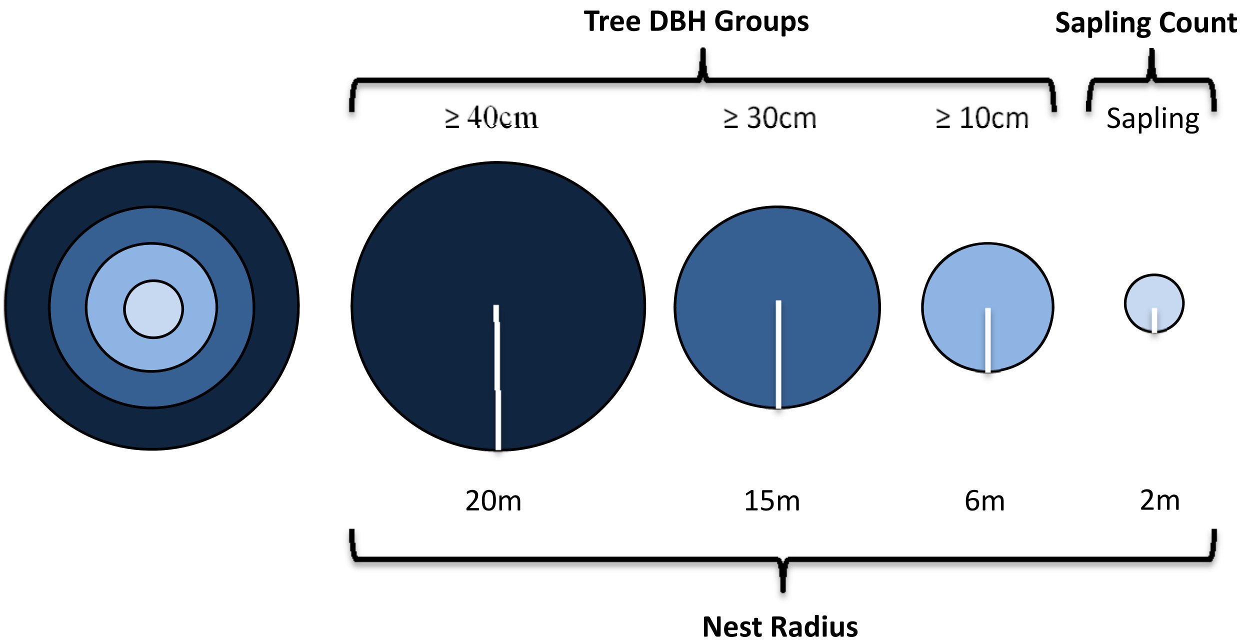

Figure 9: Tree-plot nest layout for all stratum

2.6.2 DEAD WOOD POOLS

Dead wood was measured in three categories: standing dead wood, lying dead wood and tree stumps. Standing dead wood was broken into classes. Class 1 standing dead trees included tress which have recently died and maintain a large percentage of the fine canopy branches. Class 2 trees are those which have lost many of the smaller branches and have been dead for multiple years.

Class 1

Figure 10: Standing dead wood classifications.

As per the SOP, Class 1 trees were measured using the same methods as living trees. Class 2 stand dead wood were either measured as standing boles and measured using a clinometer from top of the bole to the base along with DBH or were measured for vertical height if under 2m tall. “Stumps” were measured as the average of two diameter measurements (largest and shortest) across the center of the stump, along with stump height. All stumps were individually measured and GPS tagged as per the SOP.

Lying dead wood was measured as any fallen tree or wood item >10cm diameter intersecting a 40m transect across the center of each each sub plot (SSU). See Figure 5 for diagrams.

Where plots were placed on sloping areas, the length of the lying dead wood transect was adjusted to follow the direction of the slope and adjusted for length in the field.

2.6.3 NON-TREE VEGETATION (NTV) AND LITTER POOLS

NTV and Litter were measured according to the SOP in 0.5m x 0.5m “clip plots” outside the largest nest of the living tree plot. NTV plots included all living, green, non-tree biomass falling within the clip plot as well as any non-tree vegetation hanging or existing vertically above the clip plot. Litter pools were measured similarly, but included non-living fallen forest foliage and sticks.

Clip plots were always placed at either the north end of the lying dead wood transect, 5m from the edge of the living tree nest (25m from the center of the plot) and immediately to the left. As with the lying dead wood transect, where sub plots (SSU)s fell on sloping areas, the location of the clip plot was shifted to always be placed on the up-slope end of the lying dead wood transect. See Figure 5 for diagrams.

3 INVENTORY RESULTS

3.1 RESOURCES AND COST

3.1.1 STRATA CARBON STOCK DENSITIES

A detailed breakdown of strata-specific carbon stocks is provided in Annex 4.1 at the end of the report. By comparison with a nearly identical sampling design[6] and field SOPs the dataset collected in Houaphan Province[7], mixed deciduous forest carbon stock densities were within a similar range: **92 tC/ha** in Houaphan as compared to approximately **108.51-169.24 tC/ha**[8] in Khammouane Province (Table 2) collected during this study.

While Dry Dipterocarp and Mixed Deciduous Forest strata were technically sampled within an acceptable range of uncertainty (<20%), additional Dry Dipterocarp plots would have been ideal, until a sample size of at least 30. Due to time and access constraints, the Evergreen Forest class had only a sample size of 2, insufficient to derive a statistically meaningful sample. However, it is felt by the authors that the indicative stock density is feasible and indicative for Evergreen Forests in Laos.

Table 2: Comparison of forest strata carbon stocks using comparable methods. Biomass equation used indicated in parentheses and as described in Section 2.2.4.

Dataset	Forest Strata	Stock Density (tC/ha)
Houaphan – 2014 CliPAD (Chave et al. 2005)	***Mixed Deciduous Forest***	***92.06***
	Scrub/Shrub Vegetation	12.18
Khammouane 2015 – NFIS (Chave et al. 2005)	Dry Dipterocarp Forest	62.69
	Mixed Deciduous Forest	***169.24***
	Evergreen Forest	252.01
	Scrub Vegetation	28.70
Khammouane 2015 – NFIS (Chave et al. 2014)	Dry Dipterocarp Forest	41.19
	Mixed Deciduous Forest	***108.51***
	Evergreen Forest	166.26
	Scrub Vegetation	20.13

Uncertainty associated with all classes almost certainly has to do with low sample size. Additional error may have been associated with:

- inconsistent ground-level land cover interpretation by FIPD field teams
- inconsistent or incorrect field measurement techniques,
- classes having a highly variant biomass densities in the real world, and/or

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[6] The only major difference between the Houaphan and Khammouane sampling designs is the size of the total floating area of the 3 sub plots. The CliPAD project used a total floating zone as a circle with a radius of 500m, whereas the Khammouane inventory used a radius of 300m, to make plots more easily accessible between each other.

[7] Eickhoff, GA., 2015. Technical Summary, 2014 CliPAD Houaphan Biomass Inventory. Prepared on behalf of the Climate Protection through Avoided Deforestation Financial Cooperation Module.

[8] Range based on the use of different allometric equations used. Chave 2005 versus Chave 2014.

- differences in land use management across ecologically defined strata.

The last point mentioned above, regarding land use management, can be particularly significant. Even though ecological classes may be consistent across a district or a province, forest areas of the same ecological type and age my have statistically different carbon stocks if they fall within production forest (PFA) versus conservation areas (NPAs). As such, these management zones should be considered as different strata and taken into consideration as part of the overall survey design in order to reduce uncertainty.

3.1.2 CARBON POOLS WITHIN STRATA

Within each stratum, individual carbon pools are broken down in Annex 4.2. In the case of all forest classes, living tree biomass represents over 90% of total carbon stock of each strata. Even in the Scrub class, it is still representative of >71%. This breakdown is also consistent with the results from the field study in Mixed Deciduous forest in Houaphan Province. This indicates that for *forest classes* dead wood and bamboo could be considered (at least within in these samples) to be less than 5% of the total carbon contribution of the strata and thus either *de minimus* and non-significant[9].

3.1.3 TIME COST ASSOCIATED WITH FIELD DATA COLLECTION

In discussions with team leaders and through first-hand observation in both Houaphan and Khammouane Provinces, total cost of time per cluster plot varied based on strata type (Table 3). In most cases, one cluster plot (a collection of three sub plots) can be completed within one day using the piloted plot design. However, the 300m radius used by NFIS allowed for more time availability by reducing overall travel time and although both plot radius designs (500m and 300m) allowed (in general) for surveys to be completed within one day, the NFIS design allowed for more working time, further ensuring that plots can be completed within one day.

Situations where more than one day was necessary to complete a cluster tended to be due to a cost/distance factor related to a combination of degradation level, presence of bamboo, and slope. Degraded and low density forests, specifically MD and EG forests contain a great deal of undergrowth, substantially increasing travel time. Bamboo exacerbated this since it creates an even larger barrier than thick undergrowth. Although slope was factored in for the purposes of exclusion, based on the survey design rule set, distances were fixed and didn't take into consideration the time cost of slope.

Aside from bio-geophysical factors, coordination with villages and district government was also noted as playing a significant role in reducing efficiency and causing time delays. Teams were often unable to complete plots because up to half a day can be taken up just by locating the village authority responsible for the land and forest of the plot location, and then navigating to the location.

Table 3: Average time taken to complete single sub-plot by forest class during the NFI piloting in Khammouane.

Forest Types	Sub Plot Sample Size	Mean time per subplot (minutes)	StdDev	Standard Error	Confidence Interval
Dry Dipterocarp	35	**16.04**	9.92	1.68	3.41
Mixed Deciduous Forest	98	**23.23**	11.37	1.15	2.28
Evergreen Forest	3	**17.78**	2.76	1.60	6.86
Scrub	4	**15.39**	8.83	4.42	14.05

[9] GOFC-GOLD standard establishes non-signficant as any carbon pools contributing <20% of emissions, whereas the VCS AFOLU Requirements define this as any pools < 5%.

3.1.4 TIME ASSOCIATED WITH SPECIFIC FIELD MEASUREMENTS

Time associated with specific measurements could not be reliably assessed during the piloting. Tablet data only records the start and stop time of data collection. Based on observations, lying dead wood and NTV/Litter clip plots were started and finished within the time it took the teams to finish collecting living tree (DBH) data. Thus, lying deadwood, NTV and litter measurements added little or no additional time to the overall plot installation in situations where specific individual team members were assigned to these roles concurrent to the DBH measurements. However, without these team members, additional time would be needed to complete the measurement of these pools. While specific times for NTV, litter and lying dead wood were not measured, field observations by the author estimate the total time for measuring these pools at around 15 minutes. Leaving these pools to be measured by the tree measurement staff would would thus approximately double the total time of each plot based on the total time taken for each plot as seen in Table 3, assuming that the tree measurements were the determining time factor.

3.2 SURVEY DESIGN

3.2.1 PLOT LOCATIONS

Figure 11 shows a map of the pilot plot locations installed across Khammouane Province. Plot locations in the Evergreen Forest of Nakai National Protected Area are noticeably missing due to constraints caused by time, access and a lack of national coordination with MoNRE.

Table 4: Comparison of target number of plots installed in each strata versus actual strata sampled.

Strata	Land Cover Class	Land Management Class	Target # of Plots	Plots Installed (map land cover)	Plots Installed (observed land cover)
1a	**DD**	PFA	10	7	5
1b	**DD**	Other (Non-Zoned and NPA)	10	7	8
2a	**MDF**	NPA	11	6	6
2b	**MDF**	PFA	11	11	13
2c	**MDF**	Other (Non-Zoned and PPF)	11	12	14
3a	**EF**	NPA	11	0	0
3b	**EF**	PPF	11	2	0
3c	**EF**	Other (Non-Zoned and PFA)	11	5	2
4a	***SC***	*PFA*			*1*
4b	***SC***	*Other (Non-Zoned)*			*1*
Total			**86**	**50**	**50**

Table 4 above illustrates a comparison of the number of plots originally planned for installation in each strata as compared to the number actually installed in each strata. Differences in observed land cover as classified by FIPD staff on the ground compared to the originally mapped land cover can be seen in the last two columns. A shortage of sampling in the EF and DD classes were indicative of time constraints and institutional delays, not inadequacy of the sampling design. Strata SC was not intended to be sampled during piloting but was observed on the ground, contrasting with a mapped strata class, thus strata 4a and 4b were added for the purpose of Table 4 only.

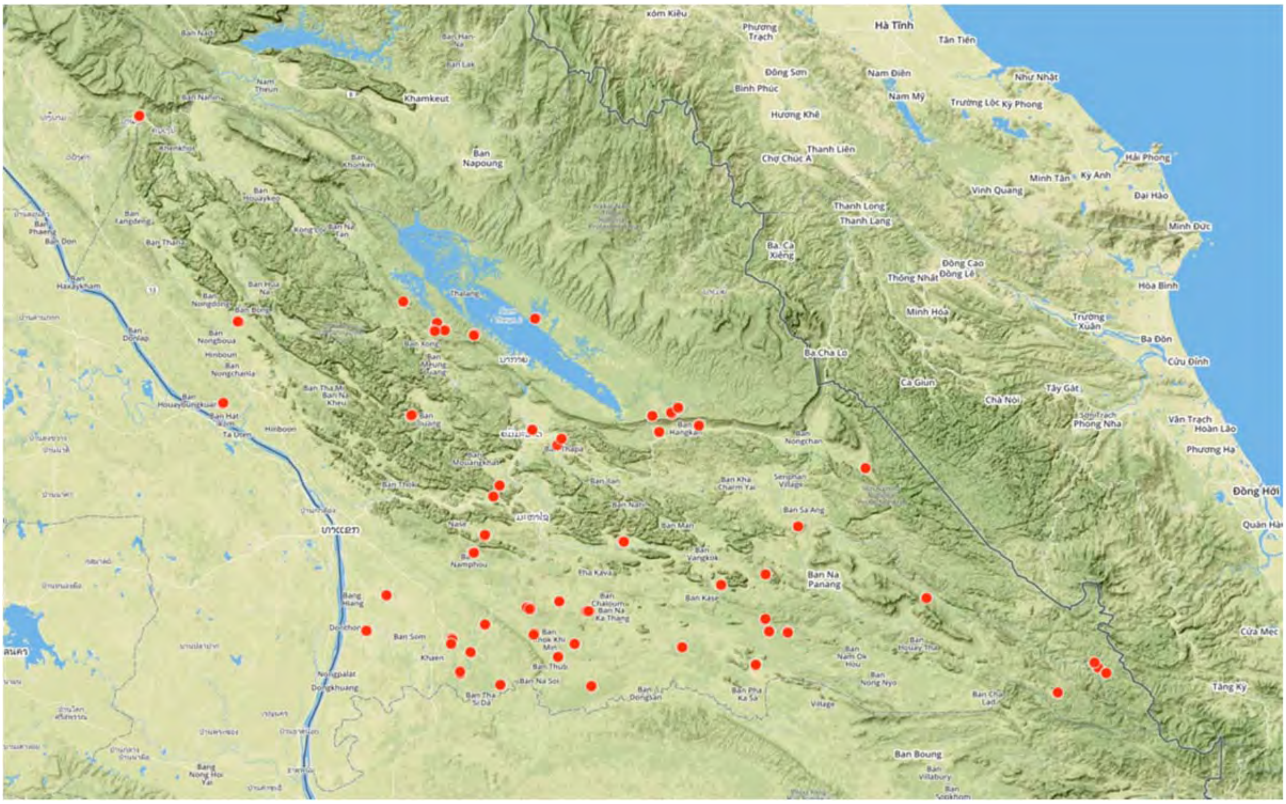


Figure 11: Pilot plot locations across Khammouane Province.

3.3 PROCEDURE

3.3.1 MAXIMUM/MINIMUM TRAVEL DISTANCE BY FOOT

The maximum/minimum travel distances discussed in Section エラー! 参照元が見つかりません。 were found to be suitable. Although he maximum exclusion zone is any distance beyond 5km from any major road, field teams were almost always able to find smaller access roads leading to villages, from which village participants would then orient the teams to walking trails.

3.3.2 RECOMMENDATIONS ON FIELD-LEVEL OR POST-FIELD PROCESS OF SLOPE ADJUSTMENT

Slope corrections to living tree measurement nest radii were done in the field. Observations by trainers and consultations with field teams indicated that this would not be a problem.

3.3.3 APPLICABILITY AND USE OF TABLET-BASED DATA COLLECTION SYSTEM FOR FULL-SCALE NFI

Field teams were provided with Samsung Galaxy Note 8 tablets for data collection and navigation. These tablets had been previously used for the province-wide inventories undertaken in Houaphan Province under the CliPAD project. The tablets used two primary apps for these purposes, ODK Collect for data collection and OruxMaps for navigation.

Data entry forms were created in Lao language using Microsoft Excel. Forms reflected the data acquisition needs and stepwise process of the Standard Operating Procedure, enabling each team to individually collect and record data, following the form as a guide. Upon completion of each subplot, data was automatically sent from the tablet device to a secure web platform (www.ona.io) where it was aggregated, safely stored and monitored by team managers and trainers in Vientiane (Figure 11 above).

The use of OruxMaps enabled field teams to view pre-loaded high resolution satellite imagery, GIS shape files, village locations, road access, and a many other GIS layers. While navigation to plot locations was often done by using a GPS, Orux maps allowed the teams to communicate and demonstrate clearly to District and village authorities the locations of plots, and from satellite imagery identify access routes and low sloping terrain, reducing work and travel times.

3.3.4 APPLICABILITY AND USE OF AN R-SCRIPT FOR DATA ANALYSIS

Raw data collected by ODK collect and stored on Ona.io enables the teams to access the entire aggregate data of survey on an on-going basis, as data is uploaded to the server from the field tablets. Since data is immediately accessible as either a .csv or .xlsx file, it was possible to design a script to process and analyze the data while also outputting tables on strata carbon stocks and associated statistics, stand tables and time analyses.

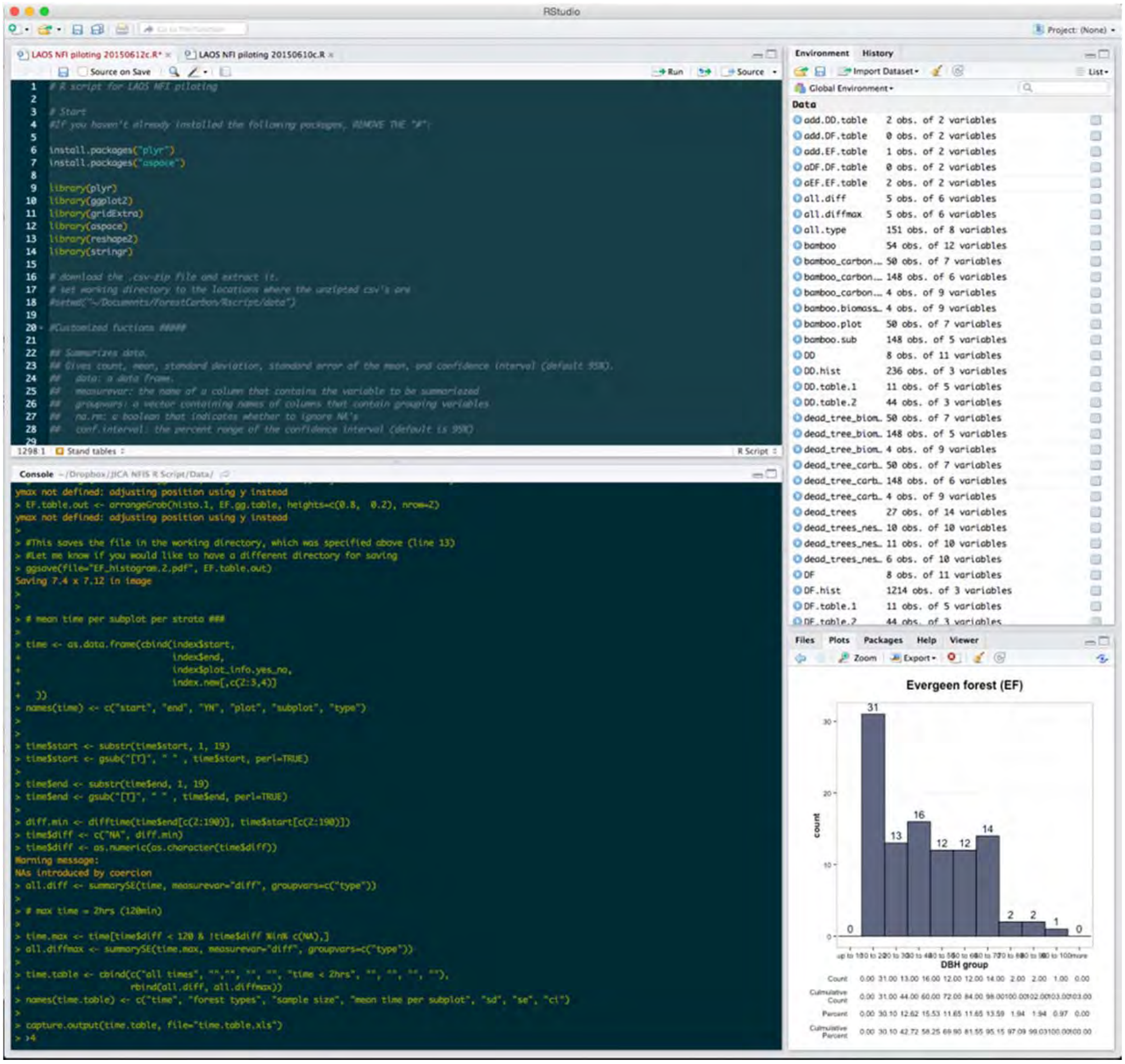


Figure 12: Above, a screen shot of the R-Script analysis tool for processing of field data made for NFIS.

Typically NFI data processing form paper to computer, and computer to meaningful results can take multiple months, if not over a year to complete. The tablet technology and use of R has made this possible to complete within a relatively short period of time (10-15 seconds). Due to error reduction from data entry constraints in ODK, data cleaning needs are minimal. This means that the entire NFI process can be largely automated once data has been collected and sent from the field.

4 OBSERVATIONS AND RECOMMENDATIONS

The following observations and recommendations were made during the pilot survey and during consultations with team leaders.

Plot Design

- **Floating Plot Design –** It is strongly recommended that the floating plot design be used in the full NFI based on piloting in Houaphan in Khammouane provinces to save time, cost and workloads of field teams.
- **Carbon Pools** – Given that the % of living tree AG and BG biomass comprises a mean of >91% of total biomass in every forest strata measured, leaving the remaining pools as “non-significant” the National Forest Inventory need only focus on living tree biomass for the purposes of national greenhouse gas reporting. Non-tree vegetation and litter need not be included unless there is a specific need or interest by the government. However, it is recommended to maintain deadwood as measured and monitored pool for research purposes and indicative measurement data of potential future use in studies on degradation and illegal logging. Further, the very little amount of time necessary for assessing deadwood does not significantly affect the overall time taken in each plot and removing it would not likely not result in a significant increase in the number of additional plots overall and would result in at least 2 fewer staff needed per plot.

Inventory Design and Plot Placement

- **Maximum/Minimum travel distance by foot** – The distances described in Section エラー**!** 参照元が見つかりません。 were found to be sufficient to the teams and plot design team.
- **Sub-plot relocation –** The practice of “shifting” sub plots 100m found to have been placed in unsuitable locations was highly successful and resulted in very few “mixed” plots.
- **Plot Backup Locations –** The use of backup plots was also highly successful and were often used by field teams. It is recommended that field teams the opportunity to choose between two different plot locations based on their preference and on-the ground knowledge. Thus, instead of having a “primary” plot and a “backup” plot, two different plot locations can be indicated and field teams can choose either option based on their assessment once on the ground. For Example: Plot 15 may be based at two separate locations (15-1 and 15-2. A GIS/RS operator in Vientiane may believe that 15-1 is easier to access, but in reality once on the ground the field teams may find that 15-2 is more easily accessible. Instead of forcing the teams to attempt to go to the primary plot (15-1) only to verify that it cannot be accessed, the field teams can simply choose to go to 15-2 directly instead, saving 1 day of travel/work time.
- **Avoid District Boundaries** – Plots should not be placed near district boundaries as villages and district staff may want to avoid accidentally entering a district outside of their jurisdiction.
- **Bamboo Patches –** Only measure individual stems of a bamboo patch within the nest, rather than trying to estimate the center of the bamboo patch.

Logistics

- **Team Size –** Based on observations and discussions 5 persons per field crew were found to be a sufficient number of participants. However, often non-essential participants are hard to avoid, as village and district staff are often assigned and/or obligated to participate, adding time and costs.
    - National Field teams (Persons 1-4) are recommended as follows:
        - **Person 1:** Team Leader/Data Collector
        - **Person 2:** DBH Measurement/DME Person 1
        - **Person 3:** DBH Measurement/DME Person 2
        - **Person 4:** Lying Dead Wood/Clip Plot Person
        - **Person 5:** Village Participant
        - **Non-essential (Person 6):** DAFO/PAFO Participant
- **Vehicle Use** – If teams are kept to the above, one single vehicle can be used for travel. However, often DAFO and PAFO participants are interested and/or assigned. In this case insufficient space may be available for

travel with a single vehicle and additional budget should be made available for the use of a DAFO/PAFO vehicle.

Data Processing

- **R-Script for Data Processing –** Since all data from the tablets will be arriving in a consistent and standardized format, it is strongly recommended that the NFI make use of the simple and easy to use "R" script program specially designed to handle the large volume of data that will be arriving during the NFI inventory. A simple program that takes the raw data as the main input and outputs a standardized set of information on strata and biomass pools, sampling intensity, confidence intervals and other relevant statistics would eliminate the need to process data manually using MS Excel and reduce significant amounts of error that would likely arise out of multiple data analysis operators manually analyzing the datasets.

Coordination

- **National Ministerial Coordination** – The NFI will target forest areas nation-wide. During the piloting, national level coordination only targeted the Department of Forestry within the Ministry of Agriculture and Forestry. Without permission from MoNRE, field teams received no support or coordination from provincial or district offices of natural resources and environment (PoNRE/DoNRE) and were barred from accessing any areas under MoNRE management.
- **Field Coordination** – It is highly recommended that each field team be assigned a provincial-level "coordinator" who travels at least 1 to 2 days ahead of the inventory team to notify villages or district governments in person about the presence of the teams, coordinate support and negotiate participation by villages.
- **Field Access Support** – If a field coordinator is present for each team, it would also be advisable to arrange for village participants to support the coordinator to locate the plot ahead of the field team arriving.
- **Additional Coordination Time with Team Leaders** – Team leaders requested a greater degree of involvement during the inventory-planning phase. They would like to review plot locations, rule sets and approve locations before heading the field.

Training

- **Additional Field Training Time** – Although FIPD staff understood the SOP, it wasn't until they were in the field-training that most practical questions were raised.
- **Additional Training Clarifications** – Teams where confused about when sub plots/clusters should be recorded and when they shouldn't be. Typically this had to do with when they arrived at plots mistakenly located in non-forest areas and decisions about when to abandon a cluster in favor of the backup plots.
- **SOP Manual in Lao Language** – Team leaders did not have the opportunity to read the manual in Lao language before the piloting.

Tablet Use

- **Use of Tablet Technology –** It is strongly recommended to use the Android tablet technology for use in data collection and navigation.
- **OruxMaps –** Very useful for the team leaders to make the decision to go to the plot by looking at the satellite image in OruxMaps. In fact, there are sometime a streams or small river that they cannot see on the images. So it would be good to have a stream or small river layer (to better know the terrain in small scale and let the team go to the plot faster)
- **ODK –** Team leaders requested additional training of "trouble shooting" and if possible a manual in lao language.

Equipment

- **Hanging Scales** – If the NFI will target the collection of NTV and Litter carbon pools, higher quality scales are an absolute necessity. Scales provided during the NFI piloting were highly unreliable.
    - 200g
    - 500g
    - 5kg
- **Additional DME –** At least 2 or 3 distance readers (only the grey button box, not the transponder) should be provided per team.
- **Small Calipers –** At least 2 pair per team for measuring bamboo. Preferably high quality with a waterproof digital display.

ANNEXES

4.1 STRATA

Chave et al. 2005

Table 5: Results of NFI Pilot Inventory with 95% CI, using Chave et al. 2005

Strata	Mean tC/ha	Std.Dev	Plots	Max	Min	STD Error	CI	Uncertainty
Dry Dipterocarp	62.69	21.42	13	18.40	103.31	5.94	12.94	21%
Mixed Deciduous	169.24	74.54	33	65.13	344.50	12.98	26.43	16%
Evergreen	252.01	61.26	2	208.69	295.33	43.32	550.41	218%
Scrub	28.70	6.87	2	23.84	33.55	4.86	61.72	215%

Chave et al. 2014

Table 6: Results of NFI Pilot Inventory with 95% CI, using Chave et al. 2014

Strata	Mean tC/ha	Std.Dev	Plots	Max	Min	STD Error	CI	Uncertainty
Dry Dipterocarp	41.19	13.40	13	12.69	65.15	3.72	8.10	20%
Mixed Deciduous	108.51	46.24	33	41.80	215.74	8.05	16.40	15%
Evergreen	166.26	41.33	2	137.04	195.48	29.22	371.29	223%
Scrub	20.13	5.82	2	16.02	24.24	4.11	52.25	260%

4.2 CONTRIBUTION OF POOLS BY STRATA

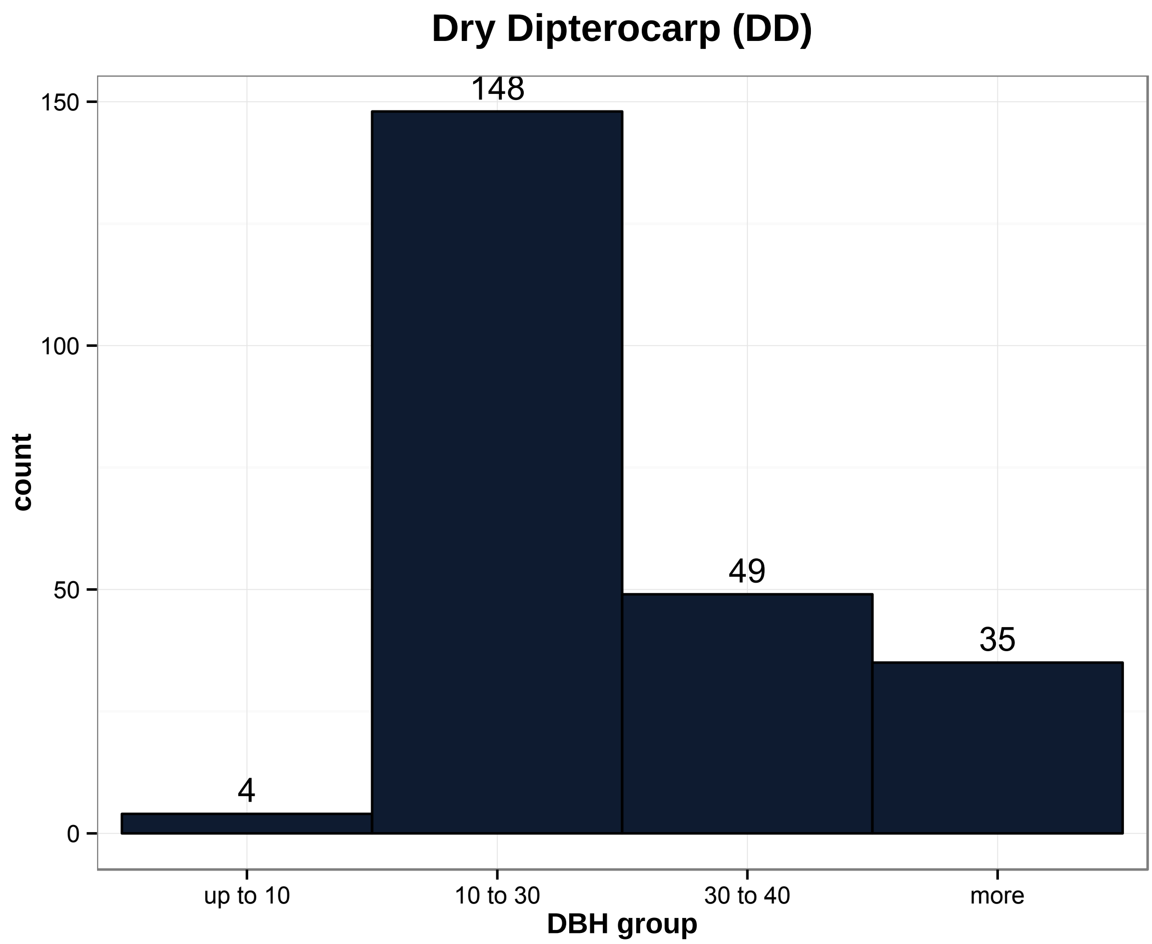
Table 7: Breakdown of carbon pools within each strata, as calculated by Chave et al. 2005 and 2014. [10]

Strata	Plots	Pool	C (tC/ha)	Min	Max	Std Dev	Percent (Chave 2005)	Percent (Chave 2014)
Scrub	2	Living Trees AGB (Chave2005)	20.48	18.6	22.37	2.67	71.37	-
		Living Trees BGB (Chave2005)	5.73	5.21	6.26	0.75	19.98	-
		Living Trees (Chave2014)	13.79	12.49	15.09	1.84	-	68.5
		Living Trees BGB (Chave2014)	3.86	3.5	4.23	0.52	-	19.18
		Bamboo	0.32	0.63	0.63	0.45	1.1	1.57
		Deadwood - Trees	0	-	NA	0	0	0
		Deadwood – Stump	0.13	0.04	0.21	0.13	0.44	0.62
		Deadwood - LDW	2.04	4.08	4.08	2.88	7.11	10.13
Evergreen Forest	2	Living Trees AGB (Chave2005)	192.7	158.8	226.6	47.94	76.47	-
		Living Trees BGB (Chave2005)	53.96	44.46	63.45	13.42	21.41	-
		Living Trees (Chave2014)	125.71	102.82	148.59	32.37	-	75.61
		Living Trees BGB (Chave2014)	35.2	28.79	41.61	9.06	-	21.17
		Bamboo	0.14	0.29	0.29	0.2	0.06	0.09
		Deadwood - Trees	2.51	5.03	5.03	3.55	1	1.51
		Deadwood – Stump	0	-	NA	0	0	0
		Deadwood - LDW	2.69	0.11	5.28	3.66	1.07	1.62
Mixed Deciduous Forest	33	Living Trees AGB (Chave2005)	128.81	49.03	266.51	58.65	76.32	-
		Living Trees BGB (Chave2005)	36.07	13.73	74.62	16.42	21.37	-
		Living Trees (Chave2014)	81.36	30.81	165.92	36.49	-	75.3
		Living Trees BGB (Chave2014)	22.78	8.63	46.46	10.22	-	21.08
		Bamboo	0.44	0	5.91	1.31	0.26	0.41
		Deadwood - Trees	1.8	0.99	9.4	2.8	1.07	1.67
		Deadwood – Stump	0.18	0.13	0.93	0.24	0.11	0.16
		Deadwood - LDW	1.49	0.06	8.32	1.74	0.88	1.38
Dry Dipterocarp Forest	13	Living Trees AGB (Chave2005)	46.96	14.01	80.41	16.5	74.91	-
		Living Trees BGB (Chave2005)	13.15	3.92	22.52	4.62	20.97	-
		Living Trees (Chave2014)	30.16	9.54	50.6	10.22	-	73.23
		Living Trees BGB (Chave2014)	8.45	2.67	14.17	2.86	-	20.5
		Bamboo	0.59	0.23	6.97	1.92	0.94	1.44

[10] Note: does not include sapling biomass as average sapling weight was not measured during field data collection

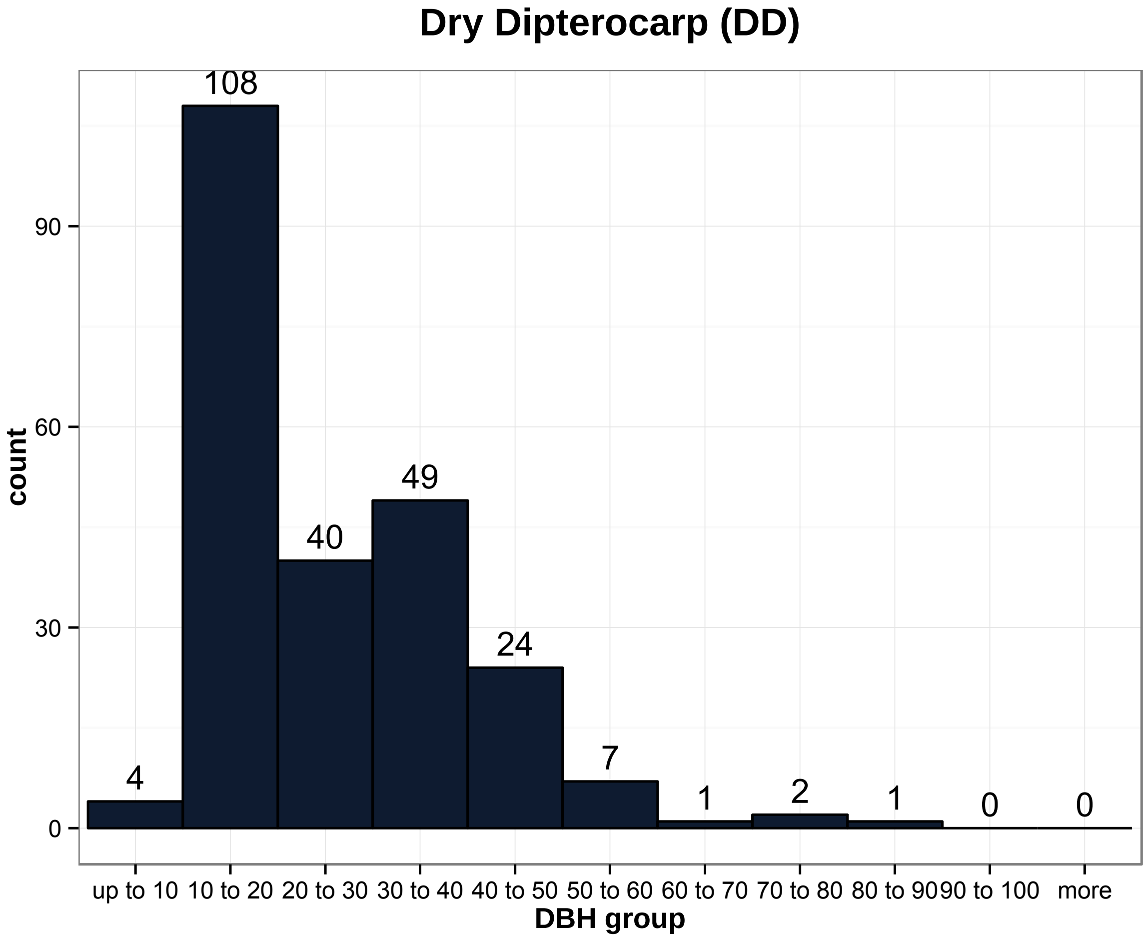
		Deadwood - Trees	0.56	2.21	2.53	1.06	0.89	1.35
		Deadwood – Stump	0.22	0.1	0.53	0.16	0.36	0.54
		Deadwood - LDW	1.21	0.13	4.6	1.37	1.92	2.93

4.3 STAND TABLES



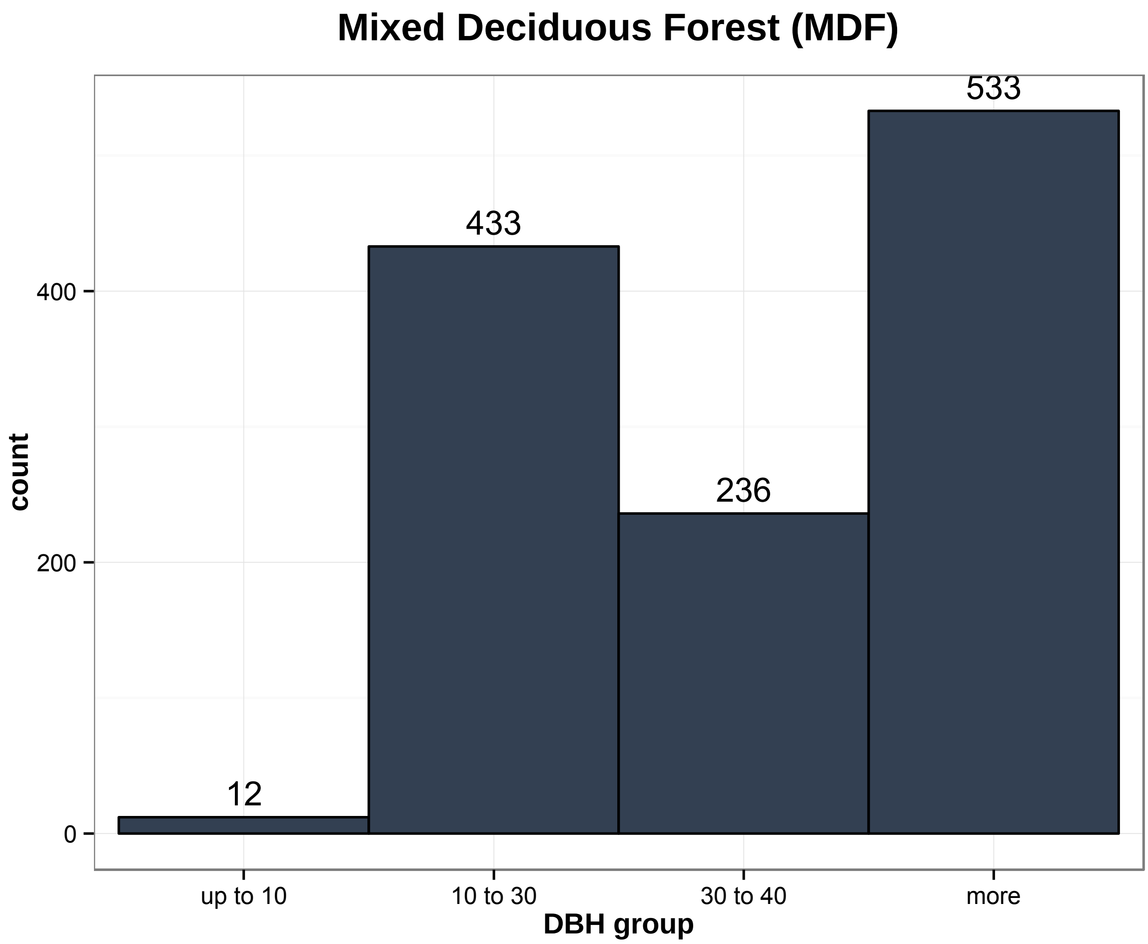
Count	4.00	148.00	49.00	35.00
Culmulative Count	4.00	152.00	201.00	236.00
Percent	1.69	62.71	20.76	14.83
Culmulative Percent	1.69	64.41	85.17	100.00

Figure 13: Stand tables of dry dipterocarp forest by tree plot nest



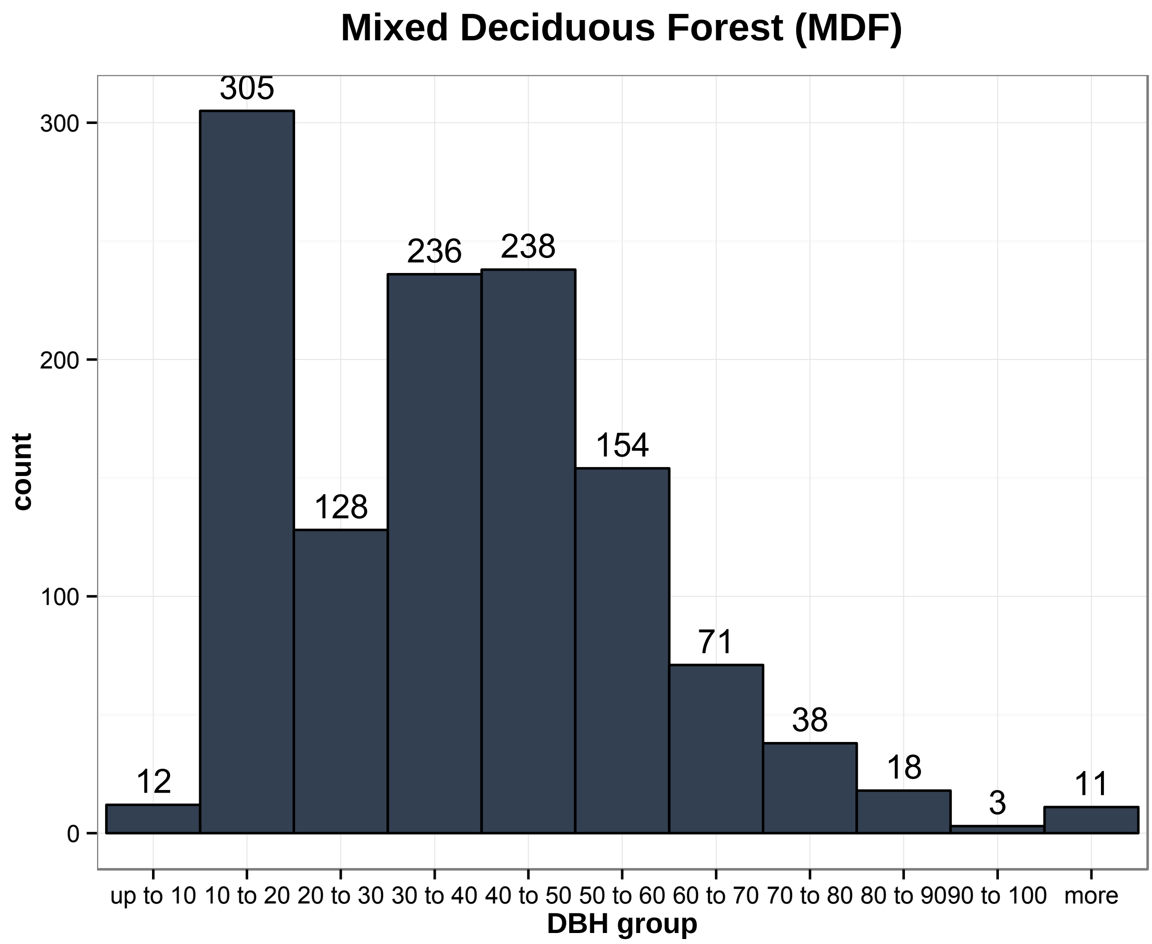
Count	4.00	108.00	40.00	49.00	24.00	7.00	1.00	2.00	1.00	0.00	0.00
Culmulative Count	4.00	112.00	152.00	201.00	225.00	232.00	233.00	235.00	236.00	236.00	236.00
Percent	1.69	45.76	16.95	20.76	10.17	2.97	0.42	0.85	0.42	0.00	0.00
Culmulative Percent	1.69	47.46	64.41	85.17	95.34	98.31	98.73	99.58	100.00	100.00	100.00

Figure 14: Stand tables of dry dipterocarp forest by 10cm increments



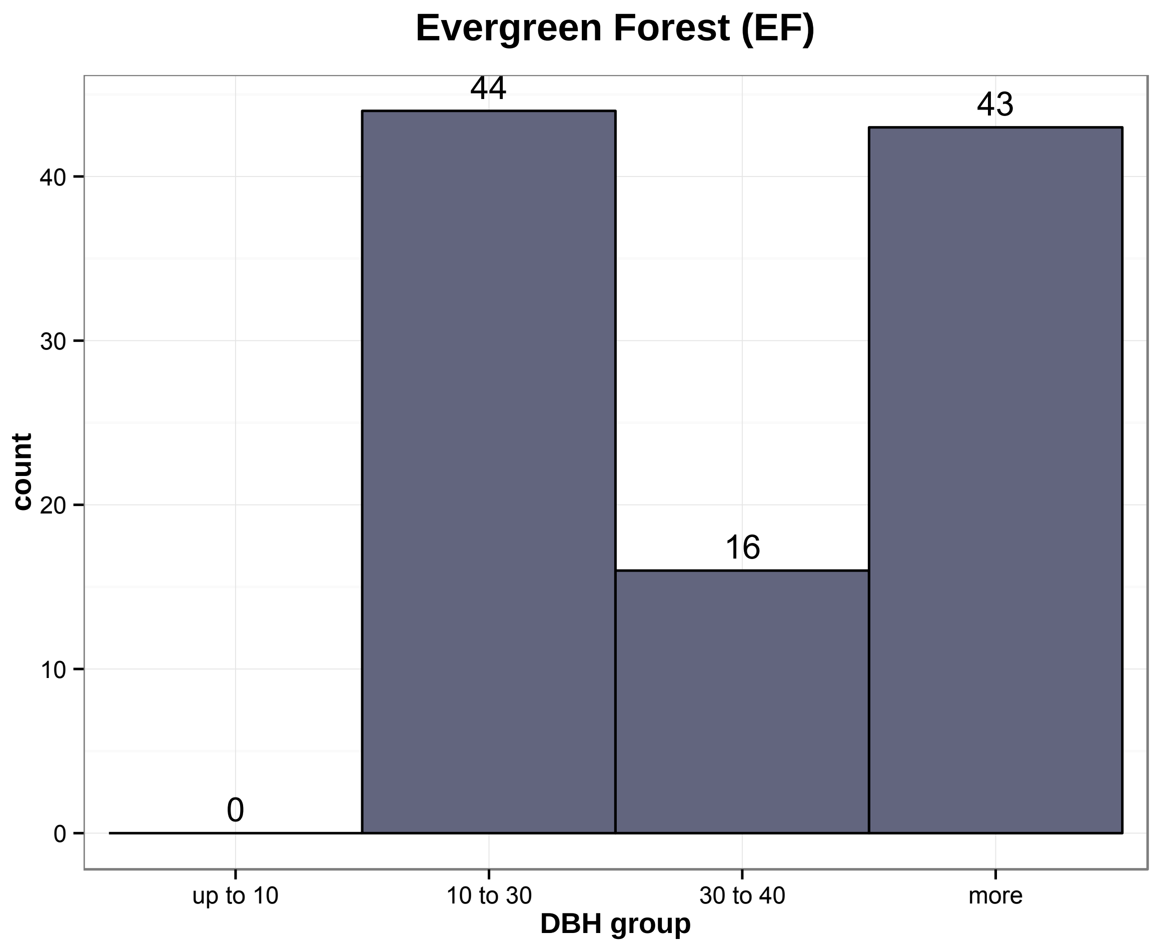
Count	12.00	433.00	236.00	533.00
Culmulative Count	12.00	445.00	681.00	1214.00
Percent	0.99	35.67	19.44	43.90
Culmulative Percent	0.99	36.66	56.10	100.00

Figure 15: Stand tables of mixed deciduous forest by tree plot nests



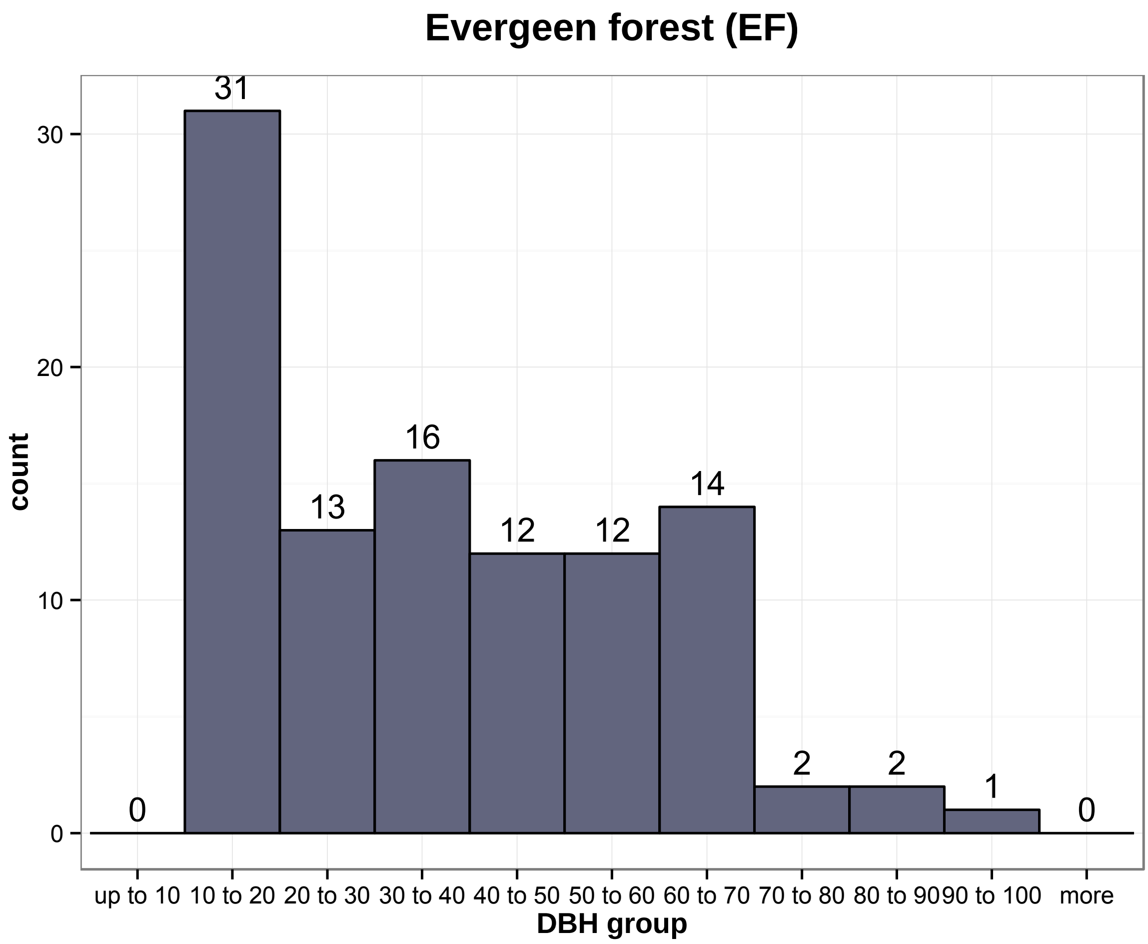
Count	12.00	305.00	128.00	236.00	238.00	154.00	71.00	38.00	18.00	3.00	11.00
Culmulative Count	12.00	317.00	445.00	681.00	919.00	1073.00	1144.00	1182.00	1200.00	1203.00	1214.00
Percent	0.99	25.12	10.54	19.44	19.60	12.69	5.85	3.13	1.48	0.25	0.91
Culmulative Percent	0.99	26.11	36.66	56.10	75.70	88.39	94.23	97.36	98.85	99.09	100.00

Figure 16: Stand tables of mixed deciduous forest by 10cm increments



	up to 10	10 to 30	30 to 40	more
Count	0.00	44.00	16.00	43.00
Culmulative Count	0.00	44.00	60.00	103.00
Percent	0.00	42.72	15.53	41.75
Culmulative Percent	0.00	42.72	58.25	100.00

Figure 17: Stand tables of evergreen forest by tree plot nests



Count	0.00	31.00	13.00	16.00	12.00	12.00	14.00	2.00	2.00	1.00	0.00
Culmulative Count	0.00	31.00	44.00	60.00	72.00	84.00	98.00	100.00	102.00	103.00	103.00
Percent	0.00	30.10	12.62	15.53	11.65	11.65	13.59	1.94	1.94	0.97	0.00
Culmulative Percent	0.00	30.10	42.72	58.25	69.90	81.55	95.15	97.09	99.03	100.00	100.00

Figure 18: Stand tables of evergreen forest by 10cm increments

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業務完了報告書

添付資料13：REDD+の参照レベル（REL/RL）開発の方法論に係る整理分析レポート

REDD+の参照レベル(REL/RL)開発の方法論に係る整理分析レポート

緒言

参照レベル開発に係る方法論については UNFCCC の関連決議と既に提出された参照レベルの整理・分析、並びに FCPF 炭素基金及び VCS の準国レベルにおける方法論の整理・分析を最終報告書において報告しているため、このレポートにおいてはラオスにおける UNFCCC 及び炭素基金提出を想定した参照レベル暫定版についてとりまとめる。

1　基本的事項

1.1 森林定義及び土地・森林分類

森林定義

ラオスにおける森林は次のように定義されている；最小面積　0.5ha、最小樹冠率　胸高直径（DBH）10cm 以上の樹木の樹冠率が 20%以上。

森林の平均樹高は定義に含まれていないが、これは広範に存在する休閑地－森林への遷移を樹高で判断するには衛星画像上での把握が困難であり、５m程度の高解像度画像であれば一定の大きさの樹冠が見えること、また、メコン川沿いには緑肥や樹脂採取用に大径木を残した水田が存在するが雲等を避けるために画像が撮影される乾季には水田は画像上で確認し難く、樹木があれば森林との誤判読を避ける為である。

また、この定義は過去また将来の地上調査において DBH10cm 以上の樹木を調査していることとも合致しており、画像判読で樹高を使用した場合に比べより正確に材積や炭素量を推定できる。

土地/森林分類と層化

層化としての土地/森林分類は次の通り合意されている。

IPCC Definition	National Level Classification System for Lao PDR		
	Level 1	Level 2	
Forest Land	Current Forest	Evergreen Forest	EF
		Mixed Deciduous Forest	MD
		Dry Dipterocarp Forest	DD
		Coniferous Forest	CF
		Mixed Coniferous and Broadleaved Forest	MCB
		Forest Plantation	P
	Regenerating Vegetation	Bamboo	B
		Regenerating Vegetation	RV
Grassland	Other Vegetated Areas	Savannah	SA
		Scrub	SC
		Grassland	G
Wetlands		Swamp	SW
Cropland	Cropland	Upland Crop	UC
		Rice Paddy	RP
		Other Agriculture	OA
		Agriculture Plantation	AP
Settlements	Non Vegetated Areas	Urban	U
Other Land		Barren Land and Rock	BR
	Other Land	Other Land	O
Wetlands	Water	Water	W

1.2　森林劣化の層化の検討

常緑林及び混交林劣化の主なドライバーと考えられる焼畑移動耕作、択伐及び薪炭材採取等について層化を試みる。この試みを通じてラオスにおける森林劣化が定義付けられると期待されている。

既存データは限られているが、その中でリモートセンシングと地上調査の組合せにより撹乱の程度に応じた劣化の層化を試みる。現時点では、焼畑移動耕作については時間経過に応じた焼畑耕作地の確定とモザイク的土地利用地域の設定により、択伐については生産林における地上調査データ分析により、また、薪炭材採取については高解像度画像を用いた道路や集落からの距離、傾斜度等薪炭材採取と関連した変数との関連性分析により層化を検討する。

1.3　Activity Data

JICA 支援により 2000、05、及び 2010 年の全国森林図(上記表の Level 2 の分類)が 2015 年 8 月頃、また 2016 年中頃までには 2015 年の全国森林図が作成されることとなっている。2010 年森林図が基盤図であり、森林・非森林で 80%以上、森林分類については 70%以上の精度を予定している。その他の年の森林図は基盤図との、また各年間の判読・分類の一貫性を確保するため変化抽出法により作成されることとなっている。

2010 及び 15 年には Rapideye、2005 年には SPOT4/5、また 2000 年には Landsat TM 画像を用いることとしている。

炭素基金対象地については全国面積の 3 分の 1 以上を占めることから全国森林図を AD 推定に用いることとなる。

1.4 Emission Factors

全国森林調査の設計

2016-17 年の乾季における実施を目指して第 2 回全国森林調査(NFI)が JICA の支援で設計・実施される。NFI の主な目的は森林炭素量推定のための森林分類毎(一部非森林も含む)の炭素量把握である。その他の目的として材積等の定量的データ収集及び撹乱、伐採、NTFP 等の定性的データ収集も行う予定である。

サンプルプロットのデザインは合意しており、NFI 実施及びデータ分析のための各種マニュアル等が以下の通り準備されている。

- 森林炭素サンプリングのための NFI ガイダンス
- 地上炭素計測のための標準実施手順書
- プロット数計算のためのエクセルツール
- タブレットを用いた地上データ収集
- 炭素推定計算マニュアル
- 統計計算アプリである R スクリプト
- 相対成長式による計算ガイダンス
- 標準実施手順書及びタブレット使用に関する訓練

NFIS によるパイロット結果を更に分析し、技術的適性と全国での使用可能性等を更に検討の上で第 2 回 NFI 設計を仕上げることとなる。

相対成長式の作成

炭素基金で要求されているティア 2 レベルでの排出係数（EF）推定のため、ラオス独自の相対成長式が常緑林、混交林、乾燥フタバガキ科林及び再生植生(休閑林)と竹林について開発される予定である。

2. 参照レベルの主な要素

要素	案	根拠等
炭素プール	地上部及び地下部バイオマス(地下部は地上部に対する標準係数) (枯死木も検討)	- フアパン県におけるバイオマス調査において地上部及び地下部バイオマスが森林炭素の主要なプールであり、枯死木及びリター層は重要ではないと判明している。 - ラオスでの土壌炭素に関するデータは今のところ存在しないが更に要検討。乾燥林では分解が速いため降雨林に比較し土壌炭素は少ないと考えられる。
ガス	2 酸化炭素及びバイオマス燃焼に伴うガス(CH4、CO、N2O 等)	- ラオスでは焼畑が広く行われ、プランテーション用の森林転用も焼払いが主体である。 - 燃焼面積の推定手法を検討中。
REDD+活動	森林減少からの排出抑制 (森林劣化からの排出抑制) 森林再生、植林及び森林成長による吸収増加	- ラオスでは森林減少と劣化による排出が排出全体の多くを占める。 - 再生植生(RV)の森林への回帰により相当な吸収増加が期待できる。 - 平均炭素量が少ない森林タイプへの変化が劣化に当たるかどうか更に検討を要する。
参照期間	2000－2015 年	- 森林面積変化は 3 期間分 - 主な森林タイプの排出係数はラオス独自の係数、その他は標準値
参照レベル作成手法	炭素基金用には平均であるが排出と吸収を分けて計算するなど変化を適切に反映出来るものとする。 UNFCCC 用には更にトレンド、モデルなども検討。	- 炭素基金は平均以下が標準手法 - 再生植生(RV)の森林への回帰により相当な吸収増加が期待できる。

3. UNFCCC ガイダンスとの整合性

COP17 における参照レベルの態様に関する決議のうち整合が必要な次の 2 点について整合性を検討する。

要件	整合性
年当たり 2 酸化炭素換算量トン数として表現	ラオス参照レベルは年当たり 2 酸化炭素換算量トン数として表現される。
各国の GHG インベントリーにおける人為の森林に関連する排出源毎の GHG 排出量及び吸収源毎の GHG 吸収量との一貫性の確保	‐2000－2015 年の土地・森林面積変化と炭素量変化は 2017 年提出を予定している第 3 回国別報告における GHG インベントリーのうち LULUCF 分野の主なデータとなる。 ‐GHG インベントリーを担当している MONRE の災害管理・気候変動局との連携・協力に着手している。

4. 炭素基金方法論枠組みとの整合性

方法論枠組みの指標	整合性
FREL/FRL は年間の二酸化炭素同等量(トン)で表示される。	ラオスの炭素基金対象地 FREL/FRL は年間の二酸化炭素同等量(トン)で表示される。
ERP は国レベル FREL/FRL との関連を説明する。	‐ラオスの炭素基金対象地 FREL/FRL は国レベルのデータセットを用いて計算される。 ‐対象となる活動、プール及びガス種類は国レベル参照レベルと同一である。
ERP は国レベル GHG インベントリーとの関連を説明する。	2000－2015 年の土地・森林面積変化と炭素量変化は 2017 年提出を予定している第 3 回国別報告における GHG インベントリーのうち LULUCF 分野の主なデータとなる。 ‐GHG インベントリーを担当している MONRE の災害管理・気候変動局との連携・協力に着手している。
参照期間の終期は 2013 年以前の森林被覆が IPCC アプローチ 3(wall-to-wallmapping)で表示される最も新しいデータとする。	ラオスの炭素基金対象地に関する FREL/FRL の参照期間終期は頑健性を有し、かつ最近の変動を反映するため 2015 年とし、参照期間は 15 年となる。
参照期間の始期は終期の約 10 年前とする。	同上

合理的な理由を前提に異なる始期は可能であるが 15 年以下とする。	
FREL/FRL 作成に用いた森林定義は明確に ERP に示される。国の GHG インベントリーや他国際機関への報告に用いる定義と異なる場合は ERP においてその理由、内容を説明する。	当該文書 1.1 で説明した森林定義は GHG インベントリーとの整合性で説明したように GHG インベントリーにおいても使用される。

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添付資料14：REDD+セーフガードに係る情報の整理・レポート

REDD+セーフガードに係る情報の整理・レポート

SG 情報システム（Safeguard Information System、以下 SIS）の基盤となりうる情報システムに関する検討について報告する。SIS を「3.5.3　セーフガードに関する情報整備手法に関する検討」にて整理した「カンクン合意で示されたセーフガード」に関する情報を提供するシステム、そしてそれは透明性が要求される NFMS の機能の一つとして提供しうるもの、と理解すれば、例えば、下記に整理した REDD+に関連する資料やプロジェクトに関する（空間）情報を提供する仕組み・体制を整備することは SIS 構築手法検討に向けて参考・基礎になると考えられる。

(a) 国家森林計画に相当する資料

(b) セーフガードに関連する資料

(c) Village/Community の情報（ポイントまたはポリゴン＆人口等）

(b) Awareness Workshop 情報（開催地、参加者、写真 with GPS）

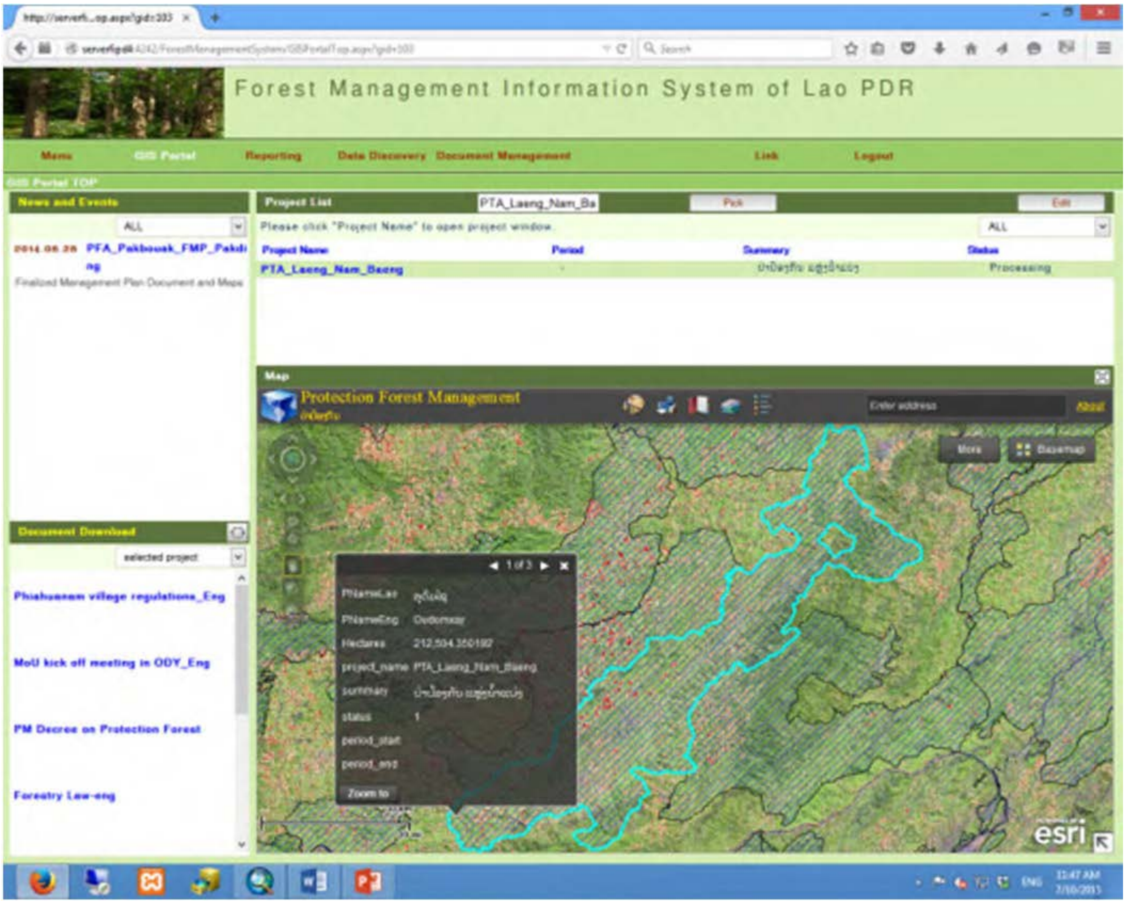
(e) 森林分布図、保護区、保全区（生物多様性優先地）等の情報

(f) 時系列の森林動態（準備が大変な場合、Hansen データで代替）

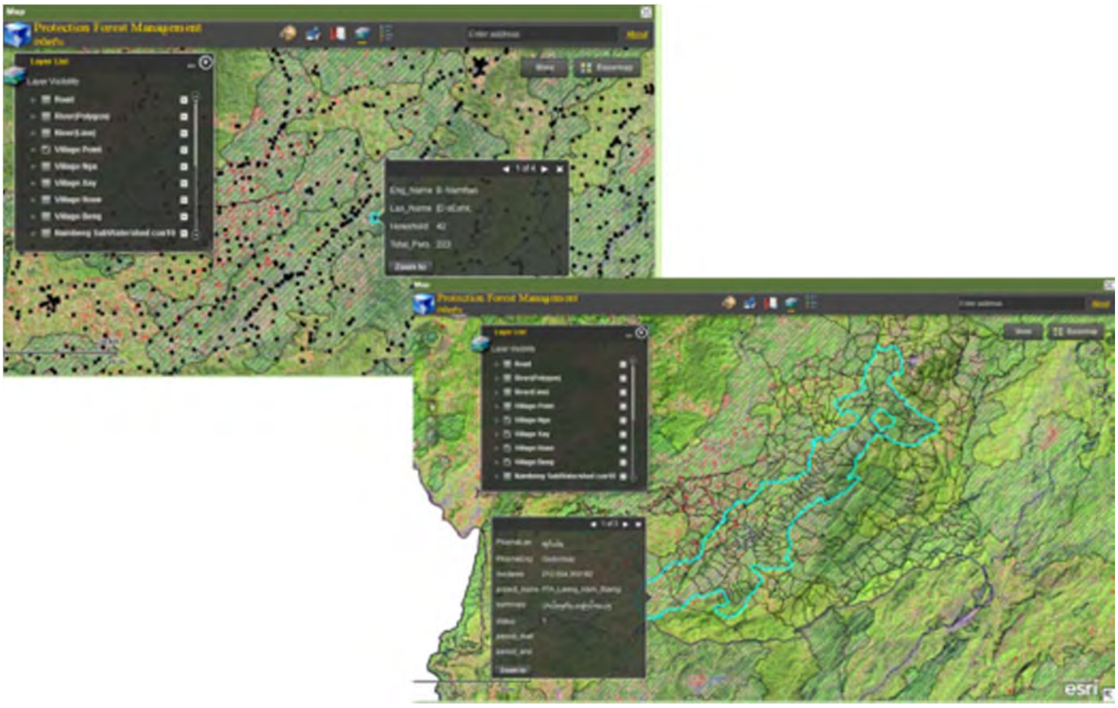
(g) プロジェクトバンダリー＋時系列衛星データ／森林減少データ

そこで、FPP/TA2 で構築した「森林情報プラットフォーム」に本プロジェクトの活動を通じて収集・整理した関連情報を載せて、最終ワークショップにて SIS 構築の検討としてデモンストレーションを行った（デモの内容は図〇～図〇を参照）。

ワークショップでは、公開するデータに関して慎重に検討すべきという意見や、既に公式となっている情報については、重複整備や不整合を避けるために積極的に公開すべきという意見、全ての情報を公開する必要はないが、NFMS では透明性が求められているため、合意形成がなされたうえで、公開していくことが必要であるという意見が挙げられた。今回のデモに対して挙げられた意見も参考に次期プロジェクトで運用に関する規定や仕組みについて、フォローアップすることが望まれる。

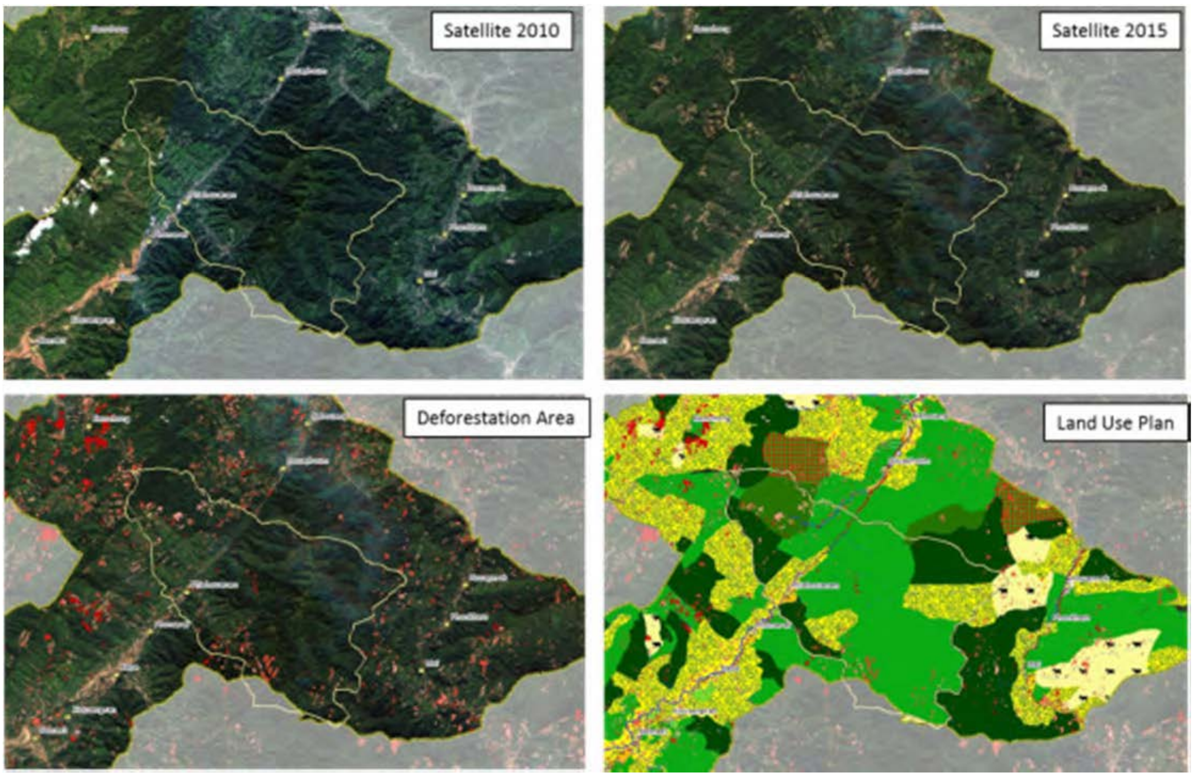


プロジェクト情報（保護林管理計画）と関連資料（ドキュメント）



Village/Community のポイント／ポリゴンおよび関連情報（人口等）

時系列の森林動態情報と保護区内の小流域（集水域）の情報



プロジェクトバウンダリと時系列衛星データおよび森林減少

一方、MAF や MONRE 等の省庁や 統計局においては、森林情報以外の関連データをウェブサイト提供しているものもあり、これらは SIS の一部となりうるものである。情報の維持管理を考えれば、将来的にはそれぞれのウェブサイトから関連レイヤをサービスとして発信してもらって、森林情報を統合した形で表示ができるようにすることが望ましい。ただ、その実現に向けては調整・合意が容易ではなく、時間がかかると予想されるため、当面は各関係機関とコンサルテーションを行ったうえで収集した情報を一箇所に集めてワンストップで確認できるようにして、詳細は各省庁の関連サイトに飛ぶようにリンクを張る形が望ましいであろう。

SIS に関連する情報を発信しているウェブサイトの例（Lao DECIDE info）

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業務完了報告書

添付資料１５:ルアンプラバン県ポンサイ郡における「森林減少抑制のための参加型土地・森林管理プロジェクト」の森林減少抑制手法の効果検証にかかる報告書

ルアンプラバン県ポンサイ郡における「森林減少抑制のための参加型土地・森林管理プロジェクト」の森林減少抑制手法の効果検証にかかる報告書

専門家氏名：名村隆行

本邦所属先：国際航業株式会社

プロジェクト名：ラオス持続可能な森林経営及び REDD+のための国家森林情報システム構築に係る能力向上プロジェクト

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1　背景と目的、期待される成果

1.1　業務の背景

ラオスの森林率は 1940 年代には 70%以上であったが、水力発電、鉱山開発、プランテーション開発等の土地利用変化により、1989 年には 47%まで減少し、2010 年には 40%まで低下した。ラオス政府は森林率を 70%に回復させることを目標とした「森林戦略 2020」を策定した。また、途上国の森林減少・劣化に由来する温室効果ガス排出の削減等（Reducing Emissions from Deforestation and Forest Degradation：　以下、REDD+）をすべてのレベルにおける管理能力強化と行政歳入及び地域住民の生計向上に資する有効な手段としてとらえ、REDD+タスクフォースを設置し、実施準備に取り組んでいる。一方で、REDD+につながる森林保全を促進するためには、森林セクター担当行政官の政策策定、実施能力の強化が必要であるが、2011 年の省庁再編に伴い、森林行政は保護林・保全林が天然資源環境省森林資源管理局、生産林は農林省林野局の所管に分離されたことから、総合的に森林保全に対応するための実施体制が十分に整備されていない。県・郡レベルの森林管理は、地方分権化に伴い、県農林事務所、郡農林事務所等が担っており、地方レベルの森林管理能力の強化についても、対策が急務となっている。

また、REDD+の実施においては、衛星情報解析等による精度の高い森林資源情報の整備が不可欠であるものの、当国において森林資源情報管理は処理能力や容量が REDD+関連データの適切な解析・管理に対応できるものでない他、情報を集積・分析する人材が不足しており、REDD+を通じた森林保全の基盤が脆弱である。

これまで JICA は、技術協力「森林減少抑制のための参加型土地・森林管理プロジェクト（以下、PAREDD）」でルアンプラバン県において土地森林管理手法の確立、「森林セクター能力強化プロジェクト」では森林セクターの政策立案・実施を支援してきた。また、「持続可能な森林経営及び REDD+のための国家森林情報システム構築にかかる能力向上プロジェクト」は、全国レベルの森林動態情報の整備等を支援している。加えて、無償資金協力では、「森林資源情報センター計画」及び「森林保全計画」を実施している。

PAREDD は 2014 年 8 月に 5 カ年のプロジェクト期間が終了したが、1 年間の延長を得て、2015 年中に開始が予定されている「持続可能な森林経営及び REDD+推進のための森林セクター政策・戦略プロジェクト」への成果の橋渡しを確実とするための業務に取り組んでいる。

PAREDD が開発した森林減少抑制手法（以下、「PAREDD アプローチ」）は、保全すべき森林と活用すべき生産地とを区分し適切な計画を立案する「土地森林利用計画」、区分された土地における適切な森林管理、農業を中心とする生産活動及び生計向上活動などを通した森林への圧力を軽減する「森林減少抑制活動」、それらの土地利用計画や活動の達成状況や課題を定期的に確認し、改善を図る「モニタリング」、これらの活動を村単位で主体的に実施するための「土地森林管理委員会」の設置、等で構成される。2009 年 8 月のプロジェクト開始後、「PAREDD アプローチ」の手順書の作成、カウンターパートへの技術移転を経て、2011 年 1 月より、対象地域のひとつである、ルアンプラバン県ポンサイ郡ホアイキン村落クラスターの 5 村において、「PAREDD アプローチ」の諸活動が実施されてきた。

ホアイキン村落クラスターでの活動開始から数年が経過し、その活動の成果が徐々に顕在化してきている。そのような中で、森林減少抑制手法の開発という本プロジェクトの目標に鑑み、PAREDD アプローチの森林減少抑制効果を明確にしておく必要がある。

1.2　目的

本業務は、ルアンプラバン県ポンサイ郡ホアイキン村落クラスターを対象地域として、過去からの森林被

覆や焼畑土地利用の変化を把握することを通じて、PAREDD アプローチの焼畑による森林減少・劣化抑制手法の効果を明らかにすることを目的とする。

1.3 期待される成果

1）森林被覆変化の観点から PAREDD 実施による効果が明らかになる。

2）焼畑土地利用変化の観点から PAREDD 実施による効果が明らかになる。

2 活動の概要

2.1 国内準備期間（2015 年 6 月 8～12 日：5 日間）

- PAREDD が作成したプロジェクトドキュメント、シェングン郡サイトの社会経済インパクト調査、シェングン郡サイトの森林被覆・土地利用状況調査、2014 年 12 月から 2015 年 1 月にかけ実施したポンサイ郡サイトの社会経済インパクト調査や PDM、PO を参照して、プロジェクトの概要を把握した。
- 派遣中の長期専門家より、プロジェクトの対象村（ルアンプラバン県ポンサイ郡ホアイキン村落クラスター）の村落領域及び土地利用図の空間情報を入手した上で、解析作業の対象エリア、および参照エリアを確定した。
- 森林被覆の変化解析作業のために、過去 10 年程度から現在に至る衛星画像を、4 時点準備した。（詳細は後述）

2.2 現地派遣期間（2015 年 6 月 18 日～2015 年 7 月 17 日：30 日間）

カウンターパート及び長期専門家とともに、以下の業務を行った。

- 業務開始時に、カウンターパート機関に対して業務計画書を提出し、業務内容と手法について説明の上、滞在中の作業内容について確認し、合意を得た。
- ラオス側関係機関と協議しながら森林被覆図作成のための森林階層を検討した。FIPD/DOFが作成している森林基盤図2010との整合を図ることが望ましいこともあり、協議の結果、ラオス国で採用している公式の森林分類に準拠している。
- 決定された森林階層に基づき、衛星画像を元に、本業務が実施される対象地域、および参照エリアを対象とした、過去から4時点の森林被覆図を作成した。
- 計150点（有効数144点）の地点を対象とした現地踏査および航空写真による正解データの収集を行い、それらのデータを基に2014年森林被覆図の精度検証を実施した。
- 上記で作成された森林被覆図に基づいて、各時点での森林面積、焼畑総面積の数値データを算出した。
- また、上記で作成された森林被覆図に傾斜農地（UC）によって実施された土地利用計画のゾーニング図を重ね合わせ、村落保全林及び村落保護林における傾斜農地面積の変化を算出した。
- PAREDDアプローチ、特に、土地利用計画によるゾーニングの影響について定性的なデータを得るために、対象村5村において、村落土地森林管理委員会を対象としたインタビューを実施した。また対象村3村において、村落の保全林・保護林内で焼畑土地利用を実施した村人を対象とした聞き取り調査を行った。
- PAREDDで2011年、及び2015年に実施された社会経済調査の結果を整理し、PAREDDアプローチの焼畑抑制効果について検討した。

・ 上記を踏まえ、PAREDDアプローチの焼畑による森林減少・劣化の抑制手法の効果取りまとめを行った。
・ 現地業務完了に際し、県関係者（PAFO、PONRE）、郡関係者（DAFO）及びプロジェクト関係カウンターパート機関を対象とした報告会を開催し、調査結果を報告した上で意見交換を実施した。
・ JICAラオス事務所に対し、業務結果の報告を実施した。

2.3　国内作業期間（2015 年 7 月 20 日～2015 年 7 月 21 日）

・　調査結果、及び意見交換の結果を踏まえ、報告書を取りまとめた
・　JICA 東京地球環境部に対し、業務結果の報告を実施した。

村人への聞き取り調査（ホアイハー村）

現地踏査による精度検証

3　検証手法方針

3.1　検証の基本方針

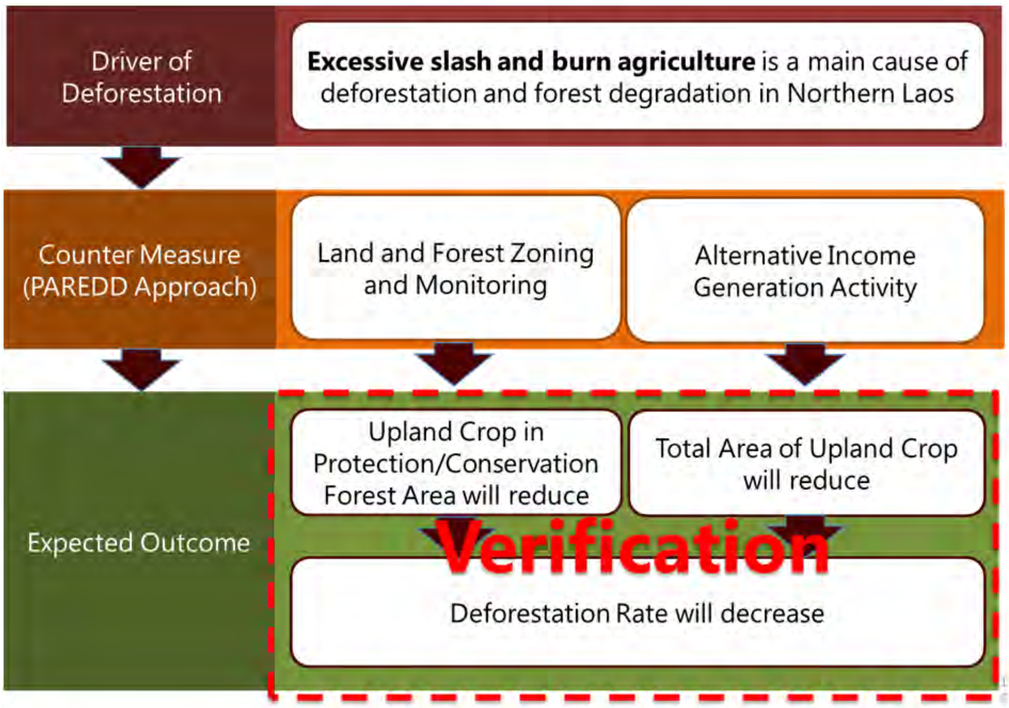
PAREDD ないしは PAREDD アプローチが想定している作業仮説は以下のようなものである。

- PAREDD が活動するラオス北部地域は森林減少・劣化が進行しており、その主要因は、焼畑土地利用である。
- PAREDD はラオス北部地域の森林減少・劣化の主要因となっている焼畑土地利用を抑制するための手法「PAREDD アプローチ」を設計し、手順書をまとめた。本手法は、以下のような活動から構成されている。
  1)過剰な焼畑土地利用を抑制するためのゾーニング
  2)焼畑土地利用を減少させるための資金的・技術的な支援による代替生計活動の促進。
  3) 土地森林管理を図るための管理組織の設立とモニタリング
  4）持続的な活動資金を担保するための村落基金の設立、等。
- PAREDD は 2011 年 12 月以降、ルアンプラバン県ポンサイ郡ホアイキン村落クラスターにおいてこれらの諸活動を計画・実施してきた。上記の諸活動を総称した「PAREDD アプローチ」が対象村落の森林被覆や土地利用にどのような影響を与えたのか、その効果を検証するために以下のような仮説を設定した。

仮説 1：土地利用計画を通じて設定された村落保全林・保護林エリアでの焼畑土地利用が減少する。
仮説 2：PAREDD アプローチの導入により、対象エリアの総焼畑土地面積が減少する。
仮説 3：PAREDD アプローチの導入により、対象エリアの森林減少率が低下する。

本検証業務では、これらの 3 つの作業仮説を検証することを通じて、PAREDD アプローチの効果を検証することとする。

図 1　本検証業務の仮説のフロー



3.2　PAREDD アプローチによるインパクト発生時期

PAREDD の実施効果を検証にするにあたり、本対象村に PAREDD アプローチが実施された時期について明確にしておく必要がある。表 1 は、ポンサイ郡ホアイキン村落クラスターにおいて、PAREDD が活動計画を立案した時期を示している。これによると、PAREDD アプローチを通じて土地森林ゾーニングと森林管理規則が設定されたのが **2012 年 6 月**、活動計画も含めて村落内で合意されたのは **2013 年 2 月**となり、その後、各種森林管理活動、生計向上活動が実施されている。よって、本検証業務においては、**2013 年初旬を基点**として、その前後の森林被覆と土地利用の変化を明らかにする。

なお、PAREDD アプローチの活動開始から現時点まで、まだ 2 年ほどしか経過しておらず、森林のゆるやかな成長速度を鑑みると、森林の増加分の変化を観察することは困難であることに留意しておく必要がある。

表 1　PAREDD アプローチ計画段階

<table>
<tr><th>Step</th><th>Details</th><th>Huay khing</th><th>Huay ha</th><th>Sakuan</th><th>Phak Bong</th><th>Huay tho</th><th>Long lath</th></tr>
<tr><td>1</td><td>Village cluster orientation meeting</td><td>Dec-11</td><td>Dec-11</td><td>Dec-11</td><td>Dec-11</td><td>Dec-11</td><td>24-28/Mar/2014</td></tr>
<tr><td>2</td><td>Whole village orientation meeting/set up LFMC</td><td>Dec-11</td><td>Dec-11</td><td>Dec-11</td><td>Dec-11</td><td>Dec-11</td><td rowspan="2">24-28/Mar/2014</td></tr>
<tr><td>3</td><td>Problem Analysis on land and natural resources use</td><td>Jan-12</td><td>Jan-12</td><td>Jan-12</td><td>Jan-12</td><td>Jan-12</td></tr>
<tr><td>4</td><td>Village boundary demarcation</td><td>Feb-12</td><td>Feb-12</td><td>Feb-12</td><td>Feb-12</td><td>Feb-12</td><td rowspan="2">May-July/2014</td></tr>
<tr><td>5</td><td>Land use zoning</td><td>Feb-12</td><td>Mar-12</td><td>Mar-12</td><td>Apr-12</td><td>Apr-12</td></tr>
<tr><td>6</td><td>Regulation and forest rehabilitation</td><td>Jun-12</td><td>Jun-12</td><td>Jun-12</td><td>Jun-12</td><td>Jun-12</td><td>July/2014</td></tr>
<tr><td>7</td><td>Selection of livelihood improvement activities</td><td>Oct-12</td><td>Oct-12</td><td>Oct-12</td><td>Oct-12</td><td>Oct-12</td><td>-</td></tr>
<tr><td>8</td><td>Detailed planning of livelihood improvement activities</td><td>Dec-12</td><td>Dec-12</td><td>Dec-12</td><td>Dec-12</td><td>Dec-12</td><td>-</td></tr>
<tr><td>9</td><td>Village infrastructure improvement planning</td><td>Jan-13</td><td>Jan-13</td><td>Jan-13</td><td>Jan-13</td><td>Jan-13</td><td>-</td></tr>
<tr><td>10</td><td>Village approval of activity plans</td><td>Feb-13</td><td>Feb-13</td><td>Feb-13</td><td>Feb-13</td><td>Feb-13</td><td>-</td></tr>
</table>

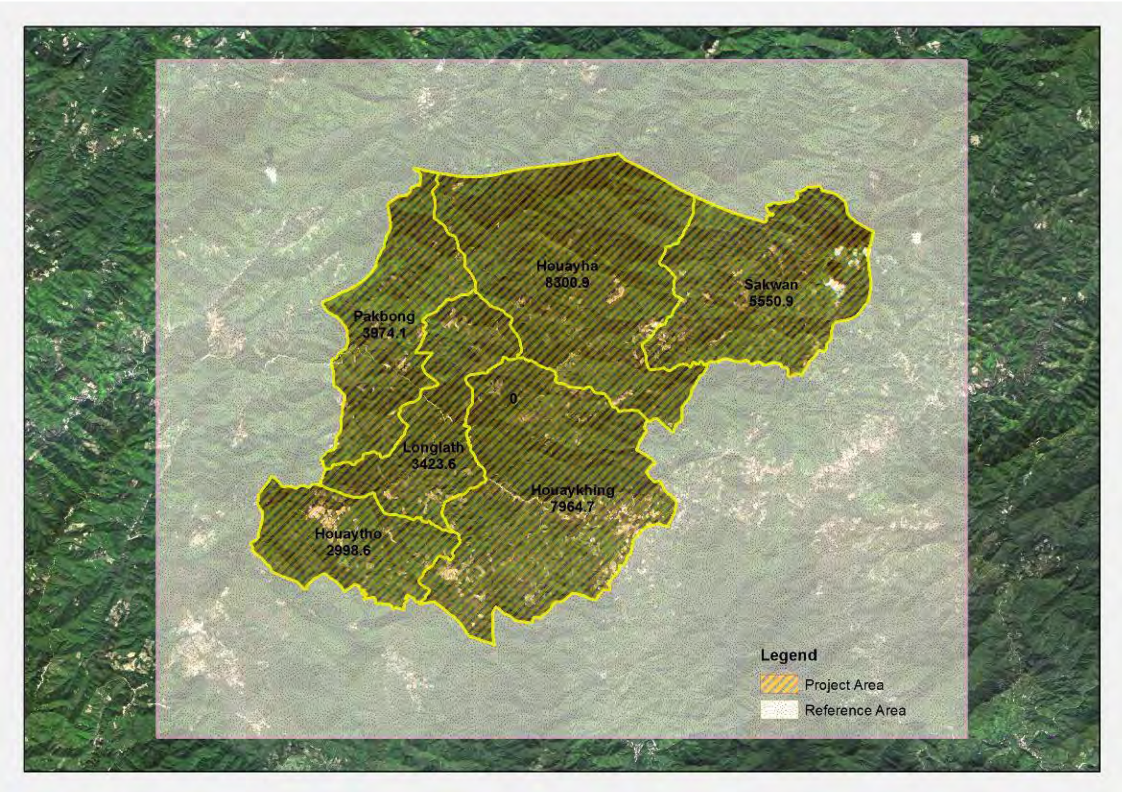
3.3　プロジェクトバウンダリの設定

本検証業務の対象地域は、PAREDD の対象地域であるルアンプラバン県ポンサイ郡ホアイキン村落クラスター（32,213.5 ヘクタール）を対象としている。

また、参照エリアを、ホアイキン村落クラスターの周辺部、約 4 キロ四方のエリア（69,672 ヘクタール）に設定した。民族特性や土地利用特性、地理的特性の類似した周辺地域を参照エリアとして設定し、

このプロジェクト対象地のデータと比較することで、プロジェクト対象地で発生した時系列の変化が、プロジェクトによる影響であったかを検証するために設けている。

図 2　プロジェクト対象地域と参照エリア



3.4　森林動態解析/衛星画像解析の手法

3.4.1 森林動態解析/衛星画像解析の方針

時系列的なデータを用いて森林被覆変化を捉えるためには、各時点の衛星を個別に解析し変化を捉える方法と、期首若しくは期末のデータを解析し、その結果を次の時点比較に用いつつ変化を捉える方法がある。森林被覆タイプ別の分類精度が高い場合は時点ごとの変化解析でも十分検出精度を保つことができるが、分類精度が低い場合は分類誤差による変化量が真の変化量を超えて計算される可能性があり、変化抽出の手法としては適切ではない。

現在､NFIS プロジェクトにてラオス林野局森林調査計画課による 2010 年の森林基盤図が整備されており、プロジェクト対象地域及び参照エリアでの森林基盤図を入手することができた。よって、本検証業務では、2010 年森林基盤図をベースマップとして、変化抽出をもとに各時点の森林被覆図を整備する後者の手法を採択することとした。

また衛星画像解析に際しては、オブジェクト指向型分類を行うこととした。これは高解像度衛星のように個別のピクセルが樹冠と樹冠の影等の細かい意味を持っている場合に、これらをひとまとめにした林相判読のように一定の林分としてのかたまりを判定するのに適している分類手法である。オブジェクト指向型分類では、衛星画像を均質な情報ごとに領域分割することが第一歩となる。つまり、オブジェクト指向型分類が実行できるリモートセンシングソフトウェアにおいて、どの程度の領域サイズまで均質なものと

みなすかを、ユーザーがパラメータ（Scale Parameter： SP）を与えて決定することになる。SP を小さくすると同一林分を複数に分割してしまうが、SP を大きくすると異なる林分を同一のものとして判断してしまう。本検証業務では、オブジェクト指向分類が可能なソフトウェア e-cognition を用いて、また SP は、2010 年森林基盤図の作成時と同様の SP=300 で領域分割を行った。

3.4.2 光学センサー画像の選定、及び時期の選定

多時点衛星データを用いて森林分類を行う場合、分類精度の一貫性に配慮する必要がある。本検証業務は変化抽出に重点を置いているため、各時点間の衛星画像も同一のセンサーを用いることが望ましい。これは各時点間の画像が有する情報量が異なる場合、抽出される情報量に差異が発生し、均一な情報に基づく変化抽出が困難になるためである。

検討の結果、本検証業務では、RapidEye を用いて各時点の森林被覆図を作成することとした。これはベースマップとなる 2010 年森林基盤図が RapidEye を元に作成されていること、さらにラオス林野局が対象地域における RapidEye の画像を多く所有していたことが理由として挙げられる。

ところが、ラオス林野局の衛星画像アーカイブを確認したところ 2009/10, 2010/11, 2011/12 年の乾季画像を所有しているが、それ以降は 2014/15 年の直近年の画像しかなく、2012/13、2013/14 年の衛星画像は保有していなかった。欠損期間中の代替手段として、センサーの異なる Landsat 画像を用いることを検討したが、残念ながら、2012/13、2013/14 年の両時期ともに、雲量 20%以下で対象地域をカバーしている Landsat 画像を発見することができなかった。よって、最終的には、2009/10, 2010/11, 2011/12,及び 2014/15 年の 4 時点（3 時点間）の変化抽出を行い、検証業務を実施することとする。

図 3 検証時点と光学衛星画像

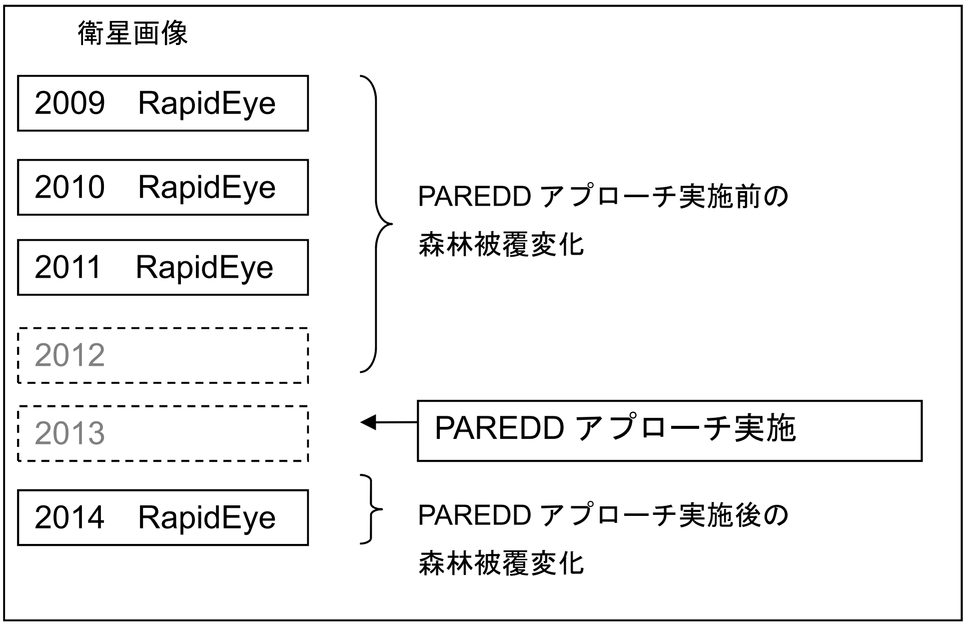


表 2 衛星画像のリスト

年	銘柄	品番	撮影時期
2009 年	RapidEye	20100209T044652_RE2_3A-NAC_3935142_90781.tif 20100209T044655_RE2_3A-NAC_3935129_90781.tif 20100213T043120_RE2_3A-NAC_3934998_90781.tif 20100213T043120_RE2_3A-NAC_3935620_90781.tif 20100213T043123_RE2_3A-NAC_3935003_90781.tif 20100213T043124_RE2_3A-NAC_3935619_90781.tif	2010 年 2 月
2010 年	RapidEye	20101108t043432_03_or_mo.img 20101108t043432_04_or_mo.img 20101109t043506_05a_or_mo.img 20101109t043506_05b_or_mo.img 20101114t043923_01_or_mo.img 20101204t043945_01a_or_mo.img	2010 年 11 月
2011 年	RapidEye	8783900_4848205.tif 8783900_4848204.tif 8783590_4848305.tif 8783590_4848306.tif 8783590_4848206.tif 8783900_4848304.tif 2012-02-28T044503_RE3_1B-NAC_8908948_132551.tif	2011 年末～2012 年初頭
2014 年	RapidEye	2015-01-23T043830_RE1_3B-NAC_19553014_295463.tif	2015 年 1 月

3.4.3 森林分類項目の設定

本検証業務で採用している森林の分類項目は、2015 年 6 月時点でのラオスの公式の森林階層区分に基づいている（表 3 参照）。本プロジェクト対象村の範囲で出現する主な森林の分類項目は、混交林（MD）、再生植生（RV）傾斜地農地（UC）である。森林減少の主要因であり、本検証業務で特定すべき「焼畑」は、傾斜農地（UC）に包含されており、本階層区分を用いて分類した場合でも、「焼畑」土地利用を抽出することは可能である。

表 3　ラオス公式森林階層区分

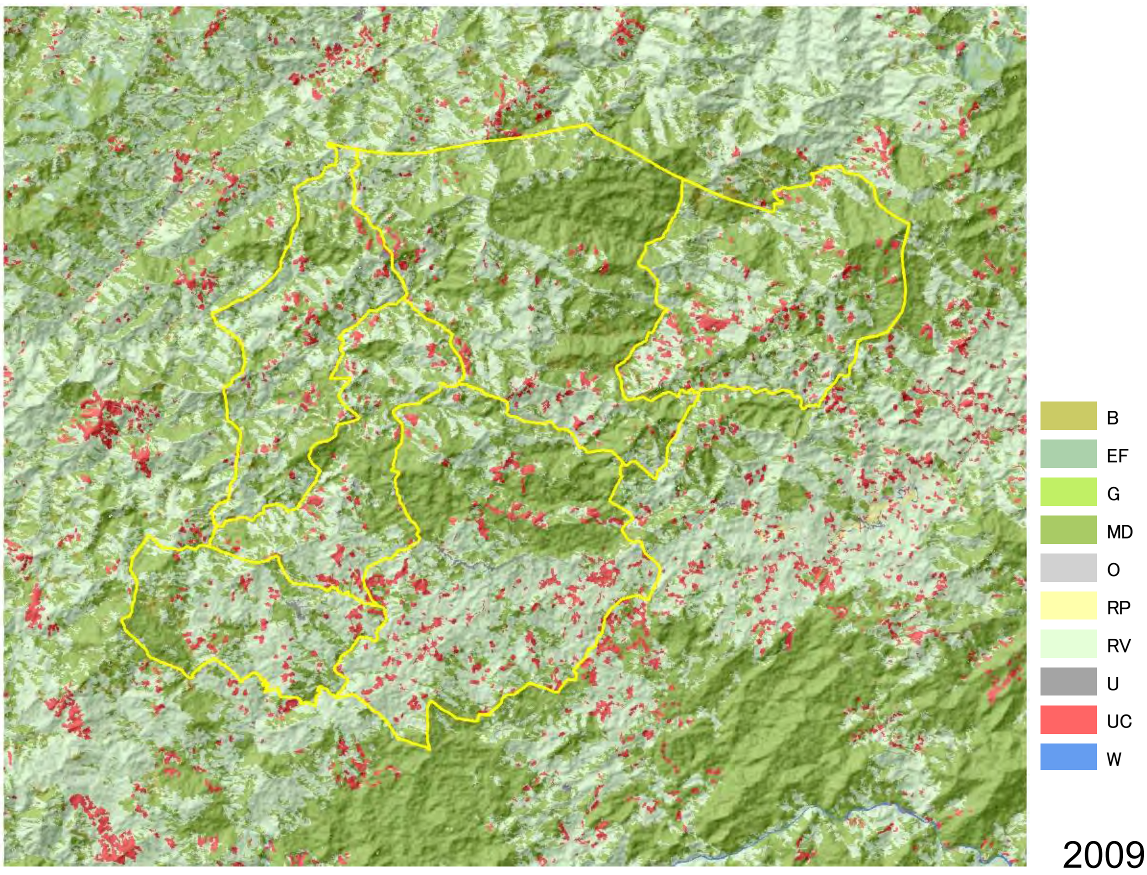
IPCC Definition	***National Level Classification System for Lao PDR***		
	Level 1	***Level 2***	
Forest Land	**Current Forest**	Evergreen Forest	EF
		Mixed Deciduous Forest	MD
		Dry Dipterocarp Forest	DD
		Coniferous Forest	CF
		Mixed Coniferous and Broadleaved Forest	MCB
		Forest Plantation	P
	Regenerating Vegetation	Bamboo	B
		Regenerating Vegetation	RV
Grassland	**Other Vegetated Areas**	Savannah	SA
		Scrub	SR
		Grassland	G
Wetlands		Swamp	SW
Cropland	**Cropland**	Upland Crop	UC

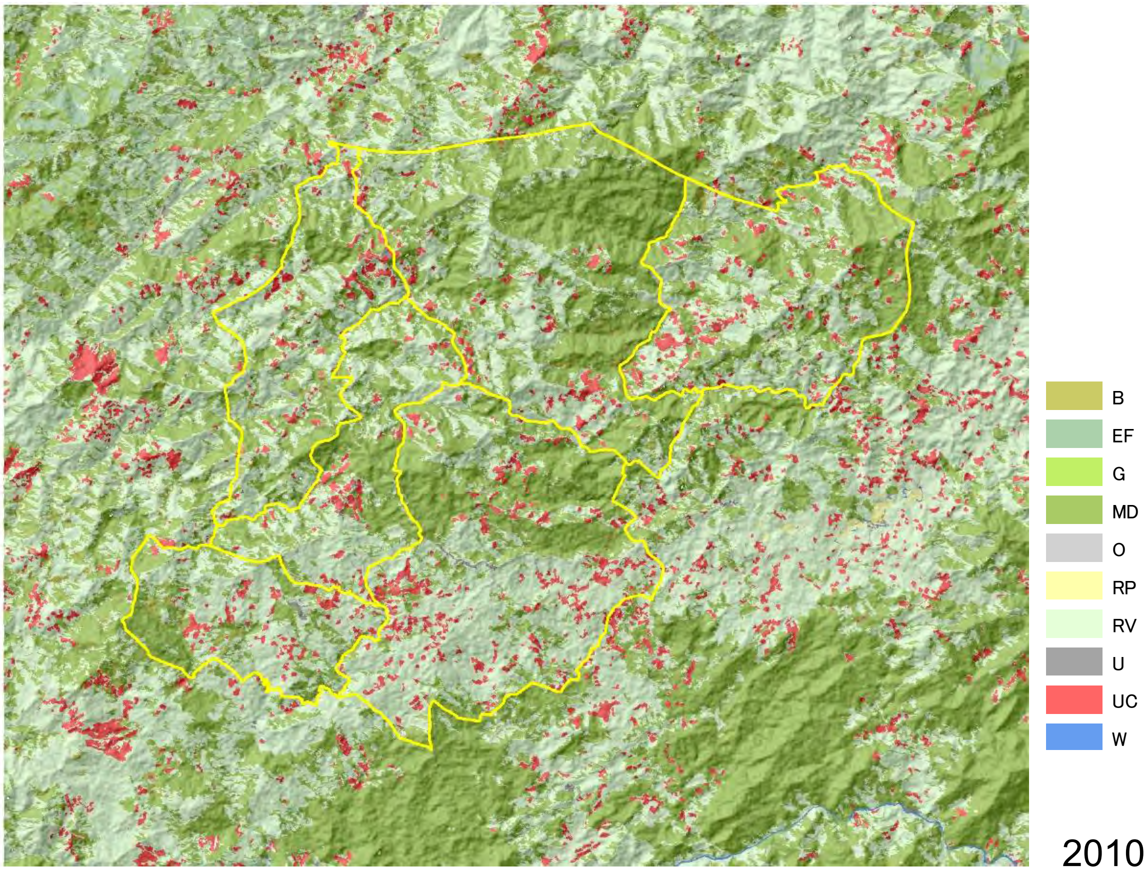
		Rice Paddy	RP
		Other Agriculture	OA
		Agriculture Plantation	AP
Settlements	**Non Vegetated Areas**	Urban	U
Other Land		Barren Land and Rock	BR
	Other Land	Other Land	O
Wetlands	**Water**	Water	W

3.4.4 森林被覆解析結果

解析結果を以下に示す。

図 4 プロジェクト対象地域および参照エリアにおける土地森林被覆図




B
EF
G
MD
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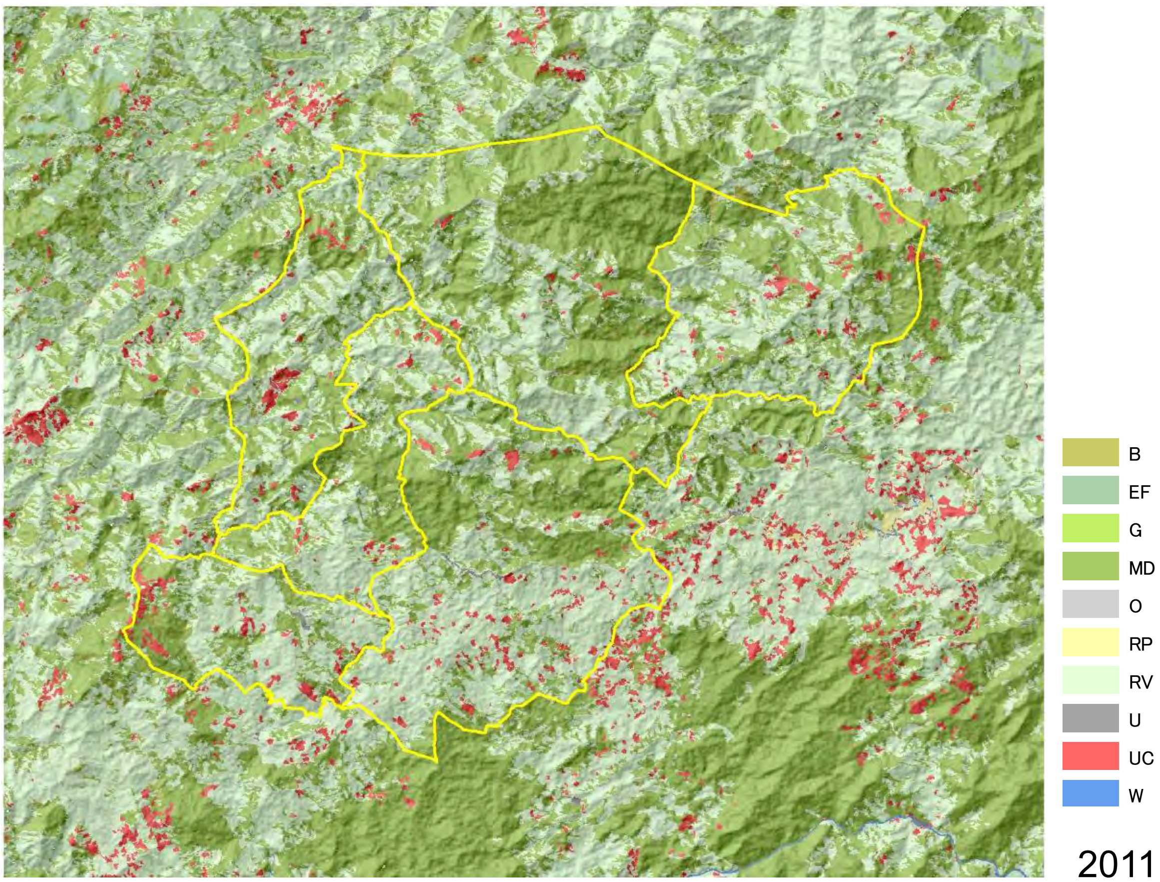
RP
RV
U
UC
W
2010


B
EF
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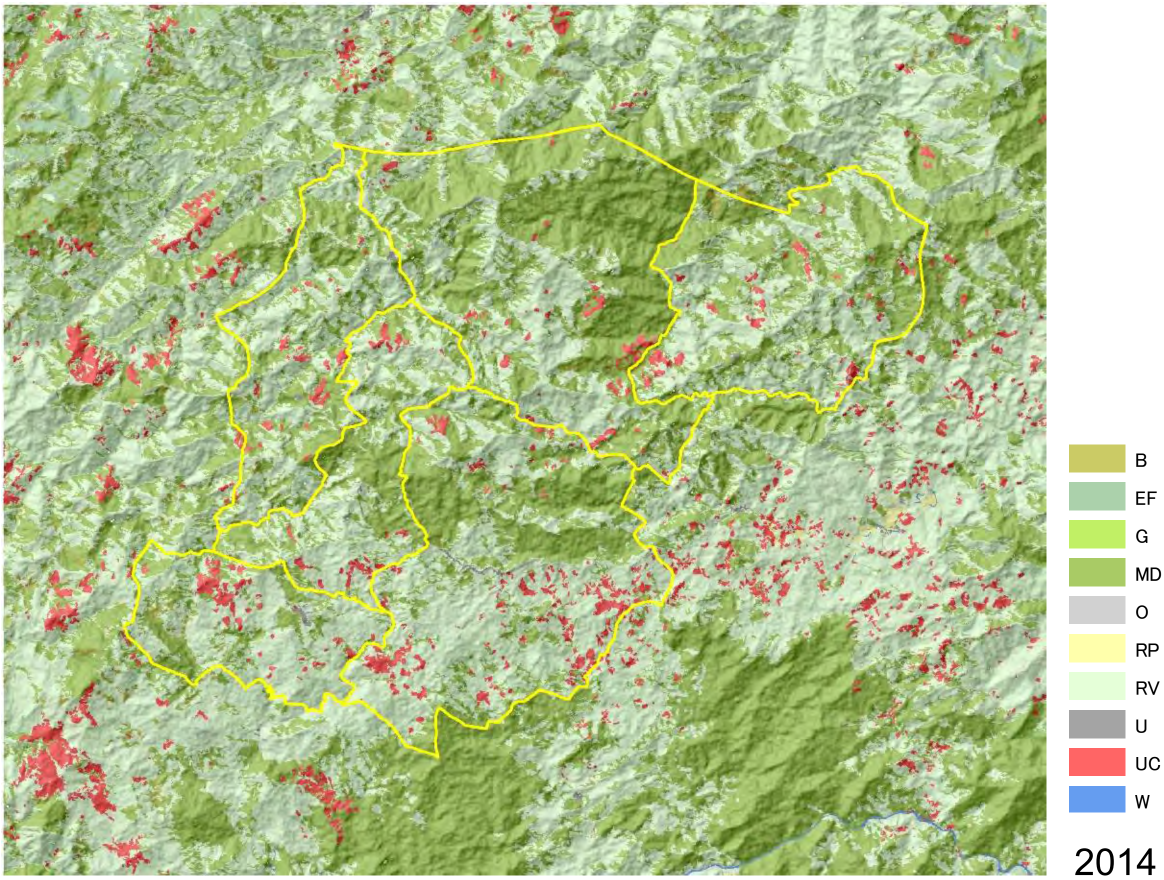
2011



3.5　精度検証

2010 年森林基盤図をベースマップとした森林被覆の変化抽出により、2009 年、2011 年、及び 2014 年の森林被覆図を作成した。この地図がある一定程度の精度を担保しているかどうか検証するために、現地踏査および航空写真を用いて、2014 年森林被覆図の精度を検証した。

本検証業務では、森林の「減少」の動態を把握することに重点をおいており、「森林」が「非森林」に変化したかどうかを判別できることが重要である。そのため本検証業務のために作成される森林被覆図は、森林内の階層を詳細に区分した Level2 の階層ではなく、Level 1 の階層の精度を担保することが重要である。このような考え方に基づき、プロジェクト対象地域および参照エリアの中で出現している Level1 の分類項目である、現状森林（Current Forest）、再生植生（Regenerating Vegetation）、農地（Cropland）、非植生地（Non Vegetated Areas）[1]、その他エリア（Other land）[2]、水域（Water）を対象とした精度検証を実施した。さらに、農地（Cropland）に関しては、森林減少の要因となっている傾斜地農地（Upland Crop）の動態を把握することが重要であるため、本対象地域で出現している農地の細目である傾斜地農地

[1] 対象地域では、「非植生地」は居住地（Urban Area）のみである。
[2] 対象地域では、「その他エリア」は道路である。

（Upland Crop）と水田（Rice Paddy）については、別途分類した上で精度検証を実施している。

このグランドトゥルースの箇所は計 150 点（有効数 144 点）であり、現状森林（Current Forest）、再生植生（Regenerating Vegetation）、傾斜地農地（Upland Crop）については現地踏査で、固定されている森林被覆区分である、水田（Rice Paddy）、非植生地（Non Vegetated Areas）、その他エリア（Other land）、水域（Water）については、2013 年付近に撮影された航空写真を用いて、分類精度を確認した。

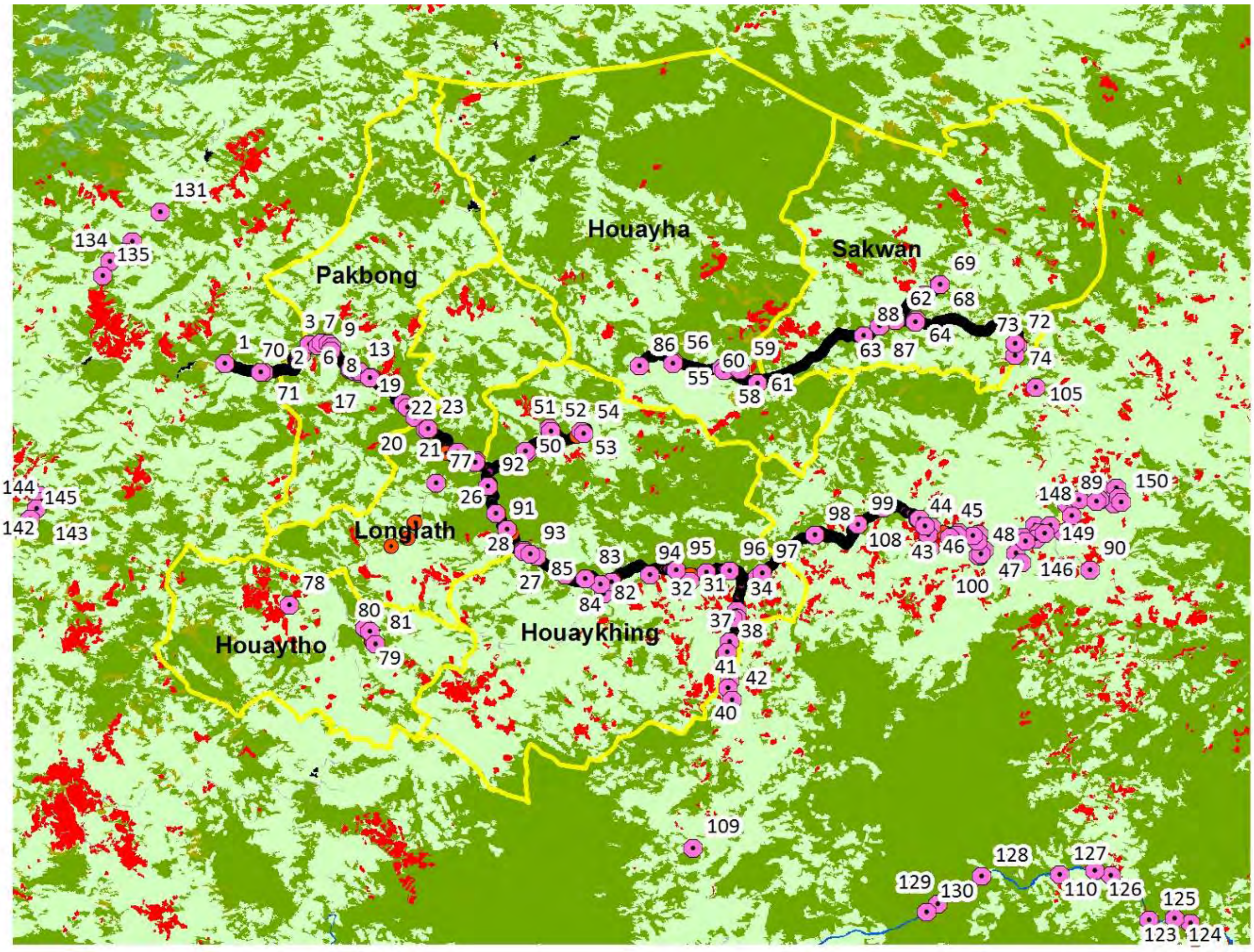


図 5 グランドトゥルース箇所位置図

以下の表 4 は、現地調査の結果と衛星画像による森林区分の判読結果を示している。全分類項目の精度を示す衛星画像解析で区分した
衛星画像解析で区分した再生植生（18 プロット）については、現地調査の結果では 13 プロットが再生植生、5 プロットが現状森林、衛星画像解析で区分した水田（20 プロット）については、現地調査の結果では 12 プロットが水田、6 プロットが再生植生、2 プロットが非植生地となり、この 2 項目については相対的に低い精度となっているが、特に焼畑の精度となる傾斜地農地の分類精度が高く（95.8%）、総合的な分類精度も 85.4%と高いため、画像解析結果は、対象地域の森林特性を十分な精度をもって表現していることが明らかになった。

表 4 現地調査結果、および航空写真を用いた衛星画像解析結果の精度検証

		現地調査結果								
		CF	RV	UC	RP	NV	O	W	Total	Users Accuracy
画像解析結果	CF	17	3	1	0	0	0	0	21	81.0%
	RV	5	13	0	0	0	0	0	18	72.2%
	UC	0	1	23	0	0	0	0	24	95.8%
	RP	0	6	0	12	2	0	0	20	60.0%
	NV	0	1	1	0	19	0	0	21	90.5%
	O	0	0	0	0	1	19	0	20	95.0%
	W	0	0	0	0	0	0	20	20	100.0%
	Total	22	24	25	12	22	19	20	144	
	Producers Accuracy	77.3%	54.2%	92.0%	100%	86.4%	100%	100%		

Overall Accuracy 85.4%

4　PAREDD の土地利用計画の概要

PAREDD は森林減少抑制のための一活動として、土地利用計画を実施している。これは、持続的に利用・保全すべき林地と農地を区分し、林地に指定された領域では持続的利用と保全を図り、過剰な土地利用の拡大を抑制することを目的としている。PAREDD の前の技術協力プロジェクトとして位置づけられている「森林管理及び住民支援プロジェクト」（FORCOM）では、持続的な土地利用技術の導入を図ることで森林減少の抑制を達成しようとしたが、土地利用区分を実施しない状況下の土地の管理は困難という最終評価での結論から導入が決定された。

PAREDD の対象村であるポンサイ郡において 2011 年 12 月から PAREDD アプローチの活動を開始し、2012 年 6 月まで、約半年かけて住民参加型でのゾーニングや森林管理規則作りを行った。その結果を**エラー! 参照元が見つかりません。**及び表 5 に示す。村落全面積の 36.7%が森林地として指定され、村落全面積の 34.8%が保全の対象である保護林・保全林となっている。

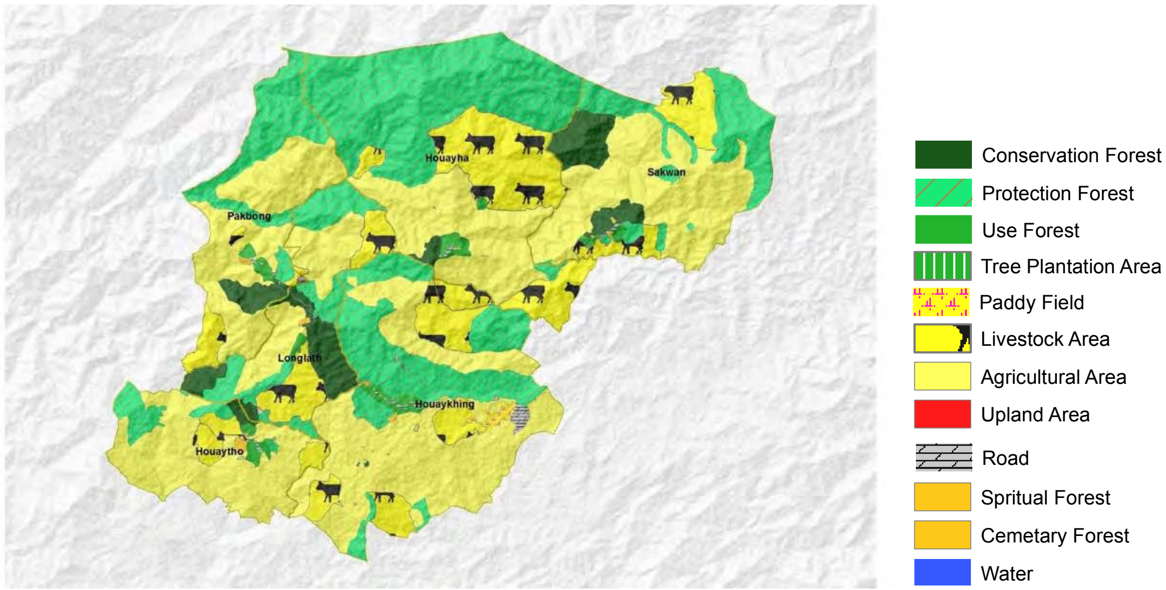


図 6　ルアンプラバン県ポンサイ郡ホアイキン村落クラスターにおける土地利用計画

表 5　ルアンプラバン県ポンサイ郡ホアイキン村落クラスターにおける土地利用計画

Land and Forest Category	Pakbong	Houayto	Houaykhing	Houayha	Sakwan	Total
Conservation Forest Area	231	92	4	78	627	1032
Protection Forest	1206	165	2359	3990	1223	8943
Managed Use Forest	76	90	124	105	51	446
Tree Plantation Area for Regeneration	2	4	6			12
Cemetery Forest	10	26	11	3	4	54
Sacred Forest		2	5		6	13
Building Land	4	7	73	7	9	100
Fruit Tree Plantation Area	1	5	6	1	1	14
Agricultural Area	2152	2290	3837.3	2040	2830	13149.3
Livestock Raising Area	297	364	1257	2077	801	4796
Paddy Field			89			89
Total (ha)	3979	3045	7771	8301	5552	28648

（Source: PAREDD 資料）

5　検証結果

5.1　仮説 1：土地利用計画を通じて設定された村落保全林・保護林エリアでの焼畑土地利用が減少する。

ホアイキン村落クラスターにおいて設定された村落保全林・保護林エリアにおける森林における森林変化及び土地利用変化を表 6、**エラー! 参照元が見つかりません。**に示している。基本的には村落保全林・保護林エリアにおける傾斜地の農地面積は年々減少傾向にあるが、特に、PAREDD が土地利用計画を実施し村落保全林・保護林エリアを設定した結果を示す 2014 年データとの比較では、2009 年と比べて 3 分の 1 以下（70%減）、2011 年と比較して、2 分の 1 以下（56.5%減）と大幅な減少率を示している。

また、これらの大幅な減少率が村落保全林・保護林の設置に伴う影響なのかを明らかにするうえで、プロジェクト対象地域および参照エリアにおける傾斜地の農地面積の変化率と比較を行った（表 7 参照）。特に村落保全林・保護林の設置の前後となる 2011 年と 2014 年の面積変化率を比較したところ、プロジェクト対象地域内が 11.8%減、参照エリア内が 5.6%減にとどまっており、村落保全林・保護林エリア内の傾斜地農地面積の変化率 56.5%が特別に高いことが理解できる。

以上、「土地利用計画を通じて設定された村落保全林・保護林エリアでの焼畑土地利用が減少する」という仮説 1 の検証の結果、村落保全林・保護林を設定することで、傾斜地の農地面積が減少するという効果を確認することができた。

表 6　村落保全林・保護林エリア内の山岳農地の面積変化 2009-2014（単位:ヘクタール）

年	2009	2010	2011	2014
傾斜地の農地面積	333.5	255.3	230.3	99.4

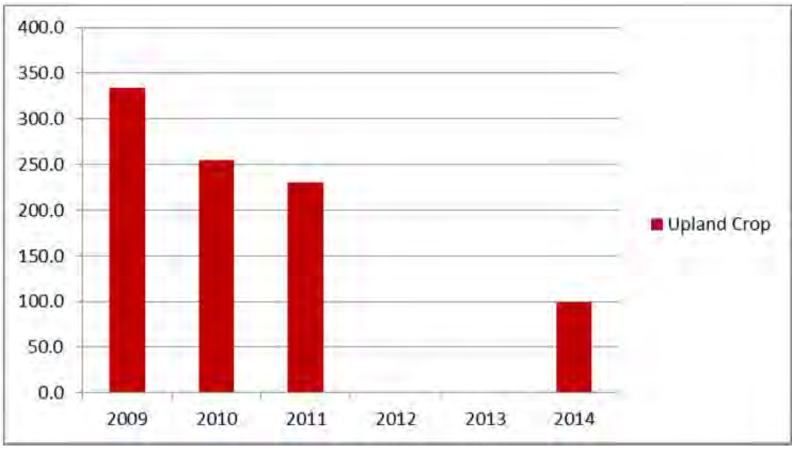


図 7 山岳農地の面積変化 2009-2014

表 7　2009 年を 100 としたときの山岳農地面積の比較　 2009-2014

年	2009	2010	2011	2014
村落保全林・保護林エリア内の傾斜地の農地面積	**100**	**77**	**69**	**30**
プロジェクト対象地域の傾斜地の農地面積	100	86	68	60
参照エリアの傾斜地の農地面積	100	89	77	72

村落保全林・保護林の設定には一定の焼畑抑制効果があることが示されたが、現在でも村落保全林・保護林の中での農地利用が行われている村が存在する。そのため、ホアイキン村落クラスター5 村の土地森林管理委員会および焼畑世帯からの聞き取りを行い、村落保全林・保護林内で農地利用が確認された世帯の土地利用行動に関する定性的な把握を試みた。

まず、対象村 5 村によると、村落保全林・保護林の中で土地利用をしている世帯数は把握した数値のみで計 22 世帯である。そのうち同一村内の世帯による土地利用の例が 15 世帯、周辺村の世帯による土地利用の例が 7 世帯である。

対象 5 村のうち、村落保全林・保護林内での土地利用が確認できず森林保全が保たれている良い例としてホアイトー村が挙げられる。図 8 はホアイトー村における土地利用計画図と 2014 年の傾斜地の農地利用の結果を重ねた図であるが、村の農地利用はほぼすべて農地内で行われており、村落保全林・保護林内に指定された地域での農地利用が行われていないことが確認できる。ホアイトー村の土地森林管理委員会によると、西部の保護林には、土地利用計画策定時に 2 世帯が農地利用を行っていたが、委員会メンバーが土地利用者に保護林の意義等を説明したため、焼畑耕作地を放棄して村内の農地に移動したとのことであった。

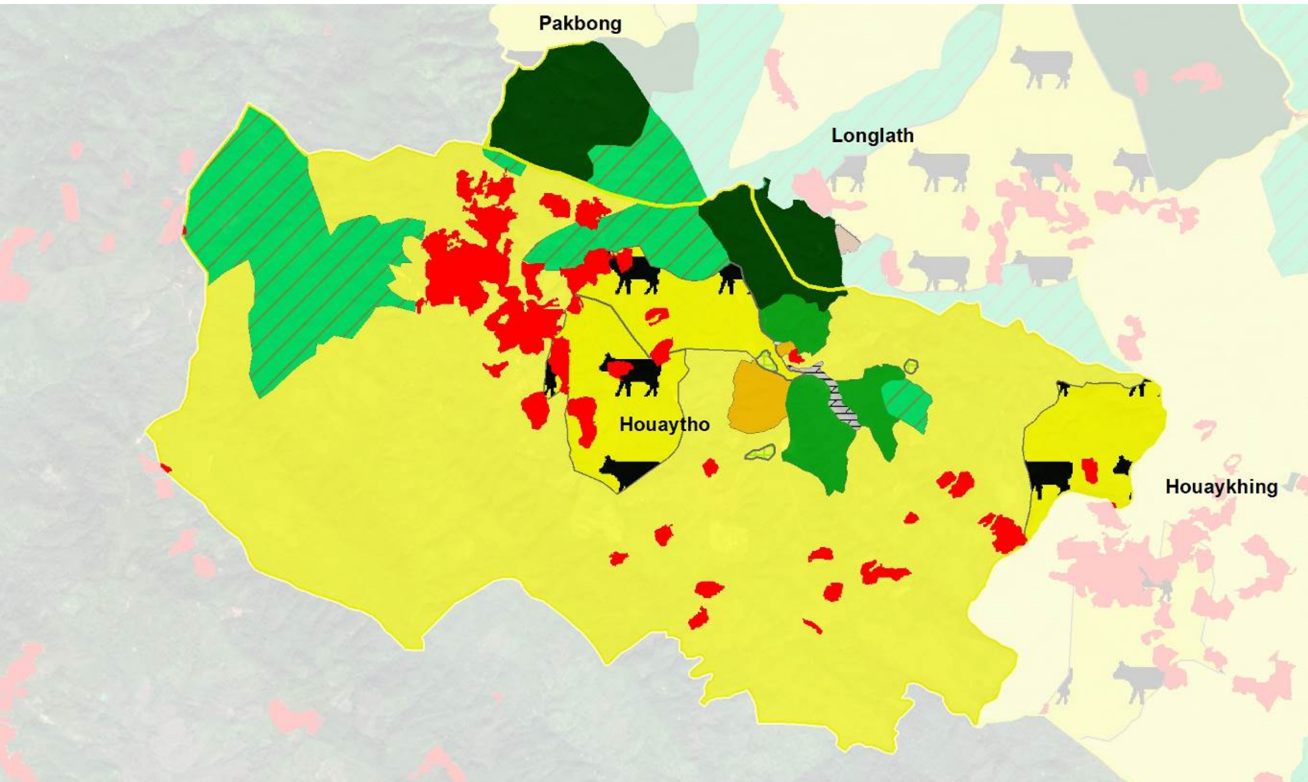


図 8　ホアイトー村における傾斜地の農地利用状況 2014

次に、現時点でも村落保全林・保護林内での土地利用が確認されている例として、ホアイキン村を挙げておく（図 9）。

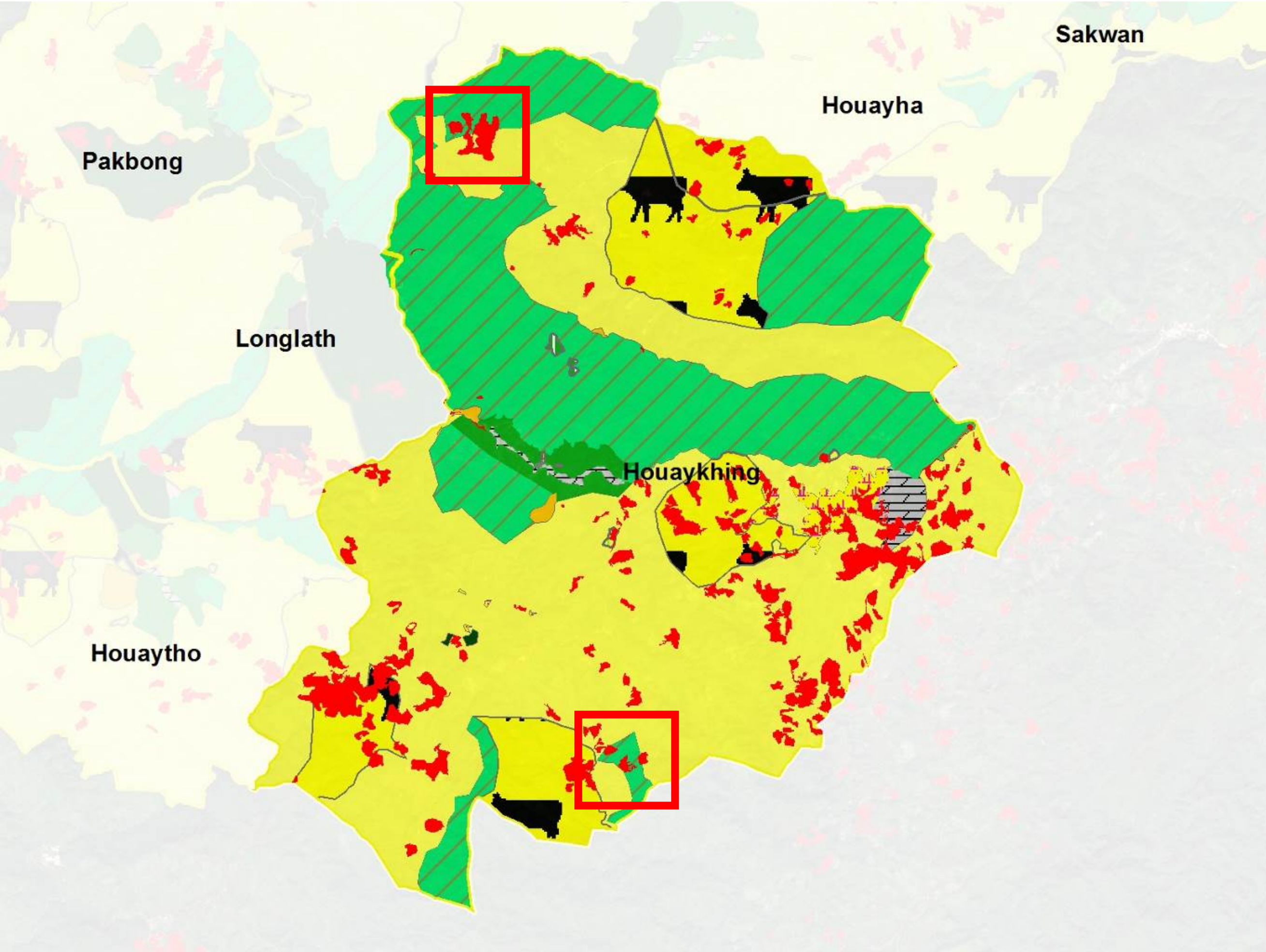


図 9　ホアイキンにおける傾斜地の農地利用状況 2014

この図中の赤枠で示した箇所が、保護林内での土地利用箇所である。村長、及び土地森林管理委員会に確認したところ、村北部の保護林内で 6 世帯、村南部の保護林内で 2 世帯が農地利用を継続しているとのことであり、村ではその世帯名も把握していた。今回、ホアイキン村では、その内 3 世帯に聞き取り調査を実施したが、いずれの世帯も、保護林の境界領域を理解しており、保護林内で農地利用していることを自覚していたが、保護林に指定されるずっと以前から農地として利用しており、また村内に代替地がないので、そのまま農地として継続せざるを得ない、という回答であった。また聞き取りを行った 3 世帯のうち 2 世帯は、PAREDD の家畜飼育活動の参加者世帯であったため、PAREDD の活動が焼畑に代わる代替生計手段となる可能性について質問したところ、将来的には可能性があるが、現時点で焼畑農地を放棄することが難しい、という意見であった。

もうひとつ別の事例として、ホアイハー村の事例を挙げておく（**エラー! 参照元が見つかりません。**参照）。ホアイハーは、村落内の世帯は、村落保全林・保護林内での土地利用は実施していないが、周辺村の７世帯が、ホアイハー村の村落保全林・保護林内にて土地利用を実施している。保護林内の土地利用を中止してもらうため、村長間や村人への話し合いは行われているが、引き続き農地として利用しているとのことであった。

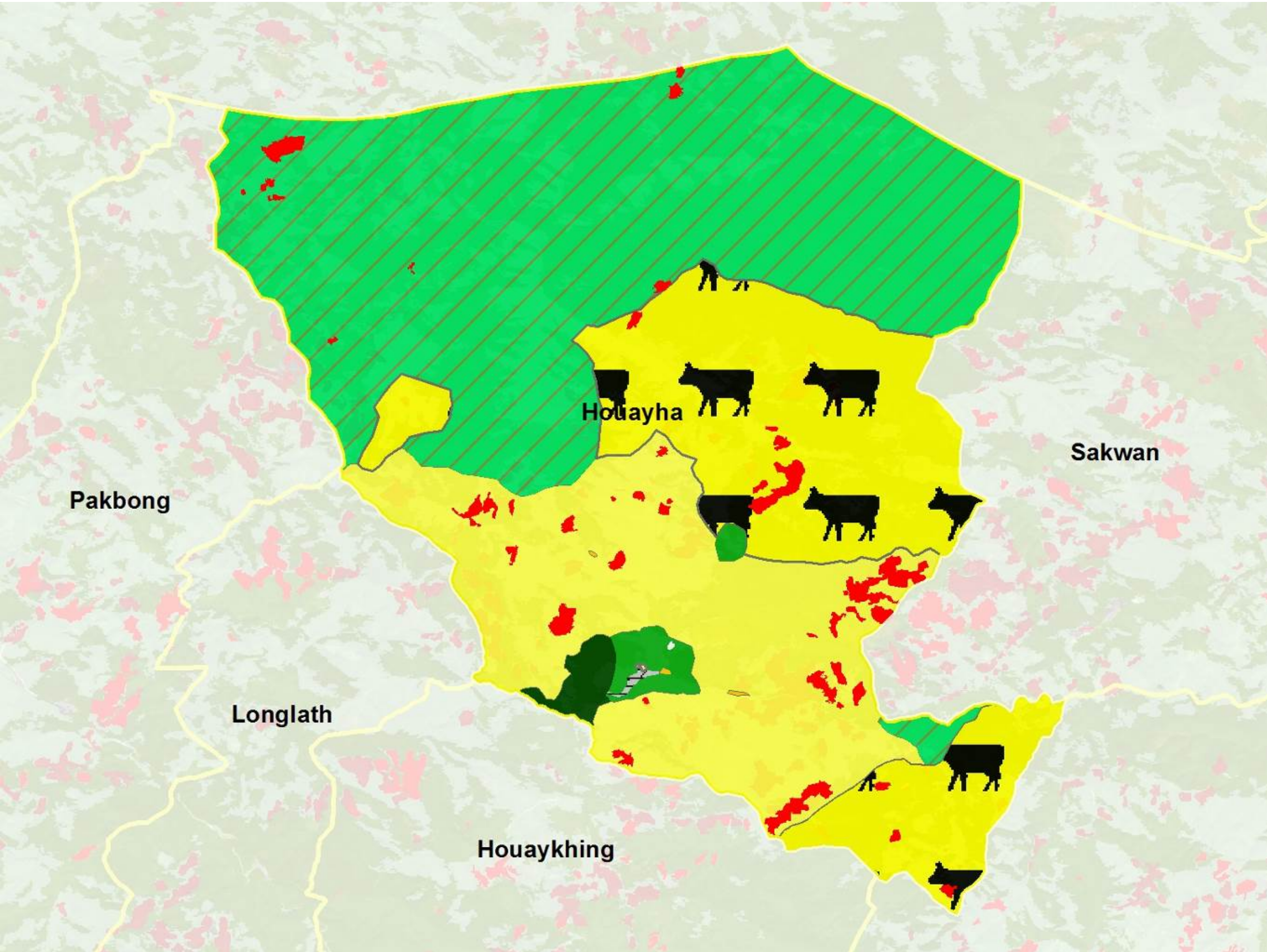


図 10　ホアイハー村における傾斜地の農地利用状況 2014

保護林内での土地利用世帯に対する村の土地森林管理委員会としての対応状況であるが、対象世帯を説得する努力は払われているが、森林管理規則に定められた罰則（主に罰金）を適用することについては、あまり積極的ではなかった。これはホアイキン村落クラスター内で調査した村すべてでほぼ同様の意見をもっており、村人が村人を取り締まることについては困難である様子が伺える。本件への対応は、村人だけでなく、上級機関である郡農林事務所の支援も必要である。なお蛇足ながら、PAREDD のカウンターパートは REDD+のセーフガードに関する研修を受けており、保護林からの農地の移転は強制ではなく、あくまで自主的な行動に基づくべきであるという意向を示していた点は、PAREDD のキャパビルの成果と

してあえて加筆しておきたい。

5.2　仮説 2：PAREDD アプローチの導入により、対象エリアの焼畑土地利用面積が減少する

PAREDD はゾーニングや生計向上活動を通じて、焼畑土地利用の抑制を図っている。本節ではプロジェクト対象地域における傾斜地の農地の変化を明らかにすることを通じて、PAREDD アプローチの効果を検証する。

表 8 及び**エラー! 参照元が見つかりません。**はプロジェクト対象地域および参照エリアの傾斜地の農地面積変化を示したものである。プロジェクト対象地域の 2014 年の傾斜地の農地面積は、2009 年と比べて-40.2%の減少、2011 年と比べて-11.8%の減少となっており、いずれもプロジェクト対象地域における傾斜地の農地面積は減少傾向にあることがわかる。また、参照エリアでは、2009 年比で-27.6%、2011 年比で-5.7%の減少に留まっている。プロジェクト対象地域のほうが参照エリアに比して減少率が高く、よってプロジェクトによる傾斜地の農地面積の一定程度の抑制効果があったと推察される。

ただし、プロジェクト対象地域における時系列の年減少率を追ってみると、2009-2010 の年減少率が-13.9%、2010-2011 の年減少率が-21.2%になっているのに対して、2011-2014 の年減少率[3]は-4.1%と低く、プロジェクト開始前のほうがプロジェクト開始後より高い減少率を示すという結果になっている。焼畑面積は天候等の要因により、年毎の面積に変動が見られるため、このデータをもって PAREDD アプローチの効果を否定することはできないが、「PAREDD アプローチの導入により対象エリアの焼畑土地利用面積が減少する」という仮説については、さらなる継続的なモニタリングとデータ収集が必要と考えられる。

表 8　プロジェクト対象地域および参照エリアの傾斜地の農地面積変化 2009-2014（単位:ヘクタール）

	2009	2010	2011	2014
プロジェクト対象地域	2158.5	1858.2	1464.5	1291.5
参照エリア	3772.9	3360.0	2895.8	2731.9

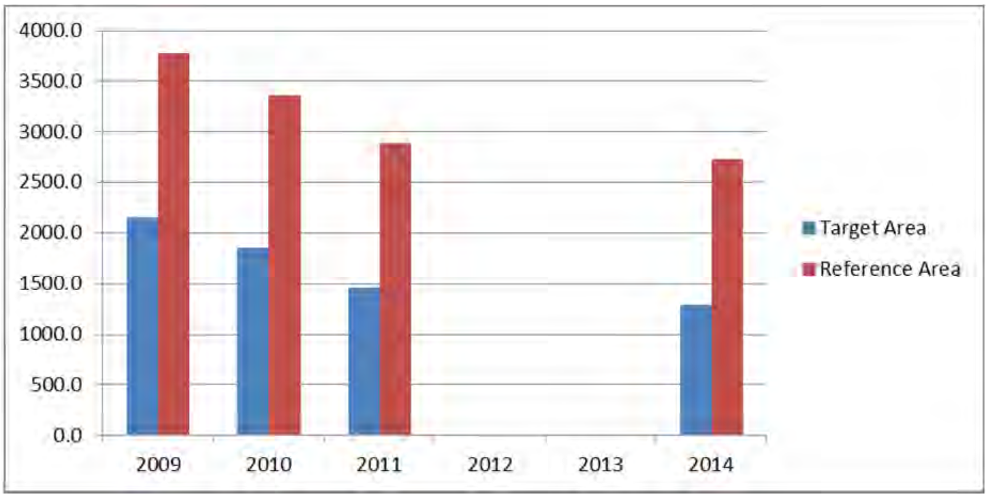


図 11 プロジェクト対象地域および参照エリアの傾斜地の農地面積変化 2009-2014

プロジェクト対象地域における焼畑が減少しているという傾向は明らかになったが、この減少要因につい

[3] 3 年間の減少面積が毎年一定であったという推計に基づく

ては明確ではない。この減少要因として１）代替生計手段の増加（畜産や賃労働等の農業外収入）、２）若年層の就労機会の増加に伴う農業従事者の減少、３）政府の森林保護政策の強化、等が推測されるが、その減少の要因を特定することは容易ではない。例えば、一般的に焼畑面積は山岳農村人口との正の相関があるといわれており、焼畑従事者が減少すれば焼畑も減少する。この相関を検証するために、プロジェクト対象村における人口動態の把握を試みた（**エラー! 参照元が見つかりません。**、表 9）。その結果、ホアイキン村では増加、パクボン村、ホアイトー村では微増、ホアイハー村、サクワン村では減少という状況にあり、少なくとも既存データでは焼畑の減少傾向が人口の増減と正の相関あると説明するのは困難である。

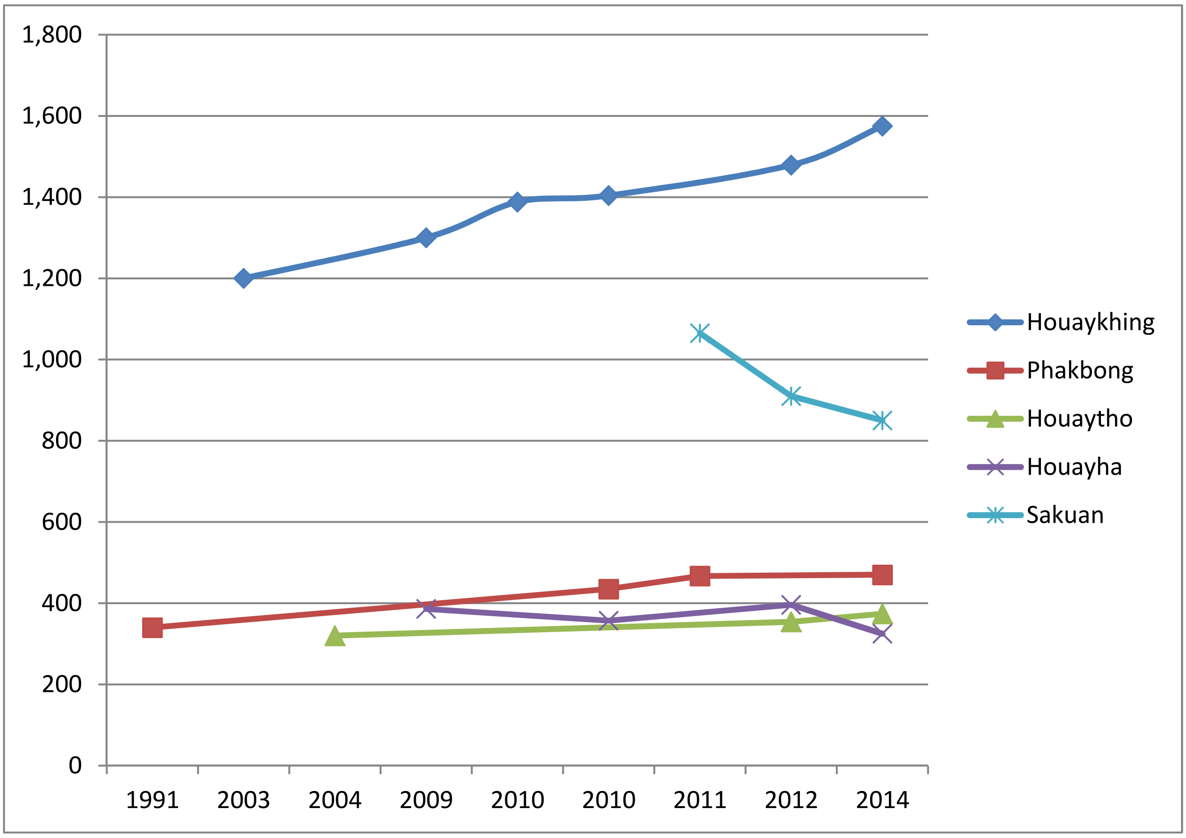


図 12 プロジェクト対象村の人口動態

表 9　プロジェクト対象村の人口動態

Year	Household/ Population	Houaykhing	Phakbong	Houaytho	Houayha	Sakuan
1991*	No. of HH		47HH			
	Population		340 ps.			
2003/01	No. of HH	165HH				
	Population	1,200 ps.				
2004	No. of HH					
	Population			320 ps.		
2009	No. of HH	188HH			49HH	
	Population	1,300 ps.			386 ps.	
2010/01	No. of HH	198HH				
	Population	1,388 ps.				

2010/06	No. of HH	202HH	80HH		47HH	
	Population	1,404 ps.	435 ps.		357 ps.	
2011	No. of HH		82HH			153HH
	Population		467 ps.			1065 ps.
2012	No. of HH	210HH	84HH	59HH	55HH	138HH
	Population	1,479 ps.		354 ps.	396 ps.	910 ps.
2014	No. of HH	229HH	82HH	67HH	50HH	115HH
	Population	1,575 ps.	470 ps.	374 ps.	325 ps.	850 ps.

（PAREDD 社会経済調査 2014 年より抜粋）

つぎに、PAREDD アプローチの生計活動支援の焼畑面積の減少効果をみるために、2015 年 1 月に PAREDD が実施した社会経済調査のデータを活用し、2011 年と 2014 年時点の、PAREDD プロジェクト参加世帯（n=35）と非参加世帯（n=36）の傾斜農地の面積の比較を試みた。ところが、各世帯のデータにばらつきが大きく、特に休閑地と焼畑地の面積の回答が混在していて、一貫した信頼性の高い時系列データとして取り扱うことが困難と判断し、ここでは検証結果は出していない。

また、プロジェクト活動の参加者と非参加世帯に差異があるという仮説で検証することについても検討すべきかと思われる。PAREDD の前身のプロジェクトである FORCOM の評価結果をみると、FORCOM が研修し、プロジェクト活動参加者が実践した農業技術を見て、非参加世帯が自ら実践するような技術普及の例も示されており、一概にプロジェクト活動の参加者と非参加世帯で採用されている農業技術に差異があるとも言い難い。また PAREDD 以外にも、TABI（The Agro-Biodiversity Initiative in the Lao PDR）や EU 畜産プロジェクトなどが PAREDD のプロジェクト対象村で活動しており、他プロジェクトがもたらす非参加者へのインパクトも否定できない。

このように、プロジェクト対象地域における焼畑が減少しているという傾向は読み取れるが、PAREDD がもたらしたインパクトの貢献度を実証することは困難であった。PAREDD は実証プロジェクトではないが、もしこのような検証を信頼度の高いデータを用いておこなう必要があれば、プロジェクト開始時点からの焼畑土地利用のモニタリング手法を工夫しておく必要がある。

5.3　仮説 3：PAREDD アプローチの導入により、プロジェクト対象地域の森林減少率が低下する。

前節までは、焼畑土地利用の視点から検証を進めてきたが、本節では、森林被覆の観点から検証を進めることとする。まず、プロジェクト対象地域であるホアイキン村落クラスターの森林被覆変化の概況であるが（表 10 及び図 13 参照）、現状森林面積は微減、休閑林面積が増加している。なお、前述のとおり、傾斜地の農地面積は減少している。このままこの傾向が続くと仮定すれば、休閑林の回復により、将来的には森林面積も徐々に増加することが想定される。

次に PAREDD アプローチの実施による森林減少率の変化について述べる。表 12 は 2010 年から 2011 年、及び 2011 年から 2014 年の現状森林の年減少率を、プロジェクト対象地域と参照エリアで比較したものである。プロジェクト対象地域の 2010 年から 2011 年の年減少率は-3.38%であったが、2011 年から 2014 年は-0.62%に低下している。また、参照エリアの年減少率は、2010 年から 2011 年が-0.45%、2011 年から 2014 年が-0.58%と、ほぼ横ばいであったことから、プロジェクト対象地域では PAREDD アプローチによって年間減少率が軽減されていることが示唆されている。ただ、今回の検証ではモニタリング対象期間が短いこともあり、森林被覆変化を検証するためにはさらなる継続的なモニタリングとデータ収集が必要と考えられる。

表 10　プロジェクト対象地域の森林被覆面積 2009-2014　（単位:ヘクタール）

Level 1	Level 2		2009	2010	2011	2014
Current Forest	Mixed Deciduous Forest	MD	15455.3	15938.0	15399.8	15114.0
Regeneration Vegetation	Bamboo	B	201.1	203.1	197.7	194.7
	Regenerating Vegetation	RV	14258.3	14074.1	15011.3	15473.0
Cropland	Upland Crop	UC	2158.5	1858.2	1464.5	1291.5
	Rice Paddy	RP	0.0	0.0	0.0	0.0
	Urban	U	67.4	67.4	67.4	67.4
Other Land	Other Land	O	72.8	72.8	72.8	72.8
Water	Water	W	0.0	0.0	0.0	0.0
TOTAL			32,213.5	32,213.5	32,213.5	32,213.5

表 11　参照エリアの森林被覆面積 2009-2014　（単位:ヘクタール）

Level 1	Level 2		2009	2010	2011	2014
Current Forest	Evergreen Forest	EF	866.8	869.8	850.0	846.5
	Mixed Deciduous Forest	MD	29977.0	30678.6	30556.3	30019.4
Regeneration Vegetation	Bamboo	B	595.0	605.6	569.4	560.2
	Regenerating Vegetation	RV	34090.7	33788.3	34430.7	35144.3
Other Vegetated Areas	Grassland	G	0.0	0.0	0.0	0.0
Cropland	Upland Crop	UC	3772.9	3360.0	2895.8	2731.9
	Rice Paddy	RP	117.4	117.4	117.4	117.4
	Urban	U	76.8	76.8	76.8	76.8
Other Land	Other Land	O	93.1	93.1	93.1	93.1
Water	Water	W	81.9	81.9	81.9	81.9
	TOTAL		69672	69672	69672	69672

表 12　プロジェクト対象地域及び参照エリアの森林減少率の比較　2009-2014

	2010-2011	2011-2014
プロジェクト対象地域	-3.38%	-0.62%
参照エリア	-0.45%	-0.58%

図 13 プロジェクト対象地域の森林被覆面積 2009-2014

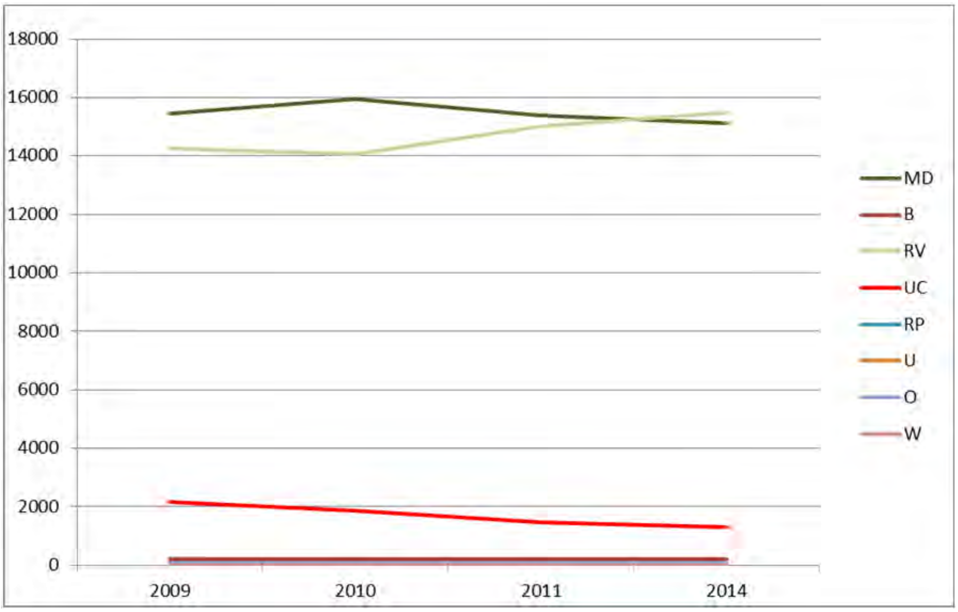
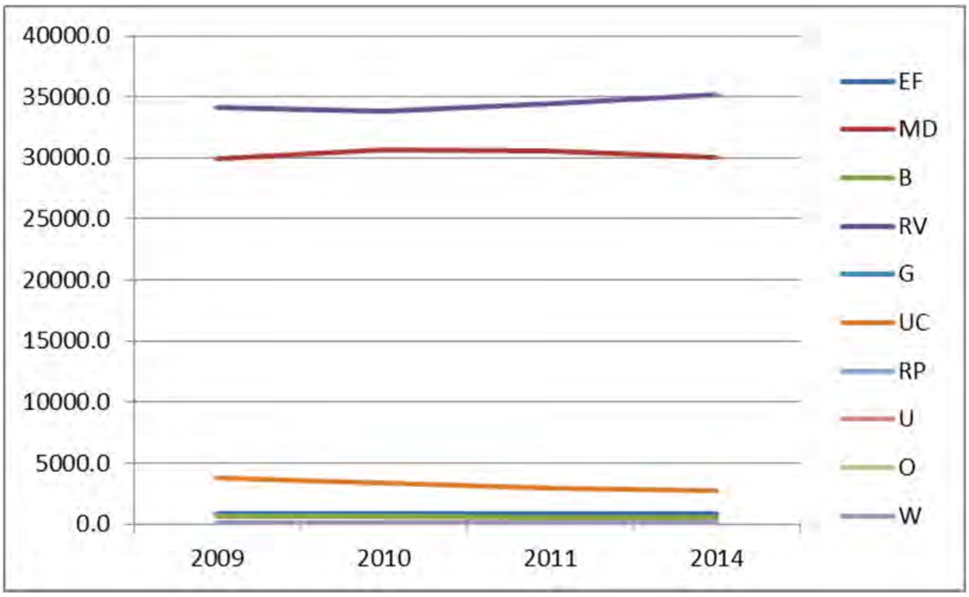


図 14 参照エリアの森林被覆面積 2009-2014



6　まとめ

本検証業務では 3 つの仮説について検証を進めてきた。

まず仮説 1「土地利用計画を通じて設定された村落保全林･保護林エリアでの焼畑土地利用が減少する」について検証したところ、PAREDD アプローチを通じて設定された村落保全林・保護林エリアの焼畑土地利用は減少傾向にあり、村落保全林・保護林エリアの設定が焼畑土地利用の抑制に寄与していることが明らかになった。村の土地森林管理委員や郡農林事務所が、村落保全林・保護林エリアを保全するためのモニタリングや指導を継続し続けている点が評価される。一方、現時点で村落保全林・保護林エリア内で土地利用をしている世帯は、新たに村落保全林・保護林エリアに進入してきた世帯ではなく、過去から継続的に利用してきた土地が村落保全林・保護林の網掛けにかかってしまった世帯が大半であるため、その意味では、継続的な指導だけでなく、代替地の準備や、村落保全林・保護林エリアの見直しも含めた対応が必要となるであろう。

つぎに仮説 2「PAREDD アプローチの導入により、対象エリアの焼畑土地利用面積が減少する」という点を検証した結果、PARDD の対象地域では、継続的に焼畑土地利用面積が減少していること、また対象エリアの焼畑土地利用面積は、参照エリアに比して減少率が高いことから、PAREDD アプローチが焼畑土地利用面積の抑制に、ある程度寄与していることが伺える。ただし、PAREDD 支援後に焼畑面積の減少が急速に進んだわけでなく、焼畑土地利用面積の減少の理由や PAREDD の寄与の度合いが、今回の調査では把握しきれなかった点は課題である。

最後に仮説 3「PAREDD アプローチの導入により、プロジェクト対象地域の森林減少率が低下する」については、2010-2011 年データと 2011-2014 年データを比較した結果、プロジェクト対象地域の年間減少率が軽減されていることが示唆されている。ただ、森林被覆変化を検証するためには、モニタリング対象期間が短いこともあり、さらなる継続的なモニタリングとデータ収集が必要と考えられる。

PAREDD アプローチの森林減少の抑制効果については、評価のタイミングが早く、効果の発現がまだ十分でなかった可能性があるにも関わらず、ポジティブな効果を確認することができた。引き続き継続的なモニタリングを実施することで、PAREDD アプローチの効果をより明確にしていく必要がある。

7　追記

PAREDD が過去 6 年間に支援してきたカウンターパートの能力強化であるが、今回の調査を通じて、カウンターパートの能力が著しい成長を見せていることを実感した。以下、例を挙げておきたい。

- 気候変動対策としての REDD+への理解の向上。
- REDD+の実施に伴う社会配慮（セーフガード）への理解の向上とモニタリング時における社会配慮の実践。
- 参加型土地森林利用計画の計画立案過程のファシリテーション能力の向上
- 土地森林利用計画に必要な GIS の基礎技術を有するカウンターパートの育成

添付書類１：NFIS 業務実施（PAREDD アプローチの効果検証業務スケジュール　日程表

Day	月日		Time	項目	場所
Day 1	06/18	木	AM	東京発	
			PM	ビエンチャン着	ビエンチャン
Day 2	06/19	金		NFIS 団内及び CP 打ち合わせ	
Day 3	06/20	土		報告書作成	
Day 4	06/21	日		ルアンプラバンへ移動	ルアンプラバン
Day 5	06/22	月		PAREDD 打ち合わせ、業務スケジュール確定	
Day 6	06/23	火		フィールド調査計画の作成、調査項目の整理、ロジ準備	
Day 7	06/24	水		フィールド調査計画の作成、調査項目の整理、ロジ準備	
Day 8	06/25	木		画像解析	
Day 9	06/26	金		画像解析	
Day 10	06/27	土		画像解析	
Day 11	06/28	日		画像解析	
Day 12	06/29	月		ホアイキン移動	
Day 13	06/30	火		ホアイキン VC 調査（インタビュー）	
Day 14	07/01	水		ホアイキン VC 調査（インタビュー）	
Day 15	07/02	木		ホアイキン VC 調査（インタビュー）	
Day 16	07/03	金		精度検証のための調査	
Day 17	07/04	土		精度検証のための調査	
Day 18	07/05	日		精度検証のための調査	
Day 19	07/06	月		精度検証のための調査	
Day 20	07/07	火		ルアンプラバン移動	
Day 21	07/08	水		データ取りまとめ	
Day 22	07/09	木		データ取りまとめ	
Day 23	07/10	金		データ取りまとめ	
Day 24	07/11	土		データ取りまとめ	
Day 25	07/12	日		データ取りまとめ、報告書ドラフト作成	
Day 26	07/13	月		データ取りまとめ、報告書ドラフト作成	
Day 27	07/14	火		検証業務成果発表会、ビエンチャン移動	
Day 28	07/15	水		JICA ラオス事務所報告	ビエンチャン
Day 29	07/16	木	PM	ビエンチャン発	
Day 30	07/17	金	AM	東京着	

添付書類 2：Ground Truth 調査票

FIELD NOTE of Ground Truth Survey

0. General Information

Plot ID	:	Date	: / / 2015
Waypoint No.	:	Surveyor	:
Province	:	Lat / Lon	: ° ' " × ° ' "
District	:	Elevation	: m

1. Forest

Type	:	EF	MD	CF	MCB	DD	P		
Density	:	Dense		Medium		Sparse			
Years Old	:	20 >	15 >	10 >	5 >	4	3	2	1

Main Species & Comment

2. Non-Forest

Land use	:	B	SB	FL	SA	SR	RP	AP	
		OA	G	SW	R	U	W	O	
Years Old	:	6	5	4	3	2	1	0	non

Main Crops & Comment

3. Photo/Sketch/Memo

Photo No.	:	,	,	,	,	,	,
Direction	:	,	,	,	,	,	,
Zoom	:	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No

Sketch/Memo

ラオス人民民主共和国
ラオス国持続可能な森林経営及びREDD+のための国家森林情報システム構築に係る能力向上プロジェクト
（第2年次）

業務完了報告書

添付資料１６：技術移転実施報告書

Lao People's Democratic Republic
Department of Forestry, Ministry of Agriculture and Forestry

The Capacity Development Project for

Establishing National Forest Information System for

Sustainable Forest Management and REDD+

Technology Transfer Report

September 2015

Japan International Cooperation Agency

Joint Venture
KOKUSAI KOGYO CO., LTD.
ASIA AIR SURVEY CO., LTD.

1. Concept for the technology transfer

Output 1 completed three main components ((1) accuracy assessment, (2) carbon stratification and (3) correction of forest type maps) as below figure. To complete these components, necessary techniques and knowledge were transferred to FRIC officers through various activities.

For (1) Accuracy assessment, the technical transfer was conducted through lectures, discussion, exercise and OJT. To design the methodology of accuracy assessment at first, discussion with C/P is most important. Otherwise, that methodology become impracticable one. After that, FRIC officers became to be familiar with the accuracy assessment work through the exercise.

(2) Carbon stratification has many research factors. It is better Japanese consultants to examine it at first before training FRIC officers. After that, technique and knowledge of carbon stratification were transferred through lecture.

For (3) Correction of forest type maps, the additional ground truth survey training was conducted at first. FRIC officers have conducted ground truth survey in FIM project though, there are still unsure land-cover/use types, and skills and experiences are still not enough. After that, technique and knowledge of correction work itself were transferred through lectures, discussion, exercise and OJT.

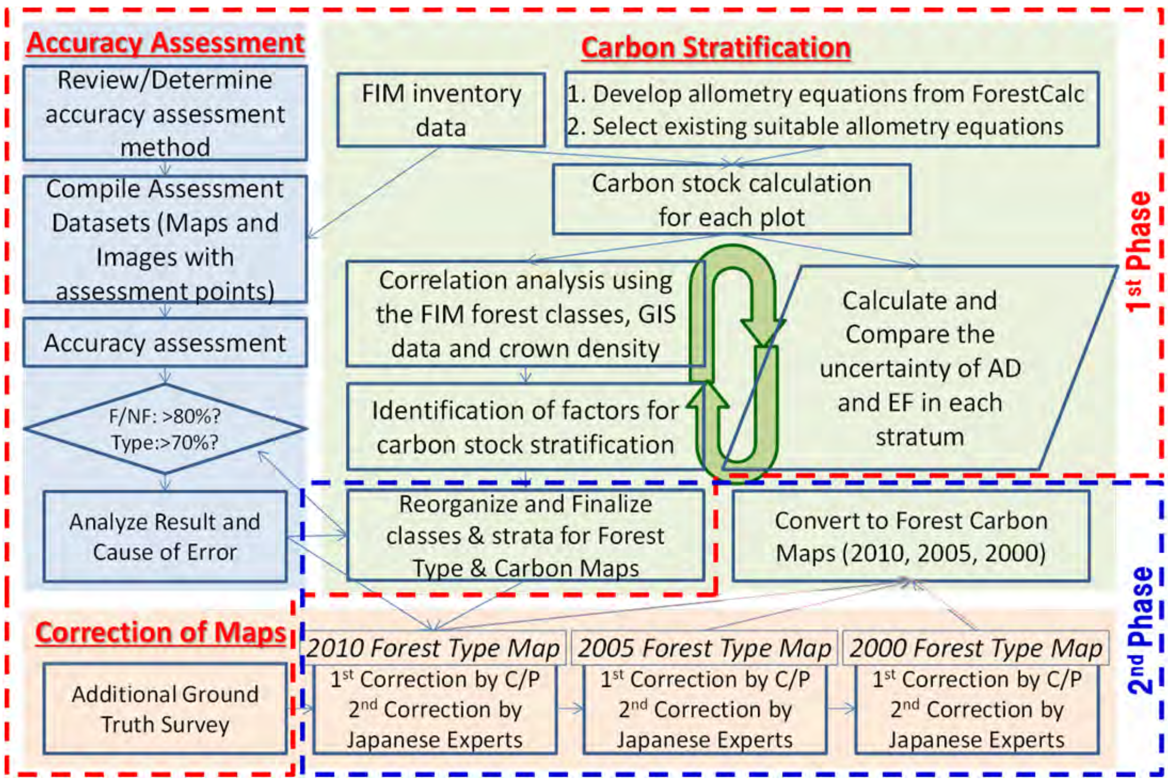


Figure: Overall Work Flow of Output 1

NFI Pilot survey training was held on FIPD meeting room and field for the Inventory section staff before implementeng the field survey. Although some inventory section staff were familir with inventory survey, remaining staff needed to learn the concept of NFI and how to use the equipments. Sub-contractor arranged this training with Japaese expert. Field survey was implemented by 3 teams. At least, team leader have to learn all idea of NFI and how to use the equipments. Refer the detail plan and concept of pilot survey training to the Pilot survey report.

2. Detailed programme

Title	Participants	Contents	Time/ Duration	Method	Venue	Trainer	Achievement
Introduction of NFIS Project	FRIC Officers	● Introducing and Discussing about 4 Outputs	November 2013 (2 days)	Lecture and Discussion	Vientiane Capital	○N. Kitamura R. Kajiwara	FRIC officers understood the outline of NFIS project and activities of 4 outputs.
Remote Sensing and GIS Training	Remote Sensing/GIS Leaders (FRIC)	● Introducing and Discussing about methodology of Accuracy Assessment and Carbon Stratification ● Practicing Accuracy Assessment Work	December 2013 (3 weeks)	Lecture and Exercise	Tokyo	R. Kajiwara	Remote Sensing/GIS Leaders (FRIC) understood how to conduct accuracy assessment and tought the other officers.
Introduction of Accuracy Assessment	Remote Sensing/GIS Officers (FRIC)	● Discussing about methodology of Accuracy Assessment	January 2014 (1 day)	Lecture and Discussion	Vientiane Capital	R. Kajiwara	Remote Sensing/GIS Officers (FRIC) understood methodology of accuracy assessment
2010 Accuracy Assessment Training	Remote Sensing/GIS Officers (FRIC)	● Practicing Accuracy Assessment Work	January 2014 (8 days)	Lecture, Exercise and OJT	Vientiane Capital	R. Kajiwara	Remote Sensing/GIS Officers (FRIC)

							understood how to conduct accuracy assessment.
Ground Truth Survey Planning Training	Remote Sensing/GIS Officers (FRIC)	● Introducing Outline of Ground Truth Survey ● Introducing Ground Truth Survey Planning ● Practicing Ground Truth Survey Planning ● Discussing Schedule and Organization of Ground Truth Survey	January 2014 (4 days)	Lecture, Exercise and Discussion	Vientiane Capital	R. Kajiwara	Remote Sensing/GIS Officers (FRIC) understood Outline of Ground Truth Survey and how to plan it. Schedule and organization of Ground Truth Survey were determined.
Ground Truth Survey Conducting Training	Remote Sensing/GIS Officers (FRIC)	● Practicing Ground Truth Survey	February and March 2014 (3 weeks)	OJT in Field Practice	Vientiane Capital (1 day) Whole Country (3 weeks)	M. Nasu 〇R. Kajiwara T. Furuya	Remote Sensing/GIS Officers (FRIC) understood how to interpret satellite imagery and developped correspondences

							between satellite imagery and actual land-cover/use types.
Creation of 2010 Interpretation Key and Card Training	Remote Sensing/GIS Officers (FRIC)	● Introducing Importance of Interpretation Key and Card. ● Discussing 2010 Interpretation Key ● Practicing Creation of 2010 Interpretation Card	June and July 2014 (12 days)	Lecture, Exercise and Discussion	Vientiane Capital	R. Kajiwara	Remote Sensing/GIS Officers (FRIC) understood importance of inter pretation key and card how to create. 2010 interpretation key was defined. 2010 interpretation card was created.
Kick-off Training for Correction of 2010 Forest Type Map (RapidEye)	Remote Sensing/GIS Officers (FRIC)	● Discussing the Methodology for Correction of 2010 Forest Type Map ● Introducing How to Correct 2010 Forest Type Map Based on RapidEye Imagery ● Discussing the	July 2014 (4 days)	Lecture, Exercise and Discussion	Vientiane Capital	R. Kajiwara	The methodology for correction of 2010 forest type map was determined. Remote Sensing/GIS Officers (FRIC) understood how to correct 2010 forest

		Schedule and Organization for the Correction Work ● Practicing the Correction Work					type map based on RapidEye imagery. The schedule and organization for the correction work was determined.
Lectures on Theory of Remote Sensing	Remote Sensing/GIS Officers (FRIC)	●	July 2014 (10 days)	Lecture, Exercise	Vientiane Capital	M. Nasu	
Creation of 2005/2000 Interpretation Key and Card Training	Remote Sensing/GIS Officers (FRIC)	● Discussing 2005/2000 Interpretation Key ● Practicing Creation of 2005/2000 Interpretation Card	August 2014 (5 days)	Lecture, Exercise and Discussion	Vientiane Capital	R. Kajiwara 〇T. Furuya	Remote Sensing/GIS Officers (FRIC) understood how to create interpretation key and card. 2005/2000 interpretation key was defined. 2005/2000 interpretation card was created.
Kick-off Training for Correction of 2010 Forest Type	Remote Sensing/GIS Officers (FRIC)	● Introducing How to Correct 2010 Forest Type Map Based on	October 2014 (2 days)	Lecture, Exercise and Discussion	Vientiane Capital	R. Kajiwara	Remote Sensing/GIS Officers (FRIC)

Map (PALSAR)		PALSAR ● Discussing the Schedule for the Correction Work ● Practicing the Correction Work					understood how to correct 2010 forest type map based on PALSAR. The schedule for the correction work was determined.
Kick-off Training for Correction of 2005/2000 Forest Type Map	Remote Sensing/GIS Officers (FRIC)	● Discussing the Methodology for Correction of 2005/2000 Forest Type Maps ● Introducing How to Correct 2005/2000 Forest Type Maps Based on RapidEye Imagery ● Discussing the Schedule for the Correction Work ● Practicing the Correction Work	December 2014 and January 2015 (3 days)	Lecture, Exercise and Discussion	Vientiane Capital	R. Kajiwara 〇T. Furuya	The methodology for correction of 2005/2000 forest type maps was determined. Remote Sensing/GIS Officers (FRIC) understood how to correct 2005/2000 forest type maps based on SPOT5 and LANDSAT TM imagery. The schedule for the correction work was determined.
Lectures on	Remote	●	March 2015 (8	Lecture,	Vientiane	M. Nasu	

Theory of Remote Sensing2	Sensing/GIS Officers (FRIC)		days)	Exercise	Capital		
2005/2000 Accuracy Assessment Training	Remote Sensing/GIS Officers (FRIC)	● Practicing Accuracy Assessment Work	June and July 2015 (4 days)	Lecture, Exercise and OJT	Vientiane Capital	R. Kajiwara 〇T. Furuya	Remote Sensing/GIS Officers (FRIC) understood how to conduct accuracy assessment.
NFI Pilot survey training	FIPD inventory section	● Introducing NFI design ● Equipment Training	March 9~13 2015(5days)	Lecture and Exercise	Vientiane Capital(FIPD)	Forest Carbon	Inventory staff understood basic knowledge of NFI. They got how to use the field equipment.

*1 Circles (〇) indicate the person who is in charge for the relevant technical transfer activitie(s).

3. C/P Assignment

Category	Output		Code	Job Titele	Name
REDD+	Output 4	Other relevant information required for REDD+ is compiled.	PD	Project Director (Director of FIPD)	Mr. Linthong KHAMDY
			PM	Project Manager (FRIC Manager)	Mr. Soukanh BOUNTHABANDID
			RD	REDD+ Officer	Mr. Phetdavong
Remote Sensing	Output 1	Information on Forest Carbon Dynamics at national level is compiled.	RS-M	Remote Sensing Unit Manager	Mr. Sombath PANYASAK
			RS-L1	Remote Sensing/GIS Leader 1/FRIC	Mr. Khamkhong INTHAVONG
			RS-L2	Remote Sensing/GIS Leader 2/FRIC	Mr. Khamsouk KODMONTY
			RS-L3	Remote Sensing/GIS Leader 3/FRIC	Mr. Onekeo LATVIENG
			RS-F1	Remote Sensing/GIS Fellow 1/FRIC	Ms. Bountanome LOUANGPASEUTH
			RS-F2	Remote Sensing/GIS Fellow 2/FRIC	Ms. Chansamou VONGSANITH
			RS-F3	Remote Sensing/GIS Fellow 3/FRIC	Ms. Konsy SYLIPHONG
GIS/ Database	Output 2	Prototype of National Forest Information Database (NFIDB) is designed.	DB-M	DB Management/Arrangement/FRIC	Mr. Souvanna CHANTHALUESY
			DB-D	DB Development/Operation/FRIC	Mr. Somphavy KEOKA
Inventory	Output 3	Next round of National Forest Inventory (NFI) is designed.	BO	Botanical Officer	Mr. Bouanlouan
			IV-FR	Inventory Officer/FRIC	Mr. Siamphone SIBOUN
			IV-DC	Inventory Officer/Data Collection	Mr. Phouangphet
			IV-DA	Inventory Officer/Data Analysis	Mr. Bounpheng VICHIT

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ラオス国持続可能な森林経営及びREDD+のための国家森林情報システム構築に係る能力向上プロジェクト
（第2年次）

業務完了報告書

添付資料１７:国家森林情報データベースのプロトタイプに係る報告書

Lao People's Democratic Republic
Department of Forestry, Ministry of Agriculture and Forestry

The Capacity Development Project for

Establishing National Forest Information System for

Sustainable Forest Management and REDD+

Basic Design Document

National Forest Information Database (Prototype)

Japan International Cooperation Agency

Joint Venture
KOKUSAI KOGYO CO., LTD.
ASIA AIR SURVEY CO., LTD.

History of Revisions

Version	Date of Insertion/ Revision	Reason for Revision and Revised Point	Prepared by
1.0	2015.09.30	First Edition	Kokusai Kogyo Co., LTD

Chapters

1. Introduction

This Basic Design Document specifies the basic design specifications of National Forest Information Database (NFIDB) developed through the capacity development project for Establishing National Forest Information System (NFIS) for Sustainable Forest Management and REDD+.

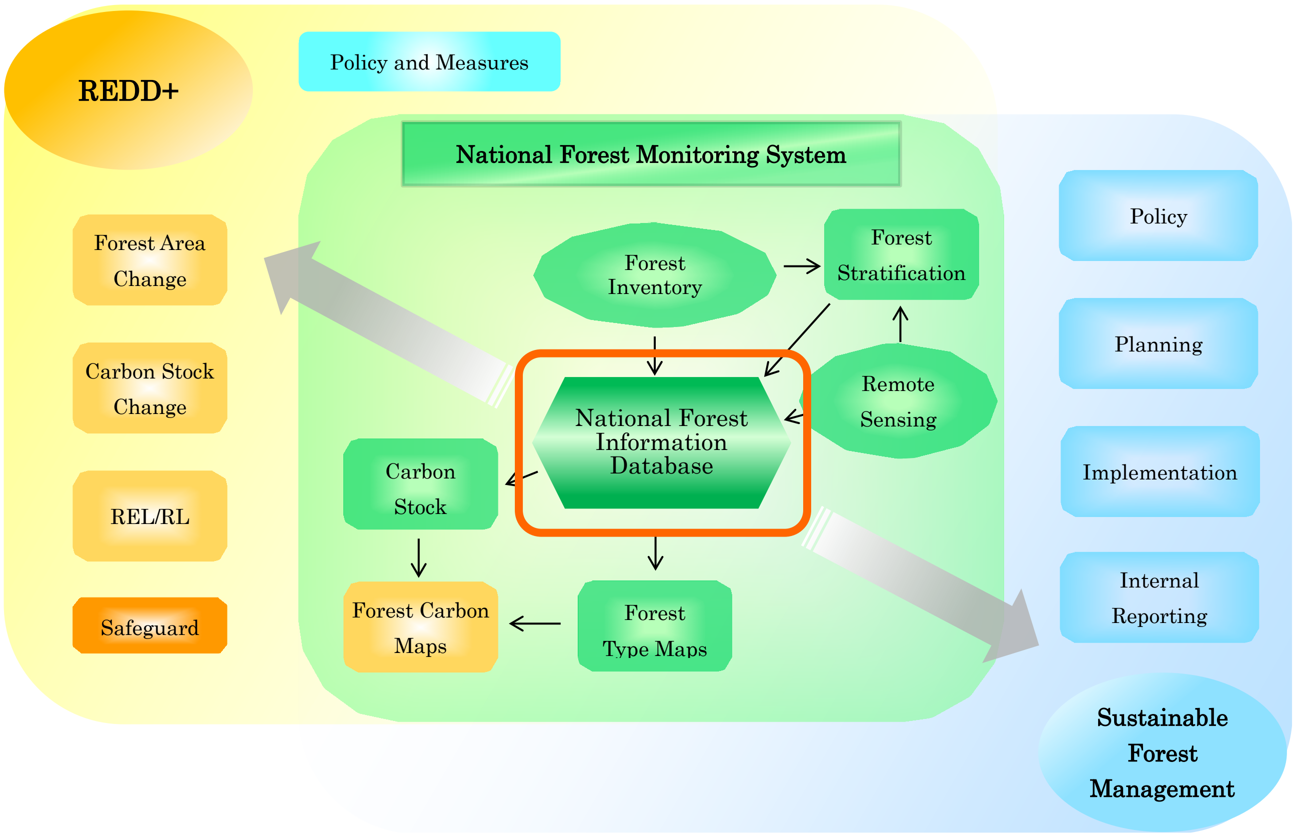
Since this is the prototype design document therefore it is necessary to make further implementation plan with detail condition (budget and time frame) before actual development

2. System Configuration

2.1. Overall Configuration

2.1.1. Overview of System

2.1.1.1 Orientation of System



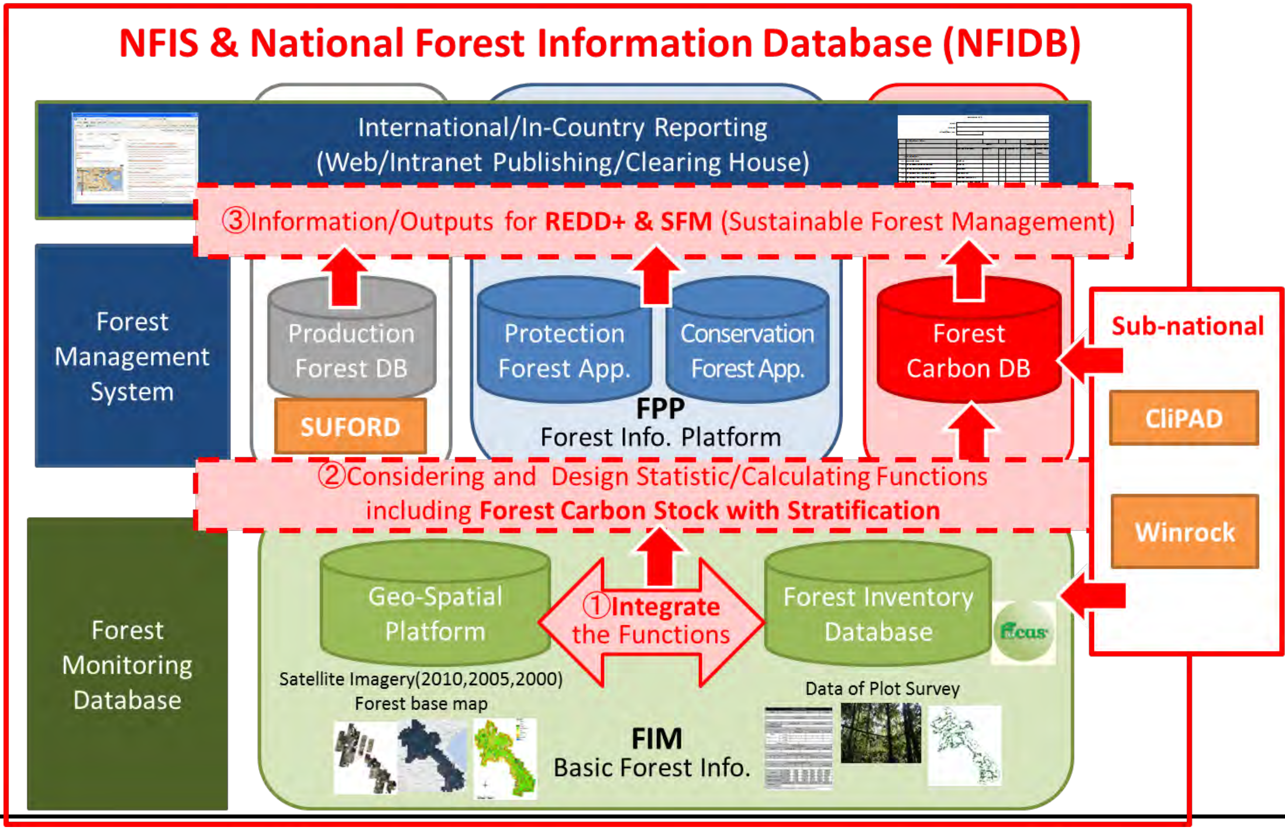
National Forest Information Database (NFIDB) needs to support the following basic functions for NFMS.

(1)To store remote sensing data and ground-based forest carbon inventory data appropriately,

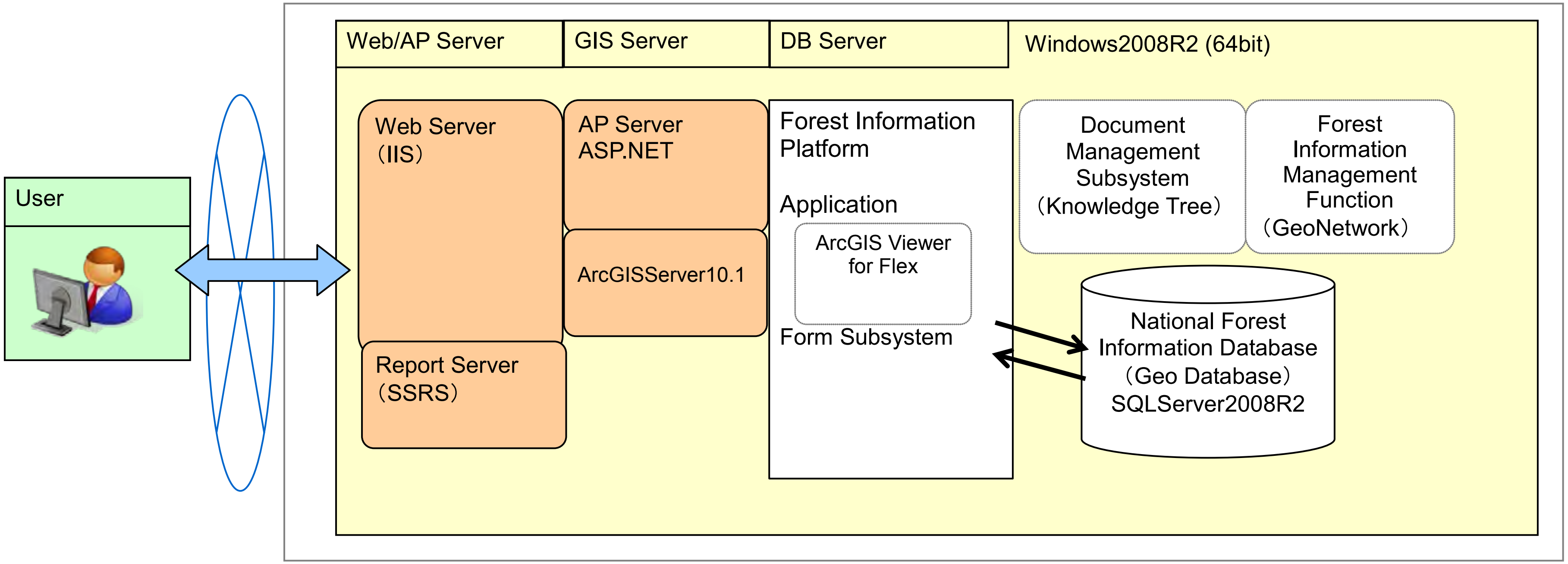
(2) To estimate forest areas by forest type and average carbon stocks by analyzing the data and to store the estimates,

(3) To estimate forest carbons stocks by examining and analyzing carbon sequestering using the stored data and

2.1.1.2 Component of System



2.1.1.3 Architecture of System



2.1.2. Operating Environment

2.1.2.1 Operating System
Windows Server 2008 R2 (64bit)

2.1.2.2 Web Server
Microsoft IIS 7.5 or 7.0

2.1.2.3 NET Framework
Microsoft .Net framework 3.5 SP1

2.1.2.4 GIS Server
ArcGISServer Enterprise Standard 10.0 or ArcGISServer Enterprise Standard 10.1

2.1.2.5 Map Application
ArcGIS Viewer for Flex 3.4

2.1.2.6 DB Server
SQLServer 2008 R2 or SQLServer 2012

2.1.2.7 Universal GIS
ArcGIS Desktop 10.0

2.1.2.8 Reporting Tool
SQLServer2008R2 Report Builder 3.0

2.1.2.9 Web Browser (For Use on Client Side)
Internet Explorer 9.0
Google Chrome 27
Firefox 24.0

2.1.3. Development Environment

2.1.3.1 Integrated Development Environment

Visual Web Developer 2010 Express (C#)
Flash Builder 4.7

2.1.3.2 Software Framework

ASP.NET

2.1.3.3 Map Application Building Tool

ArcGIS Viewer for Flex - Application Builder

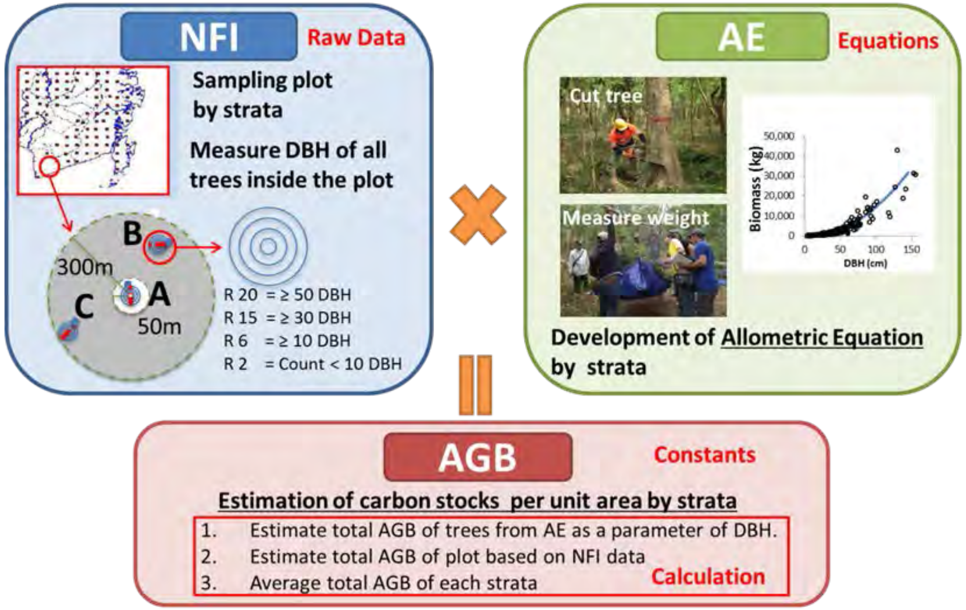
3. Functional Requirements

3.1. Outline of System

3.1.1. Basic Policy

Both the UNFCCC report and the FRA report in Lao PDR in the past have an issue of insufficient consistency of information because uniform management of data is not conducted at present. NFIDB is expected to alleviate and solve this issue. For this purpose, it is important to realize the three data types and functions listed below.

(a) Collecting and storing "survey data (raw data)" efficiently without errors
(b) Organizing and storing "calculation formulas" used to derive the biomass and carbon stocks from survey data
(c) Deriving the average biomass and carbon stocks from survey data and calculation formulas and storing them as "constants"

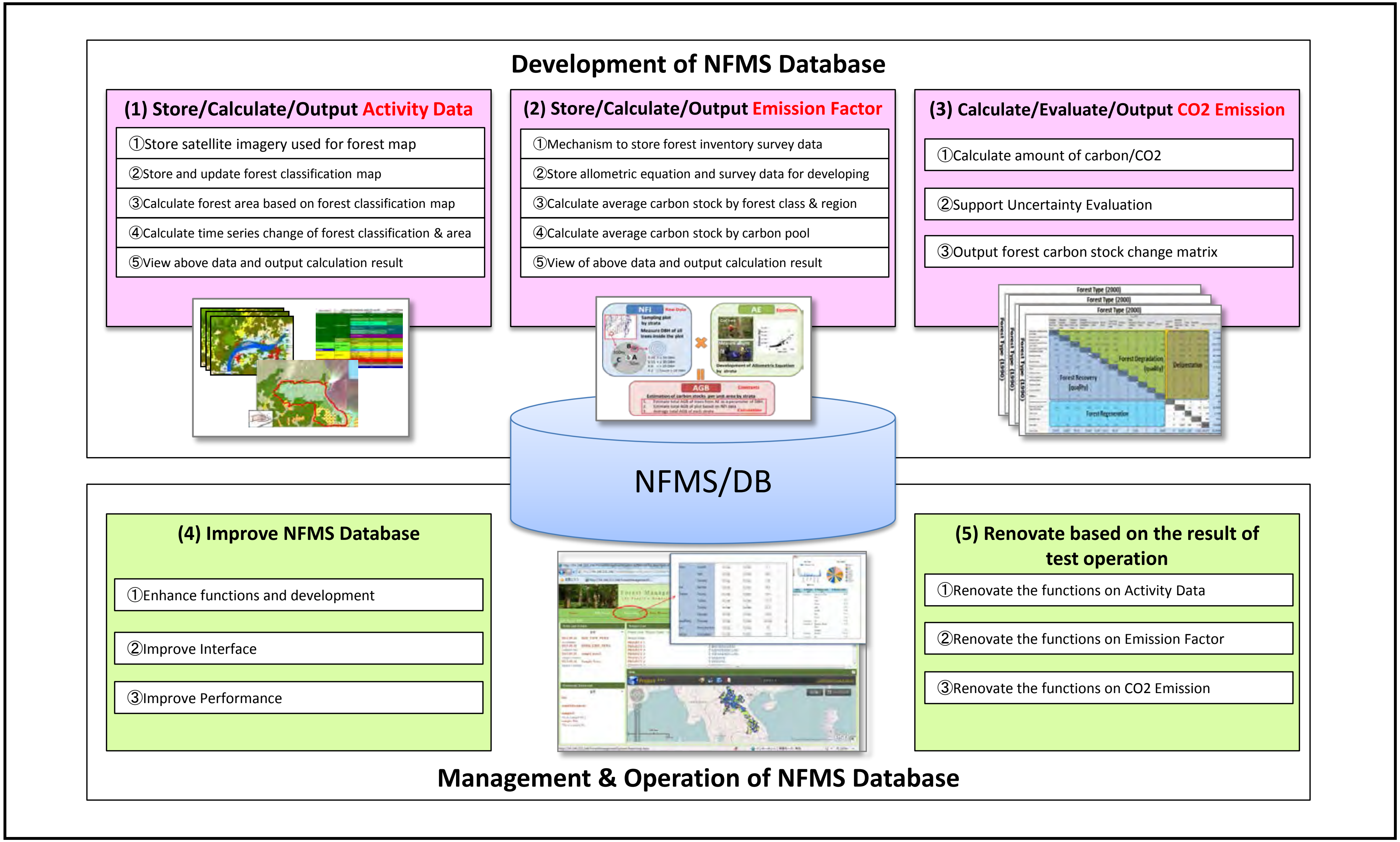


3.1.2. Functions Table

3.1.2.1 Core Functions

3.1.2.1.1.1. MRV Functions

No.	Category	Item	Function	Development	Remarks
1	Activity Data (AD)	1-1	Storage, calculation and output of activity data	Store satellite imagery data used for developing forest classification map.	
		1-2		Mechanism to store and update forest classification map (year 2010, 2005, 2000).	
		1-3		Function to calculate forest area based on forest classification data (based on region of interest like administration area and three forest area type).	
		1-4		Function to calculate time series change of forest classification and area	
		1-5		View function of above data and output function of calculation result.	
2	Emission Factor (EF)	2-1	Storage, calculation and output of emission Factor	Mechanism to store forest inventory survey data	
		2-2		Store allometric equation and survey data for developing allometric equation(nation and region-specific allometric equation, existing-equation like IPCC default equation)	
		2-3		Function to calculate mean CO2 accumulation by forest classification and region.	
		2-4		Function to calculate mean CO2 accumulation by carbon pool.	
		2-5		View function of above data and output function of calculation result.	
3	CO2 Emission	3-1	Calculation, evaluation and output of CO2 emission	Function to calculate the amount of carbon/CO2	Both function to calculate/output will be based on user specified area (Region of interest like administration area and three forest area type)
		3-2		Function to output forest change matrix	


Development of NFMS Database
(1) Store/Calculate/Output Activity Data
①Store satellite imagery used for forest map
②Store and update forest classification map
③Calculate forest area based on forest classification map
④Calculate time series change of forest classification & area
⑤View above data and output calculation result
(2) Store/Calculate/Output Emission Factor
①Mechanism to store forest inventory survey data
②Store allometric equation and survey data for developing
③Calculate average carbon stock by forest class & region
④Calculate average carbon stock by carbon pool
⑤View of above data and output calculation result
(3) Calculate/Evaluate/Output CO2 Emission
①Calculate amount of carbon/CO2
②Support Uncertainty Evaluation
③Output forest carbon stock change matrix
NFMS/DB
(4) Improve NFMS Database
①Enhance functions and development
②Improve Interface
③Improve Performance
(5) Renovate based on the result of test operation
①Renovate the functions on Activity Data
②Renovate the functions on Emission Factor
③Renovate the functions on CO2 Emission
Management & Operation of NFMS Database

3.1.2.1.1.2. Monitoring Functions

No.	Window Category	Item	Function	Development	Remarks
1	Driver	1-1	Support identifying drivers of deforestation and degradation	Utilize the necessary information for identifying drivers	
		1-2		Support identifying and analyzing the drivers	
2	Monitor	2-1	Monitor forest change with high frequency	Utilize the record of forest change with high frequency	
		2-2		Feedback to MRV system and utilize the info from MRV	

3.1.2.2 Basic Functions

No.	Window Category	Item	Function	Development	Remarks
1	Common	1-1	Language Changeover	Function for switching between English and Lao	
		1-2	Logout Function	Function for performing the logout process and returning to the Login window	
2	Log in	2-1	Login Function	Function for entering the user ID/password and logging in. The availability of operation is controlled under the authority of the login account	
		2-2	Group Selecting Function	Function for selecting a group when a user belongs to multiple groups	
3	Menu	3-1	Other Function Linking Function	Function for linking to another function	
		3-2	News Managing Function	Function for displaying a list of news and events	
		3-3	GIS Portal Menu Function	Function for displaying GIS Portal Menu (Group) and jumping to the GIS Portal window	
4	GIS Portal	4-1	Other Function Linking Function	Function for linking to another function	
		4-2	News Managing Function	Function for displaying a list of news and adding, updating and deleting any news	
		4-3	Document Managing Function	Function for uploading, downloading and linking a document to a project	
		4-4	Project List Display Function	Function for displaying a List of Projects linked to the Group selected from the Menu	
		4-5	Project Editing Function	Function for registering, updating and deleting a Project without planimetric features	
		4-6	Link Indicating Function	Function for reading external setting files, displaying a list of files and linking to any file	
		4-7	Project Managing Function	Function for displaying a List of Projects without planimetric features and registering, updating and deleting any Project	
		4-6	Map Display Function	Function for displaying a map using ArcGIS Viewer for Flex	

No.	Window Category	Item	Function	Development	Remarks
5	System Administration	5-1	User Managing Function	Function for displaying a list of users and registering, updating and deleting any user	
		5-2	Group Managing Function	Function for displaying a list of groups and registering, updating and deleting any group	
		5-3	Project Type Managing Function	Function for linking to a group, Project type, main layer or map URL and displaying the lists and registering, updating and deleting any item	
		5-4	Division Role Setting Function	Function for setting the role by combining a Group and a Project Type	

3.1.3. GIS Data

The data shall be re-organized based on the application field.

Application field	Data type
REDD+ & SFM	Contour, DEM, Geology, Soil, Watershed, River network, Road network, Administrative boundary, Village point, National Forest Inventory, Land use plan, Concession, Statistics/Census, Development plan area, Irrigation, Mining, Military zone, Forest along national borders.
REDD+	Eco-region, Climate, REDD+ project boundary, Biodiversity hotspot, Electric power line network.
SFM	Forest category, Village boundary, Forest management area.
Basemap	Satellite image, Aerial photo, and Ground truth.

3.1.4. Report Type

Type of international report	Implementing organization	Responsibility of DOF
National GHG Inventory reports consisting of: ◆ GHG Inventory Report, ◆ National Communication (NC), and ◆ Biennial Update Report (BUR).	UNFCCC	Compilation of data in forestry sector (MONRE is the focal point to UNFCCC)
Global Forest Resource Assessment (FRA))	FAO	Compilation of Country Report as National Correspondent

3.1.5. System Using Authority

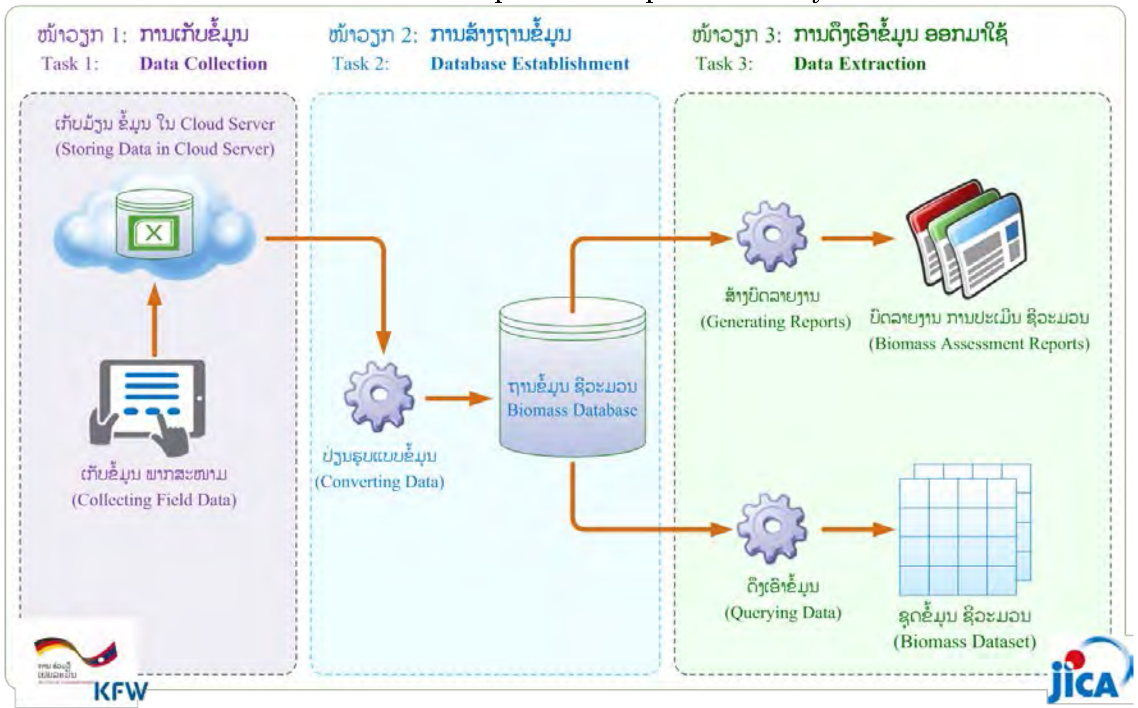
		Administrator	DOF manager (setting)	DOF public user (editor)	DOF guest user (view only)	DFRM manager (setting)	DFRM public user (editor)	DFRM guest user (view only)
User management		○						
DOF	Authority setting	○	○					
	Project data edit	○	○	○				
	Project data view/download	○	○	○	○	○	○	
	News edit	○	○	○				
	News view	○	○	○	○	○	○	
	Report view	○	○	○	○			
DFRM	Authority setting	○				○		
	Project data edit	○				○	○	
	Project data view/download	○	○	○		○	○	○
	News edit	○				○	○	
	News view	○	○	○		○	○	○
	Report view	○				○	○	○

3.2. Outline of Functions

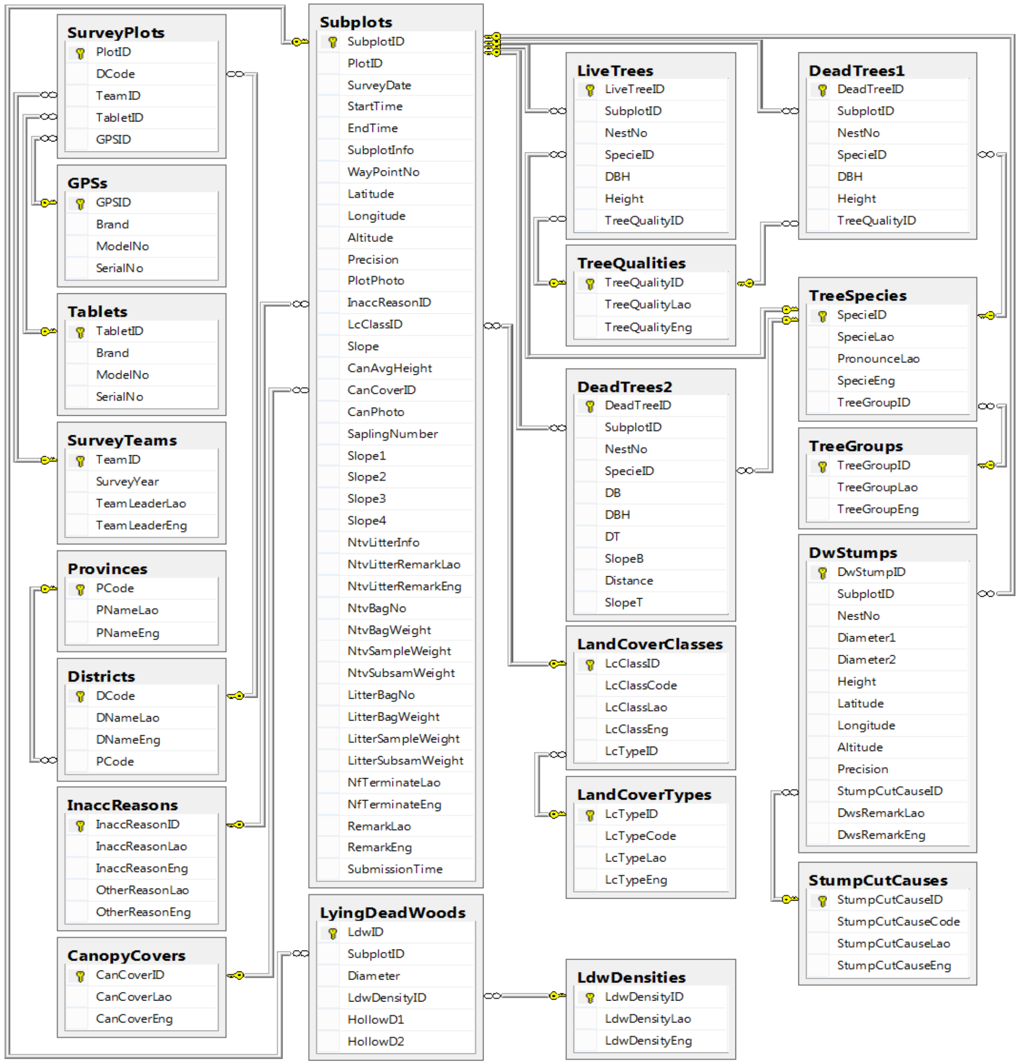
3.2.1. Basic Design

3.2.1.1 Collecting and storing “survey data (raw data)” efficiently without errors

As a means to collect survey data (raw data) efficiently without errors, it is decided to adopt a technique that uses a tablet-based survey tool and a secure cloud server based on SOP developed and implemented by CliPAD/KfW at a sub-national level.



Database tables and relations (ER diagrams) must be designed to enable importing of data to the database for analysis in order to create statistics and reports about survey data downloaded from a secure cloud server. The design of this relational database shall be based on the inventory DB (FoCAS) developed by FIM and the result of the pilot survey conducted by CliPAD/KfW in the Houaphanh Province. The pilot survey of NFI was using the same format.


SurveyPlots
PlotID
DCode
TeamID
TabletID
GPSID
GPSs
GPSID
Brand
ModelNo
SerialNo
Tablets
TabletID
Brand
ModelNo
SerialNo
SurveyTeams
TeamID
SurveyYear
TeamLeaderLao
TeamLeaderEng
Provinces
PCode
PNameLao
PNameEng
Districts
DCode
DNameLao
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Longitude
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CanCoverID
CanPhoto
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Slope2
Slope3
Slope4
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NtvLitterRemarkEng
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NtvBagWeight
NtvSampleWeight
NtvSubsamWeight
LitterBagNo
LitterBagWeight
LitterSampleWeight
LitterSubsamWeight
NfTerminateLao
NfTerminateEng
RemarkLao
RemarkEng
SubmissionTime
LyingDeadWoods
LdwID
SubplotID
Diameter
LdwDensityID
HollowD1
HollowD2
LiveTrees
LiveTreeID
SubplotID
NestNo
SpecieID
DBH
Height
TreeQualityID
TreeQualities
TreeQualityID
TreeQualityLao
TreeQualityEng
DeadTrees2
DeadTreeID
SubplotID
NestNo
SpecieID
DB
DBH
DT
SlopeB
Distance
SlopeT
LandCoverClasses
LcClassID
LcClassCode
LcClassLao
LcClassEng
LcTypeID
LandCoverTypes
LcTypeID
LcTypeCode
LcTypeLao
LcTypeEng
LdwDensities
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LdwDensityLao
LdwDensityEng
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DeadTreeID
SubplotID
NestNo
SpecieID
DBH
Height
TreeQualityID
TreeSpecies
SpecieID
SpecieLao
PronounceLao
SpecieEng
TreeGroupID
TreeGroups
TreeGroupID
TreeGroupLao
TreeGroupEng
DwStumps
DwStumpID
SubplotID
NestNo
Diameter1
Diameter2
Height
Latitude
Longitude
Altitude
Precision
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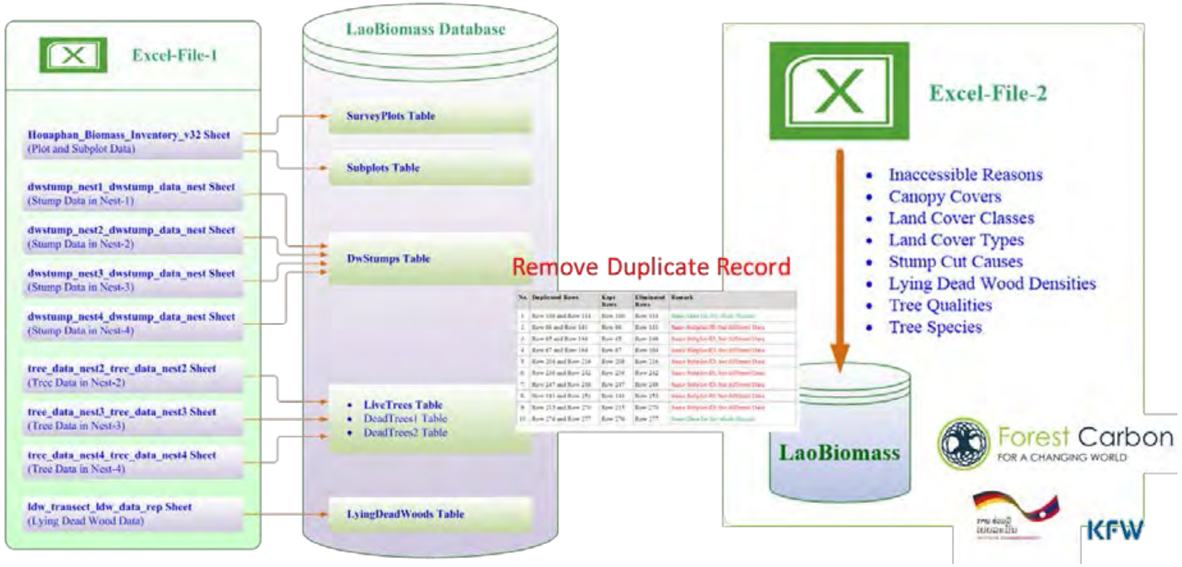
StumpCutCauseCode
StumpCutCauseLao
StumpCutCauseEng



Outline of Conversion and Storage of Inventory Survey Data to Biomass DB

3.2.1.2 Organizing and storing “calculation formulas” used to derive the biomass and carbon stocks from survey data

■ Allometric equations available at present

At present, there are the following three options:

Option (1): Existing region-based (or IPCC-registered) allometric equations

Option (2): Desk-based allometric equations based on the first NFI data (for each province)

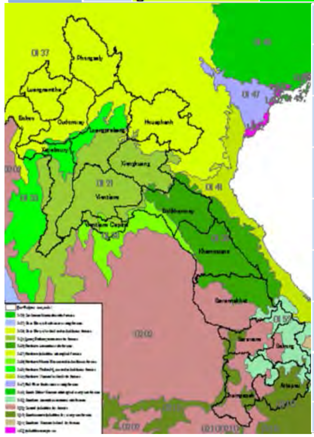
Option (3): Generic allometric equations (regardless of distinction of regions and forest types)

■ Allometric equations available in the future

In Laos, national-level destructive inspections will be conducted with the remaining budget (TA6) of FPP in March 2015 through June 2016 to develop national and region-specific allometric equations. By the end of 2016, allometric equations specific to Laos and regions will be developed and used.

All of the options of currently available allometric equations will be less needed in about one year. But it is necessary to use the currently available allometric equations according to the purposes, such as the comparison with the past data, although it is not necessary to go to great trouble for organization and storage of them.

Eco-region		Ecoregions in Laos							
		0137 Northern Indochina Subtropical Forests	0139 Northern Thailand-Laos Moist Deciduous Forests	0121 Luang Prabang Montane Rain Forests	0138 Northern Khorat Plateau Moist Deciduous Forests	0136 Northern Annamites Rain Forests	0202 Central Indochina Dry Forests	0152 Southern Annamites Montane Rain Forests	0210 Southeastern Indochina Dry Evergreen Forests
Forest Tyep in Laos	EF	1) UN-REDD: Vietnam North East	1) UN-REDD: Vietnam North East	2) UN-REDD: Vietnam North Central Coast	-	2) UN-REDD: Vietnam North Central Coast	4) Kiyono equation	3) UN-REDD: Vietnam South Central Coast	4) Kiyono equation
	MD	1) UN-REDD: Vietnam North East	1) UN-REDD: Vietnam North East	2) UN-REDD: Vietnam North Central Coast	2) UN-REDD: Vietnam North Central Coast	2) UN-REDD: Vietnam North Central Coast	4) Kiyono equation	3) UN-REDD: Vietnam South Central Coast	4) Kiyono equation
	DD	5) Monda equation	5) Monda equation	5) Monda equation	5) Monda equation	5) Monda equation	5) Monda equation	5) Monda equation	5) Monda equation
	CF	6) IPCC: Temperate/tropical pines	6) IPCC: Temperate/tropical pines	6) IPCC: Temperate/tropical pines	-	6) IPCC: Temperate/tropical pines	6) IPCC: Temperate/tropical pines	6) IPCC: Temperate/tropical pines	6) IPCC: Temperate/tropical pines
	MCB	6) IPCC: Temperate/tropical pines	6) IPCC: Temperate/tropical pines	6) IPCC: Temperate/tropical pines	-	6) IPCC: Temperate/tropical pines	6) IPCC: Temperate/tropical pines	6) IPCC: Temperate/tropical pines	6) IPCC: Temperate/tropical pines
		1) UN-REDD: Vietnam North East	1) UN-REDD: Vietnam North East	2) UN-REDD: Vietnam North Central Coast	-	2) UN-REDD: Vietnam North Central Coast	4) Kiyono equation	3) UN-REDD: Vietnam South Central Coast	4) Kiyono equation
	P	7) IPCC: Eucalyptus sp. 8) IPCC: Tectona grandis [b]	7) IPCC: Eucalyptus sp. 8) IPCC: Tectona grandis b	7) IPCC: Eucalyptus sp. 8) IPCC: Tectona grandis b	7) IPCC: Eucalyptus sp. 8) IPCC: Tectona grandis b	7) IPCC: Eucalyptus sp. 8) IPCC: Tectona grandis b	7) IPCC: Eucalyptus sp. 8) IPCC: Tectona grandis b	7) IPCC: Eucalyptus sp. 8) IPCC: Tectona grandis b	7) IPCC: Eucalyptus sp. 8) IPCC: Tectona grandis b



	Model	Equation
1)	UN-REDD: Vietnam North East	$AGB = 0.1142*DBH^{2.4451}$
2)	UN-REDD: Vietnam North Central Coast	$AGB = 0.1245*DBH^{2.4163}$
3)	UN-REDD: Vietnam South Central Coast	$AGB = \exp(-2.24267+2.47464*\ln(DBH))$
4)	Kiyono equation	$W(stem) = 2.69*ba^{1.29}*WD*^{1.35}$ $W(branch) = 0.217*ba^{1.26}*WD^{1.48}$
5)	Monda equation	$AGB = 0.3510*DBH^{2.3655}*WD^{1.7827}$
6)	IPCC: Temperate/ tropical pines	$AGB (kg/tree) = 0.887+[(10486*(DBH)^{2.84})/((DBH)^{2.84}+376$
7)	IPCC: Eucalyptus sp.	$AGB (kg/tree) = 1.22*DBH^2*H*0.01$
8)	IPCC: Tectona grandis [b]	$AGB (kg/tree) = 0.153*DBH^{2.382}$

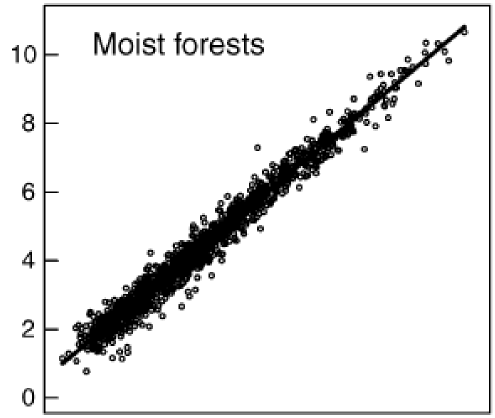
Option (1) Existing Region-based (or IPCC-registered) Allometric Equations

	Type	Slope	Multiplier	Determination Coefficient
Vientiane Capital	MD	0.0002	2.4498	R^2 = 0.9811
	DD	0.0002	2.4562	R^2 = 0.9609
Phonsaly	EF	0.0002	2.4655	R^2 = 0.9893 (Oudomxay)
	MD	0.0001	2.4445	R^2 = 0.9802
Luangnamtha	EF	0.0002	2.4655	R^2 = 0.9893 (Oudomxay)
	MD	0.0002	2.3297	R^2 = 0.9502
Oudomxay	EF	0.0002	2.4655	R^2 = 0.9893
	MD	0.0002	2.4079	R^2 = 0.978
Bokeo	MD	0.0001	2.4195	R^2 = 0.9874
	DD	0.0005	2.0564	R^2 = 0.964
Luangphabang	EF	0.0002	2.4629	R^2 = 0.9812 (Xayabury)
	MD	0.0001	2.4198	R^2 = 0.9827
	DD	0.0003	2.4056	R^2 = 0.9682
Houaphane	EF	0.0002	2.4655	R^2 = 0.9893 (Oudomxay)
	MD	0.0002	2.4475	R^2 = 0.9794
	CF	0.0003	2.2901	R^2 = 0.9786
	MCB	0.0001	2.5402	R^2 = 0.9793
Xayabury	EF	0.0002	2.4629	R^2 = 0.9812
	MD	0.0001	2.4919	R^2 = 0.9741
	DD	0.0002	2.5037	R^2 = 0.9539
Xiengkhuang	EF	0.0002	2.4629	R^2 = 0.9812 (Xayabury)
	MD	0.0002	2.3952	R^2 = 0.9735
	CF	0.0001	2.4569	R^2 = 0.9452
	MCB	0.0001	2.4835	R^2 = 0.9649
Vientiane	EF	0.0002	2.4629	R^2 = 0.9812 (Xayabury)
	MD	0.0001	2.5579	R^2 = 0.9827

	Type	Slope	Multiplier	Determination Coefficient
Bolikhamxai	EF	0.0001	2.4578	R^2 = 0.9834 (Khammuane)
	MD	0.0001	2.4995	R^2 = 0.9788
	DD	0.0002	2.4137	R^2 = 0.9492
Khammuane	EF	0.0001	2.4578	R^2 = 0.9834
	MD	0.0001	2.4673	R^2 = 0.979
	DD	0.0001	2.5344	R^2 = 0.951
	MCB	0.0001	2.5258	R^2 = 0.9833
Savannakhet	EF	0.0001	2.5756	R^2 = 0.9893
	MD	0.0001	2.5018	R^2 = 0.9756
	DD	0.0001	2.4745	R^2 = 0.9603
Saravane	EF	0.0001	2.4792	R^2 = 0.9834
	MD	0.0002	2.4386	R^2 = 0.9775
	DD	0.0002	2.4988	R^2 = 0.9635
	MCB	0.0002	2.4184	R^2 = 0.9819
Sekong	EF	0.0002	2.4268	R^2 = 0.9881
	MD	0.0002	2.4569	R^2 = 0.9785
	DD	0.0002	2.3479	R^2 = 0.9597
	CF	0.0007	2.0415	R^2 = 0.6485
Champasak	EF	0.0001	2.5208	R^2 = 0.9672
	MD	0.0002	2.4568	R^2 = 0.9797
	DD	0.0001	2.5024	R^2 = 0.9652
	MCB	0.00009	2.6345	R^2 = 0.9886
Attapeu	EF	0.0001	2.5973	R^2 = 0.9917
	MD	0.0001	2.5285	R^2 = 0.9805
	DD	0.0001	2.5342	R^2 = 0.967

No data in 1st NFI thus use the one in neighbor province

Option (2): Desk-based Allometric Equations Based on the First NFI Data (for Each Province)



Chave et al. 2005

Moist forest stands:

$$\langle AGB \rangle_{est} = \exp(-2.977 + \ln(\rho D^2 H)) \equiv 0.0509 \times \rho D^2 H$$

$$\langle AGB \rangle_{est} = \rho \times \exp(-1.499 + 2.148 \ln(D) + 0.207(\ln(D))^2 - 0.0281(\ln(D))^3)$$

Chave et al. 2014

$$\mathrm{AGB}_{est} = \exp[-1.803 - 0.976E + 0.976 \ln(\rho) + 2.673 \ln(D) - 0.0299[\ln(D)]^2]$$

$$E = (0.178 \times \mathrm{TS} - 0.938 \times \mathrm{CWD} - 6.61 \times \mathrm{PS}) \times 10^{-3}$$

Option (3): Generic Allometric Equations (Regardless of Distinction of Regions and Forest Types)

Priority of Development of Laos and Region-specific Allometric Equations

		Area (ha)	Area (%)	AGB (t)/ha	Total AGB (t)		Priority
Evergreen Forest	EF	1,300,729	5.6%	251.2	326,743,127	16.7%	1
Mixed Deciduous Forest	MD	9,684,810	42.0%	127.37	1,233,554,284	63.2%	1
Dry Dipterocarp Forest	DD	1,146,274	5.0%	97.95	112,277,573	5.8%	1
Coniferous Forest	CF	82,283	0.4%	72.31	5,949,919	0.3%	5
Mixed Coniferous/Broadleaved Forest	MCB	27,577	0.1%	164.9	4,547,370	0.2%	4
Regenerating Vegetation	FL	7,327,151	31.8%	37	268,906,427	13.8%	2
Forest Plantation	P	65,645	0.3%	N/A			-
Bamboo	B	243,388	1.1%	N/A			3

3.2.1.3 Deriving the average biomass and carbon stocks from survey data and calculation formulas and storing them as "constants"

The carbon stratification has been jointly reviewed in Outputs 1 and 3. From the viewpoint of DB development, it is sufficient to implement a system for calculating and storing as constants or dynamically calculating the average biomass and carbon stocks for each stratum using survey data and allometric equations after the carbon stratification has been determined (there can be several options). From the viewpoint of the DB performance, it is better to calculate and store in advance the average biomass and carbon stocks as constants because constants are not expected to be changed frequently.

After the completion of this implementation, it will be possible to calculate the biomass and carbon stocks in a user-specified target range (administrative boundaries such as countries and provinces or areas of interest specified on a GIS application) by multiplying the area of each carbon stratum on a map and the average carbon stock.

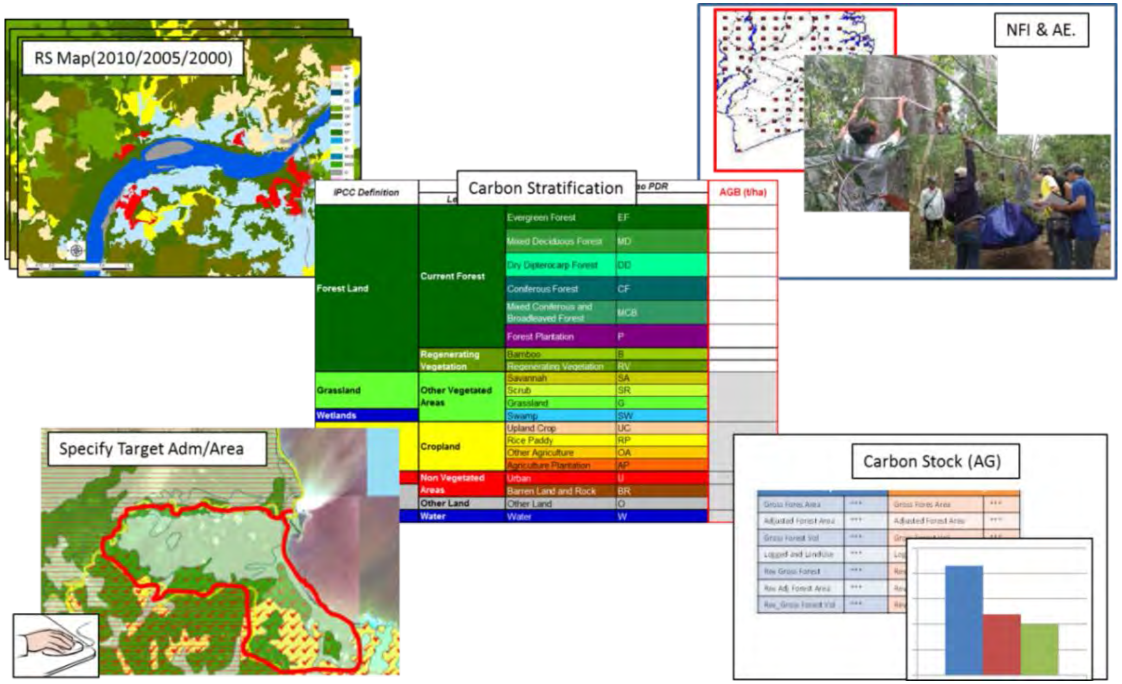


Image of Target Range (Area) for Each Carbon Stratification and Estimation of Biomass and Carbon Stocks

3.2.2. Functional Design

3.2.2.1 Core Functions

3.2.2.1.1 MRV Function

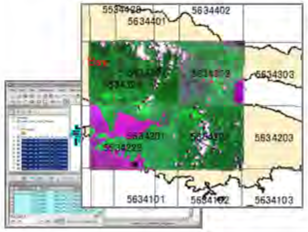
3.2.2.1.1.1. Store / Calculate / Output Activity Data

Objective: To develop (time series) the functions to storage forest type map and source satellite image then calculate forest area, output for view

Output (Effect): Country specific Activity Data of Lao is developed and the system/mechanism of utilization of it set up

Work Item	Qty	Man-hr (4 Grade)	Man-hr (5 Grade)
①Store satellite imagery used for forest map	2 func.	5M/D	10M/D
②Store and update forest classification map	2 func.	5M/D	10M/D
③Calculate forest area based on forest classification map	2 func.	5M/D	10M/D
④Calculate time series change of forest and area	2 func.	5M/D	10M/D
⑤View above data and output calculation result	4 func.	5M/D	10M/D
Total		25M/D	50M/D

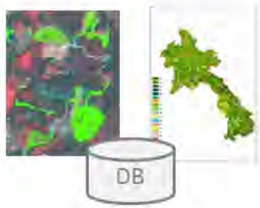
①Store satellite imagery used for forest classification map



- Prepare disclosure of satellite imagery (color enhancement, format conversion, tiling/index)
- Store satellite imagery into DB, develop browse/output function and system(for transparency)

Implementation Period: 2016.Jan - Mar

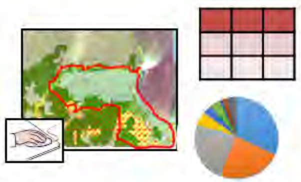
②Mechanism to store and update forest classification map



- Divide the classified map in consideration use of it, format conversion, provide template
- Mechanism to update the related information when it is modified based on accuracy assessment

Implementation Period: 2016.Apr - Jun

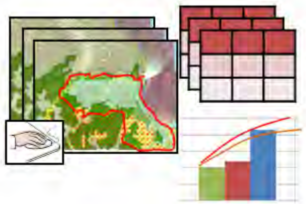
③Calculate forest area based on forest classification map



- Calculate the area of forest dynamically based on the specified area (national, province and area of interest)
- Mechanism to store forest area statically with considering update frequency & performance

Implementation Period: 2016.Jul - Sep

④Calculate time series change of forest classification and area



- Calculate forest class area and change in time series based on the functions of ③
- Verify the unrealistic change realistically as a means to ensure consistency (quality assurance)

Implementation Period: 2016.Oct - Dec.

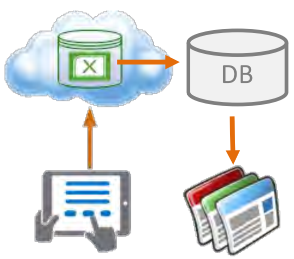
3.2.2.1.1.2. Store / Calculate / Output Emission Factor

Objective: To develop the function to store the data of National Forest Inventory and Destructive Biomass survey effectively then calculate and output average carbon stock amount

Output (Effect): Country specific Emission Factor of Lao is developed an the system/mechanism of utilization of it is set up

Work Item	Qty	Man-hr (4 Grade)	Man-hr (5 Grade)
①Store forest inventory survey data	2 fuc.	5M/D	10M/D
②Store allometric equation and survey data	2 func.	5M/D	10M/D
③Calculate average carbon stocks by forest class and region	2 func.	5M/D	10M/D
④Calculate average carbon stocks by carbon pool	2 func.	5M/D	10M/D
⑤View above data and output calculation result	4 func.	5M/D	10M/D
Total		25M/D	50M/D

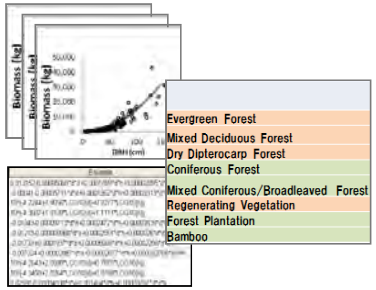
①Mechanism to store forest inventory survey data



- Import the survey records stored in the cloud server semi automatically
- Collaborate with R-Script for the rapid data analysis

Implementation Period: 2016.Jan - Mar

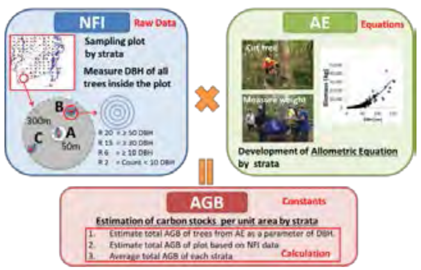
②Store allometric equation and survey data for development



- Store the data of destructive biomass survey & developed allometric equations
- Store equations developed in neighboring countries, based on the result of 1st NFI and generic equations

Implementation Period: 2016.Apr - Jun

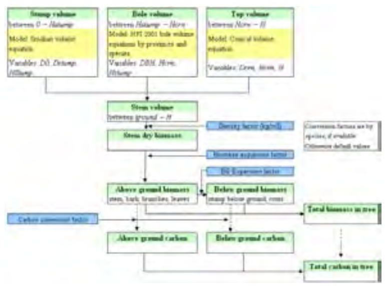
③Calculate average carbon stock by forest class & region



- Calculate the average carbon stock per area of forest class and region using NFI data and allometric equations
- Mechanism to select the survey data and allometric equations to calculate and compare the result

Implementation Period: 2016.Jul - Sep

④Calculate average carbon stock by carbon pool



- Set-up/edit the conversion factors to calculate targeted carbon pool
- Mechanism to store the source data and calculate the average carbon stock per area (in case based on the survey result)

Implementation Period: 2016.Oct - Dec

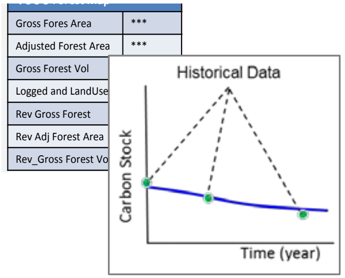
3.2.2.1.1.3. Store / Calculate / Output CO2 Emission

Objective: To develop the functions to calculate, evaluate and output the amount of carbon & CO_2 emissions by using the activity data & emission factors developed

Output (Effect): Complete the system and the mechanism to report COP emission from Lao

Work Item	Qty	Man-hr (4 Grade)	Man-hr (5 Grade)
①Calculate amount of carbon/CO2	4 func.	10M/D	20M/D
②Support Uncertainty Evaluation	4 func.	10M/D	20M/D
③Output forest carbon stock change matrix	4 func.	10M/D	20M/D
Total		30M/D	60M/D

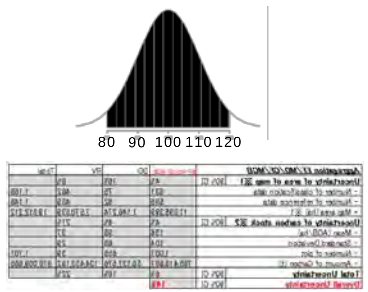
①Calculate amount of carbon/CO2



- Calculate carbon/ CO_2 by forest class(strata) and average carbon per area based on the specified area
- Mechanism to store carbon/CO_2 in consideration of the updating frequency and the performance

Implementation Period: 2017.Apr - Jun

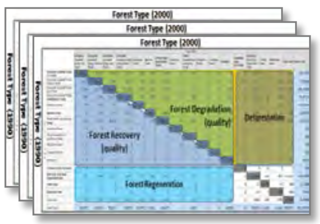
②Support Uncertainty Evaluation



- Calculate and output the uncertainty of forest class (carbon strata)
- Function that the user can select the forest class/strata interactively and consider the uncertainty

Implementation Period: 2017.Jul - Sep

③Output forest carbon stock change matrix



- Calculate and output forest change matrix by using time series of forest class area and average carbon stock per area
- Specify the area (Area of National & Provincial) and calculate forest area change and the emission

Implementation Period: 2017.Oct - Dec

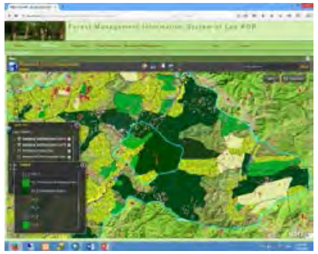
3.2.2.1.1.4. Improve NFMS Database Function

Objective: Developing & establishing the functions newly clarified but not developed in 1st phase then finalizing the system

Output (Effect): Enhanced system function, improved interface/performance

Work Item	Qty	Man-hr (4 Grade)	Man-hr (5 Grade)
① Enhance functions and development	3 func.	5M/D	15M/D
②Improve Interface	3 func.	5M/D	15M/D
③Improve Performance	3 func.	5M/D	15M/D
Total		15M/D	45M/D

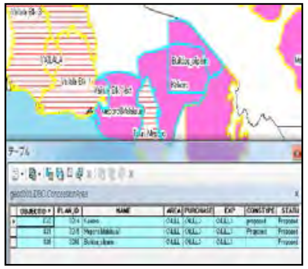
①Enhance functions and development



- e.g.1: Function to collaborate with Production Forest DB (SUFORD)
- e.g.2: Function to contribute to safeguard information system
- e.g.3: Function to support (SFM) sustainable forest management

Implementation Period: 2018.Jan - Mar

②Improve Interface



- e.g.1: Function to import the editable layer by users
- e.g.2: Function to replace the background map (admin right)
- e.g.3: Operability of data input and edit on the maps

Implementation Period: 2018.Apr - Jun

③Improve Performance

- e.g.1: Displaying, scaling, moving, editing and printing the maps
- e.g.2: Editing attribute (input, update, delete the attribute info)
- e.g.3: Spatial analysis (calculate carbon stock spatially etc)

Implementation Period: 2018.Apr - Jun

3.2.2.1.1.5. Renovate based on Test Operation

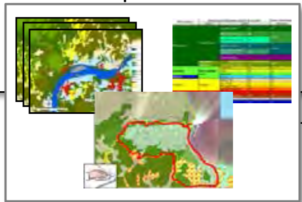
Objective: Renovate the system based on the issues and measures using forest type map of 2016 and NFI data of 2016-17

Output (Effect): Improve the functions on Activity Data, Emission Factor, CO2 Emission

Work Item	Qty	Man-hr (4 Grade)	Man-hr (5 Grade)
①Renovate the functions on Activity Data	5 func.	7.5M/D	22.5M/D
②Renovate the functions on Emission Factor	5 func.	7.5M/D	22.5M/D
③Renovate the functions on CO2 Emission	10 func.	10.0M/D	30.0M/D
Total		25.0M/D	75.0M/D

①Renovate the functions on Activity Data

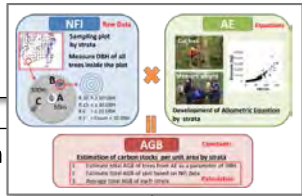
- Store satellite imagery data used for developing forest classification map
- Mechanism to store and update forest classification map
- Calculate forest area based on forest classification data
- Calculate time series change of forest classification & area
- View above data and output calculation result



Implementation Period:
①2018.Jul - Dec
②2019.Jul - Dec

②Renovate the functions on Emission Factor

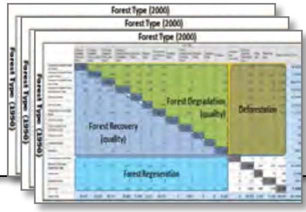
- Mechanism to store forest inventory survey data
- Store allometric equation and survey data
- Calculate average carbon stock by forest class & region
- Calculate average carbon stock by carbon pool
- View of above data and output calculation result



Implementation Period:
①2018.Jul - Dec
②2019.Jul - Dec

③Renovate the functions on CO2 Emission

- Calculate amount of carbon/CO2
- Support Uncertainty Evaluation
- Output forest carbon stock change matrix



Implementation Period:
①2018.Jul - Dec
②2019.Jul - Dec

3.2.2.1.2 Monitoring Function

3.2.2.1.2.1. Support identifying drivers of deforestation and degradation

(1) Utilize the necessary information for identifying drivers
(2) Support identifying and analyzing the drivers

3.2.2.1.2.2. Monitoring forest area change with high frequency

(1) Utilize the record of forest change with high frequency
(2) Feedback to MRV system and utilize the info from MRV

3.2.2.2 Basic Functions

3.2.2.2.1 Common Functions

3.2.2.2.1.1. Language Changeover Function

Lao and English are displayed on each window.
Language changeover in the fixed display fields on each window is possible.
Language changeover is performed using a resource file.
The indications from the Database are presented as they are.
Which language is to be displayed is selected by changeover on the Login window and the selected language is displayed on the subsequent windows.

3.2.2.2.1.2. Log-Out Function

Logout operation is performed by pressing the Logout button on each window, [Menu], [GIS Portal], [News and Events], [Download List], [System Administration], [User List], [User Management], [Group List], [Group Management] and [Reporting], and the window returns to the Login window after logging out.

When Logout operation is performed, it is registered in the Log Management Table.

3.2.2.2.1.3. Log Output

The application log is output using log4net. If any error occurs, the stack trace is also output.

3.2.2.2.2 Login

3.2.2.2.2.1. Login Function

After pressing the Login button, the User Master is required to perform authentication. If the User ID and the password are coincident and if the user belongs to any group, the user is authenticated. If multiple User IDs are input in the User Group Master, it means that the user belongs to multiple groups. In this case, the [Select Group] window is displayed to select the relevant group.

If the authentication is unsuccessful after pressing the Login button, the error message is displayed.

If the login operation is successful, it is registered in the Log Management Table.

3.2.2.2.2.2. Group Selecting Function

The authentication is performed on the Login window, and if the user belongs to multiple groups, the Select Group Window is displayed on another window.

Only the group to which the user belongs is displayed in the text (linked). When the group (link) is clicked, the login status jumps to the Menu window.

The language displayed on the Login window continues to be displayed.

3.2.2.2.3 Menu

The Login window jumps to the Menu window. The shift is performed from the Menu Link on the header of each window.

The language selected on the Login window continues to be displayed on the window to which it jumps.

3.2.2.2.3.1. Other Function Linking Function

The link to the [Forest Information Management System] or [Document Managing System] is displayed at the top of the Menu window. By clicking the Link, the relevant system can be recalled and displayed on another window.

3.2.2.2.3.2. News Managing Function

If the Login user is the [Administrator] or [Manager] (DOF, DFRM), or [Editor] (DOF, DFRM), all the news is displayed.

If the Login user is a [Guest User] (DOF, DFRM) and belongs to DOF, the user may not view the DFRM information. If the user belongs to DFRM, the user may not view the DOF information.

The News and Events are displayed by acquiring the [Insert Date], [Title] and [News/Events] from the Table of News and Events.

The display order is in descending order of the date of preparation (in which the newest is displayed at the top).

The News and Events may be screened by filtering for display.

The display of the Combo Box for filtering varies depending on the authority of the Login user.

If the Login user is the [Administrator], [All], [DFRM] and [DOF] are set.

If the user is the [Manager], [All] and [Bureau] are set.

If the user is the [Editor] or [Guest User] of DOF, [All], [Bureau] and [Division] are set.

If the user is the [Editor] or [Guest User] of DFRM, [All], [Bureau] and [Division] are set.

All ... All the news/events are displayed.

DFRM ... The news/events within DFRM are displayed.

DOF ... The news/events within DOF are displayed.

Bureau ... The news/events within the bureau (DOF or DFRM, whichever the Login user belongs to) is displayed. The group (Bureau) to which the user belongs is determined by the Group ID registered in the Table of News and Events.

Division ... The news/events of the Division (=Group) to which the Login user belongs are displayed. The news/events are displayed when Group ID in the Table of News and Events is identical with the logged in Group ID.

3.2.2.2.3.3. GIS Portal Menu Function

The GIS Portal Menu is displayed by searching the Group Master, but the display depends on the authority of the Login user.

If the Login user is the [Administrator] or [Manager] (DOF, DFRM), or [Editor] (DOF, DFRM), all the menus are displayed.

If the Login user is a [Guest User] (DOF, DFRM) and if the user belongs to DOF, the user may not view the DFRM information. If the user belongs to DFRM, the user may not view the DOF information.

The Menu is configured as follows:

All Forest Sectors are fixed and All DFRM and All DOF are fixed.

The order of displaying All DFRM and All DOF is changeable using the setup file.

The Group Master under All DFRM is searched and the Group Names belonging to DFRM are displayed, except those under the authority of the [Manager].

The Group Master under All DOF is searched and the Group Names belonging to DOF are displayed, except those under the authority of the [Manager].

When a Group Name in the Menu is clicked, the window jumps to the GIS Portal window.

The fixed items in the Menu (All Forest Sectors, All DFRM, and All DOF) are not selectable.

3.2.2.2.3.4. Display of System Administration Menu

In the System Administration Window menu, only the Administrator, DOF Manager and DFRM Manager may be displayed.

3.2.2.2.4 GIS Portal

The Menu window jumps to the GIS Portal window.
The language used on the previous window continues to be used on the subsequent windows.

3.2.2.2.4.1. Other Function Linking Function

The Links to the [Reporting System], [Forest Information Management System] and [Document Management System] are displayed at the top of the GIS Portal window. By clicking on any of the Links, the relevant system is recalled, and the window jumps to the [Reporting System] window and the [Forest Information Management System] and the [Document Management System] are displayed on other windows.

3.2.2.2.4.2. News Managing Function

If the Login user is the [Administrator] or [Manager] (DOF, DFRM), or [Editor] (DOF, DFRM), all news/events are displayed.
If the Login user is a [Guest User] (DOF, DFRM) and if the user belongs to DOF, the user may not view the DFRM information. If the user belongs to DFRM, the user may not view the DOF information.
The News and Events are displayed by acquiring the [Insert Date], [Title] and [News and Events] from the Table of News and Events.
The display order is in descending order of the date of preparation (in which the newest is at the top).
The display of the Combo Box for filtering depends on the authority of the Login user.
⇒ The Combo Box setting method is the same as the News Managing Function in the Menu. Refer to 3.2.1.3.2 News Management Function.
The filtering status is inherited from the previous window (Menu, News Details).
The News Details window is displayed by clicking the Title.

3.2.2.2.4.2.1. News Details Display

The filtering status on the previous window (GIS Portal TOP) is inherited to display the List of News.
The display method of the List of News is the same as the GIS Portal TOP window. Refer to **3.2.1.4.2 News Management Function.**

The selected news is displayed in the Details display field.
The news details are displayed by acquiring the [User Name], [Insert Date], [Title], [Link] and [News and Events]. The Link information, if any, is displayed in the inline frame by clicking Link.
The relevant record may be deleted from the Table of News and Events by pressing the Delete button.
However, the [Administrator] can delete all the information, and the [DOF Manager] and [DOF Editor] can only delete the information registered by the DOF

User.
The [DFRM Manager] and [DFRM Editor] can only delete the information registered by the DFRM user.
The [DOF Guest User] and [DFRM Guest User] may not delete any information.

After deleting the News, it is registered in the Log Management Table.

3.2.2.2.4.2.2. News Registering Process

When the Add New Article button on the News Details window is pressed, the registration dialog is displayed.
The [Administrator], [Manager] (DOF, DFRM) and [Editor] (DOF, DFRM) are allowed to perform the registration process.
In the registration process, each item on the Add News Article window is blank, but the User Name of the Login user is displayed.

Registration in the Table of News is performed by pressing the Add button.
After registering the news, it is registered in the Log Management Table.

3.2.2.2.4.2.3. News Editing Process

When the Edit News button on the Add News Article window is pressed, the editing dialog is displayed.
However, the [Administrator] may delete all the information. The [DOF Manager] and [DOF Editor] can only edit the information registered by the DOF user.
The [DFRM Manager] and [DFRM Editor] can only edit the information registered by the DFRM user.
The [DOF Guest User] and the [DFRM Editor] may not edit any information.
In the editing process, each item on the window displays the registered information.

The relevant record in the Table of News and Events can be updated by clicking the Update button.
After updating the news, it is registered in the Log Management Table.

3.2.2.2.4.3. Document Management Function

If the Login user is the [Administrator] or [Manager] (DOF, DFRM), or [Editor] (DOF, DFRM), all the related files are displayed.
If the Login user is a [Guest User] (DOF, DFRM), and if the user belongs to DOF, the user may not view the DFRM information. If the user belongs to DFRM, the user may not view the DOF information.
However, the data (documents) of the group with the authority to view the Project data may be displayed.
The List of Documents is displayed by acquiring the [Title], [Comment] and [Link] from the table of related files and the display order is the newest first.
The documents screened by filtering can be displayed.

The display of the Combo Box for filtering depends on the authority of the Login user.

The [Administrator] can set [All], [DFRM], [DOF], [Displayed Project] and [Selected Project].

The [Manager] can set [All], [Bureau], [Displayed Project] and [Selected Project].

The [Editor] or [Guest User] can set [All], [Bureau], [Division], [Displayed Project] and [Selected Project].

All ... All related files are displayed.

DFRM ... The related files in DFRM are displayed.

DOF ... The related files in DOF are displayed.

Bureau ... The related files in the Bureau (DOF or DFRM) to which the Login user belongs is displayed. The group (Bureau) to which the Login user belongs can be determined by the registered Group ID in the table of related files.

Division ... The related files in the Division (Group) to which the Login user belongs is displayed. The files for which the registered Group ID in the relevant table of files is identical with the logged in Group ID are displayed.

Displayed Project ... The related files linked with the displayed Project in the List of Projects is displayed.

Selected Project ... The related files linked with the Project selected in the List of Project is displayed.

The Project shall be screened by the authority to view the Project data.

The filtering state shall be displayed by inheriting the News and Events information on the Menu window. The filtering information on the Download List window shall also be inherited for display.

The Download process shall be started by clicking the title.

The Download process shall be common. If the file stored in the server is renamed, the original file name shall be used for downloading.

3.2.2.2.4.3.1. Download List Function

The window shall jump to the Download List window by clicking the header of the Download List.

The [Title], [Comment], [Link], [Format] and [File Size] can be acquired from the table of related files. The [Project Name] and [Summary] can be acquired and displayed from the related Layer attributes.

The filtering state is inherited from the filter on the GIS Portal TOP window and displayed. The filter type is displayed in the same way as the List of Documents and it can also be changed on the Download List window.

The Download process is started by clicking the title in the List.

3.2.2.2.4.4. Project List Function

The List of Projects that are included in the menu item (Division=Group) selected in the GIS Portal Menu on the Menu window are displayed.

The Project Type owned by the Group and the main layer linked with it are acquired from the Project Type Master. The Project Name is displayed based on the planimetric feature attributes. However, no main layer may exist, and in this case, the Table of Attributes is defined.

The List of Projects is filtered under the conditions “Implementation”, “In Planning”, “End” and “All”.

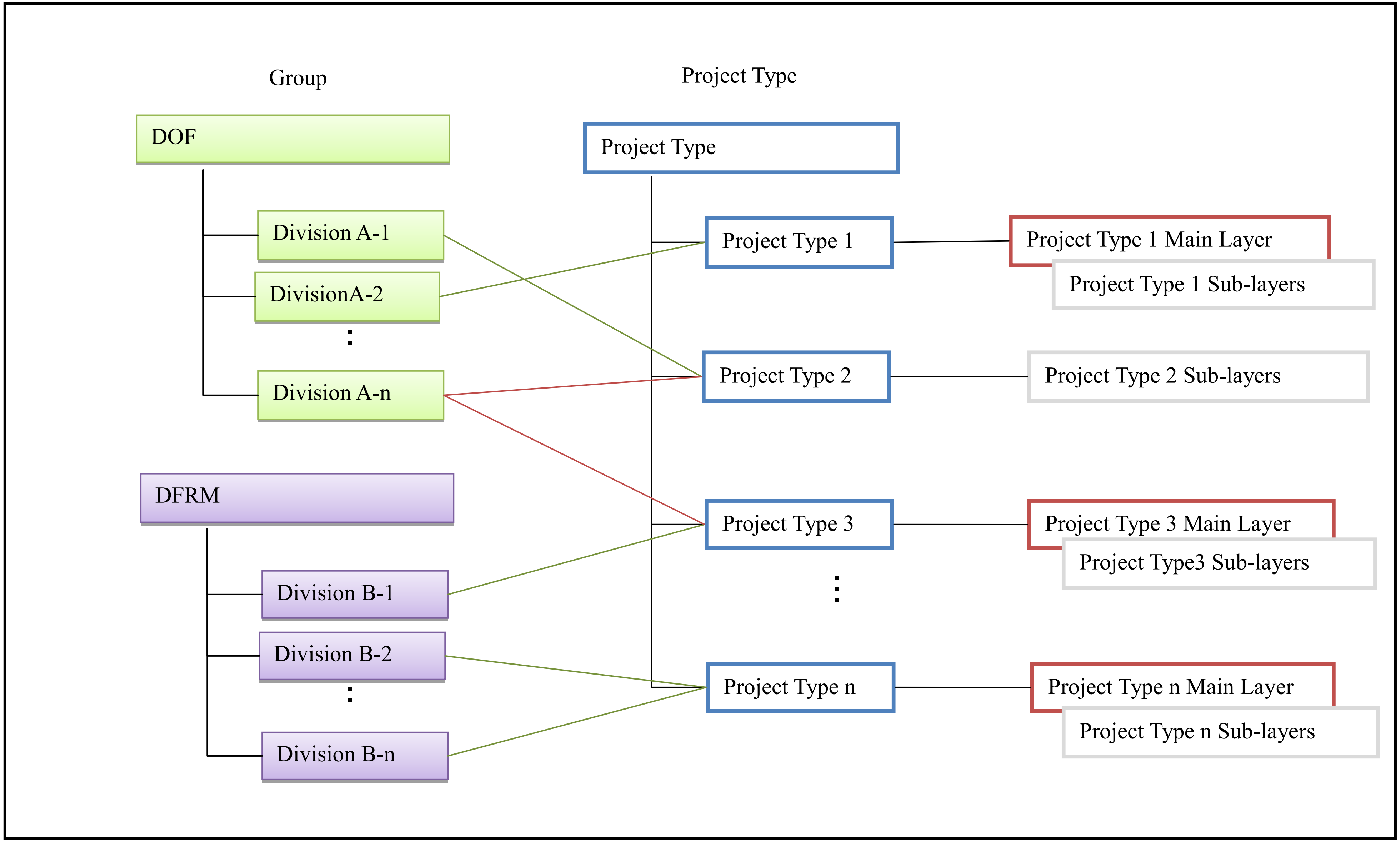
As the Project layer attributes contain the implementation conditions, filtering is performed on that item.

Clicking the item name in the List of Projects sorts the list by the item.

When the Project Name is clicked, the Attribute Details window is displayed, but with the authority to view the Project data.

When any line other than Project Name is clicked, mainly the relevant Project (planimetric features) is displayed on the Map window. The map (layer) corresponding to the Project Type to which the relevant Project is categorized is displayed.

The relationship between the Groups, Project Types and Main Layers is shown on the next page.


Group
Project Type
DOF
Division A-1
DivisionA-2
Division A-n
DFRM
Division B-1
Division B-2
Division B-n
Project Type
Project Type 1
Project Type 2
Project Type 3
Project Type n
Project Type 1 Main Layer
Project Type 1 Sub-layers
Project Type 2 Sub-layers
Project Type 3 Main Layer
Project Type3 Sub-layers
Project Type n Main Layer
Project Type n Sub-layers

In the map recall method by Project selection, the range of planimetric features is acquired and delivered as a parameter to FlexViewer.

As the FlexViewer site is prepared for each Project Type, the site of the Project Type of the selected Project is recalled.

3.2.2.2.4.4.1. Attribute Display Function

When the Project List of planimetric features on the map is clicked, the Attribute Window is displayed. ＊With the authority to view the Project data.

All the attribute information on the planimetric features is displayed. As the items of attribute information differ from layer to layer, all the items in the table are acquired and displayed.

The files linked with the planimetric features (Project) are displayed.

When the Delete button on the line of the related file is pressed, the file stored in the server and the relevant record in the relevant file table are deleted.

Deletion can be performed by the [Administrator], [Manager] and [Editor]. The [DOF Manager] and [DOF Editor] can only delete the files registered by the DOF user, and the [DFRM Manager] and [DFRM Editor] can only delete the files registered by the DFRM user.

The deletion of a related file is registered in the Log Management Table.

When the title of the related file is clicked, the Download process for the file is started.

When the [Add new document] button is pressed, the window jumps to the Update Attribute window (the related file is registered).

The window can only be switched by the [Administrator], [Manager] and [Editor].

3.2.2.2.4.4.2. Attribute Updating (Related File Registration) Function

The attribute information on the Project (planimetric features) is displayed (similarly to the previous window).

The title of the related file that has been registered is displayed.

The title and comment of the file to be newly linked and the KnowledgeTree URL (link) are entered to select the file and upload it to the server.

All the folders storing the real files of the files uploaded to the server are stored in a designated folder.

In storing the files, the files are renamed by affixing a GUID to each of them.

In registering the files, their records are added to the table of related files.

In registering the related files, they are registered to the Log Management Table.

After registering the related files, they are output to the metadata template [Laos Metadata Template (minimum)] to start registering a batch of files in the Geonetwork.

3.2.2.2.4.4.3. Attribute Updating Function

The attribute information of the Project (planimetric features) is displayed. It can be input for the same items as on the previous window.

If the Login user is the [Administrator], the DOF data selected from the Menu by the [DOF Manager] or [DOF Editor], or the DFRM data selected from the Menu by the [DFRM Manager] or [DFRM Editor] is updatable.

The value of each attribute item is changeable.

The attribute information is updated by pressing the [OK] button. Check the input information before execution of the update operation.

- Check the mandatory items not entered
- Check the attributes...Check that the entered values are coincident with the attributes of the items in the Table of Attributes. The attributes to be checked are as follows:

nvarchar: Check the number of entered characters.

int: Check the value.

date: Check the date. ∗ The format is yyyy-mm-dd.

If an error occurs when checking the entry, an error message is displayed.

When the [Cancel] button is pressed, the window returns to the full window.

3.2.2.2.4.5. Project Updating Function

For Projects with no planimetric features, addition, editing and deletion of the Project can be performed.

If the Login user is the [Administrator], the DOF data selected by the [DOF Manager] or [DOF Editor] from the Menu, or the DFRM data selected by the [DFRM Manager] or [DFRM Editor] is updatable, but with the authority of viewing the Project data.

3.2.2.2.4.5.1. Project Listing Function

All the Projects to be displayed in the List of Projects on the GIS Portal window are displayed as a list.

When the Edit button in each line is pressed, the window jumps to the Edit Project window

When the Delete button in each line is pressed, the Project information is deleted and the relevant record in the List of Projects is deleted.

When the Add button is pressed, the window jumps to the Register Project window.

3.2.2.2.4.5.2. Project Registering Function

The Project List related to the information to be registered is selected in the Combo Box.

Each item on the Input Project window is blanked.

Before pressing the OK button, check the entered attribute information.

- Check the mandatory items not entered.

・ Check the attributes ... Check that the entered values are coincident with the attributes of the items in the Table of Attributes. The attributes to be checked are as follows:

nvarchar: Check the number of entered characters.

int: Check the value.

date: Check the date. ＊The format shall be yyyy-mm-dd.

When the OK button is pressed, the attributes are registered in the List of Projects.

When the Cancel button is pressed, the window jumps to the Project List window.

3.2.2.2.4.5.3. Project Editing Function

The relevant attribute information is displayed in the items on the Edit Project window.

Before pressing the OK button, check the entered attribute information.

・ Check the mandatory items not entered

・ Check the attributes ... Check that the entered values are coincident with the attributes of the items in the Table of Attributes. The attributes to be checked are as follows:

nvarchar: Check the number of entered characters

int: Check the value.

date: Check the date. ＊The format shall be yyyy-mm-dd

When the OK button is pressed, the relevant record in the List of Projects is updated.

When the Cancel button is pressed, the window jumps to the Project List window.

3.2.2.2.4.6. Project Search Function

Enter the value in the column for the Search key entry and click the Search button. Then all the attributes in the List of Projects are searched by the LIKE button.

The acquired records are displayed as a list.

Multiple keywords may be designated using a space in the key entry column. In this case, the AND search shall be made.

If a Search is executed when the key entry column is blank, all the Projects are displayed.

3.2.2.2.4.7. Mapping Function

The FlexViewer is displayed in the in-line frame.

When the GIS Portal window is initially displayed, the site of the relevant Project Type is displayed. If the Group selected from the Menu has multiple Project Types, the site of the first acquired Project Type is displayed.

It is assumed that the application (ArcGIS Viewer for Flex) shall be built for each Project Type by the Application Builder.

When the Full Screen button is pressed, the map is displayed on the full screen of the browser (with the header also displayed).

Various settings are made using the Application Builder to perform the following operations by the Mapping Function:

Switch Layers (Display ON/OFF) ... The display of the layer is set to ON/OFF by the List of Layers and Widgets. (It is available for the details displayed on the map.)
Zooming In & Out / Move ... Zooming, scaling and moving are performed by Navigation (or using the mouse).
Switch Area Display... The display range of the map is changed when a Project is selected from the List of Projects.
The display range can be changed by setting the URL parameters.
Full Display ... The map range is set and displayed on the full screen by Navigation.
Display Attribute Table... The Attribute Table is set to [ON] and displayed on the layout of the Application Builder.
Search Geographic Names... The Address Search Function is used to search geographic names.
The addresses are registered in advance using the Geocoding Service.
The layer for the address locator is created.
The layer has planimetric features indicating places, and the planimetric features have search fields.
The address locator is created using the layer, and registered in the ArcGIS Server for public disclosure.
Search Attributes... If this function is provided in the standard functions, attribute search shall be available.
Display Planimetric Feature Attributes ... This function is customized. When a planimetric feature is clicked, information on the planimetric feature is requested to the GIS Portal.
The attribute information is displayed by the GIS Portal side function.
Edit Planimetric Feature Attributes... The attribute information is edited by the GIS Portal side function (only by linking the related file).
Measure Distance ... The distance is measured using the Drawing Widget.
Measure Area ... The area is measured using the Drawing Widget.
Bookmark ... A bookmark is registered using the Bookmark Widget to scroll to the registered point (by manual editing).
Print ... Printing is performed using the Print Widget.
Output Attribute Table... The attribute information is output in csv format as an option in the Attribute Table.

3.2.2.2.4.8. Link Window Function

The Link to jump to the Link window is located in the header part of the GIS Portal window.
The List of Links is displayed on the Link window.
The relevant window is displayed by clicking any Link.

The settings file is read to indicate the display name in the List of Links. The display names and the destination links are stored in the settings file.

【Example】

Display name and destination link

Google, https://www.google.co.jp/

Yahoo, http://www.yahoo.co.jp/

3.2.2.2.5 System Administration

3.2.2.2.5.1. System Administration Menu

The Menu window jumps to the System Administration Menu.

If the Login user is the [Administrator] or [Bureau Manager], the Menu including [User Management], [Group Management], [Project Type Management] and [Division Role Setting] is displayed.

3.2.2.2.5.2. User Management Function

3.2.2.2.5.2.1. User Information List

The user information registered in the User Master is displayed in a list. The groups to which the user belongs and their roles are displayed in a list.

When the Edit button on each line is pressed, the window jumps to the Edit User window.

When the Delete button is pressed, the user information is deleted. The relevant records in the User Master and the User Group Master are flagged.

When the Add button is pressed, the window jumps to the User Management window.

3.2.2.2.5.2.2. User Management Function

Each item on the User Management window is blanked.

When the OK button is pressed and if no parameter is entered in each item, an error is indicated.

The user_id is an error if it is duplicated with another user.

Multiple groups are selectable from the Group Master. The functions are set for each group.

If any group in the Group Master is [0: No Group], its functions can be set only as the [Administrator].

If any group in the Group Master is [1: DFRM] or [2: DOF], its functions can be set as the [Manager], [Editor] and [Guest User].

When the OK button is pressed, the user information is registered in the User Master.

When the Cancel button is pressed, the window returns to the User List window.

The records of the items registered in the User Group Master (if multiple groups are set, the records for those groups) are registered.

3.2.2.2.5.2.3. User Editing Function

The relevant user information is displayed in the items on the Edit User window.
When the OK button is pressed and if no information is entered in any item, an error is indicated.

If the user_id is duplicated with another user, an error is indicated.
Multiple groups can be selected from the Group Master and their functions can be set for each group.
If any group in the Group Master is [0: No Group], its functions can be set only as the [Administrator].
If any group in the Group Master is [1: DFRM] or [2: DOF], the functions of the group can be set as the [Manager], [Editor] and [Guest User].
When the OK button is pressed, the User Master is updated. If a group is changed, the previous group is deleted from the Group Master.
When the Cancel button is pressed, the window returns to the User List window.

The records of the updated items in the Users Group Master (if multiple groups are selected, the records for those groups) are registered.

3.2.2.2.5.3. Group Managing Function

3.2.2.2.5.3.1. Group Information List

The group information registered in the Group Master is displayed in a list.
When the Edit button on each line is pressed, the window jumps to the Edit Group window.
When the Delete button on each line is pressed, the group information is deleted. The relevant record in the Group Master and the relevant record in the Group Master are deleted.
When the Add button is pressed, the window jumps to the Register Group window.

3.2.2.2.5.3.2. Group Registering Function

Each item on the Register Group window is blanked.
When the OK button is pressed and if no information is entered in each item, an error is indicated.
If the group_id is duplicated with another group, an error is indicated.
When the OK button is pressed, the information is registered in the Group Master.
When the Cancel button is pressed, the window returns to the Group List window.

3.2.2.2.5.3.3. Group Editing Function

The relevant group information is displayed.
When the OK button is pressed and if no information is entered in each item, an error is indicated.
If the group_id is duplicated with another group, an error is indicated.
When the OK button is pressed, the Group Master is updated.
When the Cancel button is pressed, the window returns to the Group List window.

3.2.2.2.5.4. Project Type Management Function

3.2.2.2.5.4.1. Project Type List

The Project types registered in the Project Type Master are displayed in a list.
When the Edit button on each line is pressed, the window jumps to the Edit Project Type window.
When the Delete button on each line is pressed, the Project Type is deleted. The relevant records in the Project Type Master and the relevant record in the Authority Master are deleted.
When the Add button is pressed, the window jumps to the Register Project Type window.

3.2.2.2.5.4.2. Project Type Registration Function

Each item on the Project Type Management window is blanked.
When the OK button is pressed and if no information is entered in each item, an error is indicated.
If the Project Type is duplicated with another type, an error is indicated.
When the OK button is pressed, the Project Type is registered in the Project Type Master.
When the Cancel button is pressed, the window returns to the Project Type List window.

3.2.2.2.5.4.3. Project Type Editing Function

The relevant Project Type is displayed on the window.
When the OK button is pressed and if no information is entered in each item, an error is indicated.
If the Project Type is duplicated with another type, an error is indicated.
When the OK button is pressed, the Project Type Master is updated.
When the Cancel button is pressed, the window returns to the Project Type List window.

3.2.2.2.5.5. Division Role Setting Function

The information registered in the Division Role Master is displayed.
The Division Role is set for each Project Type.
When the OK button is pressed, the Division Role Master is updated.
When the Cancel button is pressed, the window returns to the System Administration Menu window.

3.2.3. GIS Data Design

3.2.3.1 Organize Data

List of data to be collected or developed for building geo-spatial database of NFIDB Basic Data

Application	Data	Category	Description of data (source, year, methodology of production)	Availability of data in FIPD (Yes or No)	Location of data (if not available in FIPD)	Necessity of creating un-available data for NFIS DB	Where, who and how to create un-available data	Contact Person	Person in Charge	Availability of Supply	Cost
REDD+ and SFM	Contour	Contour interval (100m, 50m, 20m)	NGD (National Geographic Department), Updated in 2003 based on aerial photo taken in 1999 (scale: 1:100,000), (http://www.ngdlaos.la/2012/02/01/contour-lines/)	Yes							
	DEM	Elevation, Slope	FIM (Program for Forest Information Management) project, 2010-2012, Automatic generation from ASTER G-DEM	Yes							
	Geology	Geological Structure	Geological Data (Made from various studies conducted by the government, foreign donors and private companies)	JPEG file is available but no GIS file.	DGM, MONRE	Geology data is required for forest use planning taking into account potential mining area.	Digitizing from JPEG file	Mr. Kuangnouvong (Mobile: 55702756)	Japanese Consultant	Only JPEG file	Free
	Soil	Soil type, pH, Depth	Department of Land (former Soil Research Centre of NAFRI, located in NAFRI compound)	JPEG file is available but no GIS file.	Department of Land, MAF	Necessary to collect or create GIS file.	Department of Land	Official Letter to DG of Department of Land, MAF	Japanese Consultant	Limited area with official letter. If you pay some money you may get larger area	If you pay, you can get more.

	Watershed	Main watershed, Sub-watershed	1. MRC (Mekong River Commission): Mekong watershed data 2. GTZ project (Watershed management and forest cover monitoring project), Forest cover (1994-1998), Watershed (1999), Digitization of paper maps	1. No 2. Yes	1. MRC	Necessary to collect MRC watershed data.	Check MRC for availability of watershed GIS data.		Japanese Consultant		
	River network	River, Stream, Small stream	NGD, Updated in 2003 based on aerial photo taken in 1999 (scale: 1:100,000), (http://www.ngdlaos.la/2012/02/01/rivers/)	Yes							
	Road network	Major road, Road, Logging road, Footpath	1. NGD, Updated in 2003 based on aerial photo taken in 1999 (scale: 1:100.000), (http://www.ngdlaos.la/2012/02/01/roads/) 2. Communication and Transport Department (unsure)	1. Yes 2. No		Updating of NGD road network data is necessary.	Updating will be conducted in FIPD using RapidEye images (2010) and aerial photo (2011) orthophoto images.		Khamkhong		
	Amount of Rainfall		DMH						Khamsouk		
	Temperature		DMH						Khamsouk		

	Administrative boundary	National boundary, Provincial boundary, District boundary	NGD, Updated in 2003 based on aerial photo taken in 1999 (scale: 1:100,000), (http://www.ngdlaos.la/2012/02/01/administrative-boundary/) -> Xaysomboune Province	Yes							
	Village	Village point	NGD, Updated in 2008 based on data from the Lao Statistics Bureau, (http://www.ngdlaos.la/2012/02/01/villages/)	Yes	Center of Statistics Institute/MAF	Updating of village point data is necessary.	Check Lao Statistics Bureau.	Dr. Thatheva	Khamkhong		
	National Forest Inventory	Sample plot	FIPD, NFI (1991-1999) -> Only Hard Copy, FIM project (2010-2012)	Yes							
	Land use plan	agro-ecological zoning map	Made from soil map (original) with climate data (temperature, rainfall, etc. from Department of Meteorology and Hydrology, MONRE)	No	Department of Land	Yes	Department of Land		Onkeo	Available with official letter	free for limited area, if you pay you may get nationwide map.
	Concession	Concession type and area	State Land Lease/Concession Inventory (SLLCI) ; Collected from various government organizations including provincial and district levels.	Can be accessed through internet with User ID and password provided by NREIC	MONRE, Natural Resource and Environment Information Canter (NREIC)	Yes	Check MONRE.	Ekvinay (NREIC)	(Amphayb ang), Phoukhong, Japanese Consultant	The center will provide User ID and password to access database.	free

		Population	Unsure	Yes	Lao Statistics Bureau	Yes, but possible to collect only national data in this project.	Check Lao Statistics Bureau.		Khamsouk		
		Income	Unsure	Yes	Lao Statistics Bureau	Yes, but possible to collect only national data in this project.	Check Lao Statistics Bureau.		Khamsouk		
		Employment	Unsure	Yes	Lao Statistics Bureau	Yes, but possible to collect only national data in this project.	Check Lao Statistics Bureau.		Khamsouk		
	Statistics / Census	Forestry (Timber and/or NTFP)	Unsure	Yes	Ministry of Trade (Timber trade)	Yes, but possible to collect only national data in this project.	Check Ministry of Trade.		Khamsouk		
		Illegal logging	Unsure	Yes	DOFI (Department of Forest Inspection)	Yes	Check DOFI.		Khamsouk		
		Agriculture	Unsure	Yes	MAF	Yes, but possible to collect only national data in this project.	Check MAF.		Khamsouk		
		Livestock	Unsure	Yes	MAF	Yes, but possible to collect only national data in this project.	Check MAF.		Khamsouk		

	Development plan area	Unsure	Unsure	No	Ministry of Planning and Investment	Yes	Check Ministry of Planning and Investment.		Japanese Consultant		
	Irrigation	Irrigation System (main canal, dam, weir, etc.)	Irrigation Technical Study Center, Department of Irrigation, MAF (now updating and will be completed in December 2014)	No	DOI	Yes	Available with official letter from DOF	Mr. Vongsakda VONGXAY (Deputy Director of Irrigation Technical Study Center, DOI, MAF)	Japanese Consultant	Available with official letter	Free
	Mining	Mining Concession Area	Mining Concession Area (as of October 2014)	JPEG file is available but no GIS file.	DGM, MONRE	Yes	Digitizing from JPEG file	Mr. Kuangnouvong (Mobile: 55702756)	Japanese Consultant	Only JPEG file (52Mb)	Free
	Military zone	Unsure	Unsure	No	Military	Yes, but impossible to collect data.					
	Forest along national borders	Unsure	Unsure	No	Military	Yes, but impossible to collect data.					
REDD+	Eco-region	Eco-region	The Nature Conservancy (http://maps.tnc.org/gis_data.html)	Yes	Website of The Nature Conservancy	Yes	Download from website of The Nature Conservancy.				

	Climate	temperature (max-min), humidity, dew point temperature, vapor, rainfall, sunshine, evaporation, wind direction and speed, hydrological data - water level, discharge	At present, data is observed at 45 weather stations and 109 rainfall station in the country. Period of record is different by each station.	No	DMH, MONRE	Yes		Mr. Sangkhane Thiangthammavong (DDG of DMH, Office: 021-215010), Mr. Nikhom Keosavan (Climate and Agro-Meteorology Div., Mobile: 22209181)	Japanese Consultant	DMH requested us to specify necessary data type/kind, period, frequency, etc.	Free
	REDD+ project boundary	Project boundary	PAREDD, Clipad, WWF	No	PAREDD, CliPAD, WWF, etc.	Yes	Check each project.		Japanese Expert		
	Biodiversity hotspot	NBCA boundary	NBCA (National Biodiversity Conservation Area)	Yes, but only boundary is available. No attributes data.	MONRE (Ministry of Natural Resource and Environment)	Yes, need to create attribute data for NBCA boundary data (shapefile).	English translation by the project side and data input by FIPD.		Amphaybang		
	Electric power line network	Electric power line network	Unsure	No	Department of Energy, Trade and Business	Yes	Check Department of Energy, Trade and Business.		Amphaybang		
SFM	Forest category	Conservation forest	MONRE	Yes							

		Protection forest	MONRE	Yes						
		Production forest	DOF	Yes						
	Village	Village boundary		No	Center of Statistics Institute/MAF	Yes, but impossible to create in this project.		Dr. Thatheva	Khamkhong		
	Forest management area	FMA (Forest Management Area), Sub-FMA, FC (Forest Compartment)		No	SUFORD	Yes	Check SUFORD as well as Forest Product and Harvest Division (Section name in English is not sure).		Phoukhong		
Basemap	Satellite image		RapidEye (2010), ALOS (2010), SPOT-5 (2005)	Yes						
	Aerial photo		Ortho-rectified aerial photo (2011): 6 provinces from Khammouan down to South (http://www.ngdlaos.la/2012/02/01/aerial-photograph/)	Yes						
	Ground truth		FIM (2010-2012), 720 points from non-forest and 1,680 points from forest	Yes						

3.2.3.2 Existing Data

3.2.3.2.1 Basic Information

Category 1	Category 2	Layer name	Remarks
Basic Layers	Boundary	CountryBoundary	
		Country	
		District	
		Provinces	
	Road	Road_Louangphabang_edited_48	
	ForestCategory	CSA20110203	
		PFA20110203	
		PTA20110203	
	GDEM	astgtm2_mosaic_utm	
		slope_gdem2	
	SRTM	srtm_laos_mosaic_rp_sub_utm	
		srtm_laos_mosaic_rp_sub_utm_10m	
		srtm_laos_mosaic_rp_sub_utm_aspect	
		srtm_laos_mosaic_rp_sub_utm_slope	
	IndexMap	Photo_Index_SNGS_2011	
		MapIndex5000	
		MapIndex10000	
		MapIndex25000	
		MapIndex50000	
		MapIndex100000	
		MapIndex200000	
		MapIndex500000	
		MapIndex1000000	
		MapIndex_5000	
		MapIndex_10000	
		MapIndex_25000	
		MapIndex_50000	
		MapIndex_100000	
		MapIndex_200000	

Category 1	Category 2	Layer name	Remarks
		MapIndex_500000	
		MapIndex_1000000	
	Land Cover Change 2000-2014	Hansen_GFC2014_lossyear_Laos.tif	Added 2015
Satellite Image	ALOS-AVNIR2_2010 (Ortho_Mosaic)	ALOS-AVNIR2_2010 (Ortho_Mosaic)	
	ALOS-PRISM_2010 (Ortho_Mosaic)	ALOS-PRISM_2010 (Ortho_Mosaic)	
	ALOS-PRISM_AVNIR2_Pansharpen	265933190_200_or_mo_su_ps	
	ALOS-PALSAR (PALSAR_2009_Dry)	ALOS-PALSAR (PALSAR_2009_Dry)	
	ALOS-PALSAR (PALSAR_2009_Rainy)	ALOS-PALSAR (PALSAR_2009_Rainy)	
	ALOS-PALSAR (PALSAR_2010_Dry)	ALOS-PALSAR (PALSAR_2010_Dry)	
	ALOS-PALSAR (PALSAR_2010_Rainy)	ALOS-PALSAR (PALSAR_2010_Rainy)	
	ALOS-PALSAR (PALSAR_Layerstack)	LAOS479_40_09d10r10d	
	SPOT5_2005 (Ortho_Mosaic)	Sms_mo_zz_SK0608_02_0404	
	SPOT5_2005 (Atmospheric)	Sms_at_zz_SK1004_02_0404	
	SPOT5_2005 (Topographic)	Sms_to_zz_KP0607_02_0404	
	SPOT5_2005 (NDVI)	Sms_ix_nd_SK0613_02_0404	
	SPOT5_2005 (ShapeFile)	Sms_cl_su_SK0615_02_0404	
	RapidEye-2010 (Ortho_Mosaic)	20101108t045545_02_or_mo	
	RapidEye-2010 (NDVI)	20101108t045545_02_or_mo_nd	
	RapidEye-2010 (ShapeFile)	t043432_02	
	LANDSAT 2000 (Annual Greenest Pixel: cloud free mosaic)	Hansen_GFC2014_first_Laos.tif	Added 2015
	LANDSAT 2013 (Annual Greenest Pixel: cloud free mosaic)	Hansen_GFC2014_last_Laos.tif	Added 2015

3.2.3.2.2 Inventory Survey

Category 1	Category 2	Layer name	Remarks
Forest Inventory Survey 2010 - 2o11	Plot	1_PL_ALL_Final2010	
	Non_Forest	2_NF_ALL_Final2010	
Forest Inventory Survey 2010 - 2o11	Plot	01_Vientiane_Capital_PL	
		02_Phongsary_PL	
		03_Luangnamtha_PL	
		04_Oudomxay_PL	
		05_Bokeo_PL	
		06_Luangprabang_PL	
		07_Houaphanh_PL	
		08_Xayaboury_PL	
		09_Xiengkuang_PL	
		10_Vientian_PL	
		11_Bolikhamxay_PL	
		12_Khammuane_PL	
		13_Savannakhet_PL	
		14_Saravane_PL	
		15_Sekong_PL	
		16_Champasak_PL	
		17_Attapeu_PL	
		Whole_Laos_PL	
	Non_Forest	01_Vientiane_Capital_NF	
		02_Phongsary_NF	
		03_Luangnamtha_NF	
		04_Oudomxay_NF	
		05_Bokeo_NF	
		06_Luangprabang_NF	
		07_Houaphanh_NF	
		08_Xayaboury_NF	

		09_Xiengkuang_NF	
		10_Vientian_NF	
		11_Bolikhamxay_NF	
		12_Khammuane_NF	
		13_Savannakhet_NF	
		14_Saravane_NF	
		15_Sekong_NF	
		16_Champasak_NF	
		17_Attapeu_NF	
		Whole_Laos_NF	
Admin_Province_DD	Admin_Province_DD	01_admin_vientiane_capital_dd	
		02_admin_phongsaly_dd	
		03_admin_luangnamtha_dd	
		04_admin_oudomxay_dd	
		05_admin_bokeo_dd	
		06_admin_luangprabang_dd	
		07_admin_houaphanh_dd	
		08_admin_xayaboury_dd	
		09_admin_xiengkuang_dd	
		10_admin_vientiane_dd	
		11_admin_bolikhamxay_dd	
		12_admin_khammuane_dd	
		13_admin_savannakhet_dd	
		14_admin_saravane_dd	
		15_admin_sekong_dd	
		16_admin_champasak_dd	
		17_admin_attapeu_dd	
		admin_province_dd	

3.2.3.2.3 Production Forest

Category 1	Category 2	Layer name	Remarks
LOC (Land of Category?)		Road_network_z48	
		Provinces_z48	
		Districts_z48	
		River_Polygon_z48	
		PFA20110203	
		SFMA_in_thasi_z48	
		Districts_z48	
Top (Topographic)	Basemap	UpVillage2009_z48	
		Elevition_Point_z48	
		Stream_Line_z48	
		sfma_thasi_contour	
		road_network_z48	
		River_Polygon_z48	
		PFA20110203	
		SFMA_in_thasi_z48	
LUC (Land Use Current)	New Group Layer	UpVillage2009_z48	
		Elevition_Point_z48	
		Stream_Line_z48	
		road_network_z48	
		River_Polygon_z48	
		PFA20110203	
		SFMA_in_thasi_z48	
		LUC_Thasi24122012c	
LUP (Land Use Planned)	Basemap	UpVillage2009_z48	
		Elevition_Point_z48	
		Stream_Line_z48	
		road_network_z48	
		River_Polygon_z48	
		SFMA_in_thasi_z48	
		Buffer_SFMA_thasi120726a	

Category 1	Category 2	Layer name	Remarks
		LUP_SFMA_thasi20120726a	
		PFA20110203	
ACC (Annual Allowable Cut)	UL	UpVillage2009_z48	
		Elevition_Point_z48	
		Stream_Line_z48	
		Buffer_AAC_SFMA_thasi120726a_1	
		road_network_z48	
		SFMA_in_thasi_z48	
		River_Polygon_z48	
		AAC_LUC_Buffer_SFMA_thasi20120917b	
		AAC_LUC_Buffer_SFMA_thasi20120917b	
	LL	UpVillage2009_z48	
		Elevition_Point_z48	
		Stream_Line_z48	
		road_network_z48	
		SFMA_in_thasi_z48	
		River_Polygon_z48	
		Buffer_AAC_SFMA_thasi120726a_1	
		AAC_LUC_Buffer_SFMA_thasi20120917b	
		AAC_LUC_Buffer_SFMA_thasi20120917b	
	UR	UpVillage2009_z48	
		Elevition_Point_z48	
		Stream_Line_z48	
		road_network_z48	
		SFMA_in_thasi_z48	
		River_Polygon_z48	
		Buffer_AAC_SFMA_thasi120726a_1	
		AAC_LUC_Buffer_SFMA_thasi20120917b	
		AAC_LUC_Buffer_SFMA_thasi20120917b	
	Index_PBK	AAC_LUC_Buffer_SFMA_thasi20120917b	
		SFMA_in_thasi_z48	

Category 1	Category 2	Layer name	Remarks
FRA ()	Basemap	UpVillage2009_z48	
		Elevition_Point_z48	
		Stream_Line_z48	
		road_network_z48	
		River_Polygon_z48	
		PFA20110203	
		SFMA_in_thasi_z48	
		LUP_SFMA_thasi20120726a	
NTP (Non Timber Forest Production)		NTFP_in_SFMA_thasi	
	Basemap	UpVillage2009_z48	
		Elevition_Point_z48	
		Stream_Line_z48	
		road_network_z48	
		River_Polygon_z48	
		SFMA_in_thasi_z48	
		Buffer_SFMA_thasi120726a	
		LUC_Thasi24122012c	
HCV (High Conserve)		NTFP_in_SFMA_thasi	
	New Group Layer	UpVillage2009_z48	
		Elevition_Point_z48	
		Stream_Line_z48	
		road_network_z48	
		River_Polygon_z48	
		Buffer_SFMA_thasi120726a	
		SFMA_in_thasi_z48	
		LUC_Thasi24122012c	
		PFA20110203	

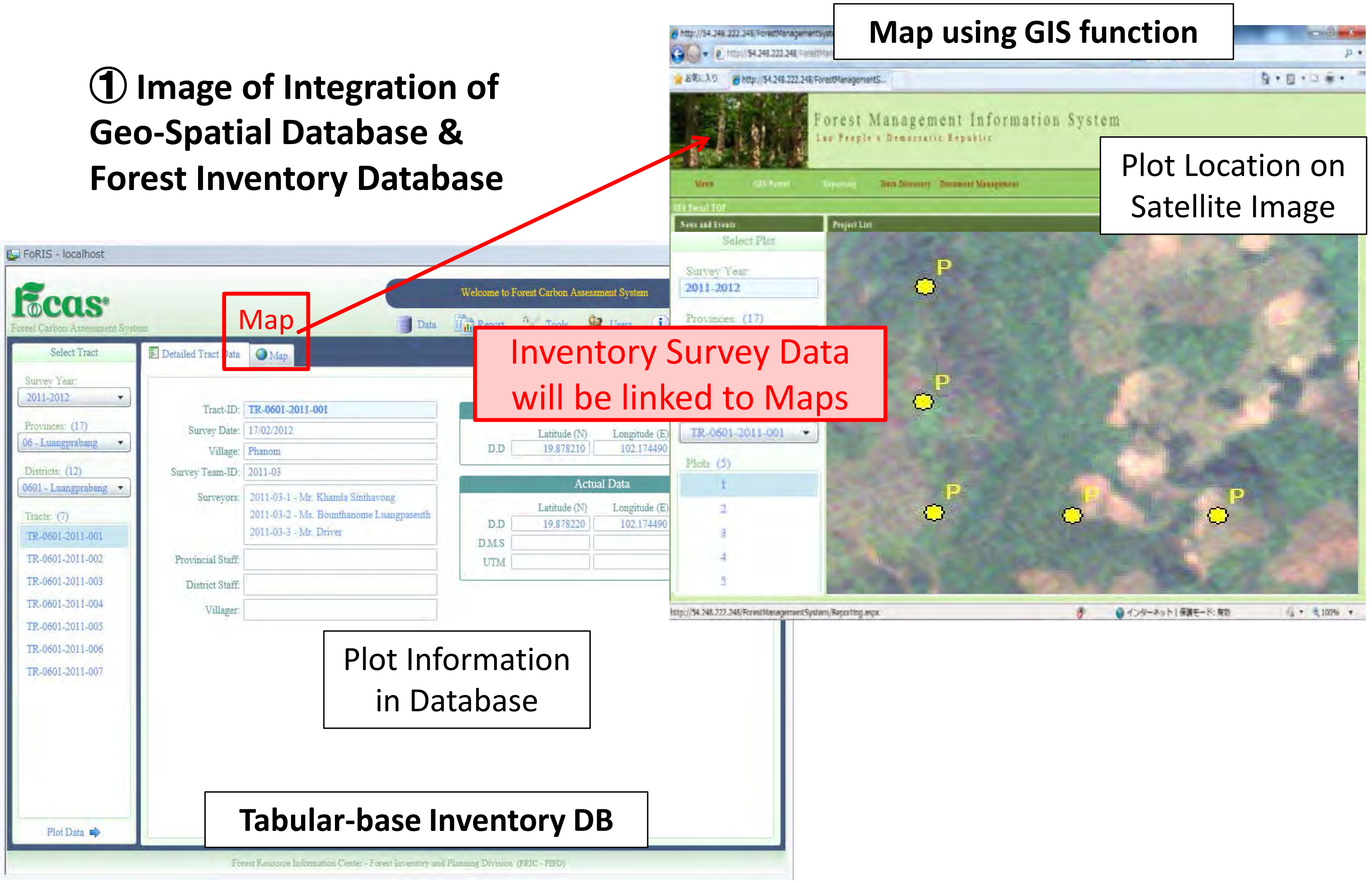
3.2.3.2.4 Protection & Conservation Forest

Category 1	Category 2	Layer name	Remarks
Protection Forest Area	Forest Category	ProtectionForestArea	
	Watershed	Nambeng_SubWatershed_con1000.shp	Demo data 2015
	Landslide Risk	Nambeng_SubWatershed_con1000_landslide_index.shp	Demo data 2015
	Landuse Plan	Nambeng_LUP_UTM48.shp	Demo data 2015
Conservation Forest Area	Forest Category	ConservationForestArea	

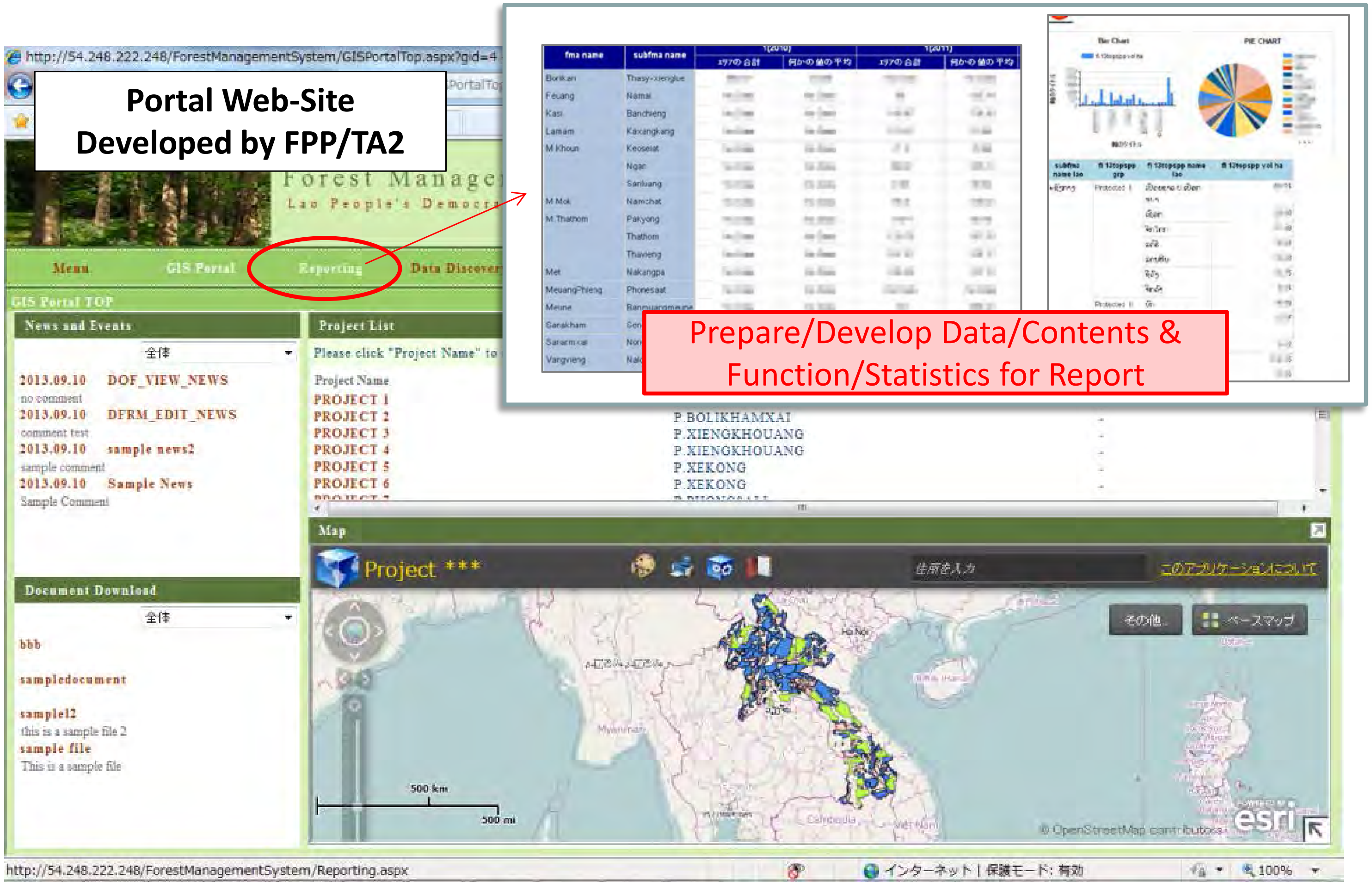
3.2.4. Window Design

3.2.4.1 New Windows

3.2.4.1.1 Linkage of Spatial DB and Inventory

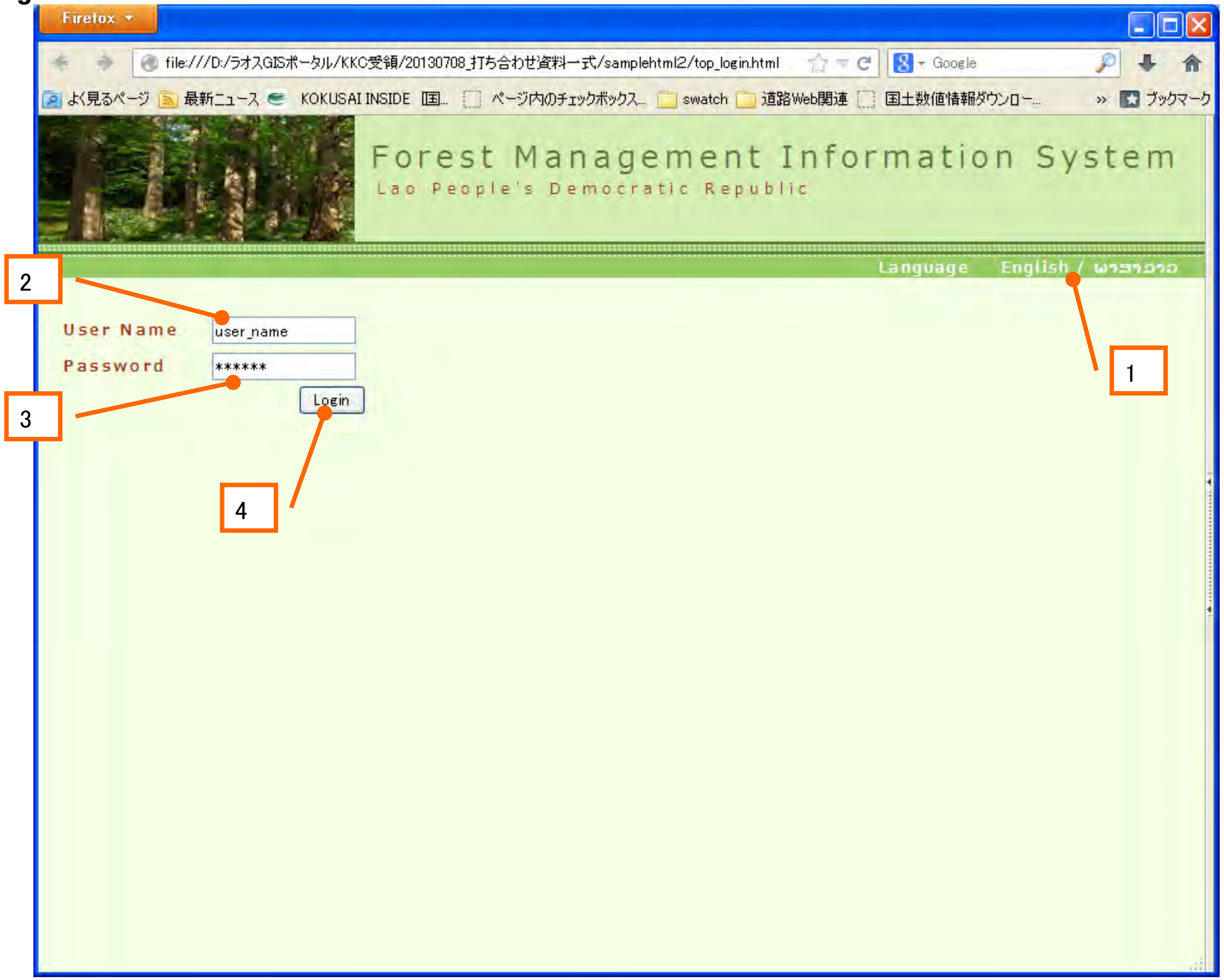


3.2.4.1.2 Reporting Interface (Browser based)



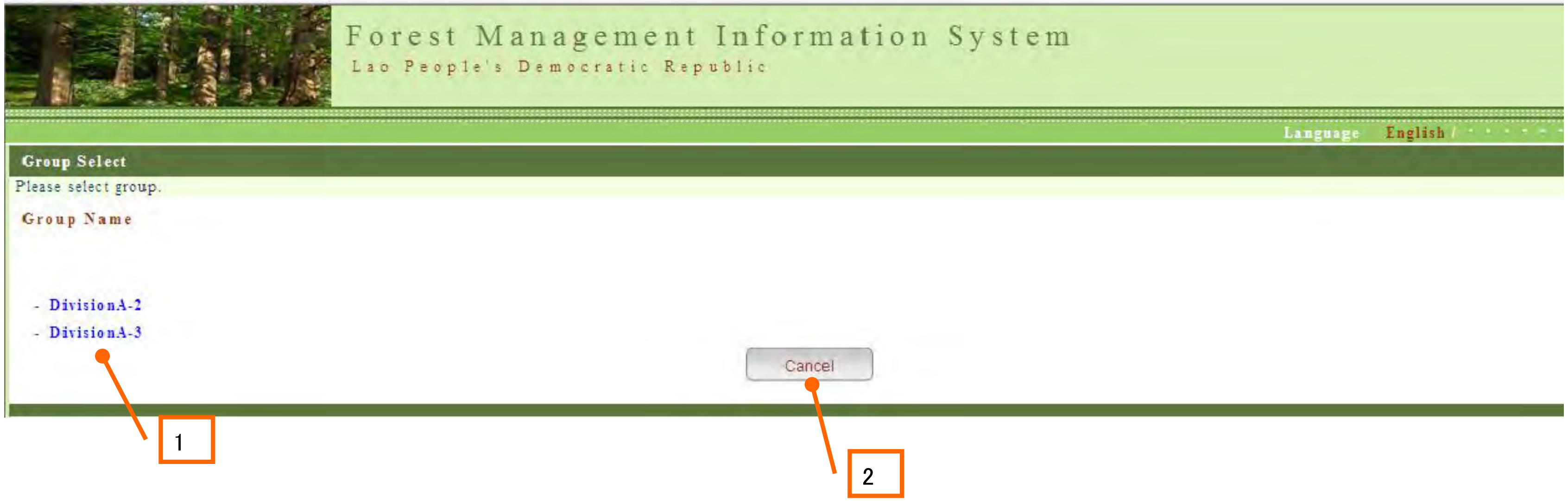
3.2.4.2 Basic Windows

3.2.4.2.1 Login Window



No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Language	Indication	-	-	Language switching English and Lao can be switched on this window. (The information acquired from DB is displayed in the original language.)	-	-
2	User Name	Text	-	○	Enter the User ID	m_user	user_id
3	password	Text	○	○	Enter the password, The input value is indicated by ●.	m_user	password
4	Login	Button	-	-	The current menu item is changed to the next menu item by pressing the button.	-	-

3.2.4.2.2 Select Group Window

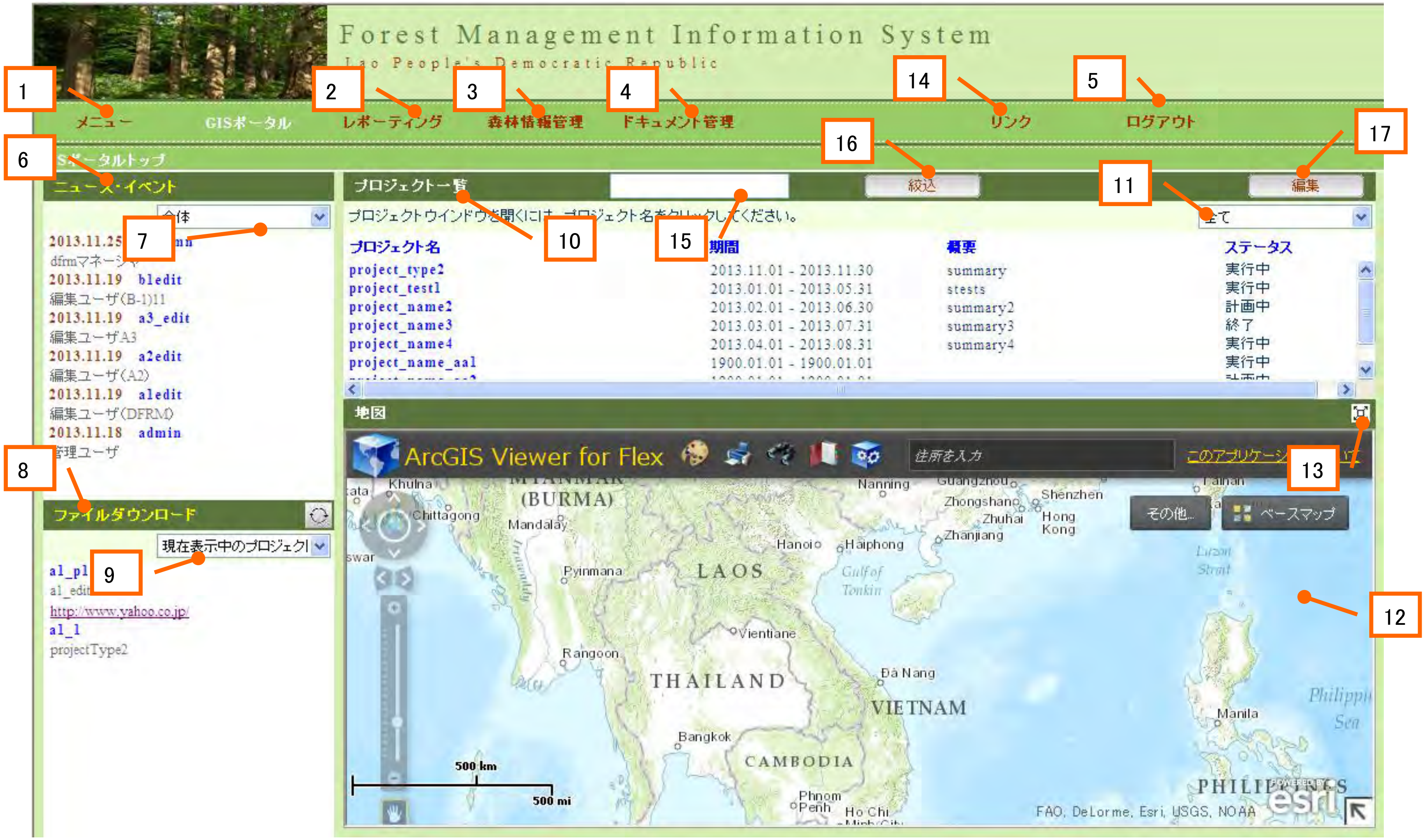


No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Group	Text	-	-	The group to which the user belongs is displayed in Text (Link).	m_group	group_id
3	Cancel	Button	-	-	When this button is pressed, this window is closed and returns to the Login window.	-	-

3.2.4.2.3 Menu Window

No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Data Discovery	Link	-	-	Linked to the Forest Information Management Function	-	-
2	Document Management	Link	-	-	Linked to the Document Management System	-	-
3	Logout	Link	-	-	When clicked, the system is logged out and the Login window appears.	-	-
4	News and Events	Text	-	-	The List of News and Events is displayed.	Information	insert_date, title, comment
5	Filter	Combo Box	Show all	-	Screening by filter	-	-
6	GIS Portal Menu	Text	-	-	The GIS Portal Menu is displayed.	m_group	group_name
7	Management Window Menu	Link	-	-	When clicked, the window changes to the Management Window.	-	-

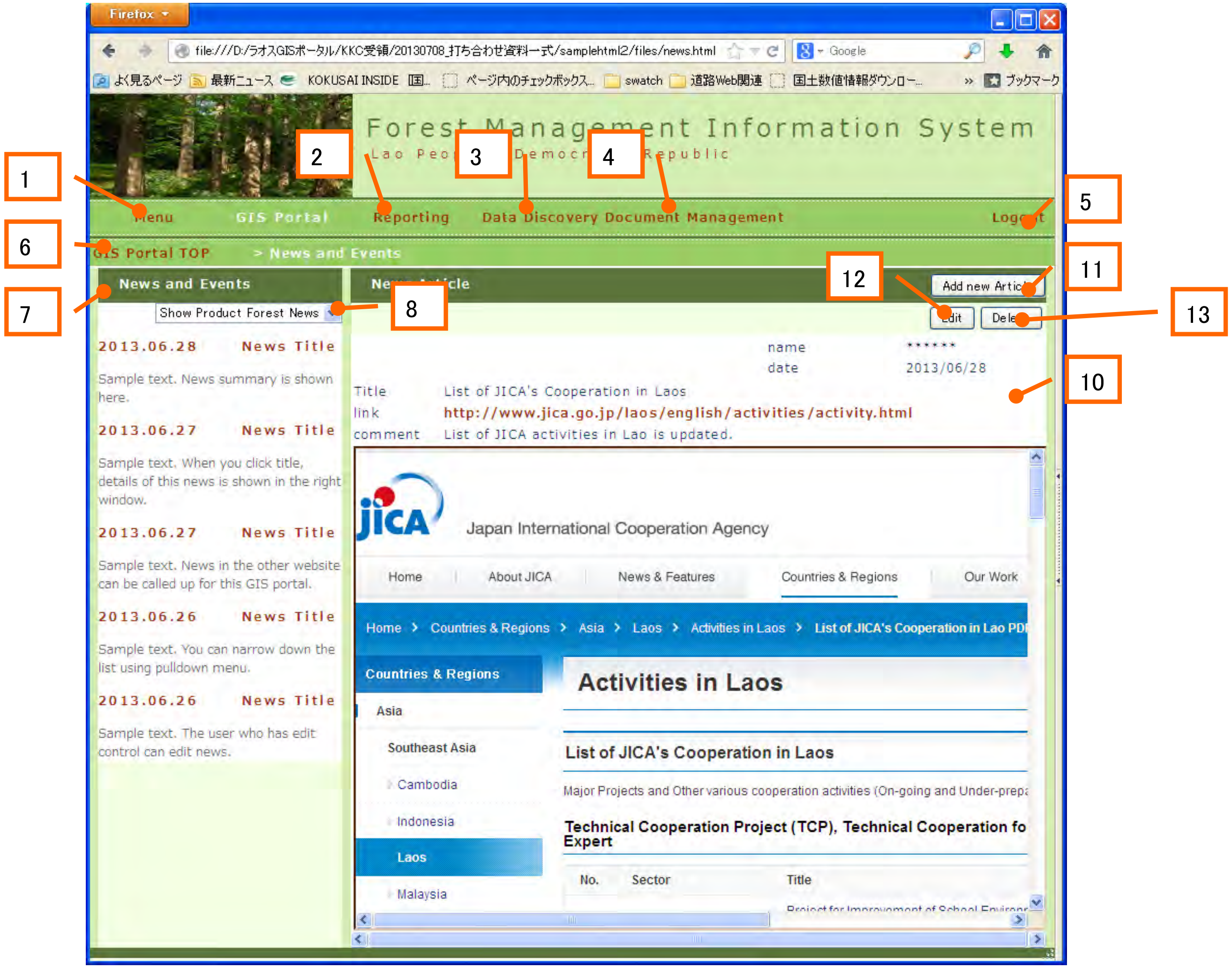
3.2.4.2.4 GIS Portal Window



No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Menu	Link	-	-	Jumps to the Menu window	-	-
2	Reporting	Link	-	-	Jumps to the Reporting window	-	-
3	Data Discovery	Link	-	-	Linked to the Forest Information Management Function	-	-
4	Document Management	Link	-	-	Linked to the Document Management System	-	-
5	Logout	Button	-	-	When clicked, the system is logged out and the Login window appears.	-	-
6	News and Events	Text	-	-	The List of News and Events is displayed.	Information	insert_date, title, comment
7	Filter	Combo	○	-	Screening by filter	-	-
8	Document Download	Text	-	-	The List of Documents is displayed.	RelationFile	All
9	Filter		-	-	Screening by filter	-	-
10	Project List	Text	-	-	The List of Projects is displayed.	Project Layer	Attribute information
11	Filter				Screening for [Implementing], [In Planning], [End] and [All]	-	-
12	Map				The ArcGIS Viewer for Flex is displayed in the In-line frame	-	-
13	Full Screen	Button	-	-	A map is displayed on the full screen of the GIP Portal.	-	-
14	Link	Link	-	-	Jumps to the Link window	-	-
15	Search Condition Entry	Text	-	-	The search conditions are entered.	-	-
16	Pick	Button	-	-	Screening of the search conditions	-	-
17	Edit	Button	-	-	Jumps to the Project Management window	-	-

When a Combo Box is selected, the list changes.

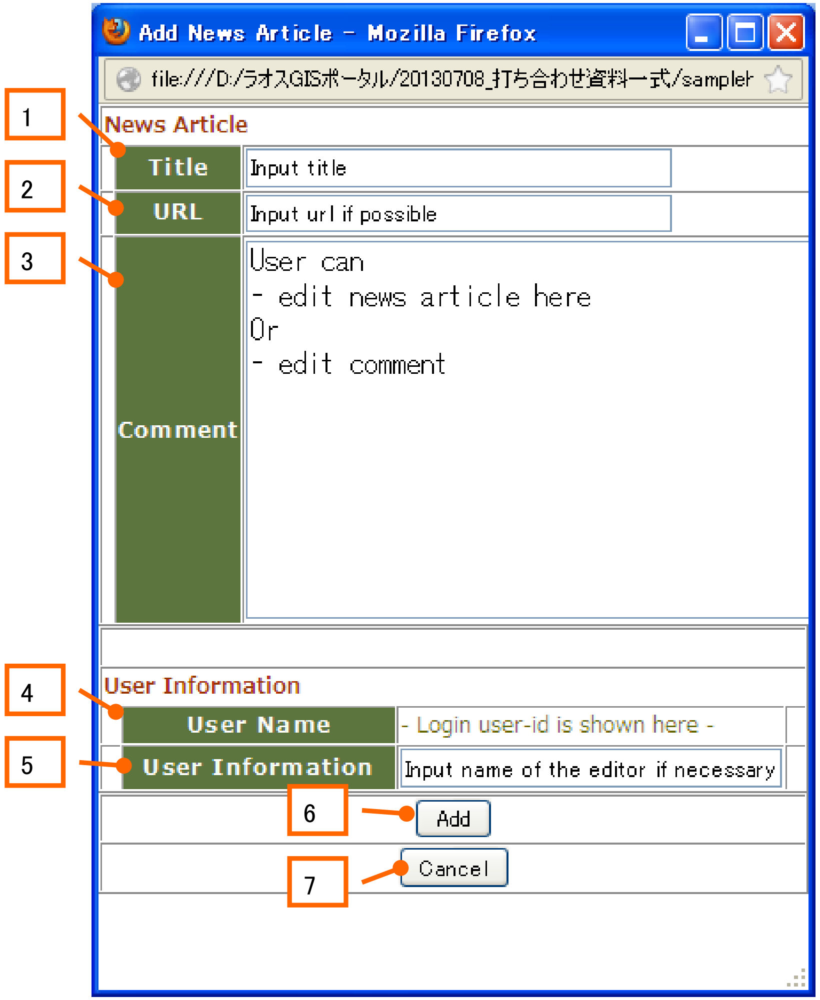
3.2.4.2.5 News and Events Window



No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Menu	Link	-	-	Jumps to the Menu window	-	-
2	Reporting	Link	-	-	Jumps to the Reporting window	-	-
3	Data Discovery	Link	-	-	Linked to the Forest Information Management Function	-	-
4	Document Management	Link	-	-	Linked to the Document Management System	-	-
5	Logout	Button	-	-	When clicked, the system is logged out and the Login window appears.	-	-
6	GIS Portal TOP	Button	-	-	Returns to TOP window of GIS Portal	-	-
7	News and Events	Text	-	-	The List of News and Events is displayed.	Information	insert_date, title, comment
8	Filter	Combo	○	-	Screening of All, Bureau and Division	-	-
9	NewsArticle	Text	-	-	The details of news and events are displayed.	Information	insert_date, title, comment, m_user_id, link
10	AddnewArticle	Button	-	-	The Add News Article window appears.	-	-
11	Edit	Button	-	-	The Edit News Article window appears.	-	-
12	Delete	Button	-	-	The News information is deleted.	-	-

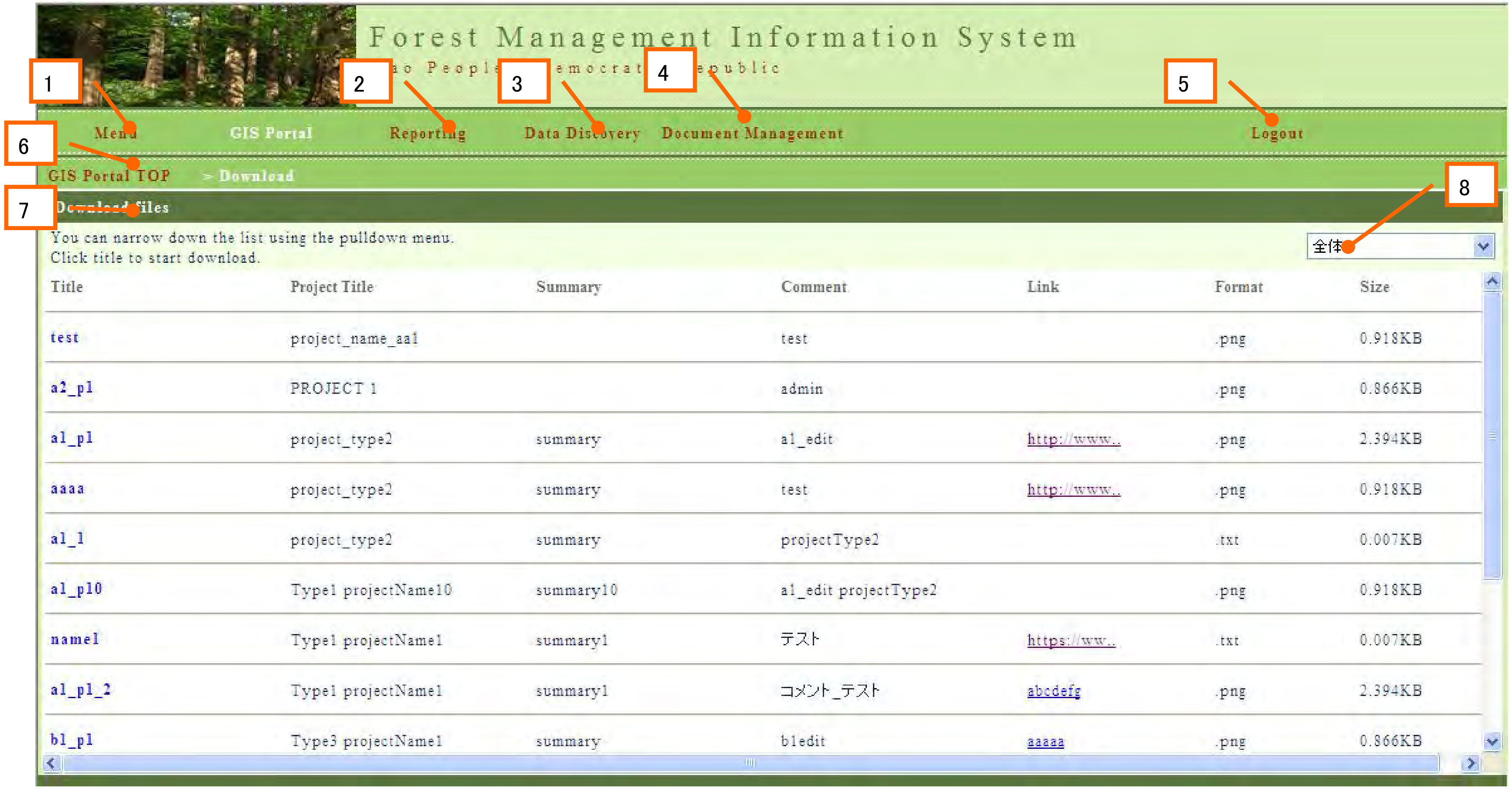
When a Combo Box is selected, the list changes.

3.2.4.2.6 Add News Article Window



No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Title	Display	-	○	The title is displayed.	Information	title
2	URL	Text	-	-	URL is displayed.	Information	link
3	Comment	Text	○	-	The comment is displayed.	Information	comment
4	UserName	Text	-	○	The logged-in user name is displayed.	-	-
5	UserInformation	Text	-	-	The user's comment is entered.	Information	userInformation
6	Add/Update	Button	-	-	The news article is registered / updated.	-	-
7	Cancel	Button	-	-	This window is closed.	-	-

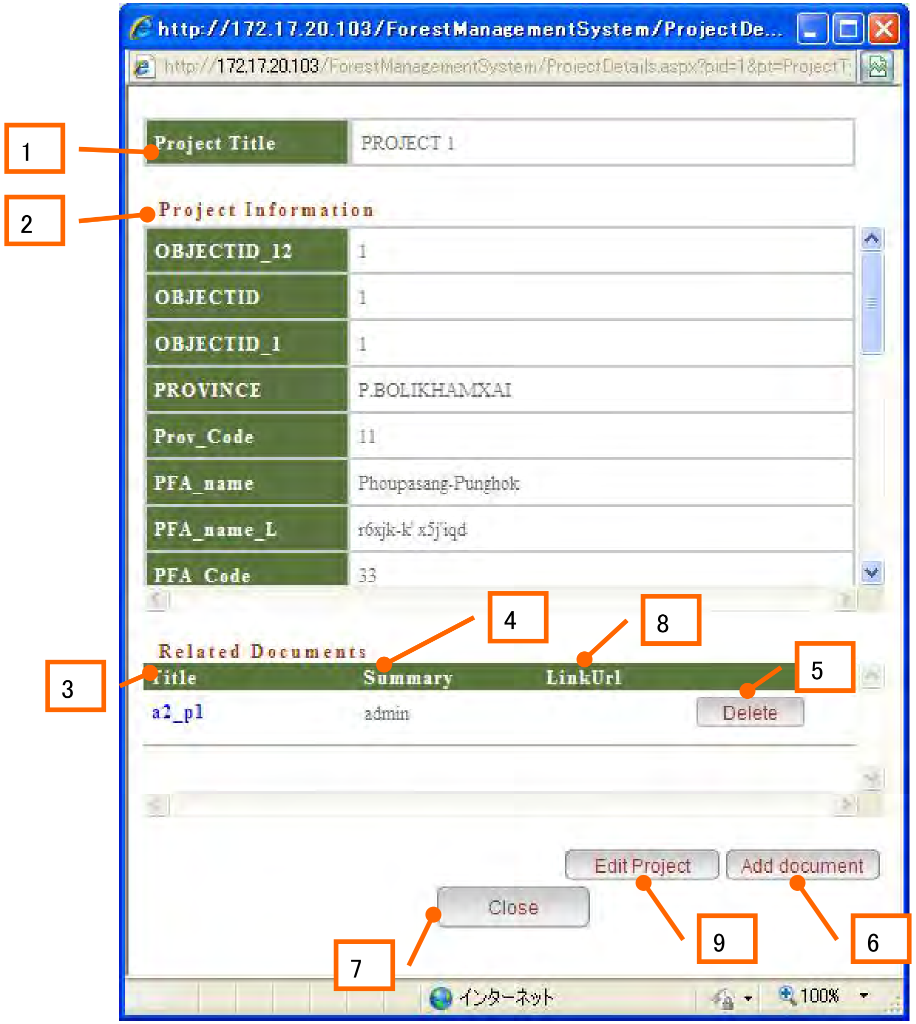
3.2.4.2.7 Download List Window



No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Menu	Link	-	-	Jumps to the Menu window	-	-
2	Reporting	Link	-	-	Jumps to the Reporting window	-	-
3	Data Discovery	Link	-	-	Linked to the Forest Information Management Function	-	-
4	Document Management	Link	-	-	Linked to the Document Management System	-	-
5	Logout	Button	-	-	When clicked, the system is logged out and the Login window appears.	-	-
6	GIS Portal TOP	Button	-	-	Returns to TOP window of GIS Portal	-	-
7	Download files	Text	-	-	The List of Documents is displayed.	RelationFile	All
8	Filter		-	-	Screening of All, Bureau and Division	-	-

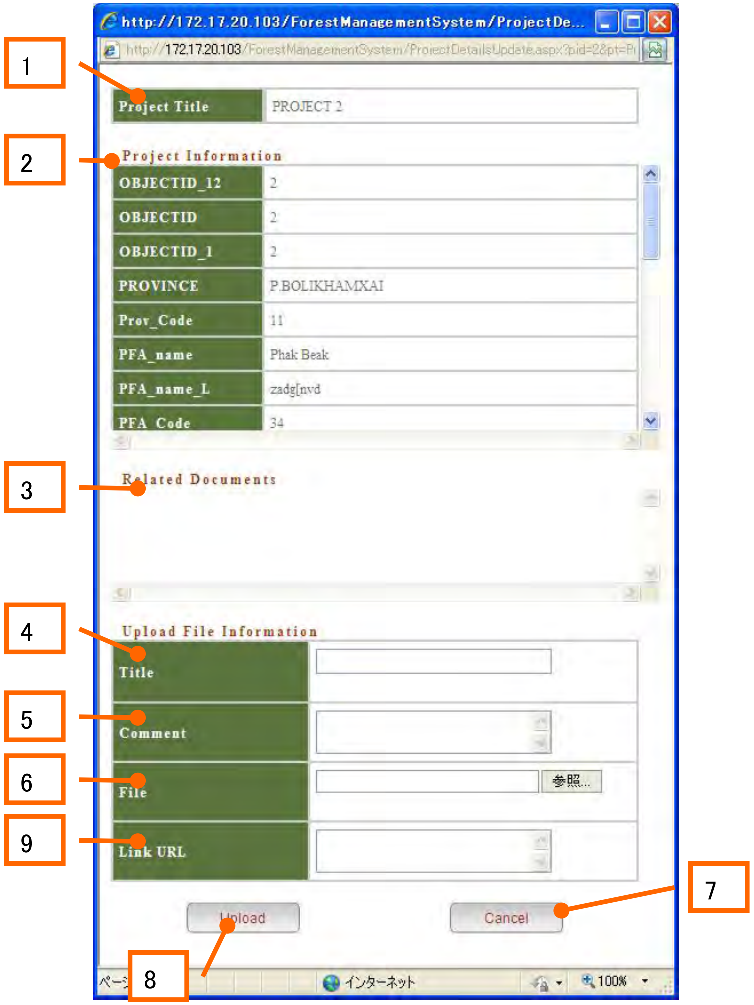
When a Combo Box is selected, the list changes.

3.2.4.2.8 Attribute Information Window



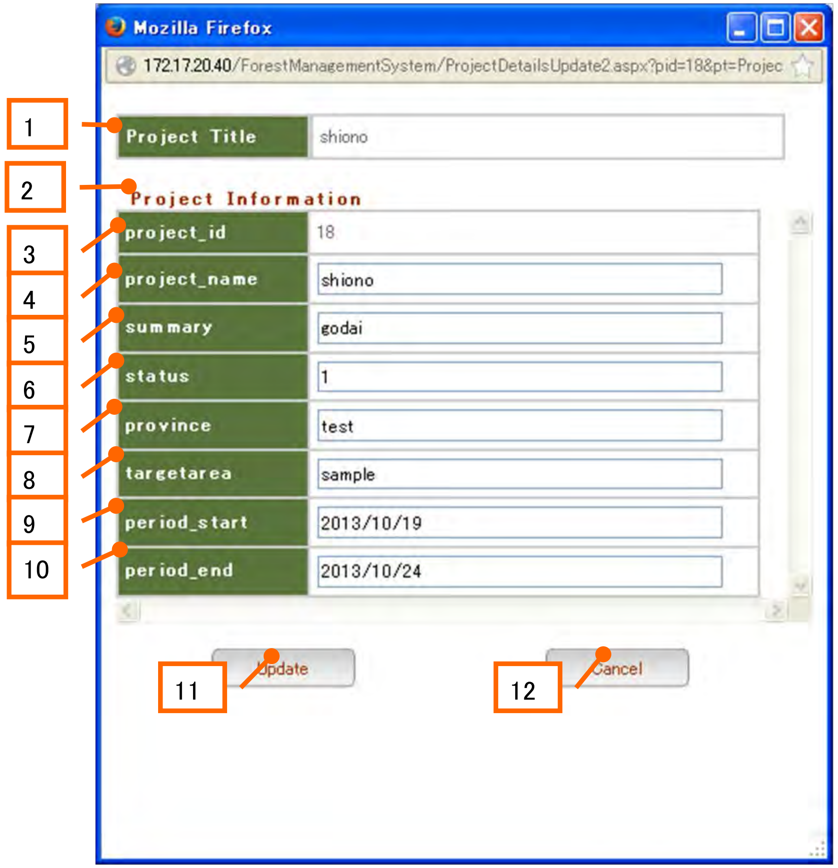
No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Project Title	Display	-	-	The Project name is displayed.	Layer Table	project_name
2	Project Information	Display	-	-	The attribute information is displayed. (The item differs from layer to layer.)	Layer Table	All attribute items
3	Title	Link	-	-	The title of the related file is displayed.	RelationFile	title
4	Summary	Display	-	-	The summary of the file is displayed.	RelationFile	comment
5	Delete	Button	-	-	The file on the clicked line is deleted.	-	-
6	Add new document	Button	-	-	When clicked, the window jumps to the Upload File window.	-	-
7	Close	Button	-	-	This window is closed.	-	-
8	LinkUrl	Display	-	-	The URL linked to the related file is displayed.	RelationFile	link_url
9	Edit Project	Button	-	-	When clicked, the window jumps to the Edit window.	-	-

3.2.4.2.9 Upload File Window



No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Project Title	Display	-	-	The Project name is displayed.	Layer Table	project_name
2	Project Information	Display	-	-	The attribute information is displayed. (The item differs from layer to layer.)	Layer Table	All attribute items
3	Title	Display	-	-	The title of the related file is displayed.	RelationFile	title
4	Title	Text	-	○	The title of the file to be uploaded is entered.	RelationFile	title
5	Comment	Text	-	-	The comment for the file is entered.	RelationFile	comment
6	FileSelect	Button	-	-	The file to be uploaded is selected.	-	-
7	Upload	Button			The file is uploaded to the server.	-	-
8	Cancel	Button	-	-	Returns to the Attribute Information window.	-	-
9	Link URL	Text	-	-	The URL link is entered.	RelationFile	link_url

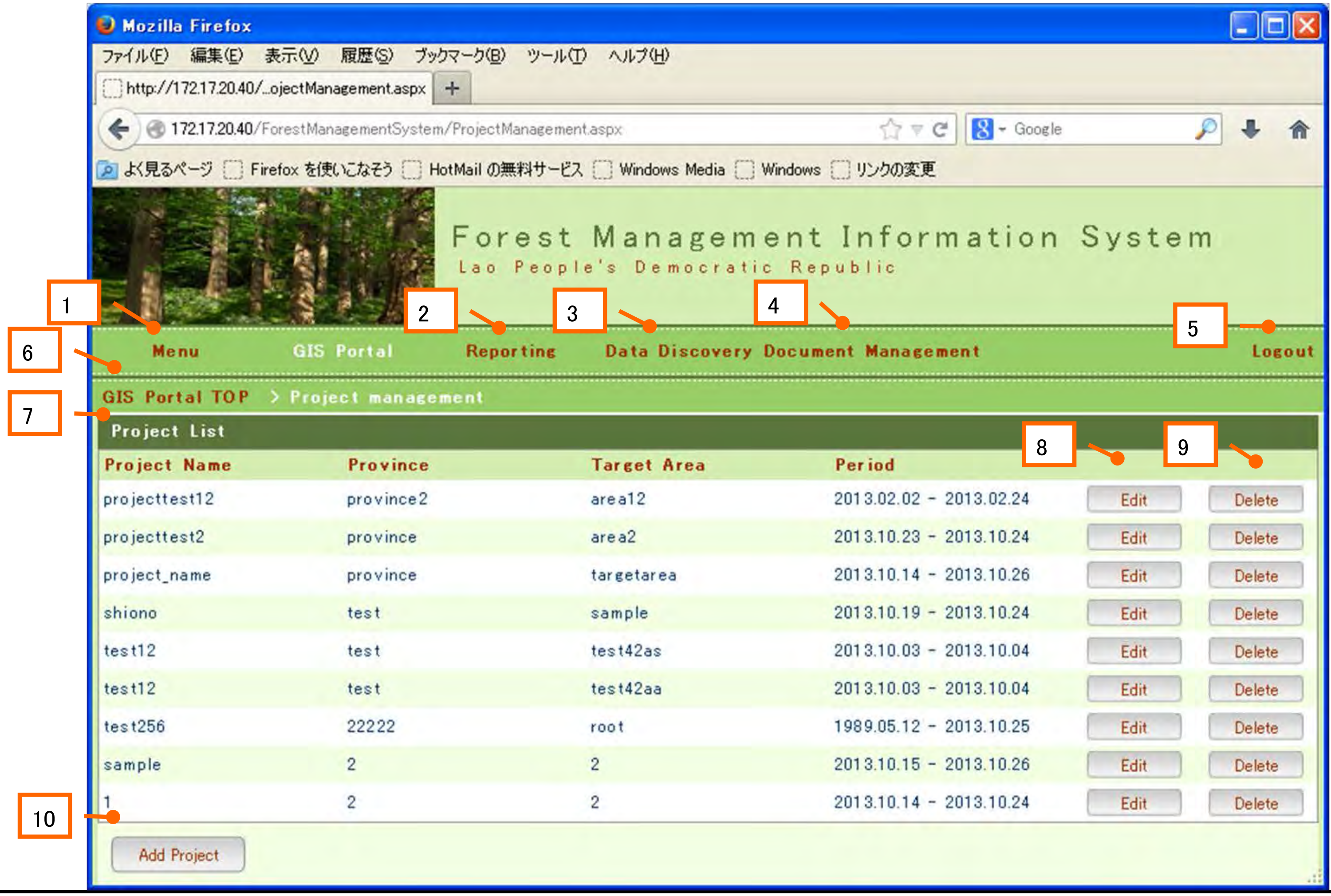
3.2.4.2.10 Edit Project Window



No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Project Title	Display	-	-	The Project name is displayed.	Layer Table	project_name
2	Project Information	Display	-	-	The attribute information is displayed. (The item differs from layer to layer.)	Layer Table	All attribute items
3	Project_id	Display	-	○	The Project ID is displayed. (Entry is disabled.)	ProjectAttr	project_id
4	Project_name	Text	-	-	The Project name is displayed. (Text entry is disabled.)	ProjectAttr	project_name
5	Summary	Text	-	-	The summary is displayed. (Text entry is disabled.)	ProjectAttr	summary
6	Status	Text	-	-	The implementing status is displayed. (Text entry is disabled.)	ProjectAttr	status
7	Province	Text	-	-	The Province is displayed. (Text entry is disabled.9	ProjectAttr	province
8	Targetarea	Text	-	-	The target area name is displayed. (Text entry is disabled.)	ProjectAttr	targetarea
9	Period_start	Text	-	-	The Project period (start) is displayed. (Text entry is disabled.)	ProjectAttr	period_start
10	Period_end	Text	-	-	The Project period (end) is displayed. (Text entry is disabled.)	ProjectAttr	period_end
11	Update	Button	-	-	The attribute information is updated.	ProjectAttr	All attribute items
12	Cancel	Button	-	-	Returns to the Attribute Information window.	-	-

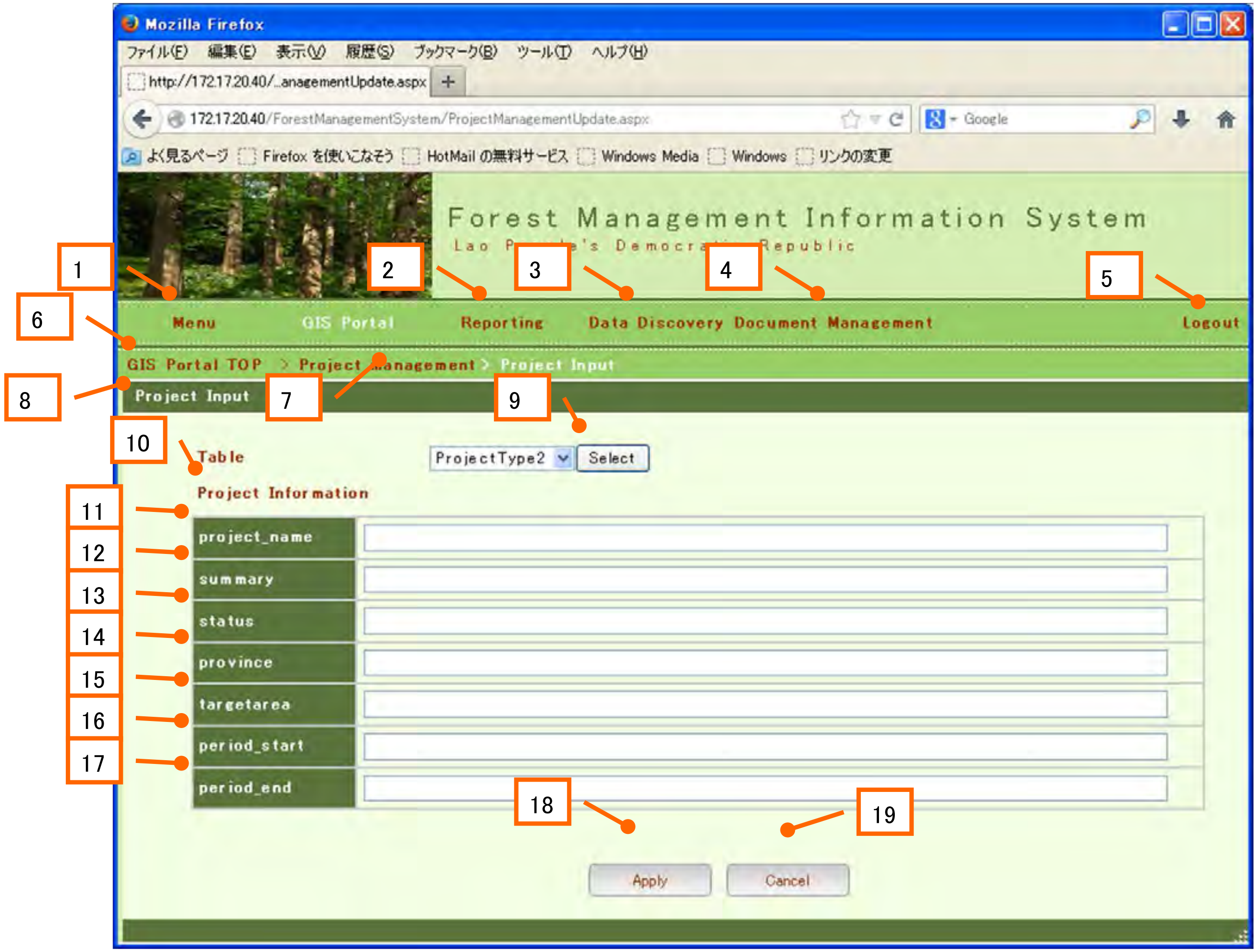
*The Table Name differs from table to table.

3.2.4.2.11 Project List Window - Edit / Add / Delete



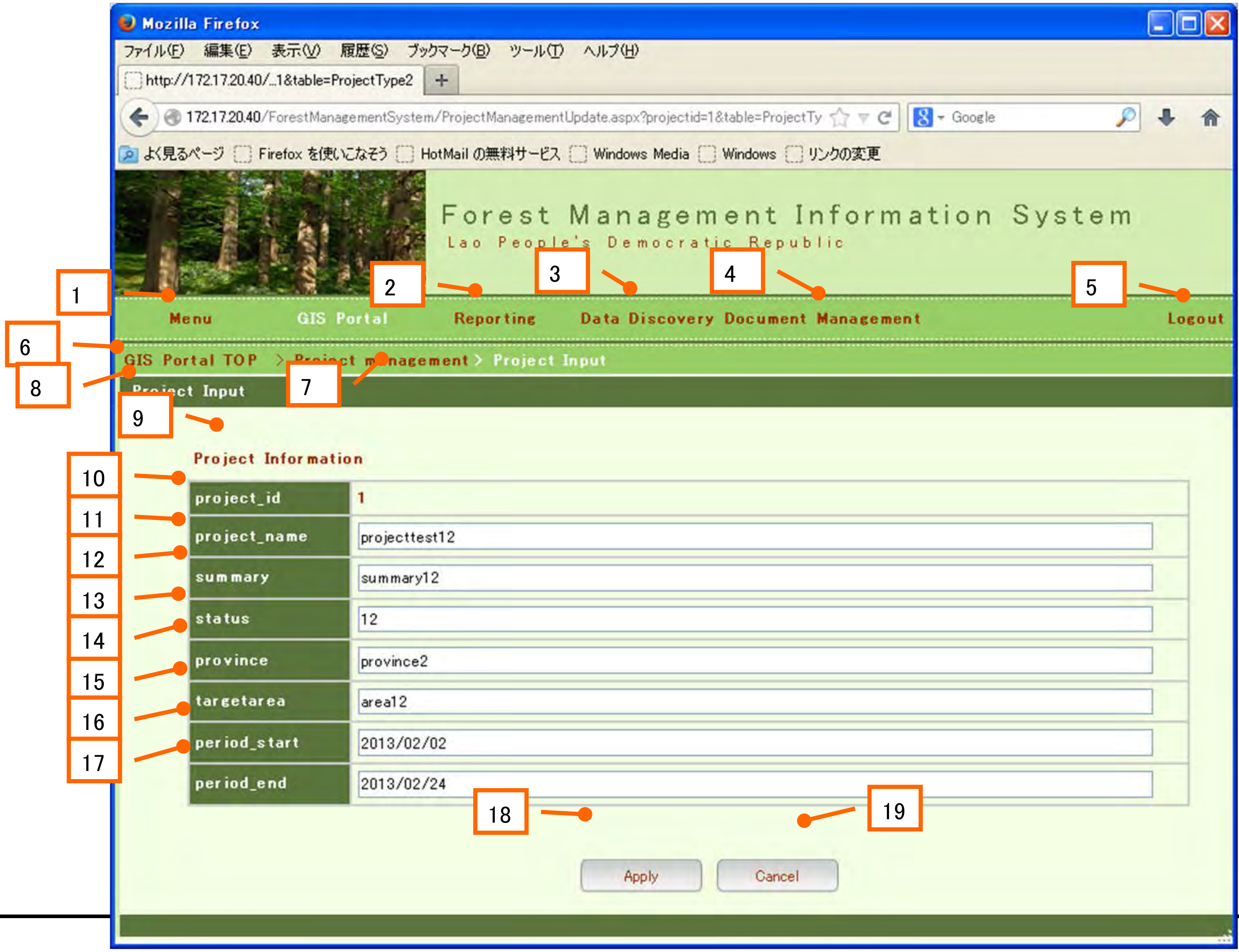
No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Menu	Link	-	-	Jumps to the Menu window	-	-
2	Reporting	Link	-	-	Jumps to the Reporting window	-	-
3	Data Discovery	Link	-	-	Jumps to the Forest Information Management window	-	-
4	Document Management	Link	-	-	Jumps to the Document Management window	-	-
5	Logout	Link	-	-	When clicked, the system is logged out and the Login window appears.	-	-
6	GIS Portal TOP	Link	-	-	Jumps to the GIS Portal TOP window	-	-
7	Project List	List	-	-	The List of Projects is displayed.	ProjectAttr	-
8	Project Name	Text	-	-	The Project name is displayed.	ProjectAttr	project_name
9	Province	Text	-	-	The Province is displayed.	ProjectAttr	province
10	Target Area	Text	-	-	The target area is displayed.	ProjectAttr	targetarea
11	Period	Text	-	-	The Project period is displayed.	ProjectAttr	period_start,period_end
12	Edit	Button	-	-	Jumps to the Edit Project window	-	-
13	Delete	Button	-	-	The Project information is deleted.	-	-
14	Add Project	Button	-	-	Jumps to the Add Project window	-	-

3.2.4.2.12 Add Project Window



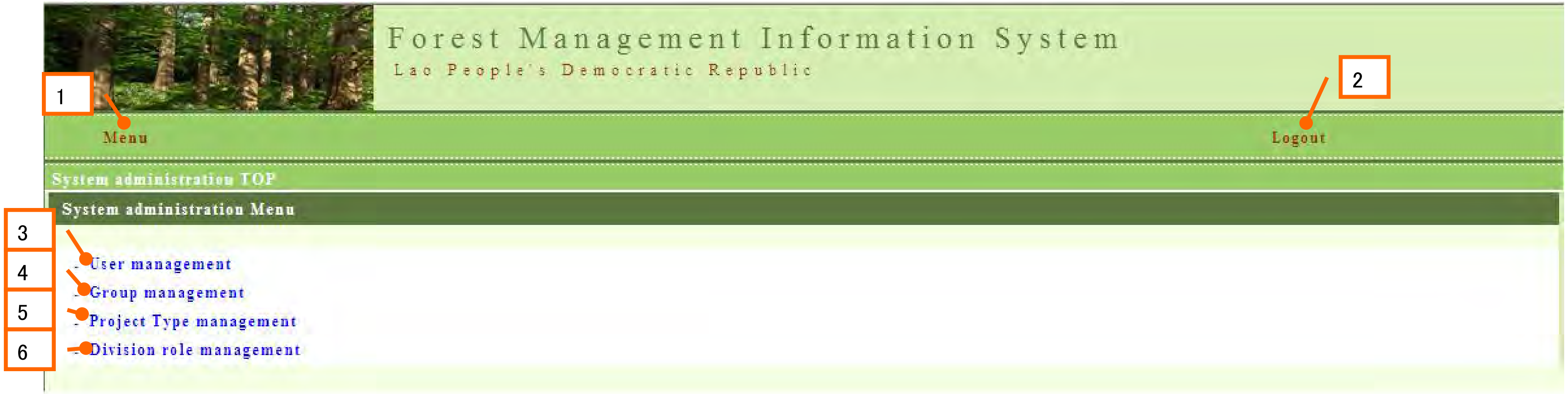
No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Menu	Link	-	-	Jumps to Menu window	-	-
2	Reporting	Link	-	-	Jumps to the Reporting window	-	-
3	Data Discovery	Link	-	-	Jumps to Forest Information Management window	-	-
4	Document Management	Link	-	-	Jumps to the Document Management window	-	-
5	Logout	Link	-	-	When clicked, the system is logged out and the Login window appears.	-	-
6	GIS Portal TOP	Link	-	-	Jumps to the GIS Portal TOP window	-	-
7	Project Management	Link	-	-	Returns to the Project Management window	-	-
8	Project Input	List	-	-	The Project name is displayed.	ProjectAttr	-
9	Table	Button	-	-	Select a Project to be added	-	-
10	Project Information	Display	-	-	The attribute information is displayed. (The item differs from layer to layer.)	Layer Table	All attribute items
11	Project_Name	Text	-	-	The Project name can be entered.	ProjectAttr	project_name
12	Summary	Text	-	-	The summary can be entered in text form.	ProjectAttr	summary
13	Status	Text	-	-	The implementing status can be entered in text form.	ProjectAttr	status
14	Province	Text	-	-	The Province can be entered in text form.	ProjectAttr	province
15	Targetarea	Text	-	-	The target area can be entered in text form.	ProjectAttr	targetarea
16	Period_Start	Text	-	-	The Project period (start) can be entered in text form.	ProjectAttr	period_start
17	Period_End	Text	-	-	The Project period (end) can be entered in text form.	ProjectAttr	period_end
18	Apply	Button	-	-	Any Project information can be added.	-	-
19	Cancel	Button	-	-	The entry of any Project information is cancelled.	-	-

3.2.4.2.13 Edit Project Window



No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Menu	Link	-	-	Jumps to Menu window	-	-
2	Reporting	Link	-	-	Jumps to the Reporting window	-	-
3	Data Discovery	Link	-	-	Jumps to Forest Information Management window	-	-
4	Document Management	Link	-	-	Jumps to the Document Management window	-	-
5	Logout	Link	-	-	When clicked, the system is logged out and the Login window appears.	-	-
6	GIS Portal TOP	Link	-	-	Jumps to the GIS Portal TOP window	-	-
7	Project Management	Link	-	-	Returns to the Project Management window	-	-
8	Project Input	List	-	-	The list of Projects is displayed.	ProjectAttr	-
9	Project Information	Display	-	-	The attribute information is displayed. (The item differs from layer to layer.)	Layer Table	All attribute items
10	Project_id	Display	-	○	The Project ID is displayed. (Input is disabled.)	ProjectAttr	project_id
11	Project_name	Text	-	-	The Project name can be entered.	ProjectAttr	project_name
12	Summary	Text	-	-	The summary is displayed. (Text entry is enabled.)	ProjectAttr	summary
13	Status	Text	-	-	The implementing status is displayed. (Text entry is enabled.)	ProjectAttr	status
14	Province	Text	-	-	The Province is displayed. (Text entry is enabled.)	ProjectAttr	province
15	Targetarea	Text	-	-	The target area is displayed. (Text entry is enabled.)	ProjectAttr	targetarea
16	Period_start	Text	-	-	The Project period (start) is displayed. (Text entry is enabled.)	ProjectAttr	period_start
17	Period_end	Text	-	-	The Project period (end) is displayed. (Text entry is enabled.)	ProjectAttr	period_end
18	Apply	Button	-	-	Any Project information can be added.	-	-
19	Cancel	Button	-	-	The entry of any Project information is cancelled.	-	-

3.2.4.2.14 System Administration Window

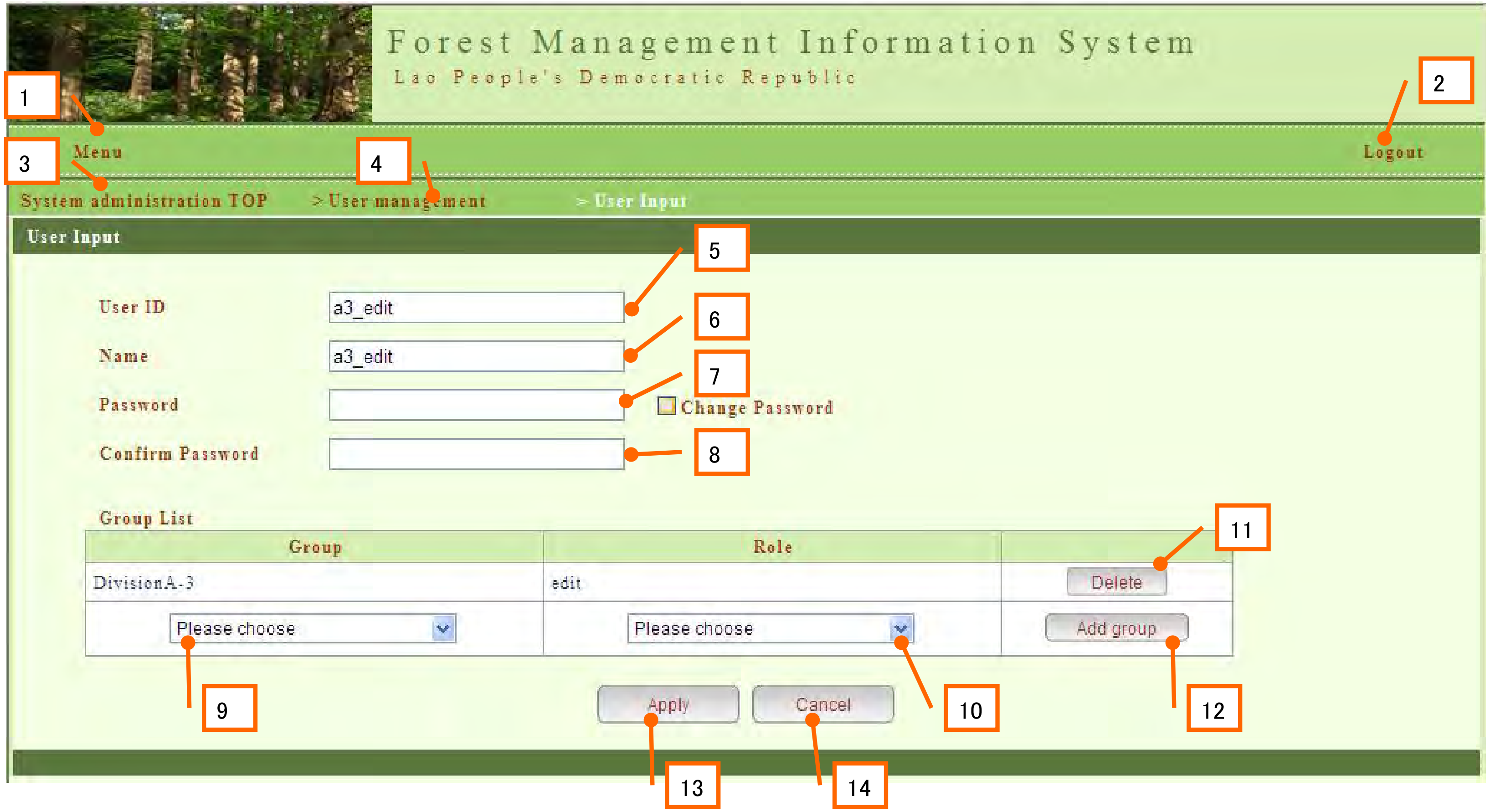


No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Menu	Link	-	-	Jumps to Menu window	-	-
2	Logout	Link	-	-	When clicked, the system is logged out and the Login window appears.	-	-
3	User management	Button	-	-	Jumps to the User Management window.	-	-
4	Group management	Button	-	-	Jumps to the Group Management window.	-	-
5	Project Type management	Button	-	-	Jumps to the Project Type Management window	-	-
6	Division Role management	Button	-	-	Jumps to the Division Role Management window	-	-

3.2.4.2.15 User List Window

No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Menu	Link	-	-	Jumps to Menu window	-	-
2	Logout	Link	-	-	When clicked, the system is logged out and the Login window appears.	-	-
3	SysMenuTOP	Link	-	-	Jumps to the System Administration TOP window	-	-
4	User List	List	-	-	The list of Users is displayed	m_user	
4-1	user_id	Text	-	-	The User ID is displayed.	m_user	user_id
4-2	user_name	Text	-	-	The User name is displayed.	m_user	user_name
4-3	group/role	Text	-	-	The group name and role are displayed. Multiple groups to which the user belongs are displayed on another line.	m_userGroup	role
4-4	insert_date	Text	-	-	The date of registration is displayed.	m_user	insert_date
4-5	update_date	Text	-	-	The date of updating is displayed.	m_user	update_date
5	Edit	Button	-	-	Jumps to the Edit User window		
6	Delete	Button	-	-	The user information is deleted.		
7	Add User	Button	-	-	Jumps to the User Management window	-	-

3.2.4.2.16 User Management Window

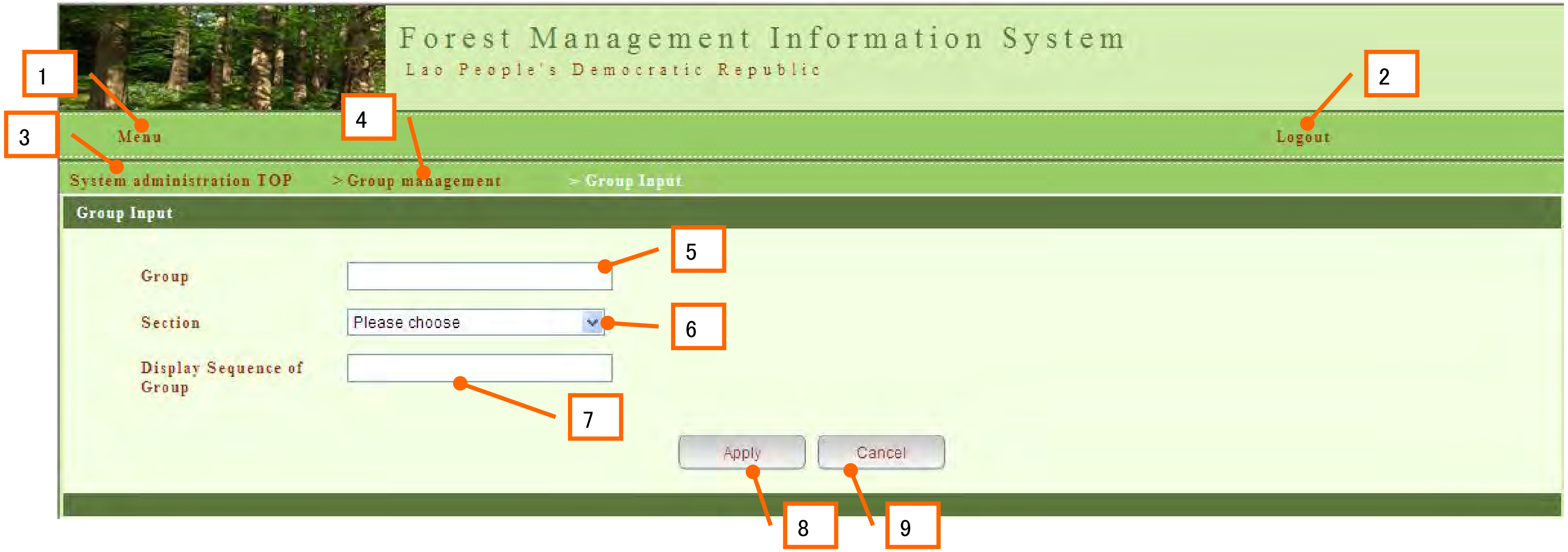


No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Menu	Link	-	-	Jumps to Menu window	-	-
2	Logout	Link	-	-	When clicked, the system is logged out and the Login window appears.	-	-
3	SysMenuTOP	Link	-	-	Jumps to the System Administration TOP window	-	-
4	UserManagement	Link	-	-	Jumps to User Management window	-	-
5	user_id	Text	-	○	Enter User ID	m_user	user_id
6	user_name	Text	-	○	Enter User Name	m_user	user_name
7	password	Text	-	○	The password is entered and indicated by ●.	m_user	password
8	Confirm password	Text	-	○	The password is reentered and indicated by ●.	m_user	password
9	group	Combo	-	○	A group is selected. (Multiple groups are selectable.)	m_userGroup	m_group_id
10	role	Combo	-	○	A role is set.（1: Administrator; 2: Manager; 3: Editor; 4: Browser）	m_userGroup	role
11	Delete	Button	-	-	The line for the group to which the user belongs is deleted.	-	-
12	Add group	Button	-	-	The button is pressed to add a group to which the user belongs.	-	-
13	OK	Button	-	-	The data in the User Master is registered / updated by the input information.	-	-
14	Cancel	Button	-	-	The input information is canceled and returns to the User List window.	-	-

3.2.4.2.17 Group List Window

No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Menu	Link	-	-	Jumps to Menu window	-	-
2	Logout	Link	-	-	When clicked, the system is logged out and the Login window appears.	-	-
3	SysMenuTOP	Link	-	-	Jumps to System Management TOP window	-	-
4	Group List	List	-	-	The list of groups is displayed.	m_group	
4-1	group	Text	-	-	Group names are displayed	m_group	group_name
4-2	Section	Text	-	-	The group to which the user belongs is displayed.	m_group	Affiliation
4-3	insert_date	Text	-	-	The input data is displayed.	m_group	insert_date
4-4	update_date	Text	-	-	The updating date is displayed.	m_group	update_date
4-5	Disp_seq	Text	-	-	The display sequence order is displayed.	m_group	Disp_seq
5	Edit	Button	-	-	Jumps to the Edit Group window		
6	Delete	Button	-	-	The group information is deleted.		
7	Add Group	Button	-	-	Jumps to the Edit Group window	-	-

3.2.4.2.18 Group Management Window

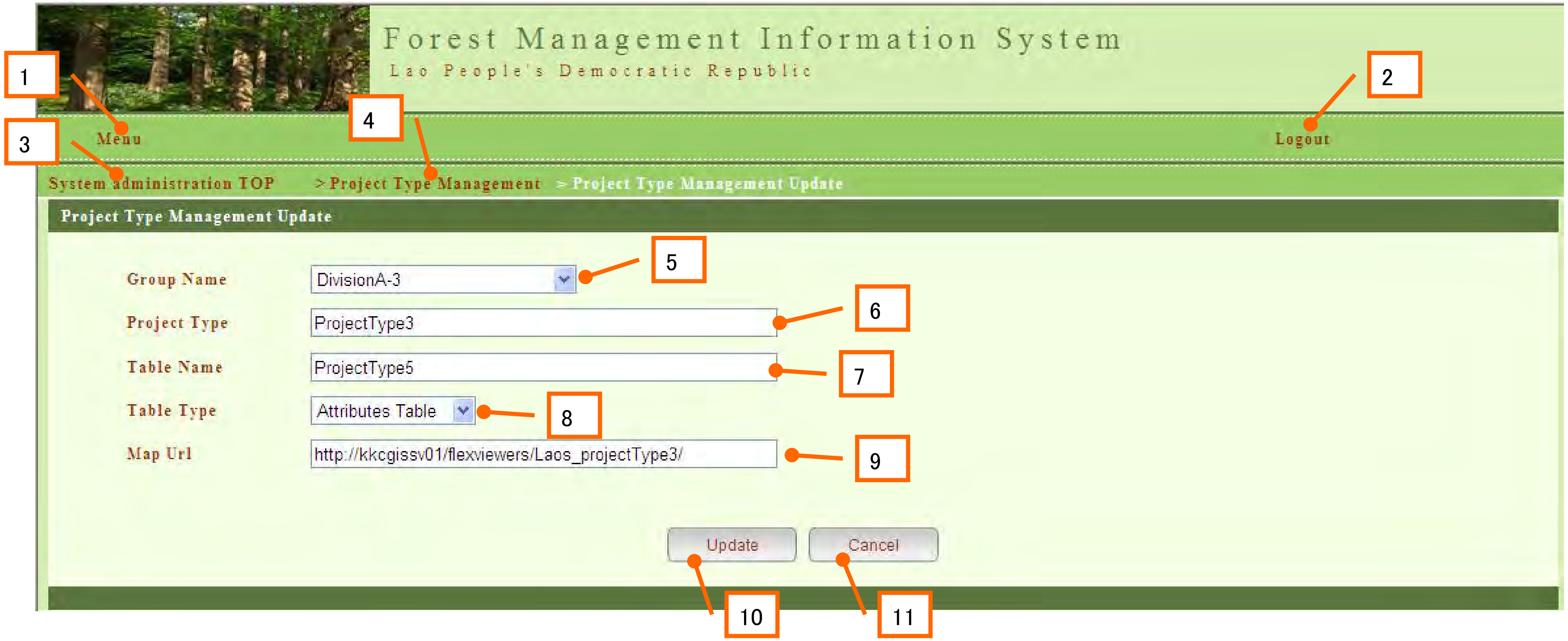


No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Menu	Link	-	-	Jumps to Menu window	-	-
2	Logout	Link	-	-	When clicked, the system is logged out and the Login window appears.	-	-
3	SysMenuTOP	Link	-	-	Jumps to the System Administration TOP window	-	-
4	Group management	Link	-	-	Jumps to the Group Management window	-	-
5	group	Text	-	○	A group name is entered.	m_group	group _name
6	Section	Combo	-	○	The group to which the user belongs is selected. （0: No group; 1: DFRM; 2: DOF）	m_group	Affiliation
7	Display Sequence of Group	Text	-	○	The group display sequence is entered.	m_group	disp_seq
8	OK	Button	-	-	The input information is registered in the Group Master.	-	-
9	Cancel	Button	-	-	The input information is canceled and returns to the User List window.	-	-

3.2.4.2.19 Project Type List Window

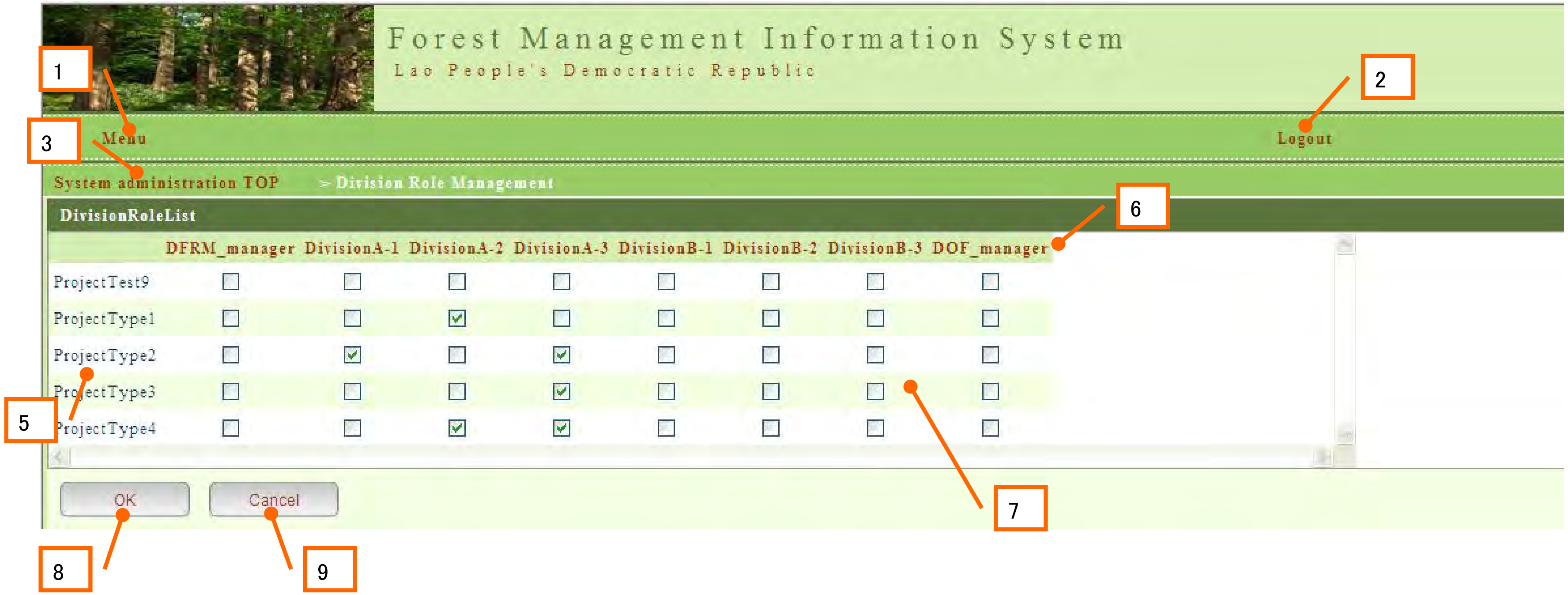
No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Menu	Link	-	-	Jumps to Menu window	-	-
2	Logout	Link	-	-	When clicked, the system is logged out and the Login window appears.	-	-
3	SysMenuTOP	Link	-	-	Jumps to the System Administration TOP window	-	-
4	Project Type List	List	-	-	The list of Project types is displayed.	m_project_type	
5	Edit	Button	-	-	Jumps to the Edit Project Type window		
6	Delete	Button	-	-	The Project Type information is deleted		
7	Add Group	Button	-	-	Jumps to the Register Project Type window	-	-

3.2.4.2.20 Project Type Management – Register / Edit Window



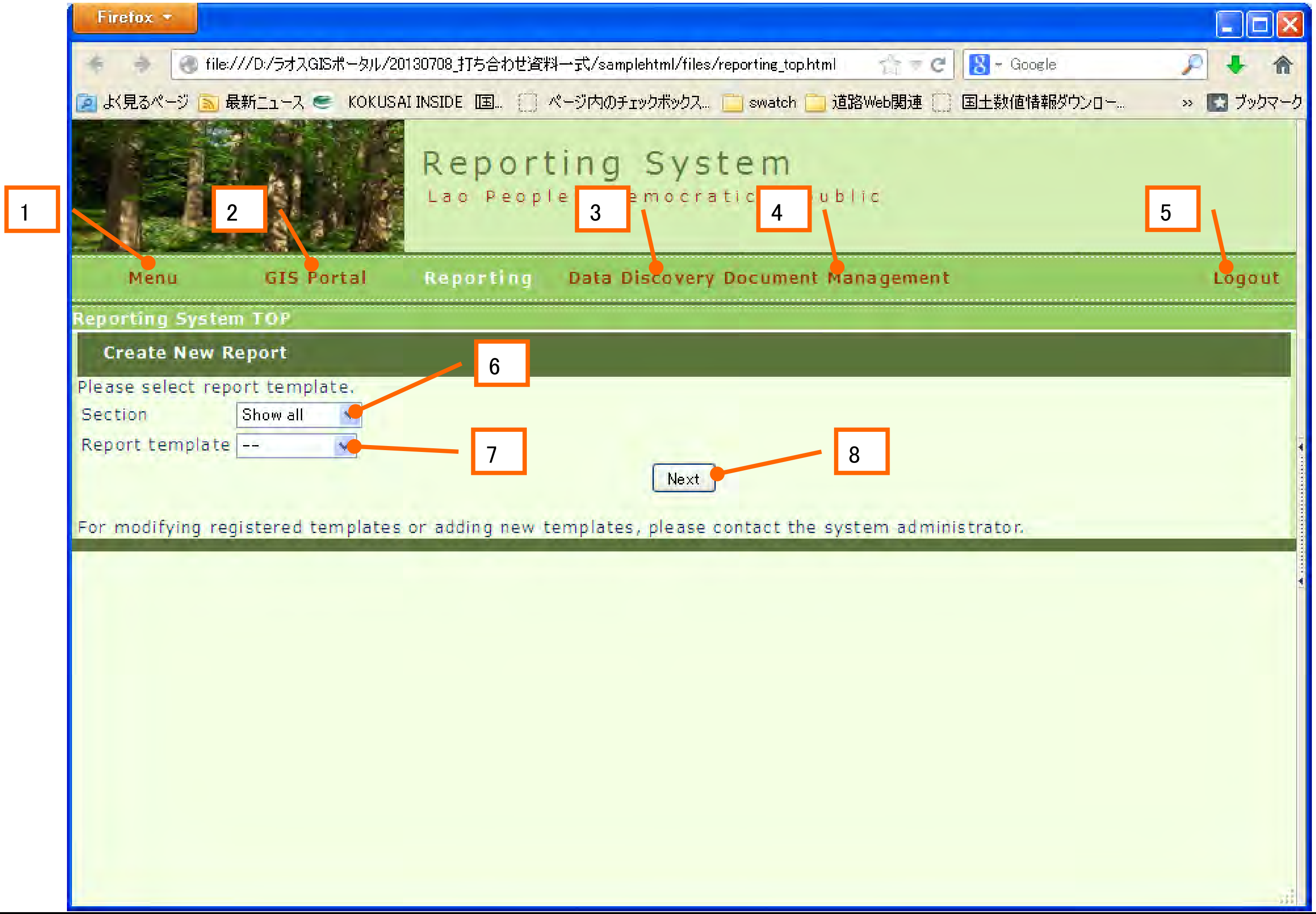
No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Menu	Link	-	-	Jumps to Menu window	-	-
2	Logout	Link	-	-	When clicked, the system is logged out and the Login window appears.	-	-
3	SysMenuTOP	Link	-	-	Jumps to the System Administration TOP window	-	-
4	Group management	Link	-	-	Jumps to the Group Management window	-	-
5	Group Name	Combo	-	○	A group name is selected.	m_project_type	m_group_id
6	Project_type	Text	-	○	A Project Type is entered.	m_project_type	Project_type
7	Table Name	Text	-	○	A Table name is entered.	m_project_type	table_name
8	Table Type	Combo	-	○	A table type is selected.	m_project_type	table_type
9	Map Url	Text	-	○	A Map URL is entered.	m_project_type	map_url
10	Add or Update	Button	-	-	The input information is registered in the Project Type Master.	-	-
11	Cancel	Button	-	-	The input information is canceled and the window returns to the Project Type List window.	-	-

3.2.4.2.21 Division Role Setting Windows



No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Menu	Link	-	-	Jumps to Menu window	-	-
2	Logout	Link	-	-	When clicked, the system is logged out and the Login window appears.	-	-
3	SysMenuTOP	Link	-	-	Jumps to the System Administration TOP window	-	-
5	ProjectType	Text	-	-	Project Type	m_project_type	Project_type
6	group_name	Text	-	-	Group name (group to which a user belongs)	m_group	group _name
7	Role	Combo	-	-	The role is marked with a check. (Check mark ✔: Authorized)	m_division_role	Role
8	OK	Button	-	-	The input information is registered/updated in the Division Role Master.	-	-
9	Cancel	Button	-	-	The input information is cancelled and the window returns to the Project Type List window.	-	-

3.2.4.2.22 Reporting Window



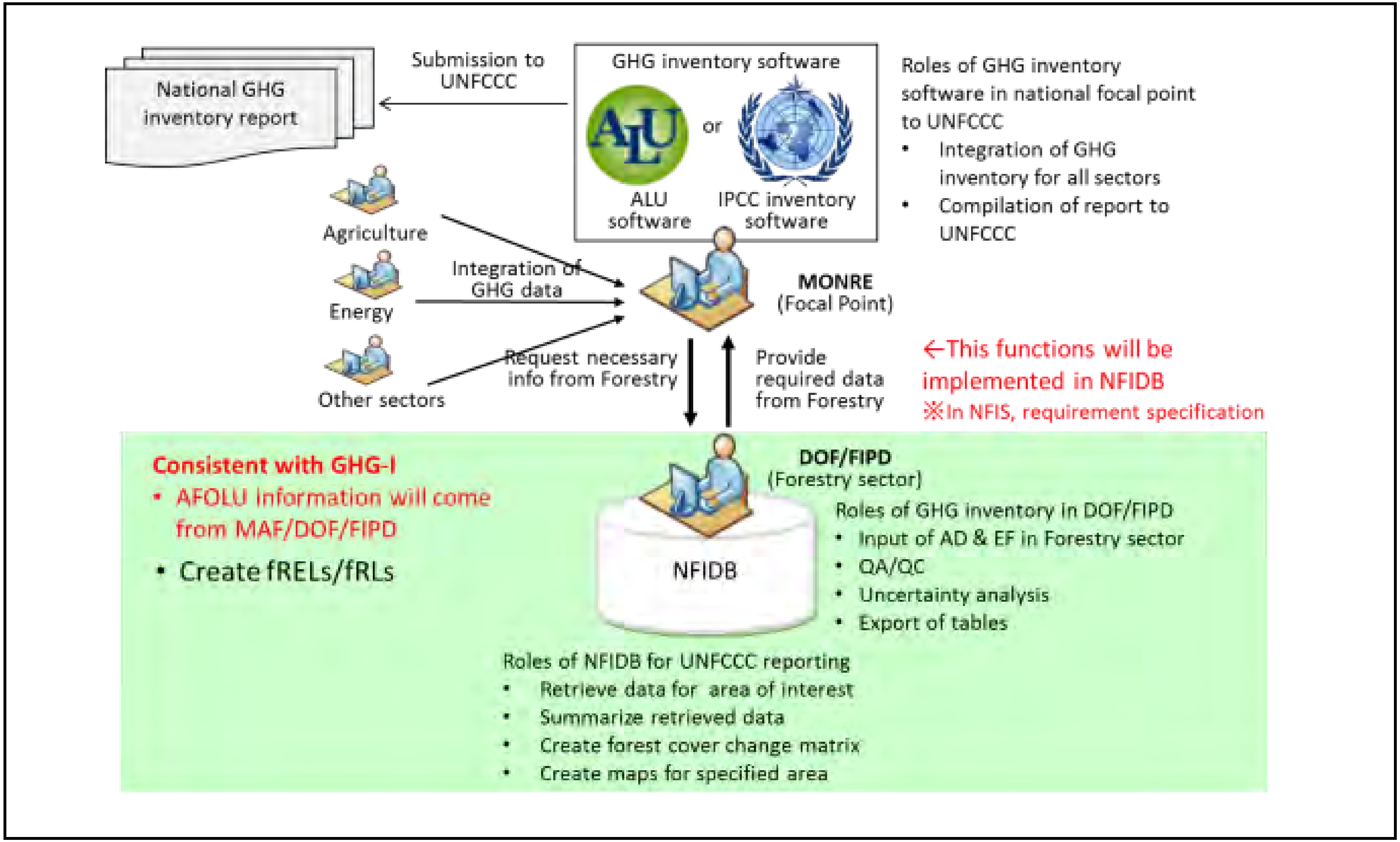
No.	Item name	Element	Input assistance/default	Required	Description	Acquisition table	Field
1	Menu	Link	-	-	Jumps to the Menu window	-	-
2	GIS Portal	Link	-	-	Jumps to the GIS Portal window	-	-
3	Data Discovery	Link	-	-	Linked to the Forest Information Management Function	-	-
4	Document Management	Link	-	-	Linked to the Document Management System	-	-
5	Logout	Link	-	-	When clicked, the system is logged out and the Login window appears.	-	-
6	Section	ComboBox	ShowAll	○	A section is selected. (Section=Group Name)	m_group	group_name
7	Report template	ComboBox	-	○	A report file is selected.	Catalog	Path
8	Next	Button	-	-	The report is displayed.		

3.2.5. Report Design

3.2.5.1 Report List

3.2.5.1.1 For UNFCCC

<table>
<tr><th></th><th>Second National Communication (2013)</th><th colspan="2">Next National GHG Inventory report</th></tr>
<tr><td rowspan="2">Activity data [Tier level]</td><td>NFI database (2002) [Tier 2]</td><td colspan="2" rowspan="2">NFIS DB (2000, 2005, 2010) [Tier 2]</td></tr>
<tr><td>Five-Year Sustainable Forest Protection Action Plan (2006 – 2010) [Tier 1]</td></tr>
<tr><td rowspan="3">Emission factor [Tier level]</td><td rowspan="3">Default values in the 1996 IPCC Guidelines [Tier 1]</td><td rowspan="2">Forest land</td><td>Country-specific allometric equation: Average biomass for forest types [Tier 2]</td></tr>
<tr><td>Default values in the IPCC Guidelines: Ratio of below-ground to above-ground biomass (R) and carbon fraction (CF) [Tier 1]</td></tr>
<tr><td>Other land use</td><td>Default values in the IPCC Guidelines [Tier 1]</td></tr>
</table>


National GHG inventory report
Submission to UNFCCC
GHG inventory software
ALU
or
ALU software
IPCC inventory software
Roles of GHG inventory software in national focal point to UNFCCC
• Integration of GHG inventory for all sectors
• Compilation of report to UNFCCC
Agriculture
Energy
Other sectors
Integration of GHG data
MONRE (Focal Point)
Request necessary info from Forestry
Provide required data from Forestry
←This functions will be implemented in NFIDB
※In NFIS, requirement specification
Consistent with GHG-I
• AFOLU Information will come from MAF/DOF/FIPD
• Create fRELs/fRLs
DOF/FIPD (Forestry sector)
NFIDB
Roles of GHG inventory in DOF/FIPD
• Input of AD & EF in Forestry sector
• QA/QC
• Uncertainty analysis
• Export of tables
Roles of NFIDB for UNFCCC reporting
• Retrieve data for area of interest
• Summarize retrieved data
• Create forest cover change matrix
• Create maps for specified area

3.2.5.1.2 For FRA / FAO

Tables in FRA2015	Variable	Unit	Reporting year for FRA2015					Reporting responsible department/section	Data source for FRA2015	Data source for FRA2020	Remarks
			1990	2000	2005	2010	2015				
FOREST AREA AND FOREST CHARACTERISTICS											
1a	Forest area	1000 ha	x	x	x	x	x	FIPD	NFI database (1982, 1992, 2002) & Quick assessment map (2010)	NFI database (1982, 1992) & NFIS database (2000, 2005, 2010)	
	Area of other wooded land	1000 ha	x	x	x	x	x				
	Area of other land	1000 ha	x	x	x	x	x				
	… of which with tree cover	1000 ha	x	x	x	x	x		n.a		
	Inland water bodies	1000 ha	x	x	x	x	x		NFI database (1982, 1992, 2002) & Quick assessment map (2010)	NFI database (1982, 1992) & NFIS database (2000, 2005, 2010)	
	Total country area	1000 ha	x	x	x	x	x		FAOSTAT	FAOSTAT	
1b	Forest expansion	1000 ha/yr	x	x	x	x		FIPD	NFI database (1982, 1992, 2002) & Quick assessment map (2010)	NFI database (1982, 1992) & NFIS database (2000, 2005, 2010)	
	… of which afforestation	1000 ha/yr	x	x	x	x			n.a		
	… of which natural expansion of forest	1000 ha/yr	x	x	x	x					
	Deforestation	1000 ha/yr	x	x	x	x			NFI database (1982, 1992, 2002) & Quick assessment map (2010)	NFI database (1982, 1992) & NFIS database (2000, 2005, 2010)	
	… of which human induced	1000 ha/yr	x	x	x	x			n.a		
	Reforestation	1000 ha/yr	x	x	x	x			n.a		
	… of which artificial	1000 ha/yr	x	x	x	x					
2a	Primary forest	1000 ha	x	x	x	x	x		NBCA data	NBCA data	
	Other naturally regenerated forest	1000 ha	x	x	x	x	x		SUFORD database	SUFORD database	
	… of which introduced species	1000 ha	x	x	x	x	x		n.a		
	… of which naturalized	1000 ha	x	x	x	x	x				
	Planted forest	1000 ha	x	x	x	x	x	SUFORD & FIPD	SUFORD/FIPD forest cover data from SPOT-5 and Landsat	SUFORD database	
	… of which introduced species	1000 ha	x	x	x	x	x		n.a		
2b	Primary forest transition matrix	1000 ha	(1990-2000, 2000-2010, 2010-2015)					FIPD	n.a		
2c	Area of mangrove forest	1000 ha	x	x	x	x	x	-	-	-	No mangrove forest in Lao PDR
	… of which planted	1000 ha	x	x	x	x	x				
PRODUCTION											
3a	Total forest growing stock	Million m3	x	x	x	x	x	FIPD & SUFORD	NFI database (1982, 1992, 2002) & Quick assessment map (2010) as well as SUFORD database	NFI database (1982, 1992) & NFIS database (2000, 2005, 2010) as well as SUFORD database	Growing stock factor (Forest: 59.27 m3/ha, OWD: 6.87) derived by NFI (1992-1997) is applied to forest area.
	… of which coniferous	Million m3	x	x	x	x	x				
	… of which broadleaved	Million m3	x	x	x	x	x				
	Total other wooded land growing stock	Million m3	x	x	x	x	x				
	… of which coniferous	Million m3	x	x	x	x	x		n.a		
	… of which broadleaved	Million m3	x	x	x	x	x				
3b	Volume of top ten species	Million m3	x	x	x	x		SUFORD	SUFORD database	SUFORD database	
3c	Net annual increment	m3/ha/yr	x	x	x	x			n.a		
	… of which coniferous	m3/ha/yr	x	x	x	x					
	… of which broadleaved	m3/ha/yr	x	x	x	x					
3d	Above-ground biomass	Million tonnes	x	x	x	x	x	FIPD	NFI database (1982, 1992, 2002) & Quick assessment map (2010) as well as default BCEF values from 2006 IPCC Guidelines	NFI database (1982, 1992) & NFIS database (2000, 2005, 2010) as well as country/region specific allometry functions	
	Below-ground biomass	Million tonnes	x	x	x	x	x				
	Dead wood	Million tonnes	x	x	x	x	x		n.a		
3e	Carbon in above-ground biomass	Million tonnes	x	x	x	x	x		Default carbon fraction value from 2006 IPCC Guidelines	Default carbon fraction value from 2006 IPCC Guidelines	
	Carbon in below-ground biomass	Million tonnes	x	x	x	x	x				
	Carbon in dead wood	Million tonnes	x	x	x	x	x		n.a		
	Carbon in litter	Million tonnes	x	x	x	x	x		Default value from 2006 IPCC Guidelines	Default value from 2006 IPCC Guidelines	
	Soil carbon	Million tonnes	x	x	x	x	x		n.a		
4a	Production forest	1000 ha	x	x	x	x	x	FIPD	SUFORD database	SUFORD database	
	Multiple use forest	1000 ha	x	x	x	x	x		n.a		
4b	Value of most important commercial NWFP	1000 local currency				x		NAFRI	n.a		

: information to be updated by the result of NFIS project

*Abbreviation
- n.a: not available
- DFRM: Department of Forest Resource Management
- DOF: Department of Forestry
- FRDF: Forestry and Forest Resource Development Fund
- MONRE: Ministry of Natural Resources and Environment
- NBCA: National Biodiversity Conservation Area
- OWL: Other wooded land
- BCEF: Biomass conversion and expansion factors

PROTECTIVE FUNCTIONS ECOSYSTEM SERVICES											
5a	Protection of soil and water	1000 ha	x	x	x	x	x	DFRM・MONRE	Protection area data	Protection area data	
	…of which production of clean water	1000 ha	x	x	x	x	x		n.a		
	…of which coastal stabilization	1000 ha	x	x	x	x	x				
	… of which desertification control	1000 ha	x	x	x	x	x				
	… of which avalanche control	1000 ha	x	x	x	x	x				
	… of which erosion, flood protection or reducing flood risk	1000 ha	x	x	x	x	x				
	… of which other	1000 ha	x	x	x	x	x				
5b	Ecosystem services, cultural or spiritual values	1000 ha	x	x	x	x	x		n.a		
	… of which public recreation	1000 ha	x	x	x	x	x				
	… of which carbon storage or sequestration	1000 ha	x	x	x	x	x				
	… of which spiritual or cultural services	1000 ha	x	x	x	x	x				
	… of which other	1000 ha	x	x	x	x	x				
BIODIVERSITY/CONSERVATION											
6	Conservation of biodiversity	1000 ha	x	x	x	x	x	DFRM・MONRE	NBCA data	NBCA data	
	Forest area within protected areas	1000 ha	x	x	x	x	x	FIPD	n.a	NFI database (1982, 1992) & NFIS database (2000, 2005, 2010)	
7	List of woody invasive species	1000 ha			x	x		DFRM・MONRE	n.a		
	Area of forest affected by woody invasive species	1000 ha			x	x					
DISTURBANCE AND FOREST DEGRADATION											
8a	Total land area burned	1000 ha	Annual data 2003-2012					FIPD	n.a		
	… of which forest area burned	1000 ha	Annual data 2003-2012								
8b	Area of forest damaged by outbreak of: insects, diseases and severe weather	1000 ha	List of year(s) of latest outbreak								
9	Area of forest with reduced canopy cover	% canopy cover	2000-2010								
MEASURING PROGRESS TOWARD SFM											
i. National-scale enabling environment for SFM											
10	Policies supporting sustainable forest management	Boolean	Latest available year					SUFORD	Yes	Yes	
	… of which in publicly owned forests	Boolean	Latest available year								
	… of which in privately owned forests	Boolean	Latest available year								DOF policy/law includes regulation for village forests.
	Legislation and regulations supporting SFM	Boolean	Latest available year						Yes	Yes	
	… of which in publicly owned forests	Boolean	Latest available year								
	… of which in privately owned forests	Boolean	Latest available year								
11	National stakeholder platform	Boolean	Latest available year					DOF	n.a		
12	Forest area intended to be in permanent forest land use	1000 ha				x		DOF	n.a		
	… of which permanent forest estate	1000 ha				x					
13a	Forest area monitored under a national forest monitoring framework		Latest available year					FIPD	n.a	Filled based on the result of NFIS project	
13b	Criteria and indicators reporting	Boolean	Latest available year						n.a		
	Periodic national state of the forest reporting	Boolean	Latest available year					FIPD	n.a		
	Other	Boolean	Latest available year						n.a		
	None	Boolean	Latest available year						n.a		

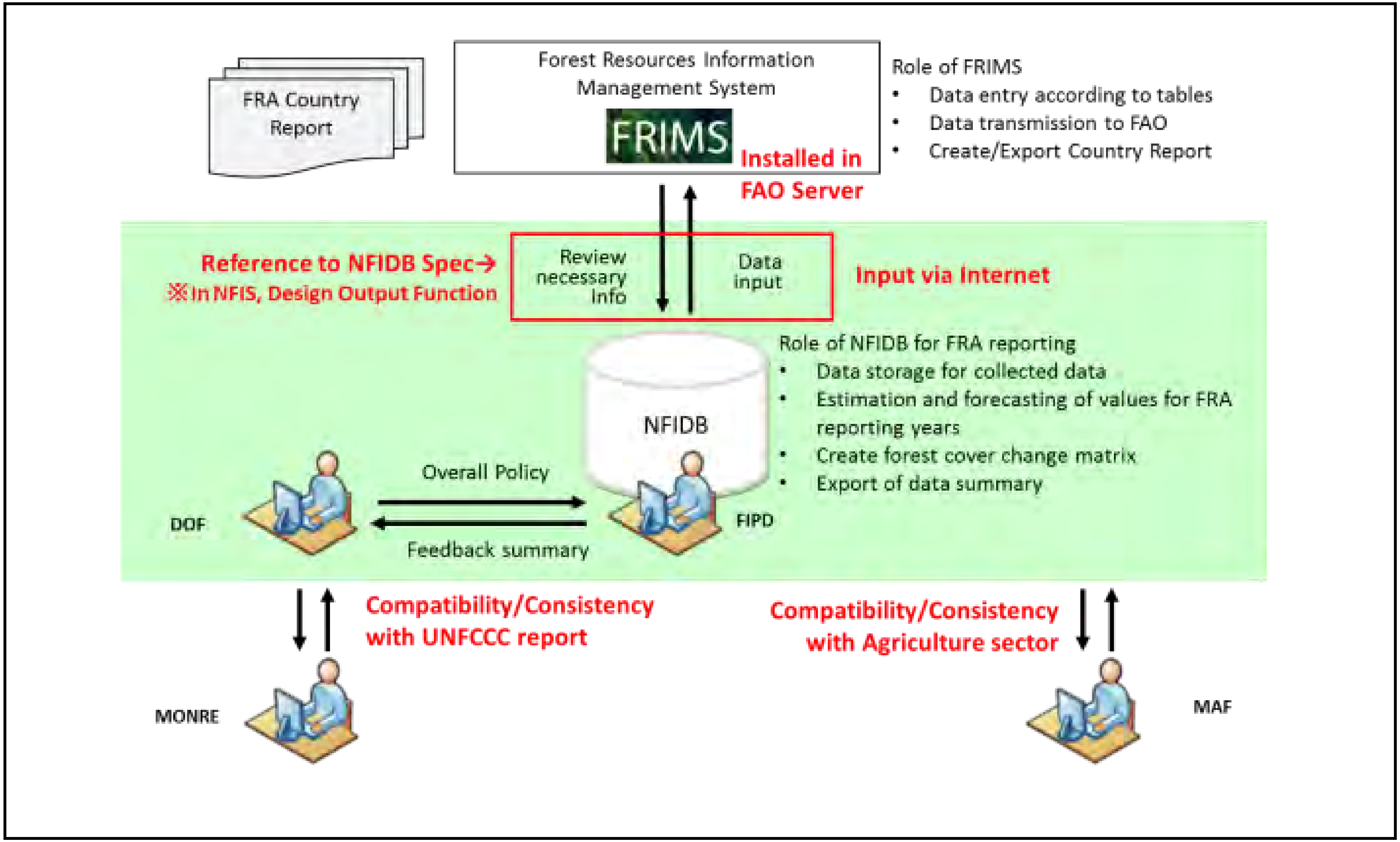
: information to be updated by the result of NFIS project

*Abbreviation
n.a: not available
DFRM: Department of Forest Resource Management
DOF: Department of Forestry
FRDF: Forestry and Forest Resource Development Fund
MONRE: Ministry of Natural Resources and Environment
NBCA: National Biodiversity Conservation Area
OWL: Other wooded land
BCEF: Biomass conversion and expansion factors

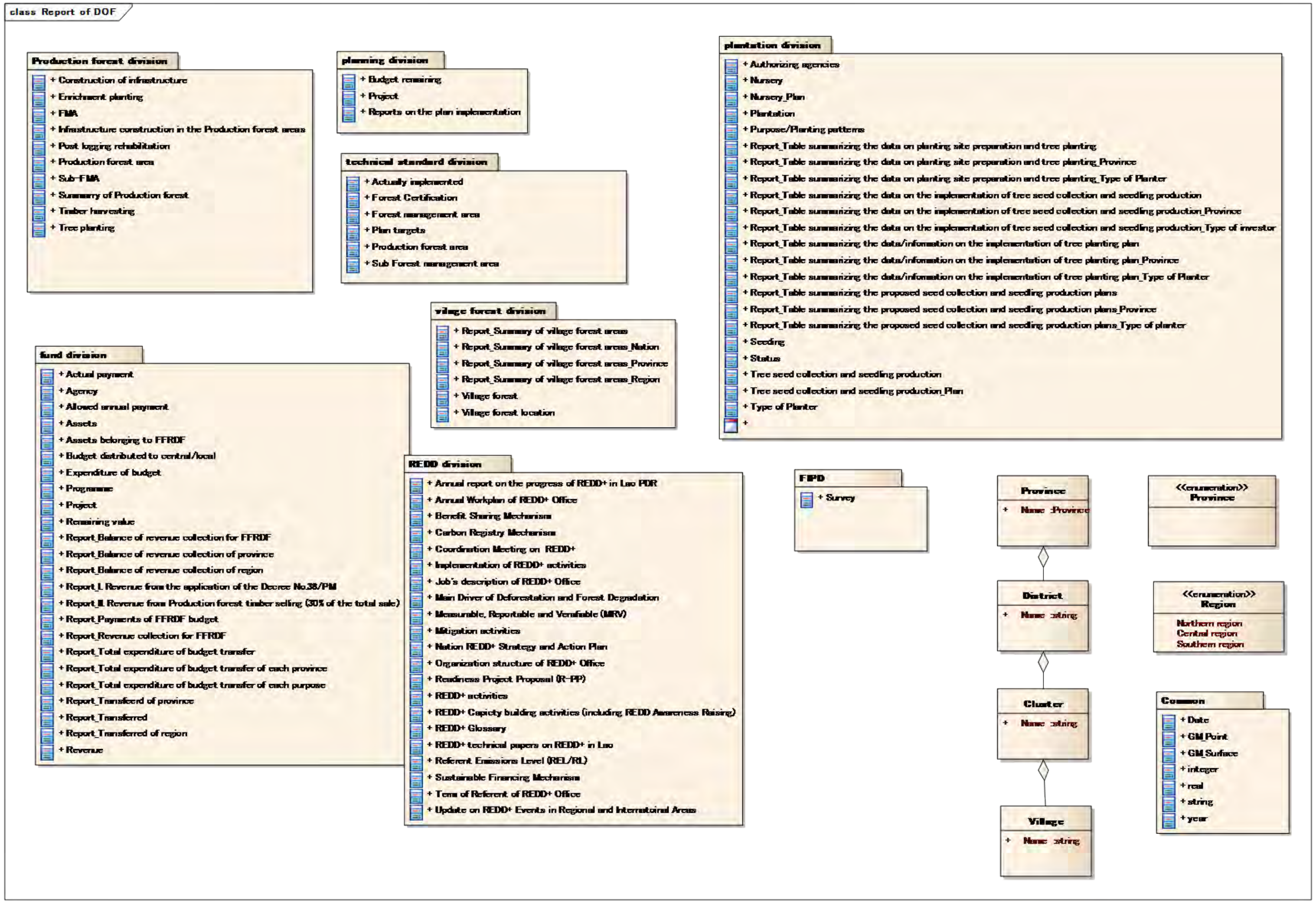
ii. Operational scale progress toward SFM											
14a	Forest area with management plan	1000 ha				x		SUFORD	n.a		
	… of which for production	1000 ha				x					
	… of which for conservation	1000 ha				x		DFRM・MONRE			
14b	Monitoring of forest management plans		Latest available year					SUFORD & FIPD	n.a		
	Soil and water management	Boolean	Latest available year					Not clear			
	High conservation value forest delineation	Boolean	Latest available year					Not clear			
	Social consideration/community involvement	Boolean	Latest available year					DAFO/village			
14c	Percent of area under forest management plan that is monitored annually	%	Latest available year					SUFORD & FIPD	n.a		
15	Type of stakeholder inputs		Latest available year					PAFO & DAFO	n.a		
	Planning phase Boolean Not applicable	Boolean	Not applicable								
	Operations phase Boolean Not applicable	Boolean	Not applicable								
	Review of operations Boolean Not applicable	Boolean	Not applicable								
16a	Area of forest certified under FSC 1000 ha Annual data 2000-2012	1000 ha	Annual data 2000-2012					DOF & SUFORD	n.a		
	Area of forest certified under PEFC 1000 ha Annual data 2000	1000 ha	Annual data 2000								
	Area of forest certified by other international certification	1000 ha	Annual data 2000								
16b	Domestic forest management certification	1000 ha	Annual data 2000					n.a	n.a		
ECONOMICS/ LIVELIHOODS											
17	Forest revenue	1000 local currency		x	x	x		FRDF	Record from DOF	Record from DOF	
	Public expenditures on forests	1000 local currency		x	x	x					
18a	Public ownership	1000 ha	x	x	x	x		DOF	Record from DOF	Record from DOF	
	… of which owned by the state at national scale	1000 ha	x	x	x	x			n.a		
	… of which owned by the state at the sub-national government scale	1000 ha	x	x	x	x					
	Private ownership	1000 ha	x	x	x	x			n.a		
	… of which owned by individuals	1000 ha	x	x	x	x					
	… of which owned by private business entities and institutions	1000 ha	x	x	x	x					
	… of which owned by local, tribal and indigenous communities	1000 ha	x	x	x	x					
	Unknown ownership	1000 ha	x	x	x	x					
18b	Holder of management rights of public forests	1000 ha	x	x	x	x		DOF, PAFO, DAFO, village	n.a		
	Public administration	1000 ha	x	x	x	x					
	Individuals	1000 ha	x	x	x	x					
	Private companies	1000 ha	x	x	x	x					
	Communities	1000 ha	x	x	x	x					
	Other	1000 ha	x	x	x	x					
19	Employment in forestry	1000 FTE	x	x	x	x		DOF, PAFO, DAFO, village	Record from DOF and DFRM・MONRE	Record from DOF and DFRM・MONRE	
	… of which female	1000 FTE	x	x	x	x					
20	Gross value added from forestry	Million local currency	Latest available year					FRDF	n.a		
LOOKING FORWARD											
21a	Government targets/aspirations for forest area in 2020 and 2030	1000 ha	2020 and 2030					DOF	2020 strategy is available. But modification is planning to be made for 2030 by DOF and DFRM.		
21b	Forest area earmarked for conversion	1000 ha	2013					Ministry of Industry and Trade, and MAF	n.a		

: information to be updated by the result of NFIS project

*Abbreviation	n.a: not available	DOF: Department of Forestry	MONRE: Ministry of Natural Resources and Environment	OWL: Other wooded land
	DFRM: Department of Forest Resource Management	FRDF: Forestry and Forest Resource Development Fund	NBCA: National Biodiversity Conservation Area	BCEF: Biomass conversion and expansion factors


FRA Country Report
Forest Resources Information Management System
FRIMS
Installed in FAO Server
Role of FRIMS
• Data entry according to tables
• Data transmission to FAO
• Create/Export Country Report
Reference to NFIDB Spec→
※In NFIS, Design Output Function
Review necessary Info
Data input
Input via Internet
NFIDB
Role of NFIDB for FRA reporting
• Data storage for collected data
• Estimation and forecasting of values for FRA reporting years
• Create forest cover change matrix
• Export of data summary
Overall Policy
Feedback summary
DOF
FIPD
Compatibility/Consistency with UNFCCC report
Compatibility/Consistency with Agriculture sector
MONRE
MAF

3.2.5.2 Report Diagram (Domestic)



3.2.5.3 Reporting Function

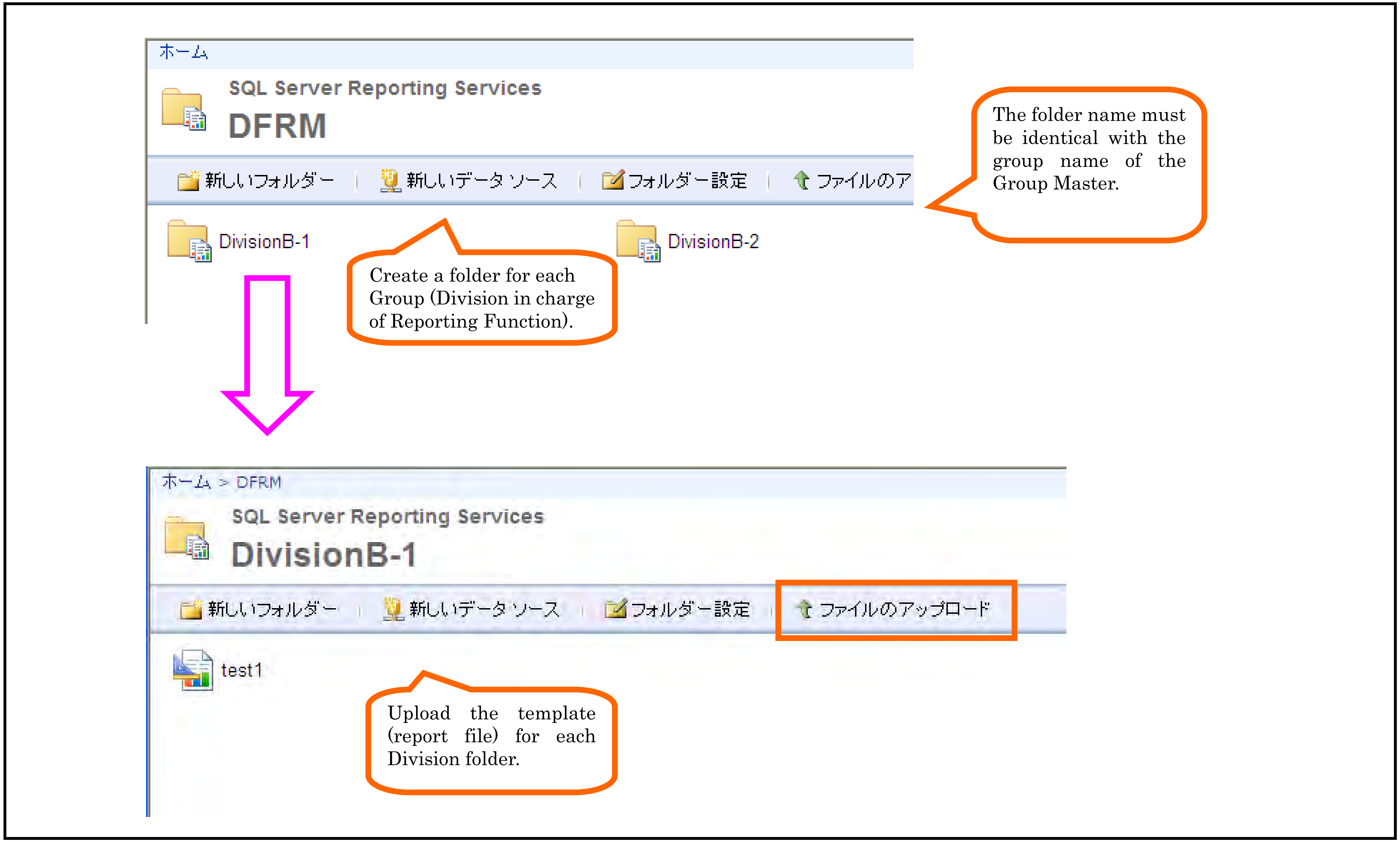
3.2.5.3.1 Reporting Procedures

The filter for Division is set in the Combo Box as follows:
The [Administrator] can set [All], [DFRM], [DOF] and [Division].
The [DFRM Manger], [DFRM Editor], [DFRM Guest User] can set [DFRM] and [Division].
The [DOF Manager], [DOF Editor], [DOF Guest User] can set [DOF and [Division].
All ... All the report files are displayed.
DFRM ... The report files within DFRM are displayed.
DOF ... The report files within DOF are displayed.
Division ... The report files within each Division are displayed.

The template (reports) included in the selected Division are set in the Combo Box.
When the Next button is pressed, the URL for the relevant reports is designated to display the reports.

* The reports are prepared by the Report Builder in advance and the report files for each Division are uploaded by the Report Manager.
Uploading for each Division means that the reports are uploaded in a folder which is created under the Division name.


SQL Server Reporting Services
ホーム
新しいフォルダー
新しいデータ ソース
フォルダー設定
ファイルのア
DFRM
DOF
DOF用
Create the folders for DFRM and DOF



ホーム
SQL Server Reporting Services
DFRM
新しいフォルダー
新しいデータ ソース
フォルダー設定
ファイルのア
DivisionB-1
DivisionB-2
The folder name must be identical with the group name of the Group Master.
Create a folder for each Group (Division in charge of Reporting Function).
ホーム > DFRM
SQL Server Reporting Services
DivisionB-1
新しいフォルダー
新しいデータ ソース
フォルダー設定
ファイルのアップロード
test1
Upload the template (report file) for each Division folder.

3.2.5.3.2 Single Sign-On Function

The authentication process is performed when recalling a report.
Custom authentication by the Report Server is performed.
The user information in the GIS Portal is used to log in to the system.

3.2.6. Registration/Updating

3.2.6.1 Registration of Log Management Table

Log Management Table Item	Description						
	Login	Logout	Register News & Events	Update News & Events	Delete News & Events	Register Related File	Delete Related File
ID	Automatic Numbering	Automatic Numbering	Automatic Numbering	Automatic Numbering	Automatic Numbering	Automatic Numbering	Automatic Numbering
User ID	Login User ID	Login User ID	Login User ID	Login User ID	Login User ID	Login User ID	Login User ID
Group ID	Login Group ID	Login Group ID	Login Group ID	Login Group ID	Login Group ID	Login Group ID	Login Group ID
Log type	Set 1 (Login)	Set 2 (Logout)	Set 3 (Register News & Events)	Set 4 (Update News & Events)	Set 5 (Delete News & Events)	Set 6 (Register related file)	Set 7 (Delete related file)
Title	Set none	Set none	Title of New & Event	Title of New & Event	Title of New & Event	File title	File title
Layer name	Set none	Set none	Set none	Set none	Set none	Layer name to be linked	Layer name to be linked
Project name	Set none	Set none	Set none	Set none	Set none	Project name to be linked	Project name to be linked
Insert Date	Date of System	Date of System	Date of System	Date of System	Date of System	Date of System	Date of System

3.2.6.2 Registration/Updating of News and Events Table

News & Events Table Item	Description	
	News & Events Registration	News & Events Updating
ID	Automatic numbering	No change
Title	Set the input item on the window	Set the input item on the window
Link	Set the input item on the window	Set the input item on the window
Comment	Set the input item on the window	Set the input item on the window
User’s Comment	Set the input item on the window	Set the input item on the window
Registered User ID	Login User ID	No change
Registered Group ID	Login Group ID	No change
Updated User ID	Set none	Login User ID
Updated Group ID	Set none	Login Group ID
Insert Date	Date of System	No change
Update Date	Set none	Date of System

3.2.6.3 Registration of Related Files Table

Related Files Item	Description
	Related File Registration
ID	Automatic numbering
Layer Name	Name of a layer or attribute table containing the Project to be related
Project Name	Name of the Project to be related
Title	Set the input item on the window
File Name	Set the input item on the window
File Path	Set the address in the server via the file path and set the renamed file name

Comment	Set the input item on the window
Format	Acquire and set the extension of the file to be uploaded
File Size	Acquire and set the size of the file to be uploaded
Registered User ID	Login User ID
Registered Group ID	Login Group ID
Table Type	With planimetric features: Y　No planimetric features: N
Link	Set the URL for the entered KnowledgeTree.
Insert Date	Date of System

* When deleting, the relevant record is deleted.

3.2.6.4 User Master Registration

User Master Item	Description	
	User Registration	User Updating
ID	Automatic numbering	No change
User ID	Set the input item on the window	Set the input item on the window.
User Name	Set the input item on the window	Set the input item on the window.
Password	Set the input item on the window	Set the input item on the window
Insert Date	Date of System	No change
Update Date	Set none	Date of System
Delete Flag	0	0

* When deleting, the delete flag for the relevant record is set to 1.

3.2.6.5 User Group Master Registration

User Group Master Item	Description
	User Registration/Updating
ID	Automatic numbering
Group Master ID	Group Master ID linked to a Group Name entered on the window.
User Master ID	User Master ID for the relevant record

Role	Set the input item on the window. (1: Administrator; 2: Manager: 3: Editor; 4: Browsers)
Insert Date	Date of System
Update Date	Set none
Delete Flag	0

* When deleting a user, the delete flag for the relevant record is set to 1.

When changing a group to which the user belongs, the group remains if it exists, a new group is added if it does not exist, and any group to which the user does not belong is deleted (by setting the delete flag to 1).

3.2.6.6 Group Master Registration/Updating

Group Master Item	Description	
	Group Registration	Group Updating
ID	Automatic numbering	No change
Group Name	Set the input item on the window	Set the input item on the window
Affiliation	Set the input item on the window (0: No Group; 1: DFRM; 2: DOF)	Set the input item on the window (0: No Group; 1: DFRM; 2: DOF)
Display Sequence	Set the input item on the window	Set the input item on the window
Insert Date	Date of System	No change
Update Date	Set none	Date of System
Delete Flag	0	0

* When deleting a user, the delete flag for the relevant record is set to 1.

3.2.6.7 Project Table Registration/Updating

Project Table Item	Description	
	Project Registration	Project Updating
Project ID	Set the input item on the window	No change
Project Name	Set the input item on the window	Set the input item on the window
Project Summary	Set the input item on the window	Set the input item on the window
Implementing Status	Set the input item on the window	Set the input item on the window
Project Period (Start)	Set the input item on the window	Set the input item on the window

Project Period (End)	Set the input item on the window	Set the input item on the window
·	·	·
·	·	·

3.2.6.8 Project Type Master Registration/Updating

Project Master Item	Description	
	Project Type Registration	Project Type Updating
ID	Automatic numbering	No change
Group ID	Set the input item on the window	Set the input item on the window
Project Type	Set the input item on the window	Set the input item on the window
Table Name	Set the input item on the window	Set the input item on the window
Table Type	Set the input item on the window	Set the input item on the window
Map URL	Set the input item on the window	Set the input item on the window
Delete Flag	0	0

3.2.6.9 Division Role Master Registration/Updating

Division Role Master Item	Description	
	Division Role Registration	Division Role Updating
ID	Automatic numbering	No change
Project Type ID	Set the input item on the window	Set the input item on the window
Group ID	Set the input item on the window	Set the input item on the window
Role	Marked: 0 (authority given) Not Marked: 1 (No authority given)	Marked: 0 (authority given) Not Marked: 1 (No authority given)

Lao People's Democratic Republic
Department of Forestry, Ministry of Agriculture and Forestry

The Capacity Development Project for

Establishing National Forest Information System for

Sustainable Forest Management and REDD+

Basic Design Document

National Forest Information Database (Prototype)

Japan International Cooperation Agency

Joint Venture
KOKUSAI KOGYO CO., LTD.
ASIA AIR SURVEY CO., LTD.

History of Revisions

Version	Date of Insertion/ Revision	Reason for Revision and Revised Point	Prepared by
1.0	2015.09.30	First Edition	Kokusai Kogyo Co., LTD

Lao People's Democratic Republic
Department of Forestry, Ministry of Agriculture and Forestry

The Capacity Development Project for Establishing National Forest Information System for Sustainable Forest Management and REDD+

Requirements Definition of GIS Data

September 2015

Japan International Cooperation Agency

Joint Venture
KOKUSAI KOGYO CO., LTD.
ASIA AIR SURVEY CO., LTD.

1. Categories and Layers

1-1. Basic Information

Category 1	Category 2	Layer name	Remarks
Basic Layers	Boundary	CountryBoundary	
		Country	
		District	
		Provinces	
	Road	Road_Louangphabang_edited_48	
	ForestCategory	CSA20110203	
		PFA20110203	
		PTA20110203	
	GDEM	astgtm2_mosaic_utm	
		slope_gdem2	
	SRTM	srtm_laos_mosaic_rp_sub_utm	
		srtm_laos_mosaic_rp_sub_utm_10m	
		srtm_laos_mosaic_rp_sub_utm_aspect	
		srtm_laos_mosaic_rp_sub_utm_slope	
	IndexMap	Photo_Index_SNGS_2011	
		MapIndex5000	
		MapIndex10000	
		MapIndex25000	
		MapIndex50000	
		MapIndex100000	
		MapIndex200000	
		MapIndex500000	
		MapIndex1000000	
		MapIndex_5000	
		MapIndex_10000	
		MapIndex_25000	
		MapIndex_50000	
		MapIndex_100000	
		MapIndex_200000	
		MapIndex_500000	
		MapIndex_1000000	
	Land Cover Change 2000-2014	Hansen_GFC2014_lossyear_Laos.tif	Added 2015
Satellite Image	ALOS-AVNIR2_2010 (Ortho_Mosaic)	ALOS-AVNIR2_2010 (Ortho_Mosaic)	
	ALOS-PRISM_2010 (Ortho_Mosaic)	ALOS-PRISM_2010 (Ortho_Mosaic)	
	ALOS-PRISM_AVNIR2_Pansharpen	265933190_200_or_mo_su_ps	
	ALOS-PALSAR (PALSAR_2009_Dry)	ALOS-PALSAR (PALSAR_2009_Dry)	
	ALOS-PALSAR (PALSAR_2009_Rainy)	ALOS-PALSAR (PALSAR_2009_Rainy)	
	ALOS-PALSAR (PALSAR_2010_Dry)	ALOS-PALSAR (PALSAR_2010_Dry)	
	ALOS-PALSAR (PALSAR_2010_Rainy)	ALOS-PALSAR (PALSAR_2010_Rainy)	
	ALOS-PALSAR (PALSAR_Layerstack)	LAOS479_40_09d10r10d	
	SPOT5_2005 (Ortho_Mosaic)	Sms_mo_zz_SK0608_02_0404	
	SPOT5_2005 (Atmospheric)	Sms_at_zz_SK1004_02_0404	
	SPOT5_2005 (Topographic)	Sms_to_zz_KP0607_02_0404	

Category 1	Category 2	Layer name	Remarks
	SPOT5_2005 (NDVI)	Sms_ix_nd_SK0613_02_0404	
	SPOT5_2005 (ShapeFile)	Sms_cl_su_SK0615_02_0404	
	RapidEye-2010 (Ortho_Mosaic)	20101108t045545_02_or_mo	
	RapidEye-2010 (NDVI)	20101108t045545_02_or_mo_nd	
	RapidEye-2010 (ShapeFile)	t043432_02	
	LANDSAT 2000 (Annual Greenest Pixel: cloud free mosaic)	Hansen_GFC2014_first_Laos.tif	Added 2015
	LANDSAT 2013 (Annual Greenest Pixel: cloud free mosaic)	Hansen_GFC2014_last_Laos.tif	Added 2015

1-2. Inventory Survery

Category 1	Category 2	Layer name	Remarks
Forest Inventory Survey 2010 - 2o11	Plot	1_PL_ALL_Final2010	
	Non_Forest	2_NF_ALL_Final2010	
Forest Inventory Survey 2010 - 2o11	Plot	01_Vientiane_Capital_PL	
		02_Phongsary_PL	
		03_Luangnamtha_PL	
		04_Oudomxay_PL	
		05_Bokeo_PL	
		06_Luangprabang_PL	
		07_Houaphanh_PL	
		08_Xayaboury_PL	
		09_Xiengkuang_PL	
		10_Vientian_PL	
		11_Bolikhamxay_PL	
		12_Khammuane_PL	
		13_Savannakhet_PL	
		14_Saravane_PL	
		15_Sekong_PL	
		16_Champasak_PL	
		17_Attapeu_PL	
		Whole_Laos_PL	
	Non_Forest	01_Vientiane_Capital_NF	
		02_Phongsary_NF	
		03_Luangnamtha_NF	
		04_Oudomxay_NF	
		05_Bokeo_NF	
		06_Luangprabang_NF	
		07_Houaphanh_NF	
		08_Xayaboury_NF	
		09_Xiengkuang_NF	
		10_Vientian_NF	
		11_Bolikhamxay_NF	
		12_Khammuane_NF	
		13_Savannakhet_NF	
		14_Saravane_NF	
		15_Sekong_NF	
		16_Champasak_NF	
		17_Attapeu_NF	
		Whole_Laos_NF	
Admin_Provinc	Admin_Province_DD	01_admin_vientiane_capital_dd	

e_DD		02_admin_phongsaly_dd	
		03_admin_luangnamtha_dd	
		04_admin_oudomxay_dd	
		05_admin_bokeo_dd	
		06_admin_luangprabang_dd	
		07_admin_houaphanh_dd	
		08_admin_xayaboury_dd	
		09_admin_xiengkuang_dd	
		10_admin_vientiane_dd	
		11_admin_bolikhamxay_dd	
		12_admin_khammuane_dd	
		13_admin_savannakhet_dd	
		14_admin_saravane_dd	
		15_admin_sekong_dd	
		16_admin_champasak_dd	
		17_admin_attapeu_dd	
		admin_province_dd	

1-3. Production Forest

Category 1	Category 2	Layer name	Remarks
LOC (Land of Category?)		Road_network_z48	
		Provinces_z48	
		Districts_z48	
		River_Polygon_z48	
		PFA20110203	
		SFMA_in_thasi_z48	
		Districts_z48	
Top (Topographic)	Basemap	UpVillage2009_z48	
		Elevition_Point_z48	
		Stream_Line_z48	
		sfma_thasi_contour	
		road_network_z48	
		River_Polygon_z48	
		PFA20110203	
		SFMA_in_thasi_z48	
LUC (Land Use Current)	New Group Layer	UpVillage2009_z48	
		Elevition_Point_z48	
		Stream_Line_z48	
		road_network_z48	
		River_Polygon_z48	
		PFA20110203	
		SFMA_in_thasi_z48	
		LUC_Thasi24122012c	
LUP (Land Use Planned)	Basemap	UpVillage2009_z48	
		Elevition_Point_z48	
		Stream_Line_z48	
		road_network_z48	
		River_Polygon_z48	
		SFMA_in_thasi_z48	
		Buffer_SFMA_thasi120726a	
		LUP_SFMA_thasi20120726a	

Category 1	Category 2	Layer name	Remarks
		PFA20110203	
ACC (Annual Allowable Cut)	UL	UpVillage2009_z48	
		Elevition_Point_z48	
		Stream_Line_z48	
		Buffer_AAC_SFMA_thasi120726a_1	
		road_network_z48	
		SFMA_in_thasi_z48	
		River_Polygon_z48	
		AAC_LUC_Buffer_SFMA_thasi20120917b	
		AAC_LUC_Buffer_SFMA_thasi20120917b	
	LL	UpVillage2009_z48	
		Elevition_Point_z48	
		Stream_Line_z48	
		road_network_z48	
		SFMA_in_thasi_z48	
		River_Polygon_z48	
		Buffer_AAC_SFMA_thasi120726a_1	
		AAC_LUC_Buffer_SFMA_thasi20120917b	
		AAC_LUC_Buffer_SFMA_thasi20120917b	
	UR	UpVillage2009_z48	
		Elevition_Point_z48	
		Stream_Line_z48	
		road_network_z48	
		SFMA_in_thasi_z48	
		River_Polygon_z48	
		Buffer_AAC_SFMA_thasi120726a_1	
		AAC_LUC_Buffer_SFMA_thasi20120917b	
		AAC_LUC_Buffer_SFMA_thasi20120917b	
	Index_PBK	AAC_LUC_Buffer_SFMA_thasi20120917b	
		SFMA_in_thasi_z48	
FRA ()	Basemap	UpVillage2009_z48	
		Elevition_Point_z48	
		Stream_Line_z48	
		road_network_z48	
		River_Polygon_z48	
		PFA20110203	
		SFMA_in_thasi_z48	
		LUP_SFMA_thasi20120726a	
NTP (Non Timber Forest Production)		NTFP_in_SFMA_thasi	
	Basemap	UpVillage2009_z48	
		Elevition_Point_z48	
		Stream_Line_z48	
		road_network_z48	
		River_Polygon_z48	
		SFMA_in_thasi_z48	
		Buffer_SFMA_thasi120726a	
		LUC_Thasi24122012c	
HCV (High Conserve)		NTFP_in_SFMA_thasi	
	New Group Layer	UpVillage2009_z48	
		Elevition_Point_z48	
		Stream_Line_z48	
		road_network_z48	
		River_Polygon_z48	
		Buffer_SFMA_thasi120726a	

Category 1	Category 2	Layer name	Remarks
		SFMA_in_thasi_z48	
		LUC_Thasi24122012c	
		PFA20110203	

1-4. Protection & Conservation Forest

Category 1	Category 2	Layer name	Remarks
Protection Forest Area	Forest Category	ProtectionForestArea	
	Watershed	Nambeng_SubWatershed_con1000.shp	Demo data 2015
	Landslide Risk	Nambeng_SubWatershed_con1000_landslide_index.shp	Demo data 2015
	Landuse Plan	Nambeng_LUP_UTM48.shp	Demo data 2015
Conservation Forest Area	Forest Category	ConservationForestArea	

2. Requirements definition

2-1. Basic Information

CountryBoundary

Requirements definition of GIS data

Name of Object	CountryBoundary
Definition	Outline of country
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Line
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
FID_Country		Integer	—		—	
ຊືປະເທດ	Country name in Lao	Integer	—	50	—	
CountryName	Country name in English	String	—	50	—	
Shape_Length	Shape length	Float	—		—	

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Country

Requirements definition of GIS data

Name of Object	Country					
Definition	Shape of country					
Origin Data	FIM (Forest Information Management)					
Acquisition Basis						
Spatial Attribute	Polygon					
Time Attribute	—					
Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
ຊືປະເທດ	Country name in Lao	String	—	50	—	
CountryName	Country name in English	String	—	50	—	
Shape_Length	Shape length	Float	—		—	
Shape_Area	Shape area	Float	—		—	

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Provinces

Requirements definition of GIS data

Name of Object	Provinces
Definition	Shape of provinces
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
ລະຫັດແຂວງ	Province code	String	—	2	—	
ຊື່ແຂວງ	Province name in Lao	String	—	50	—	
ProvinceName	Province name in English	String	—	50	—	
Shape_Length	Shape length	Float	—		—	
Shape_Area	Shape area	Float	—		—	

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Districts

Requirements definition of GIS data

Name of Object	Districts
Definition	Shape of districts
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
ລະຫັດເມືອງ	District code	String	—	4	—	
ຊື່ເມືອງ	District name in Lao	String	—	50	—	
DistrictName	District name in English	String	—	50	—	
ລະຫັດແຂວງ	Province code	String	—	2	—	
ຊື່ແຂວງ	Province name in Lao	String	—	50	—	
ProvinceName	Province name in English	String	—	50	—	
Shape_Length	Shape length	Float	—		—	
Shape_Area	Shape area	Float	—		—	

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Road_Louangphabang_edited_48 (other 16 roads data are in FIM)

Requirements definition of GIS data

Name of Object	Road_Louangphabang_edited_48					
Definition	Road of Louangphabang					
Origin Data	FIM (Forest Information Management)					
Acquisition Basis						
Spatial Attribute	Line					
Time Attribute	—					
Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
FID_Road_N	Road Number	Integer	—	9	—	
ROADID	Road ID	String	—	10	—	
LINKID	Link ID	String	—	10	—	
STAT1	Starting Point	Float	—	Digit: 17 after the decimal point: 2	—	
STAT2	Ending Point	Float	—	Digit: 17 after the decimal point: 2	—	
LRP1	?	Integer	—	8	—	
LRP2	?	Integer	—	8	—	
START	Description of Starting Point Name?	String	—	120	—	
END	Description of Ending Point Name?	String	—	120	—	
LOCSTART	?	String	—	120	—	
LOCEND	?	String	—	120	—	
LENGTH	Length of Road	Float	—	Digit: 17 after the decimal point: 2	—	
WIDTH	Width of Road	Float	—	Digit: 17 after the decimal point: 2	—	
SWIDTH	?	String	—	10	—	
MTYPE	?	String	—	15	—	
PTYPE	?	String	—	15	—	
TOPO	?	String	—	15	—	
RAIN	?	String	—	15	—	
MATPROXIMI	?	String	—	10	—	
SLIPWASH	?	String	—	10	—	
X	Longitude	Float	—	Digit: 17 after the decimal point: 2	—	
Y	Latitude	Float	—	Digit: 17 after the decimal point: 2	—	
Z	Height	Float	—	Digit: 17	—	

				after the decimal point: 2		
ADMID	?	String	—	50	—	
DESCR	?	String	—	254	—	
LOCDESCR	?	String	—	254	—	
MSLINK	?	Integer	—	8	—	
RINI	?	String	—	10	—	
REV	?	String	—	8	—	
RCOMMENTS	?	String	—	50	—	
CFACTOR	?	Float	—	Digit: 17 after the decimal point: 2	—	
FNODE_	?	Integer	—	9	—	
TNODE_	?	Integer	—	9	—	
LPOLY_	?	Integer	—	9	—	
RPOLY_	?	Integer	—	9	—	
WHOLE_ROAD	?	Integer	—	9	—	
WHOLE_RO_1	?	Integer	—	9	—	
CLSID	?	Integer	—	8	—	
FID_1	?	Integer	—	9	—	
LENGTH_1	?	Float	—	Digit: 17 after the decimal point: 2	—	
FID_Provin	?	Integer	—		—	
PCode	Province Code	String	—	2	—	
PNameLao	Province Name in Lao	String	—	50	—	
PNameEng	Province Name in English	String	—	50	—	
Shape_Leng	Shape Length	Float	—		—	
Shape_Area	Shape Area	Float	—		—	

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

astgtm2_mosaic_utm

Requirements definition of GIS data

Name of Object	astgtm2_mosaic_utm
Definition	Digital Elevation Model (mosaic)
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Image
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

slope_gdem2

Requirements definition of GIS data

Name of Object	slope_gdem2
Definition	Digital Elevation Model (slope)
Origin Data	FIM (Forest Information Management)
Acquisition Basis	.
Spatial Attribute	Image
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

srtm_laos_mosaic_rp_sub_utm

Requirements definition of GIS data

Name of Object	srtm_laos_mosaic_rp_sub_utm
Definition	Digital Elevation Model (slope)
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Image
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

srtm_laos_mosaic_rp_sub_utm_10m

Requirements definition of GIS data

Name of Object	srtm_laos_mosaic_rp_sub_utm_10
Definition	Digital Elevation Model (slope)
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Image
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

srtm_laos_mosaic_rp_sub_utm_aspect

Requirements definition of GIS data

Name of Object	srtm_laos_mosaic_rp_sub_utm_aspect
Definition	Digital Elevation Model (slope)
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Image
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

srtm_laos_mosaic_rp_sub_utm_slope

Requirements definition of GIS data

Name of Object	srtm_laos_mosaic_rp_sub_utm_slope
Definition	Digital Elevation Model (slope)
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Image
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Photo_Index_SNGS_2011

Requirements definition of GIS data

Name of Object	Photo_Index_SNGS_2011
Definition	Satellite imagery (ALOS-PALSAR)
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Image
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	—	—	—

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

MapIndex5000

Requirements definition of GIS data

Name of Object	MapIndex5000
Definition	MapIndex5000
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Line
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
LEFT_FID	LEFT FID	Integer	—		—	
RIGHT_FID	RIGHT FID	Integer	—		—	
Shape_Leng	Shape length	Float	—		—	

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

MapIndex200000

Requirements definition of GIS data

Name of Object	MapIndex200000
Definition	MapIndex5000
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Line
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
GR10_ID	GR10_ID	Float	—	11 digit 0 decimal places	—	
DEGREES	DEGREES	String	—	20	—	
DMS	DMS	String	—	20	—	

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

MapIndex500000

Requirements definition of GIS data

Name of Object	MapIndex500000
Definition	MapIndex5000
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Line
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
GR10_ID	GR10_ID	Float	—		—	
DEGREES	DEGREES	String	—	20	—	
DMS	DMS	String	—	20	—	
Shape_Leng	Shape length	Float	—		—	

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

MapIndex_5000

Requirements definition of GIS data

Name of Object	MapIndex_5000
Definition	Provinces area
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
MapID	Map ID	String	—	20	—	

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Hansen_GFC2014_lossyear_Laos.tif

Requirements definition of GIS data

Name of Object	Hansen_GFC2014_lossyear_Laos.tif
Definition	Land Cover Change 2000-2014
Origin Data	USGS and UMD(University of Maryland)
Acquisition Basis	
Spatial Attribute	Image
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
■	※	N/A	※	※	※	※	※

265933190_200_or_mo_su_ps

Requirements definition of GIS data

Name of Object	265933190_200_or_mo_su_ps
Definition	Satellite imagery (ALOS-PRISM_AVNIR2_Pansharpen)
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Image
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

LAOS479_40_09d10r10d

Requirements definition of GIS data

Name of Object	LAOS479_40_09d10r10d
Definition	Satellite imagery (ALOS-PALSAR)
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Image
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Sms_mo_zz_SK0608_02_0404

Requirements definition of GIS data

Name of Object	Sms_mo_zz_SK0608_02_0404
Definition	Satellite imagery (SPOT5_2005 Ortho_Mosaic)
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Image
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Sms_at_zz_SK1004_02_0404

Requirements definition of GIS data

Name of Object	Sms_at_zz_SK1004_02_0404
Definition	Satellite imagery (SPOT5_2005 Atmospheric)
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Image
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Requirements definition of GIS data

Name of Object	Sms_to_zz_KP0607_02_0404
Definition	Satellite imagery (SPOT5_2005 Topographic)
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Image
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Sms_ix_nd_SK0613_02_0404

Requirements definition of GIS data

Name of Object	Sms_ix_nd_SK0613_02_0404
Definition	Satellite imagery (SPOT5_2005 NDVI)
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Image
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Sms_cl_su_SK0615_02_0404

Requirements definition of GIS data

Name of Object	Sms_cl_su_SK0615_02_0404
Definition	Satellite imagery (SPOT5_2005 ShapeFile)
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
Class_name	Class name	String	—	254	—	
Class1	Class 1	String	—	20	—	
Class2	Class 2	String	—	20	—	
ID	ID	Integer	—		—	

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

20101108t045545_02_or_mo

Requirements definition of GIS data

Name of Object	20101108t045545_02_or_mo
Definition	Satellite imagery (RapidEye-2010　Ortho_Mosaic)
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Image
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

20101108t045545_02_or_mo_nd

Requirements definition of GIS data

Name of Object	20101108t045545_02_or_mo_nd
Definition	Satellite imagery (RapidEye-2010　NDVI)
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Image
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

t043432_02

Requirements definition of GIS data

Name of Object	t043432_02
Definition	Satellite imagery (RapidEye-2010　ShapeFile)
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
CHECK	Check	Float	—		—	
CLASS_NAME	Class name	String	—	254	—	
MODIFY1	Modify1	String	—	254	—	
MODIFY2	Modify2	String	—	254	—	
ORIG_FID	Orignal FID	Float	—		—	
Modify3	Modify3	String	—	10	—	
Shape_Leng	Shape length	Float	—		—	
Shape_Area	Shape area	Float	—		—	

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Hansen_GFC2014_first_Laos.tif

Requirements definition of GIS data

Name of Object	Hansen_GFC2014_first_Laos.tif
Definition	LANDSAT 2000 (Annual Greenest Pixel: cloud free mosaic)
Origin Data	USGS and UMD(University of Maryland)
Acquisition Basis	
Spatial Attribute	Image
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Hansen_GFC2014_last_Laos.tif

Requirements definition of GIS data

Name of Object	Hansen_GFC2014_last_Laos.tif
Definition	LANDSAT 2000 (Annual Greenest Pixel: cloud free mosaic)
Origin Data	USGS and UMD(University of Maryland)
Acquisition Basis	
Spatial Attribute	Image
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

National_NBCA_2011

Requirements definition of GIS data

Name of Object	National_NBCA_2011
Definition	National Biodiversity Conservation Area in Laos
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
Hectares	Shape Area	Float	ha		—	
NAME	Name in English	String	—	50	—	
PROVINCE	Province name in English	String	—	30	—	
District_N	District name	String	—	30	—	
Type	Type	Float	—		—	
Lao_Name	Name in Lao	String	—	30	—	
AREA	Area	Float	—		—	
Shape_Leng	Shape Length	Float	m		—	
Shape_Area	Shape Area	Float	m^2		—	

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

National_PTA_2011

Requirements definition of GIS data

Name of Object	National_PTA_2011
Definition	Protection Forest Area in Laos
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
OBJECTID_1	ID 1	Integer	—		—	
Name_Eng	Name in English	String	—	50	—	
LTYPE	L Type	String	—	12	—	
DNameLao	District name in Lao	String	—	50	—	
DNameEng	District name in English	String	—	50	—	
PCode	Province code	String	—	2	—	
PNameLao	Province name in Lao	String	—	50	—	
PNameEng	Province name in English	String	—	50	—	
Name_Lao	Name in Lao	String	—	50	—	
OBJECTID	ID	Integer	—		—	
Type	Type	Float	—		—	
Lao_Dist	District name in Lao	String	—	50	—	
Eng_Dist	District name in English	String	—	50	—	
Lao_Provin	Province name in Lao	String	—	50	—	
Eng_Provin	Province name in English	String	—	50	—	
PTA_class	PTA class	String	—	25	—	
PTA_name	PTA name in English	String	—	50	—	
PTA_NameL	PTA name in Lao	String	—	30	—	
Hectares	Area (Hectares)	Float	ha		—	
PTA_code	PTA code	Float	—		—	
Area_Decre	Area_Decre	Float	—		—	
OBJECTID_2	ID	Integer	—		—	
Shape_Leng	Shape Length	Float	—		—	
Shape_Le_1	Shape Length	Float	—		—	
Shape_Le_2	Shape Length	Float	—		—	
Shape_Le_3	Shape Length	Float	—		—	
Shape_Area	Shape Area	Float	—		—	

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name

—	—	—
Area of Scope for Object	Laos	
Description		
Edit	Cannot be edited	
Others		

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

category1_2_3

Requirements definition of GIS data

Name of Object	category1_2_3
Definition	National Biodiversity Conservation Area in Laos
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
AREA	Area	Float	—		—	
PERIMETER	Perimeter	Float	—		—	
NBCA2_	NBCA2	Float	—		—	
NBCA2_ID	NBCA2 ID	Float	—		—	
NAME	Name in English	String	—	10	—	
Hectares	Area (Hectares)	Float	ha	18 digit 11 decimal places	—	
Province	Province name in English	String	—	35	—	
Lao_Name	Name in Lao	String	—	40	—	
CATE_	Cate	Float	—	11 digit 0 decimal places	—	
CATE_ID	Cate ID	Float	—	11 digit 0 decimal places	—	
OBJECTID_1	ID	Float	—	11 digit 0 decimal places	—	
NATION_TYP	Nation type code	Integer	—		—	
DISTRICT_N	District name in English	String	—	30	—	
TYPE	Type code	Float	ha	18 digit 11 decimal places	—	
NATION_T_1	Nation type code	Float	ha	18 digit 11 decimal places	—	

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited

Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

PTA20110203

Requirements definition of GIS data

Name of Object	PTA20110203
Definition	Protection Forest Area in Laos
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
OBJECTID_1	ID 1	Integer	—		—	
Shape_Leng	Shape Length	Float	—		—	
Shape_Le_1	Shape Length	Float	—		—	
PCode	Province code	String	—	2	—	
PNameLao	Province name in Lao	String	—	50	—	
PNameEng	Province name in English	String	—	50	—	
Type	Province name in Lao	Float	—		—	
Lao_Dist	District name in Lao	String	—	50	—	
Eng_Dist	District name in English	String	—	50	—	
Lao_Provin	Province name in Lao	String	—	50	—	
Eng_Provin	Province name in English	String	—	50	—	
PTA_class	PTA class	String	—	25	—	
PTA_name	PTA name in English	String	—	50	—	
PTA_NameL	PTA name in Lao	String	—	30	—	
Hectares	Area (Hectares)	Float	ha		—	
PTA_code	PTA code	Float	—		—	
Area_Decre	Area decre	Float	—		—	
Shape_Length	Shape Length	Float	—		—	
Shape_Area	Shape Area	Float	m^2		—	

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

PFA20110203

Requirements definition of GIS data

Name of Object	PFA20110203
Definition	Protection Forest Area in Laos
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
OBJECTID_1	ID 1	Integer	—		—	
PROVINCE	Province name in English	Float	—		—	
Prov_Code	Province code	Float	—		—	
PFA_name	PFA name in English	String	—	2	—	
PFA_name_L	PFA name in Lao	String	—	50	—	
PFA_Code	PFA code	String	—	50	—	
PFA_projec	PFA project	Float	—		—	
Hectares	Area (Hectares)	String	—	50	—	
Area_on_De	Area on de	String	—	50	—	
Area_Approved	Area approved	String	—	50	—	
A_De_GIS	A de GIS	String	—	50	—	
A_Perc_Diff	A perc diff	String	—	25	—	
Shape_Length	Shape Length	String	—	50	—	
Shape_Area	Shape Area	String	—	30	—	

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

CSA20110203

Requirements definition of GIS data

Name of Object	CSA20110203
Definition	Protection Forest Area in Laos
Origin Data	FIM (Forest Information Management)
Acquisition Basis	
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
FID_NBCA2011	ID 1	Integer	—		—	
F3CAT_Code	F3CAT code	String	—	6	—	
Name_Eng	Name in English	String	—	30	—	
Name_Lao	Name in Lao	String	—	30	—	
Hectare	Area (Hectares)	Float	—		—	
Degree_No	Degree No	Integer	—		—	
Degree_Date	Degree date	Date	—		—	
Degree_Area	Degree area	Float	—		—	
Shape_Length	Shape Length	Float	—		—	
Shape_Area	Shape Area	Float	—		—	

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

2-2. Inventory Survery

1_PL_ALL_Final2010

Requirements definition of GIS data

Name of Object	1_PL_ALL_Final2010
Definition	Represent a location of foret inventory survey
Origin Data	Forest Inventory Survey (2010 to 2011)
Acquisition Basis	Acquire a field survey point data from origin data.
Spatial Attribute	Point
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
Record_ID	Record ID	Text	—	254	—	
Date	Date of survey	Text	—	254	—	
Province	Provinces of Laos	Text	—	254	—	
District	Districts of Laos	Text	—	254	—	
Village	Villages of Laos	Text	—	254	—	
Surveyor	Surveyor for field survey	Text	—	254	—	
Tract_ID	Tract ID	Text	—	254	—	
TR_P_Lat	Planned latitude [North]	Float	—	digit:18 after the decimal point:6	—	
TR_P_Lon	Planned longitude [East]	Float	—	digit:18 after the decimal point:6	—	
TR_A_Lat	Actual latitude (Tract) [North]	Float	—	digit:18 after the decimal point:6	—	
TR_A_Lon	Actual longitude (Tract) [East]	Float	—	digit:18 after the decimal point:6	—	
TR_Alt	Actual altitude (Tract) [m]	Float	—	digit:18 after the decimal point:6	—	
Plot_ID	Plot ID	Float	—	digit:18 after the decimal point:6	—	
PL_A_Lat	Actuallatitude (Plot) [North]	Float	—	digit:18 after the decimal point:6	—	
PL_A_Lon	Actual longitude (Plot) [East]	Float	—	digit:18 after the decimal point:6	—	

PL_A_Alt	Actual altitude (Plot) [m]	Float	—	digit:18 after the decimal point:6	—	
PH_N	Photo (North)	Text	—	254	—	
PN_E	Photo (East)	Text	—	254	—	
PH_S	Photo (South)	Text	—	254	—	
PH_W	Photo (West)	Text	—	254	—	
PH_CE	Photo (Center)	Text	—	254	—	
CD_N	Crown Density (North)	Float	—	digit:18 after the decimal point:6	—	
CD_E	Crown Density (East)	Float	—	digit:18 after the decimal point:6	—	
CD_S	Crown Density (South)	Float	—	digit:18 after the decimal point:6	—	
CD_W	Crown Density (West)	Float	—	digit:18 after the decimal point:6	—	
CD_Ave	Crown Density (Average)	Float	—	digit:18 after the decimal point:6	—	
Landuse	Forest type or other land cover type	Text	—	254	—	
Structure	Diameter at breast height, or D.B.H.	Text	—	254	—	
DR_Slope	Direction of the slope face	Text	—	254	—	

Subject Figure				
Name	Name	Name	Name	Name
—	—	—	—	—

Object Relation		
Related Name	Related Name	Related Name
—	—	—

Area of Scope for Object	Whole Laos
Description	This spetial data can be confirmed a field survey location.
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Requirements definition of GIS data

Name of Object	2_NF_ALL_Final2010
Definition	Represent a location of foret inventory survey (Non-Forest Area)
Origin Data	Forest Inventory Survey (2010 to 2011)
Acquisition Basis	Acquire a field survey point data from origin data.
Spatial Attribute	Point
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
Record_ID	Record ID	Text	—	254	—	
Date	Date of survey	Text	—	254	—	
Province	Provinces of Laos	Text	—	254	—	
District	Districts of Laos	Text	—	254	—	
Village	Villages of Laos	Text	—	254	—	
Surveyor	Surveyor for field survey	Text	—	254	—	
Tract_ID	Tract ID	Text	—	254	—	
TR_A_Lat	Actual latitude (Tract) [North]	Float	—	digit:18 after the decimal point:6	—	
TR_A_Lon	Actual longitude (Tract) [East]	Float	—	digit:18 after the decimal point:6	—	
TR_Alt	Actual altitude (Tract) [m]	Float	—	digit:18 after the decimal point:6	—	
PH_N	Photo (North)	Text	—	254	—	
PN_E	Photo (East)	Text	—	254	—	
PH_S	Photo (South)	Text	—	254	—	
PH_W	Photo (West)	Text	—	254	—	
PH_CE	Photo (Center)	Text	—	254	—	
Landuse	Forest type or other land cover type	Text	—	254	—	

Subject Figure

Name	Name	Name	Name	Name
—	—	—	—	—

Object Relation

Related Name	Related Name	Related Name
—	—	—

Area of Scope for Object	Whole Laos
Description	This spetial data can be confirmed a field survey location (Non-Forest Area).
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

※ 2011_2012 — Plot
01_Vientiane_Capital_PL

Requirements definition of GIS data

Name of Object	01_Vientiane_Capital_PL
Definition	Represent a location of foret inventory survey
Origin Data	Forest Inventory Survey (2011 to 2012)
Acquisition Basis	Acquire a field survey point data from origin data.
Spatial Attribute	Point
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
Record_ID	Record ID	Text	—	254	—	
Date	Date of survey	Text	—	254	—	
Province	Provinces of Laos	Text	—	254	—	
District	Districts of Laos	Text	—	254	—	
Village	Villages of Laos	Text	—	254	—	
Surveyor	Surveyor for field survey	Text	—	254	—	
Tract_ID	Tract ID	Text	—	254	—	
TR_P_Lat	Planned latitude [North]	Float	—	digit:15 after the decimal point:6	—	
TR_P_Lon	Planned longitude [East]	Float	—	digit:15 after the decimal point:6	—	
TR_A_Lat	Actual latitude (Tract) [North]	Float	—	digit:15 after the decimal point:6	—	
TR_A_Lon	Actual longitude (Tract) [East]	Float	—	digit:15 after the decimal point:6	—	
TR_Alt	Actual altitude (Tract) [m]	Float	—	digit:15 after the decimal point:6	—	
Plot_ID	Plot ID	Float	—	digit:15 after the decimal point:6	—	
PL_A_Lat	Actual latitude (Plot) [North]	Float	—	digit:15 after the decimal point:6	—	

PL_A_Lon	Actual longitude (Plot) [E]	Float	—	digit:15 after the decimal point:6	—	
PL_A_Alt	Actual altitude (Plot) [m]	Float	—	digit:15 after the decimal point:6	—	
F17	Waypoint No.	Text	—	254	—	
PH_N	Photo (North)	Text	—	254	—	
PN_E	Photo (East)	Text	—	254	—	
PH_S	Photo (South)	Text	—	254	—	
PH_W	Photo (West)	Text	—	254	—	
PH_CE	Photo (Center)	Text	—	254	—	
F23	Photo (Out of Area)	Text	—	254	—	
CD_N	Crown Density (North)	Float	—	digit:15 after the decimal point:6	—	
CD_E	Crown Density (East)	Float	—	digit:15 after the decimal point:6	—	
CD_S	Crown Density (South)	Float	—	digit:15 after the decimal point:6	—	
CD_W	Crown Density (West)	Float	—	digit:15 after the decimal point:6	—	
CD_Ave	Crown Density (mean)	Float	—	digit:15 after the decimal point:6	—	
Landuse	Forest type or other land cover type	Text	—	254	—	
Structure	Diameter at breast height, or D.B.H.	Text	—	254	—	
DR_Slope	Direction of the slope face	Text	—	254	—	

Subject Figure				
Name	Name	Name	Name	Name
—	—	—	—	—

Object Relation		
Related Name	Related Name	Related Name
—	—	—

Area of Scope for Object	Vientiane Capital
Description	This spetial data can be confirmed a field survey location.
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Whole_Laos_PL

Requirements definition of GIS data

Name of Object	Whole_Laos_PL
Definition	Represent a land cover type
Origin Data	Forest Inventory Survey (2011 to 2012)
Acquisition Basis	Acquire a field land cover type from origin data.
Spatial Attribute	Point
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
Landuse	Land cover type	Text	—	254	—	

Subject Figure

Name	Name	Name	Name	Name
—	—	—	—	—

Object Relation

Related Name	Related Name	Related Name
—	—	—

Area of Scope for Object	Vientiane Capital
Description	This spetial data can be confirmed a land cover type.
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

※ 2011_2012 ― Non_Forest

01_Vientiane_Capital_NF

Requirements definition of GIS data

Name of Object	01_Vientiane_Capital_NF
Definition	Represent a location of foret inventory survey (Non-Forest Area)
Origin Data	Forest Inventory Survey (2011 to 2012)
Acquisition Basis	Acquire a field survey point data from origin data.
Spatial Attribute	Point
Time Attribute	―

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
Record_ID	Record ID	Text	―	254	―	
Date	Date of survey	Text	―	254	―	
Province	Provinces of Laos	Text	―	254	―	
District	Districts of Laos	Text	―	254	―	
Village	Villages of Laos	Text	―	254	―	
Surveyor	Surveyor for field survey	Text	―	254	―	
Tract_ID	Tract ID	Text	―	254	―	
TR_P_Lat	Planned latitude [North]	Float	―	digit:15 after the decimal point:6	―	
TR_P_Lon	Planned longitude [East]	Float	―	digit:15 after the decimal point:6	―	
PL_A_Lat	Actual latitude (Tract) [North]	Float	―	digit:15 after the decimal point:6	―	
PL_A_Lon	Actual longitude (Tract) [East]	Float	―	digit:15 after the decimal point:6	―	
PL_A_Alt	Actual altitude (Tract) [m]	Float	―	digit:15 after the decimal point:6	―	
Way_point	Waypoint No.	Float	―	digit:15 after the decimal point:6	―	
PH_N	Photo (North)	Text	―	254	―	
PN_E	Photo (East)	Text	―	254	―	
PH_S	Photo (South)	Text	―	254	―	
PH_W	Photo (West)	Text	―	254	―	
PH_CE	Photo (Center)	Text	―	254	―	
PH_OUT	Photo (Out of Area)	Text	―	254	―	
Landuse	Forest type or other land cover type	Text	―	254	―	

Subject Figure

Name	Name	Name	Name	Name
—	—	—	—	—
Object Relation				
Related Name	Related Name			Related Name
—	—			—
Area of Scope for Object	Vientiane Capital			
Description	This spetial data can be confirmed a field survey location.			
Edit	Cannot be edited			
Others				

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Whole_Laos_NF

Requirements definition of GIS data

Name of Object	Whole_Laos_NF
Definition	Represent a land cover type
Origin Data	Forest Inventory Survey (2011 to 2012)
Acquisition Basis	Acquire a field land cover type from origin data.
Spatial Attribute	Point
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
Landuse	Land cover type	Text	—	254	—	

Subject Figure				
Name	Name	Name	Name	Name
—	—	—	—	—

Object Relation		
Related Name	Related Name	Related Name
—	—	—

Area of Scope for Object	Vientiane Capital
Description	This spetial data can be confirmed a land cover type.
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

01_admin_vientiane_capital_dd

Requirements definition of GIS data

Name of Object	01_admin_vientiane_capital_dd
Definition	Represent an area of provinces
Origin Data	
Acquisition Basis	Acquire an area of provinces from origin data.
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
LAYER	Type of layer	Text	—	254	—	
OBJECTID	Object ID	Text	—	254	—	
PCode	Province code	Text	—	254	—	
PNameLao	Province name in Lao	Text	—	254	—	
PNameEng	Province name in English	Text	—	254	—	
Shape_Leng	Outer perimeter	Text	—	254	—	
Shape_Area	Area of polygon	Text	—	254	—	
Area_km2	Area of polygon	Float	—	digit:15 after the decimal point:6	—	

Subject Figure				
Name	Name	Name	Name	Name
—	—	—	—	—

Object Relation		
Related Name	Related Name	Related Name
—	—	—

Area of Scope for Object	Vientiane Capital
Description	This spetial data can be confirmed an area of provinces.
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

admin_province_dd

Requirements definition of GIS data

Name of Object	admin_vientiane_capital_dd						
Definition	Represent an area of provinces						
Origin Data							
Acquisition Basis	Acquire an area of provinces from origin data.						
Spatial Attribute	Polygon						
Time Attribute	—						
Subject Attribute							
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure	
LAYER	Type of layer	Text	—	254	—		
OBJECTID	Object ID	Text	—	254	—		
PCode	Province code	Text	—	254	—		
PNameLao	Province name in Lao	Text	—	254	—		
PNameEng	Province name in English	Text	—	254	—		
Shape_Leng	Outer perimeter	Text	—	254	—		
Shape_Area	Area of polygon	Text	—	254	—		
Area_km2	Area of polygon	Float	—	digit:15 after the decimal point:6	—		
Team		String	—	10	—		
Subject Figure							
Name	Name	Name	Name	Name			
—	—	—	—	—			
Object Relation							
Related Name	Related Name	Related Name					
—	—	—					
Area of Scope for Object	Vientiane Capital						
Description	This spetial data can be confirmed an area of provinces.						
Edit	Cannot be edited						
Others							

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

2-3. Production Forest

road_network_z48

Requirements definition of GIS data

Name of Object	road_network_z48
Definition	Road data of Laos
Origin Data	FOMIS (Forest Management Information System)
Acquisition Basis	Acquire a road line data from origin data..
Spatial Attribute	Line
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
ROAD_NETWO	?	Float	—		—	
PRO_CODE	Province Code	String	—	4	—	
ROAD_N	?	String	—	6	—	
ROAD_CAT	?	String	—	6	—	
ROAD_CAT2	?	String	—	2	—	
ROAD_N1	?	String	—	8	—	
ROAD_CAT1	?	String	—	8	—	
OFFSET_STA	?	Float	—		—	
OFFSET_END	?	Float	—		—	
SURF_TYPE	?	String	—	20	—	
ROAD_CON	?	String	—	4	—	
LENGTH1	?	Float	—		—	
Shape_Length	Shape length	Float	—		—	

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Whole Laos
Description	This spatial data can be confirmed a road line data.
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Provinces_z48

Requirements definition of GIS data

Name of Object	Provinces_z48
Definition	Province data in Laos
Origin Data	FOMIS (Forest Management Information System)
Acquisition Basis	Acquire a province shape data from origin data..
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
ລະຫັດແຂວງ	Province Code	String	—	2	—	
ຊື່ແຂວງ	Province name in Latin caracters	String	—	50	—	
Province_Name	Province name in English	String	—	50	—	
Shape_Length	Shape length	Float	—		—	
Shape_Area	Shape area	Float	—		—	
Project_Name	Project name	String	—	50	—	
Project_Period	Project period	String	—	20	—	

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Whole Laos
Description	This spatial data can be confirmed a province shape data.
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Districts_z48

Requirements definition of GIS data

Name of Object	Districts_z48
Definition	District data of Laos
Origin Data	FOMIS (Forest Management Information System)
Acquisition Basis	Acquire a district shape data from origin data..
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
ລະຫັດເມືອງ	District code	String	—	4	—	
ຊື່ເມືອງ	District name in Lao	String	—	50	—	
District_Name	District name in English	String	—	50	—	
ລະຫັດແຂວງ	Province Code	String	—	2	—	
ຊື່ແຂວງ	Province name in Latin caracters	String	—	50	—	
Province_Name	Province name in English	String	—	50	—	
Shape_Length	Shape length	Float	—		—	
Shape_Area	Shape area	Float	—		—	

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Whole Laos
Description	This spatial data can be confirmed a district shape data.
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

River_Polygon_z48

Requirements definition of GIS data

Name of Object	River_Polygon_z48
Definition	River data of Laos
Origin Data	FOMIS (Forest Management Information System)
Acquisition Basis	Acquire a river line data from origin data.
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
WHOLE_HYPO	?	Integer	—		—	
CLSID	?	Integer	—		—	
Shape_Length	Shape length	Float	—		—	
Shape_Area	Shape area	Float	—		—	
AREA	Area	Float	—		—	
PERIMETER	perimeter	Float	—		—	
WHOLE_HY_1	?	Integer	—		—	

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Whole Laos
Description	This spatial data can be confirmed a river line data.
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

PFA20110203

Requirements definition of GIS data

Name of Object	PFA20110203
Definition	Production Forest Area data of Laos
Origin data.	FOMIS (Forest Management Information System)
Acquisition Basis	Acquire a PFA shape data from origin data.
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
PFA_name	PFA name in English	String	—	30	—	
PFA_name_L	PFA name in Laos	String	—	30	—	
PFA_Code	PFA code	String	—	2	—	
PFA_projec	PFA project	String	—	30	—	
Area_on_De	Area on De	String	—	2	—	
Area_Approved	Area approved	Float	—		—	
Shape_Length	Shape length	Float	—		—	
Shape_Area	Shape area	Float	—		—	
PFA_Degr_Area	PFA degr area	Float	—		—	
F3CAT_Cod	F3CAT code	String	—	6	—	
temp_id	Temp ID	Integer	—		—	

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Whole Laos
Description	This spatial data can be confirmed a PFA shape data.
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

SFMA_in_thasi_z48

Requirements definition of GIS data

Name of Object	SFMA_in_thasi_z48
Definition	Sub Forest Management Area data of Laos
Origin data.	FOMIS (Forest Management Information System)
Acquisition Basis	Acquire a SFMA shape data from origin data.
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
Shape_Length	Shape Length	Float	—		—	
Shape_Area	Shape Area	Float	—		—	
SFMA_Name_Eng	SFMA Name in English	String	—	30	—	
SFMA_Name_Lao	SFMA Name in Lao	String	—	30	—	
SFMA_ID	SFMA ID	String	—	11	—	
SFMA_IDS	SFMA IDS	Integer	—		—	

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Whole Laos
Description	This spatial data can be confirmed a SFMA shape data.
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

UpVillage2009_z48

Requirements definition of GIS data

Name of Object	UpVillage2009_z48
Definition	Location of Village
Origin data.	FOMIS (Forest Management Information System)
Acquisition Basis	Acquire a location of village represented as a point from origin data.
Spatial Attribute	Point
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
Eng_Name	Village name in English	String	—	254	—	
Lao_Name	Village name in Lao	String	—	254	—	
LATDD	Latitude DD	Float	—		—	
LONDD	Longitude DD	Float	—		—	
Howshold	Household ?	Float	—		—	
Total_Pers	Total Pers	Float	—		—	
Female	Female	Float	—		—	
Road	Road	Float	—		—	
Maeket	Maeket	Float	—		—	
Elec	Electricity?	Float	—		—	
Shool	Shool	Float	—		—	
VillageCode	Village code	String	—	7	—	

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Whole Laos
Description	This spatial data can be confirmed a location of village data.
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Elevition_Point_z48

Requirements definition of GIS data

Name of Object	Elevition_Point_z48
Definition	Elevation Point of Laos
Origin data.	FOMIS (Forest Management Information System)
Acquisition Basis	Acquire an elevation point data from origin data.
Spatial Attribute	Point
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
WHOLE_ELEV	WHOLE ELEV	Integer	—		—	
WHOLE_EL_1	WHOLE EL 1	Integer	—		—	
CLSID	CLSID	Integer	—		—	
ELEVATION	ELEVATION	Float	—		—	
INTID	INTID	Integer	—		—	
Lao_Name	Lao name	String	—	25	—	
Eng_name	English name	String	—	30	—	
Prov_Name_Eng	Province name in English	String	—	50	—	
Prov_Name_lao	Province name in Lao	String	—	50	—	

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Whole Laos
Description	This spatial data can be confirmed an elevation data.
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Stream_Line_z48

Requirements definition of GIS data

Name of Object	Stream_Line_z48
Definition	Stream of Laos
Origin data.	FOMIS (Forest Management Information System)
Acquisition Basis	Acquire a stream line data from origin data.....
Spatial Attribute	Line
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
FNODE_	FNODE	Integer	—		—	
TNODE_	TNODE	Integer	—		—	
LPOLY_	LPOLY	Integer	—		—	
RPOLY_	RPOLY	Integer	—		—	
LENGTH	LENGTH	Float	—		—	
WHOLE_HYLI	WHOLE HYLI	Integer	—		—	
WHOLE_HY_1	WHOLE HY 1	Integer	—		—	
CLSID	CLSID	Integer	—		—	
NAME	NAME	String	—	30	—	
Lao_Name	LAO NAME	String	—	30	—	
Shape_Length	Shape Length	Float	—		—	

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Whole Laos
Description	This spatial data can be confirmed a stream line data.
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

sfma_thasi_contour

Requirements definition of GIS data

Name of Object	sfma_thasi_contour
Definition	Sub Forest Management Area data of Laos
Origin data.	FOMIS (Forest Management Information System)
Acquisition Basis	Acquire a contour data from origin data...
Spatial Attribute	line
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
FNODE_	FNODE	Integer	—		—	
TNODE_	TNODE	Integer	—		—	
LPOLY_	LPOLY	Integer	—		—	
RPOLY_	RPOLY	Integer	—		—	
LENGTH	LENGTH	Float	—		—	
F_47_119_	F 47 119	Integer	—		—	
F_47_119_I	F 47 119 I	Integer	—		—	
CLSID	CLSID	Float	—		—	
ELEVATION	ELEVATION	Integer	—		—	
E_47_23_	E 47 23	Integer	—		—	
E_47_23_ID	E 47 23 ID	Integer	—		—	
FNODE1	FNODE1	Integer	—		—	
TNODE1	TNODE1	Integer	—		—	
LPOLY1	LPOLY1	Integer	—		—	
RPOLY1	RPOLY1	Integer	—		—	
E_47_22_	E 47 22	Integer	—		—	
E_47_22_ID	E 47 22 ID	Integer	—		—	
FNODE1_1	FNODE1	Integer	—		—	
TNODE1_1	TNODE1	Integer	—		—	
LPOLY1_1	LPOLY1	Integer	—		—	
RPOLY1_1	RPOLY1	Integer	—		—	
E_47_21_	E 47 21	Integer	—		—	
E_47_21_ID	E 47 21 ID	Integer	—		—	
FNODE1_12	FNODE1 12	Integer	—		—	
TNODE1_12	TNODE1 12	Integer	—		—	
LPOLY1_12	LPOLY1 12	Integer	—		—	
RPOLY1_12	RPOLY1 12	Integer	—		—	
E_47_12_	E 47 12	Integer	—		—	
E_47_12_ID	E 47 12 ID	Integer	—		—	
FNODE1__13	FNODE1 13	Integer	—		—	
TNODE1__13	TNODE1 13	Integer	—		—	
LPOLY1__13	LPOLY1 13	Integer	—		—	
RPOLY1__13	RPOLY1 13	Integer	—		—	
E_47_11_	E 47 11	Integer	—		—	
E_47_11_ID	E 47 11 ID	Integer	—		—	
FNODE1__14	FNODE1 14	Integer	—		—	

TNODE1__14	TNODE1 14	Integer	—		—	
LPOLY1__14	LPOLY1 14	Integer	—		—	
RPOLY1__14	RPOLY1 14	Integer	—		—	
E_47_10_	E 47 10	Integer	—		—	
E_47_10_ID	E 47 10 ID	Integer	—		—	
FNODE1__15	FNODE1 15	Integer	—		—	
TNODE1__15	TNODE1 15	Integer	—		—	
LPOLY1__15	LPOLY1 15	Integer	—		—	
RPOLY1__15	RPOLY1 15	Integer	—		—	
E_47_9_	E 47 9	Integer	—		—	
E_47_9_ID	E 47 9 ID	Integer	—		—	
FNODE1__16	FNODE1 16	Integer	—		—	
TNODE1__16	TNODE1 16	Integer	—		—	
LPOLY1__16	LPOLY1 16	Integer	—		—	
RPOLY1__16	RPOLY1 16	Integer	—		—	
E_47_94_	E 47 94	Integer	—		—	
E_47_94_ID	E 47 94 ID	Integer	—		—	
FNODE1__17	FNODE1 17	Integer	—		—	
TNODE1__17	TNODE1 17	Integer	—		—	
LPOLY1__17	LPOLY1 17	Integer	—		—	
RPOLY1__17	RPOLY1 17	Integer	—		—	
E_47_95_	E 47 95	Integer	—		—	
E_47_95_ID	E 47 95 ID	Integer	—		—	
FNODE1__18	FNODE1 18	Integer	—		—	
TNODE1__18	TNODE1 18	Integer	—		—	
LPOLY1__18	LPOLY1 18	Integer	—		—	
RPOLY1__18	RPOLY1 18	Integer	—		—	
E_47_106_	E 47 106	Integer	—		—	
E_47_106_I	E 47 106 I	Integer	—		—	
FNODE1__19	FNODE1 19	Integer	—		—	
TNODE1__19	TNODE1 19	Integer	—		—	
LPOLY1__19	LPOLY1 19	Integer	—		—	
RPOLY1__19	RPOLY1 19	Integer	—		—	
E_47_107_	E 47 107	Integer	—		—	
E_47_107_I	E 47 107 I	Integer	—		—	
FNODE1__20	FNODE1 20	Integer	—		—	
TNODE1__20	TNODE1 20	Integer	—		—	
LPOLY1__20	LPOLY1 20	Integer	—		—	
RPOLY1__20	RPOLY1 20	Integer	—		—	
E_47_108__	E 47 108	Integer	—		—	
E_47_108_I	E 47 108 I	Integer	—		—	
E_47_84_	E 47 84	Integer	—		—	
E_47_84_ID	E 47 84 ID	Integer	—		—	
E_47_83_	E 47 83	Integer	—		—	
E_47_83_ID	E 47 83 ID	Integer	—		—	
E_47_82_	E 47 82	Integer	—		—	
E_47_82_ID	E 47 82 ID	Integer	—		—	
E_47_72_	E 47 72	Integer	—		—	
E_47_72_ID	E 47 72 ID	Integer	—		—	
E_47_71_	E 47 71	Integer	—		—	
E_47_71_ID	E 47 71 ID	Integer	—		—	
E_47_60_	E 47 60	Integer	—		—	

E_47_60_ID	E 47 60 ID	Integer	—		—	
E_47_59_	E 47 59	Integer	—		—	
E_47_59_ID	E 47 59 ID	Integer	—		—	
E_47_48_	E 47 48	Integer	—		—	
E_47_48_ID	E 47 48 ID	Integer	—		—	
E_47_47_	E 47 47	Integer	—		—	
E_47_47_ID	E 47 47 ID	Integer	—		—	
E_47_36_	E 47 36	Integer	—		—	
E_47_36_ID	E 47 36 ID	Integer	—		—	
E_47_35_	E 47 35	Integer	—		—	
E_47_35_ID	E 47 35 ID	Integer	—		—	
E_47_24_	E 47 24	Integer	—		—	
E_47_24_ID	E 47 24 ID	Integer	—		—	
FNODE1__21	FNODE1 21	Integer	—		—	
TNODE1__21	TNODE1 21	Integer	—		—	
LPOLY1__21	LPOLY1 21	Integer	—		—	
RPOLY1__21	RPOLY1 21	Integer	—		—	
F_47_117_	F 47 117	Integer	—		—	
F_47_117_I	F 47 117 I	Integer	—		—	
FNODE1__22	FNODE1 22	Integer	—		—	
TNODE1__22	TNODE1 22	Integer	—		—	
LPOLY1__22	LPOLY1 22	Integer	—		—	
RPOLY1__22	RPOLY1 22	Integer	—		—	
F_47_118_	F 47 118	Integer	—		—	
F_47_118_I	F 47 118 I	Integer	—		—	
FNODE1__23	FNODE1 23	Integer	—		—	
TNODE1__23	TNODE1 23	Integer	—		—	
LPOLY1__23	LPOLY1 23	Integer	—		—	
RPOLY1__23	RPOLY1 23	Integer	—		—	
F_47_120_	F 47 120	Integer	—		—	
F_47_120_I	F 47 120 I	Integer	—		—	
FNODE1__24	FNODE1 24	Integer	—		—	
TNODE1__24	TNODE1 24	Integer	—		—	
LPOLY1__24	LPOLY1 24	Integer	—		—	
RPOLY1__24	RPOLY1 24	Integer	—		—	
F_47_129_	F 47 129	Integer	—		—	
F_47_129_I	F 47 129 I	Integer	—		—	
FNODE1__25	FNODE1 25	Integer	—		—	
TNODE1__25	TNODE1 25	Integer	—		—	
LPOLY1__25	LPOLY1 25	Integer	—		—	
RPOLY1__25	RPOLY1 25	Integer	—		—	
F_47_130_	F 47 130	Integer	—		—	
F_47_130_I	F 47 130 I	Integer	—		—	
FNODE1__26	FNODE1 26	Integer	—		—	
TNODE1__26	TNODE1 26	Integer	—		—	
LPOLY1__26	LPOLY1 26	Integer	—		—	
RPOLY1__26	RPOLY1 26	Integer	—		—	
F_47_131_	F 47 131	Integer	—		—	
F_47_131_I	F 47 131 I	Integer	—		—	
FNODE1__27	FNODE1 27	Integer	—		—	
TNODE1__27	TNODE1 27	Integer	—		—	
LPOLY1__27	LPOLY1 27	Integer	—		—	

RPOLY1__27	RPOLY1 27	Integer	—		—	
F_47_132_	F 47 132	Integer	—		—	
F_47_132_I	F 47 132 I	Integer	—		—	
FNODE1__28	FNODE1 28	Integer	—		—	
TNODE1__28	TNODE1 28	Integer	—		—	
LPOLY1__28	LPOLY1 28	Integer	—		—	
RPOLY1__28	RPOLY1 28	Integer	—		—	
F_47_141_	F 47 141	Integer	—		—	
F_47_141_I	F 47 141 I	Integer	—		—	
FNODE1__29	FNODE1 29	Integer	—		—	
TNODE1__29	TNODE1 29	Integer	—		—	
LPOLY1__29	LPOLY1 29	Integer	—		—	
RPOLY1__29	RPOLY1 29	Integer	—		—	
F_47_142_	F 47 142	Integer	—		—	
F_47_142_I	F 47 142 I	Integer	—		—	
FNODE1__30	FNODE1 30	Integer	—		—	
TNODE1__30	TNODE1 30	Integer	—		—	
LPOLY1__30	LPOLY1 30	Integer	—		—	
RPOLY1__30	RPOLY1 30	Integer	—		—	
F_47_143_	F 47 143	Integer	—		—	
F_47_143_I	F 47 143 I	Integer	—		—	
FNODE1__31	FNODE1 31	Integer	—		—	
TNODE1__31	TNODE1 31	Integer	—		—	
LPOLY1__31	LPOLY1 31	Integer	—		—	
RPOLY1__31	RPOLY1 31	Integer	—		—	
F_47_144_	F 47 144	Integer	—		—	
F_47_144_I	F 47 144 I	Integer	—		—	
FNODE1__32	FNODE1 32	Integer	—		—	
TNODE1__32	TNODE1 32	Integer	—		—	
LPOLY1__32	LPOLY1 32	Integer	—		—	
RPOLY1__32	RPOLY1 32	Integer	—		—	
F_47_60_	F 47 60	Integer	—		—	
F_47_60_ID	F 47 60 ID	Integer	—		—	
FNODE1__33	FNODE1 33	Integer	—		—	
TNODE1__33	TNODE1 33	Integer	—		—	
LPOLY1__33	LPOLY1 33	Integer	—		—	
RPOLY1__33	RPOLY1 33	Integer	—		—	
F_47_72_	F 47 72	Integer	—		—	
F_47_72_ID	F 47 72 ID	Integer	—		—	
FNODE1__34	FNODE1 34	Integer	—		—	
TNODE1__34	TNODE1 34	Integer	—		—	
LPOLY1__34	LPOLY1 34	Integer	—		—	
RPOLY1__34	RPOLY1 34	Integer	—		—	
F_47_84_	F 47 84	Integer	—		—	
F_47_84_ID	F 47 84 ID	Integer	—		—	
FNODE1__35	FNODE1 35	Integer	—		—	
TNODE1__35	TNODE1 35	Integer	—		—	
LPOLY1__35	LPOLY1 35	Integer	—		—	
RPOLY1__35	RPOLY1 35	Integer	—		—	
F_47_94_	F 47 94	Integer	—		—	
F_47_94_ID	F 47 94 ID	Integer	—		—	
FNODE1__36	FNODE1 36	Integer	—		—	

TNODE1__36	TNODE1 36	Integer	—		—	
LPOLY1__36	LPOLY1 36	Integer	—		—	
RPOLY1__36	RPOLY1 36	Integer	—		—	
F_47_95_	F 47 95	Integer	—		—	
F_47_95_ID	F 47 95 ID	Integer	—		—	
FNODE1__37	FNODE1 37	Integer	—		—	
TNODE1__37	TNODE1 37	Integer	—		—	
LPOLY1__37	LPOLY1 37	Integer	—		—	
RPOLY1__37	RPOLY1 37	Integer	—		—	
F_47_96_	F 47 96	Integer	—		—	
F_47_96_ID	F 47 96 ID	Integer	—		—	
E_48_128_	E 48 128	Float	—		—	
E_48_128_I	E 48 128 I	Float	—		—	
Shape_Length	Shape Length	Float	—		—	

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Whole Laos
Description	This spatial data can be confirmed a contour data.
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

LUC_Thasi24122012c

Requirements definition of GIS data

Name of Object	LUC_Thasi24122012c
Definition	Land Use Current data of Laos
Origin data.	FOMIS (Forest Management Information System)
Acquisition Basis	Acquire a LUC shape data from origin data.
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
Com	Compartment	String	—	5	—	
Type	Type	String	—	5	—	
Name	Name	String	—	15	—	
Hectres	Hecters	Float	—		—	
Shape_Length	Shape length	Float	—		—	
Shape_Area	Shape area	Float	—		—	

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Whole Laos
Description	This spatial data can be confirmed a LUC shape data.
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Requirements definition of GIS data

Name of Object	Buffer_SFMA_thasi120726a
Definition	Buffer from Sub Forest Mamanegmen Area data of Laos
Origin data.	FOMIS (Forest Management Information System)
Acquisition Basis	Acquire a buffer from SFMA from origin data.
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
Type	Type	String	—	5	—	
Com	Compartment	String	—	5	—	
Type_1	Type 1	String	—	5	—	
Name_1	Name 1	String	—	15	—	
Shape_Length	Shape length	Float	—		—	
Shape_Area	Shape area	Float	—		—	

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Whole Laos
Description	This spatial data can be confirmed a buffer data from SFMA.
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Requirements definition of GIS data

Name of Object	LUP_SFMA_thasi20120726a
Definition	Land Use Planned data in SFMA
Origin data.	FOMIS (Forest Management Information System)
Acquisition Basis	Acquire a LUP data in SFMA from origin data.
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
Com	Compartment	String	—	5	—	
Type	Type	String	—	5	—	
Name	Name	String	—	15	—	
Shape_Length	Shape length	Float	—		—	
Shape_Area	Shape area	Float	—		—	
LUP	Land Use Planted	String	—	20	—	

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Whole Laos
Description	This spatial data can be confirmed a LUP data in SFMA.
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Buffer_AAC_SFMA_thasi120726a_1

Requirements definition of GIS data

Name of Object	Buffer_AAC_SFMA_thasi120726a_1
Definition	Buffer from Annual　Allowable Cut data in SFMA
Origin data.	FOMIS (Forest Management Information System)
Acquisition Basis	Acquire a buffer data from AAC in SFMA from origin data.
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
Buffre	Buffer for	Float	—		—	
Shape_Length	Shape length	Float	—		—	
Shape_Area	Shape area	Float	—		—	

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Whole Laos
Description	This spatial data can be confirmed a buffer data from AAC in SFMA.
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

AAC_LUC_Buffer_SFMA_thasi20120917b

Requirements definition of GIS data

Name of Object	AAC_LUC_Buffer_SFMA_thasi20120917b
Definition	Annual Allowable Cut data in LUC
Origin data.	FOMIS (Forest Management Information System)
Acquisition Basis	Acquire an AAC shape data in SFMA from origin data.
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
Buffre	Buffer for	Float	—		—	
Com	Compartment	String	—	5	—	
Type	Type	String	—	5	—	
Name	Name	String	—	15	—	
AAC_year	Annual Allowable Cut year	String	—	5	—	
Plot	Plot	String	—	5	—	
Plots	Plots	Integer	—		—	
Shape_Length	Shape length	Float	—		—	
Shape_Area	Shape area	Float	—		—	
Com_No	COmpatment Number	Integer	—		—	

Subject Figure				
Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation		
Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Whole Laos
Description	This spatial data can be confirmed an AAC shape data in SFMA.
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

NTFP_in_SFMA_thasi

Requirements definition of GIS data

Name of Object	NTFP_in_SFMA_thasi
Definition	Non Timber Forest Production data in SFMA
Origin data.	FOMIS (Forest Management Information System)
Acquisition Basis	Acquire a NTFP data in SFMA from origin data.
Spatial Attribute	Point
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
Id	ID	Integer	—		—	
Name	Name	String	—	50	—	
Type	Type	String	—	50	—	

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Whole Laos
Description	This spatial data can be confirmed a NTFP data in SFMA.
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

2-4. Protection & Conservation Forest

Protection Forest Area

Requirements definition of GIS data

Name of Object	ProtectionForestArea
Definition	
Origin Data	
Acquisition Basis	
Spatial Attribute	
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Name	Attribute Name	Attribute Name	Attribute Name	Attribute Name	Attribute Name
name	NPA Name. The official name of the protected area.	text	—	—		
localName	Oroginal (local) NPA Name. The original name of the protected area.	text	—	—		
WDPA_ID	WDPA ID. A unique identification number assigned by UNEP-WCMC.	text				
WDPA_PID	WDPA Parent ID. This ID only applies where zones exist within a protected area.	text				
WDPA_MID	Metadata ID. An ID assigned by UNEP-WCMC that is used to link WDPA source tables to WDPA shapefiles.	text				
descriptio	Description. Brief Description including management history.	text				
country	Country, The country, territory or other administrative unit of geographical interest that a protected area jurisdictionally resides within.	text				
province	Sub-national location province. The principle subdivision that a protected area geographically resides within.	text				
district	Sub-national location district. The principle subdivision that a protected area geographically resides within.	text				
recogType	International recognition. The type of protected area as legally/officially established or recognised (e.g. national park, world heritage site) provided in Latin characters.	text				

recogDate	The type of international recognition. Please write 'national' when providing information for nationally designated sites or 'international' when providing information for a protected area recognized under an international convention.	text				
IUCN_Categ	IUCN protected area management category. Report on the classification of IUCN Category (Ia, Ib, II, III, IV, V or VI) adopted for national protected areas.	text				
localDesig	Local designation.	text				
status	Current legal or „official" standing of the site (e.g. proposed, designated).	text				
statusYear	The year in which the current status was officially decreed.	text				
reportArea	Total protected area extent, cumulative of both marine and terrestrial are as reported to UNEP-WCMC (square kilometres).	double				
governType	Governance Type.	text				
infoSource	Information source.	text				
latestScor	Latest Score.	text				
scoreDate	Date of Latest Score.	text				
boundary	Boundary.	text				
bdFin	Whether boundaries have been finalized or not.	short				
bdFinDate	The date of bouundaried finalized.	text				
bdMarked	Whether boundaries have been marked on the ground or not.	short				
bdMarkDate	The date of boundaries marked on the ground.	text				
bdAgreed	Whether zone boundaries have been agreed or not.	short	—	—		
issues	The stage and description of issues when zone boundaries have not been agreed.	text				
bdVerified	Whether boundaries have been veried against other department data or not.	short				
overlap	The description of over-lap when boundaries have not been verified against other department data.	text				
authority	The organisation(s) or agency/ies responsible for management of the protected area.	text				
mgPlanPrep	Whether a management plan has been prepared or not.	short				
mgPlanYear	A year of a prepared management plan.	long				
mgPlanAp	Whether a management plan has been approved or not.	short				
apAuthor	Approving authority.	text				
apDate	Approving date.	text				

mgDocument	A reference to an official management plan for the protected area. This could represent a hyperlink to the document(s) on-line or a legal reference.	text				
value	Priority values.	text				
valSource	The source data of priority values.	text				
threat	Priority of threats, pressure, drivers to the values.	text				
pressure	The pressure of priority threats to the values	text				
driver	Drivers of priority threats to the values	text				
threatSour	The source data of priority threats to the values.	text				
concession	Concession.	text				
mgObjectiv	Management objectives.	text				
mgObjSourc	The souce data of management objectives.	text				
under_Caus	Underlying causes.	text				
intervent	Prioritiy activities (interventions).	text				
intervSour	The source data of priority activities (interventions).	text				
PA_Manager	The name of PA manager.	text				
officeDate	The date in post of PA manager.	text				
conEmail	Email address. The contact details of PA manager.	text				
conName	Individual Name The contact details of PA maneger.	text				
conOrgName	Organization Name. The contact details of PA maneger.	text				
conPhone	Phone number. The contact details of PA maneger.	text				
conPositio	Position Name. The contact details of PA maneger.	text				
regulation	The information of local regulations.	text				
apRegulati	The approved date of local regulations.	short				
approvDate	Approval date	text				
infrastruc	The document link of infrastructure information. -existing / planned -date	text				
wpApBy	The authority a work plan has been approved by.	text				
wpApDate	The date of a work plan approved.	text				
wpBudgApBy	The Approved operating budget by whom	text				
wpBudget	The amount of required operating budget.	long				
wpBudgDate	The date of an operating budget approved.	text				
wpExpendit	The amount of total management expenditure.	text				
wpApproved	Whether it has an approved Work Plan or not.	short				
propSource	Proposed source	text				

propExpend	Purpose of linked expenditure	text				
requirBudg	Required budget	long				
mgExpeSour	Source of total management expenditure	text				
mgExpendit	Total management expenditure	text				
LUPDate	Date of last participatory land use planning and land allocation.	text				
LUStage	The stage of land use certification.	text				
LUDate	The date of land use certification.	text				
changPerce	% land in Protection forest area that has been converted (MAR requires % encroachment, changes)	double				
changeDate	Date of % land in Protection forest area	text				
changeAnal	Analysis of encroachment change	text				
lawApprove	Whether the site has an approved law enforcement strategy or not.	short				
infoLaw	Information of approved law enforcement strategy	text				
minStanSys	Whether the site is working to "Minimum Standards of Enforcement" system or not	short				
minSSInfo	Information of "Minimum Standards of Enforcement" system	text				
staffNumbe	Number of Staff	long				
staffLevel	Level of Staff	text				
filled	Filled	short				
staffDate	Date of staffing information	text				
staffSourc	Source of staffing information	text				
staffName	Name of staff	text				
staffQuali	Information on Qualifications / Competencies of staff	text				
staffTrain	Training courses run at PA or courses staff have attended	text				
concesInPA	Whether there are concessions inside the PA or not.	short				
concesInfo	Brief Description of Number/Size/Type and location compared to priority areas	text				
assissType	Type	text				
assisDurat	Duration	text				
assisValue	Value	text				
donor	Donor	text				
assisRepor	Links to reports	text				
m_eSystem	Whether there is an agreed monitoring and evaluation system in place or not.	short				
m_eSysInfo	Information of agreed monitoring and evaluation system.	text				
mgEffectiv	Whether assesment has been made of management effectiveness or not.	short				
METTReport	Links of METT Assessment Reports	text				

carbonStoc	Information/ links of carbon stocks that have been assessed	text				
illegActiv	Informathion/ links of formal records kept of illegal activities	text				
recordiSys	Links/ information of that they use MIST or SMART recording system	text				
PESScheme	Whether there have been PES or other benefit sharing schemes operating or not	short				
PESDesc	Description of PES or other benefit sharing schemes	text				
PESScheLin	Links of PES or other benefit sharing schemes	text				
REDD	Whether the site is included in a REDD + programme or not.	short				
REDDInfo	Information of REDD + programme	text				
vilNumber	Number of Villages just outside PA.	long				
vilNumDate	Date	text				
population	Estimated population	long				
populaDate	Date of estimated population	text				
sEcoSurvey	Whether a socio-economic survey has been conducted or not	short				
sEcoSuDate	Condacted date of socio-economic survey	text				
sEcoSuLink	Link of socio-economic survey	text				
timbTypVal	Types and value of timber and NTFPs	text				
sEcoSituat	Socio-economic situation, and changes	text				
surroundPA	The name(s) of PAs next to the site	text				
surroundVN	Number of Villages just outside forest area	long				
surroundPo	Population of Villages just outside forest area	long				
downstream	Information of downstream water users	text				
downstLink	Formal link downstream water users	text				
surroundLU	Primary Land Uses outside Boundary	text				
survSummar	Brief summary	text				
survReport	Links to reports	text				
primHabita	Description of Primary Habitats	text				
primHabAre	Area of Primary Habitats	double				
wildliSurv	The wildlife survey that has been carried out.	short				
redList	Red list species present	text				
PrimFPerce	% of Primary Forest	double				
SecoFPerce	% of Secondary Forest	double				
FCondiDate	Date of % of Primary and secondary Forest	text				
vegeSurvey	Surveys, Maps or links of a vegetation survey that has been carried out.	short				

Subject Figure				
Quantity	Quantity	Quantity	Quantity	Quantity
—	—	—	—	—

Object Relation		
Related Name	Related Name	Related Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B

Nambeng_SubWatershed_con1000

Requirements definition of GIS data

Name of Object	Nambeng_SubWatershed_con1000
Definition	Watershed
Origin data.	
Acquisition Basis	
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
Id	ID	Long	—		—	
gridcode	Grid Code	Long	—		—	
Shape_Length	Shape length	Double	—		—	
Shape_Area	Shape area	Double	—		—	
OBJECTID_1	Object ID	Long	—		—	
Id_1	Original ID	Long	—		—	
COUNT	Number of Zone Stat	Long	—		—	
AREA	Area of Zone Stat	Long	—		—	
MIN	MIN of Zone Stat	Long	—		—	
MAX	MAX of Zone Stat	Long	—		—	
RANGE	Range of Zone Stat	Long	—		—	
MEAN	Mean of Zone Stat	Long	—		—	
STD	Std of Zone Stat	Long	—		—	
SUM	Sum of Zone Stat	Long	—		—	

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Nambeng area
Description	This spatial data can be used for protection forest management planning
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Nambeng_SubWatershed_con1000_landslide_index

Requirements definition of GIS data

Name of Object	Nambeng_SubWatershed_con1000_landslide_index
Definition	Landslide Risk
Origin data.	
Acquisition Basis	
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
Id	ID	Long	—		—	
gridcode	Grid Code	Long	—		—	
OBJECTID_1	Object ID	Long	—		—	
Id_1	Original ID	Long	—		—	
COUNT	Number of Zone Stat	Long	—		—	
MEAN	Mean of Zone Stat	Long	—		—	
Shape_Length	Shape length	Double	—		—	
Shape_Area	Shape area	Double	—		—	
Area_ha	Area (hectare)	Double	—		—	

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Nambeng area
Description	This spatial data can be used for protection forest management planning
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Nambeng_LUP_UTM48

Requirements definition of GIS data

Name of Object	Nambeng_LUP_UTM48
Definition	Watershed
Origin data.	
Acquisition Basis	
Spatial Attribute	Polygon
Time Attribute	—

Subject Attribute

Attribute Name	Attribute Definition	Type	Unit	Range	Number of Degit	Scope of Disclosure
OBJECTID_1	Object ID	Long	—		—	
PCODE	Provincial Code	Text	—	50	—	
DCODE	District Code	Text	—	50		
VCODE	Village Code	Text	—	50		
LU_GCODE	Landuse Code	Text	—	50		
LU_Gname_E	Landuse Name (EN)	Text	—	50	—	
LU_Gname_L	Landuse Name(Lao)	Text	—	50	—	
LU_VCODE	Landuse Village	Text	—	50	—	
LU_Vname_E	Landuse Village(EN)	Text	—	50	—	
LU_Vname_L	Landuse Village(Lao)	Text	—	50	—	
Area_ha	Area (hectare)	Double	—		—	
Shape_Leng	Shape Length	Double	—		—	
Shape_Area	Shapre Area	Double	—		—	
			—		—	

Subject Figure

Name	Attribute Definition	Type	Quantity	Related Attribute
—	—	—	—	—

Object Relation

Related Name	Related Definition	Related Object Name
—	—	—

Area of Scope for Object	Nambeng area
Description	This spatial data can be used for protection forest management planning
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Conservation Forest Area

Requirements definition of GIS data

Name of Object	Conservation ForestArea
Definition	
Origin Data	
Acquisition Basis	
Spatial Attribute	
Time Attribute	—

Subject Attribute						
Attribute Name	Attribute Name	Attribute Name	Attribute Name	Attribute Name	Attribute Name	Attribute Name
name	NPA Name. The official name of the protected area.	text	—	—		
localName	Oroginal (local) NPA Name. The original name of the protected area.	text	—	—		
WDPA_ID	WDPA ID. A unique identification number assigned by UNEP-WCMC.	text				
WDPA_PID	WDPA Parent ID. This ID only applies where zones exist within a protected area.	text				
WDPA_MID	Metadata ID. An ID assigned by UNEP-WCMC that is used to link WDPA source tables to WDPA shapefiles.	text				
descriptio	Description. Brief Description including management history.	text				
country	Country, The country, territory or other administrative unit of geographical interest that a protected area jurisdictionally resides within.	text				
province	Sub-national location province. The principle subdivision that a protected area geographically resides within.	text				
district	Sub-national location district. The principle subdivision that a protected area geographically resides within.	text				
recogType	International recognition. The type of protected area as legally/officially established or recognised (e.g. national park, world heritage site) provided in Latin characters.	text				

recogDate	The type of international recognition. Please write 'national' when providing information for nationally designated sites or 'international' when providing information for a protected area recognized under an international convention.	text				
IUCN_Categ	IUCN protected area management category. Report on the classification of IUCN Category (Ia, Ib, II, III, IV, V or VI) adopted for national protected areas.	text				
localDesig	Local designation.	text				
status	Current legal or „official‟ standing of the site (e.g. proposed, designated).	text				
statusYear	The year in which the current status was officially decreed.	text				
reportArea	Total protected area extent, cumulative of both marine and terrestrial are as reported to UNEP-WCMC (square kilometres).	double				
governType	Governance Type.	text				
infoSource	Information source.	text				
latestScor	Latest Score.	text				
scoreDate	Date of Latest Score.	text				
boundary	Boundary.	text				
bdFin	Whether boundaries have been finalized or not.	short				
bdFinDate	The date of bouundaried finalized.	text				
bdMarked	Whether boundaries have been marked on the ground or not.	short				
bdMarkDate	The date of boundaries marked on the ground.	text				
bdAgreed	Whether zone boundaries have been agreed or not.	short	—	—		
issues	The stage and description of issues when zone boundaries have not been agreed.	text				
bdVerified	Whether boundaries have been veried against other department data or not.	short				
overlap	The description of over-lap when boundaries have not been verified against other department data.	text				
authority	The organisation(s) or agency/ies responsible for management of the protected area.	text				
mgPlanPrep	Whether a management plan has been prepared or not.	short				
mgPlanYear	A year of a prepared management plan.	long				
mgPlanAp	Whether a management plan has been approved or not.	short				
apAuthor	Approving authority.	text				
apDate	Approving date.	text				

mgDocument	A reference to an official management plan for the protected area. This could represent a hyperlink to the document(s) on-line or a legal reference.	text				
value	Priority values.	text				
valSource	The source data of priority values.	text				
threat	Priority of threats, pressure, drivers to the values.	text				
pressure	The pressure of priority threats to the values	text				
driver	Drivers of priority threats to the values	text				
threatSour	The source data of priority threats to the values.	text				
concession	Concession.	text				
mgObjectiv	Management objectives.	text				
mgObjSourc	The souce data of management objectives.	text				
under_Caus	Underlying causes.	text				
intervent	Prioritiy activities (interventions).	text				
intervSour	The source data of priority activities (interventions).	text				
PA_Manager	The name of PA manager.	text				
officeDate	The date in post of PA manager.	text				
conEmail	Email address. The contact details of PA manager.	text				
conName	Individual Name The contact details of PA maneger.	text				
conOrgName	Organization Name. The contact details of PA maneger.	text				
conPhone	Phone number. The contact details of PA maneger.	text				
conPositio	Position Name. The contact details of PA maneger.	text				
regulation	The information of local regulations.	text				
apRegulati	The approved date of local regulations.	short				
approvDate	Approval date	text				
infrastruc	The document link of infrastructure information. -existing / planned -date	text				
wpApBy	The authority a work plan has been approved by.	text				
wpApDate	The date of a work plan approved.	text				
wpBudgApBy	The Approved operating budget by whom	text				
wpBudget	The amount of required operating budget.	long				
wpBudgDate	The date of an operating budget approved.	text				
wpExpendit	The amount of total management expenditure.	text				
wpApproved	Whether it has an approved Work Plan or not.	short				
propSource	Proposed source	text				

propExpend	Purpose of linked expenditure	text				
requirBudg	Required budget	long				
mgExpeSour	Source of total management expenditure	text				
mgExpendit	Total management expenditure	text				
LUPDate	Date of last participatory land use planning and land allocation.	text				
LUStage	The stage of land use certification.	text				
LUDate	The date of land use certification.	text				
changPerce	% land in Protection forest area that has been converted (MAR requires % encroachment, changes)	double				
changeDate	Date of % land in Protection forest area	text				
changeAnal	Analysis of encroachment change	text				
lawApprove	Whether the site has an approved law enforcement strategy or not.	short				
infoLaw	Information of approved law enforcement strategy	text				
minStanSys	Whether the site is working to "Minimum Standards of Enforcement" system or not	short				
minSSInfo	Information of "Minimum Standards of Enforcement" system	text				
staffNumbe	Number of Staff	long				
staffLevel	Level of Staff	text				
filled	Filled	short				
staffDate	Date of staffing information	text				
staffSourc	Source of staffing information	text				
staffName	Name of staff	text				
staffQuali	Information on Qualifications / Competencies of staff	text				
staffTrain	Training courses run at PA or courses staff have attended	text				
concesInPA	Whether there are concessions inside the PA or not.	short				
concesInfo	Brief Description of Number/Size/Type and location compared to priority areas	text				
assissType	Type	text				
assisDurat	Duration	text				
assisValue	Value	text				
donor	Donor	text				
assisRepor	Links to reports	text				
m_eSystem	Whether there is an agreed monitoring and evaluation system in place or not.	short				
m_eSysInfo	Information of agreed monitoring and evaluation system.	text				
mgEffectiv	Whether assesment has been made of management effectiveness or not.	short				
METTReport	Links of METT Assessment Reports	text				

carbonStoc	Information/ links of carbon stocks that have been assessed	text				
illegActiv	Informathion/ links of formal records kept of illegal activities	text				
recordiSys	Links/ information of that they use MIST or SMART recording system	text				
PESScheme	Whether there have been PES or other benefit sharing schemes operating or not	short				
PESDesc	Description of PES or other benefit sharing schemes	text				
PESScheLin	Links of PES or other benefit sharing schemes	text				
REDD	Whether the site is included in a REDD + programme or not.	short				
REDDInfo	Information of REDD + programme	text				
vilNumber	Number of Villages just outside PA.	long				
vilNumDate	Date	text				
population	Estimated population	long				
populaDate	Date of estimated population	text				
sEcoSurvey	Whether a socio-economic survey has been conducted or not	short				
sEcoSuDate	Condacted date of socio-economic survey	text				
sEcoSuLink	Link of socio-economic survey	text				
timbTypVal	Types and value of timber and NTFPs	text				
sEcoSituat	Socio-economic situation, and changes	text				
surroundPA	The name(s) of PAs next to the site	text				
surroundVN	Number of Villages just outside forest area	long				
surroundPo	Population of Villages just outside forest area	long				
downstream	Information of downstream water users	text				
downstLink	Formal link downstream water users	text				
surroundLU	Primary Land Uses outside Boundary	text				
survSummar	Brief summary	text				
survReport	Links to reports	text				
primHabita	Description of Primary Habitats	text				
primHabAre	Area of Primary Habitats	double				
wildliSurv	The wildlife survey that has been carried out.	short				
redList	Red list species present	text				
PrimFPerce	% of Primary Forest	double				
SecoFPerce	% of Secondary Forest	double				
FCondiDate	Date of % of Primary and secondary Forest	text				
vegeSurvey	Surveys, Maps or links of a vegetation survey that has been carried out.	short				

Subject Figure				
Quantity	Quantity	Quantity	Quantity	Quantity
—	—	—	—	—

Object Relation		
Related Name	Related Name	Related Name
—	—	—

Area of Scope for Object	Laos
Description	
Edit	Cannot be edited
Others	

【Figure Speficication】

Shape	Scale	Related File	Weight	Color	R	G	B

ラオス人民民主共和国
ラオス国持続可能な森林経営及びREDD+のための国家森林情報システム構築に係る能力向上プロジェクト
（第2年次）

業務完了報告書

添付資料１８：GHGインベントリソフトとの連携の検討

ラオス人民民主共和国
ラオス国農林省林野局

ラオス人民民主共和国
ラオス国持続可能な森林経営及びREDD+のための国家森林情報システム構築に係る能力向上プロジェクト（第2年次）

GHGインベントリソフトとの連携の検討

平成27年 9月
（2015年 9月）

独立行政法人
国際協力機構(JICA)

国際航業株式会社
アジア航測株式会社

目　　次

１．背景・目的

１年次にレビューした GHG インベントリソフト（IPCC inventory software、ALU software）のうち、GIS データとの連携機能が比較的強い ALU software について、連携するためのステップを調査した。

２．検討内容

2.1　Approach 1(Tier1 レベル)での GIS データインポート

(1) インポートの流れ

①IPCC Soil ファイルの作成

2006IPCC Guideline の Figure 3A.5.4 に従い、Soil ファイルを作成した。ラオス政府から土壌図を入手していないので、HWSD を使いた。別添ファイル「IPCC_Soil.pdf」に元データの HWSD と作成した IPCC soil ファイルを整理した。

②IPCC Climate ファイルの作成

2006IPCC Guideline の Figure 3A.5.2 に従い、Climate ファイルを作成した。Climate ファイルの作成には標高データと降水量データが必要となる。今回の検討には標高データは SRTM「Elevation.pdf」、降水量はカリフォルニア大学からダウンロードした TRMM データ「Precipitation.pdf」を使い、年平均気温はビエンチャンの年平均気温を使用した。これらのデータより作成した IPCC climate ファイルを「IPCC_climate.pdf」として整理した。

③森林図への LULUCF クラスの定義

2010 年森林図（中間成果）のラオス土地利用・被覆クラスを参照して暫定的な LULUCF クラス（6 クラス）を定義した。「森林クラス_変換テーブル_LULUCF_ラオス森林クラス_仮.xls」にテストで用いた LULUCF クラスを記載した。

④GIS データのインターセクト

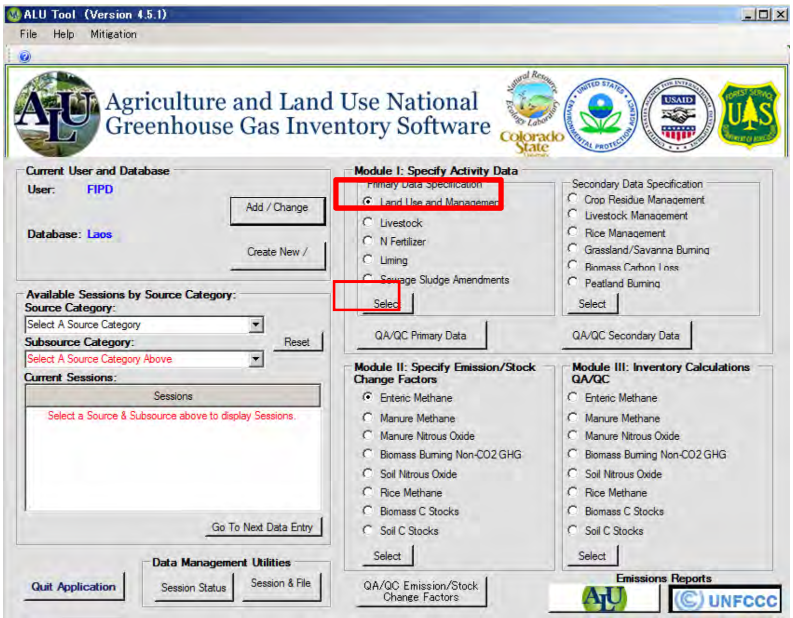
上記①、②、③の GIS データをインターセクトし、シェープファイルを作成した上で、シェープファイルの DBF ファイルから csv ファイル「LULUCF_LP.csv」を作成した。

⑤ALU ソフトへの GIS データのインポート

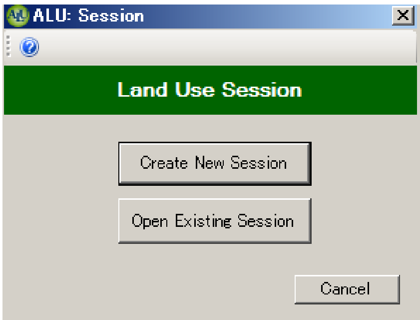
下記の記載に従って、④の csv ファイルを ALU ソフトにインポートした。

Procedure of importing GIS data to ALU software

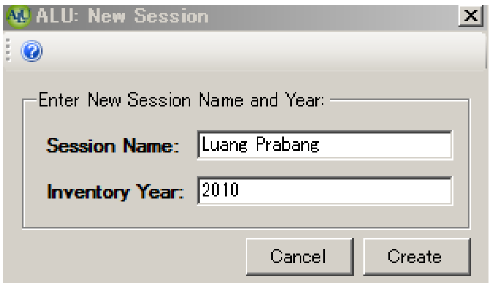
1. Open ALU software> Main menu> select Land Use and Management> Click Select



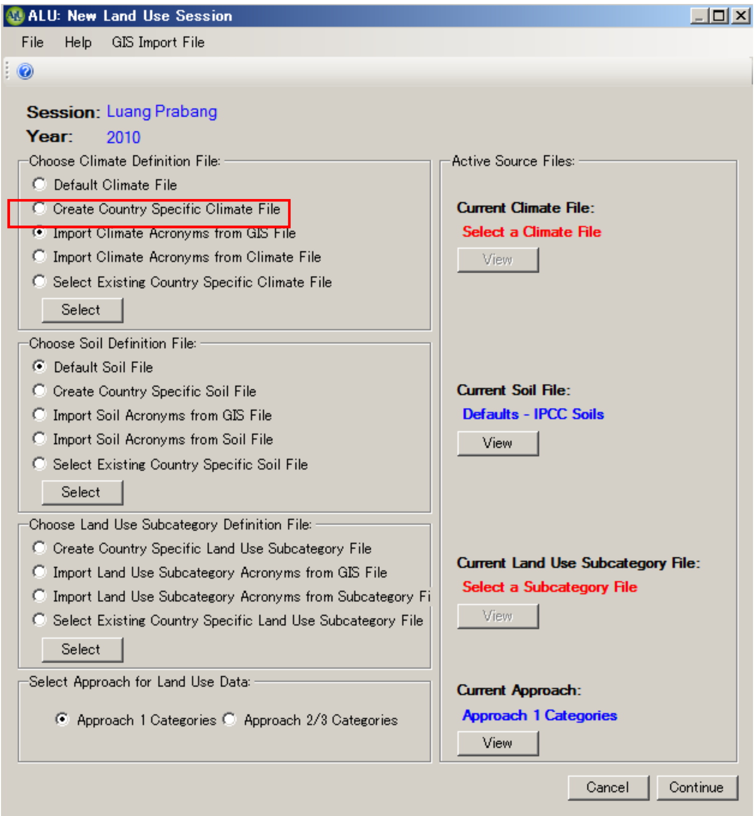
2. Click Create New Session



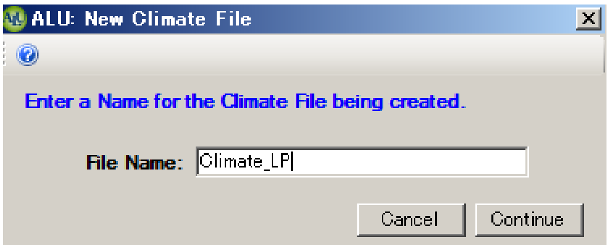
3. Fill in Session Name and Inventory Year> Click Create



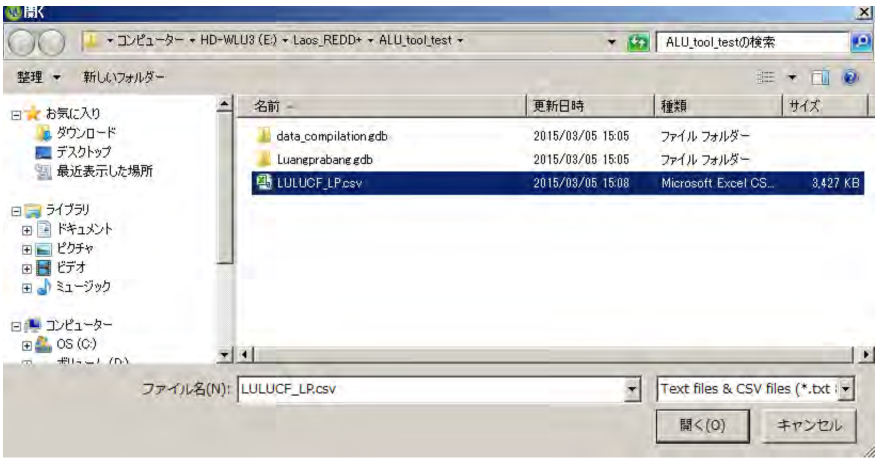
4. In Choose Climate Definition File, select Import Climate Acronyms from GIS file> Click Select



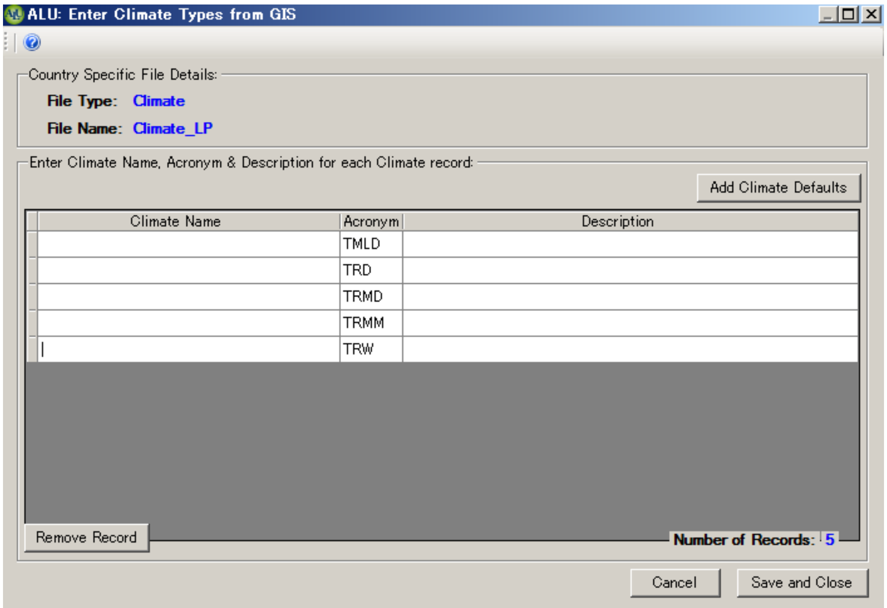
5. Enter File Name> Click Continue



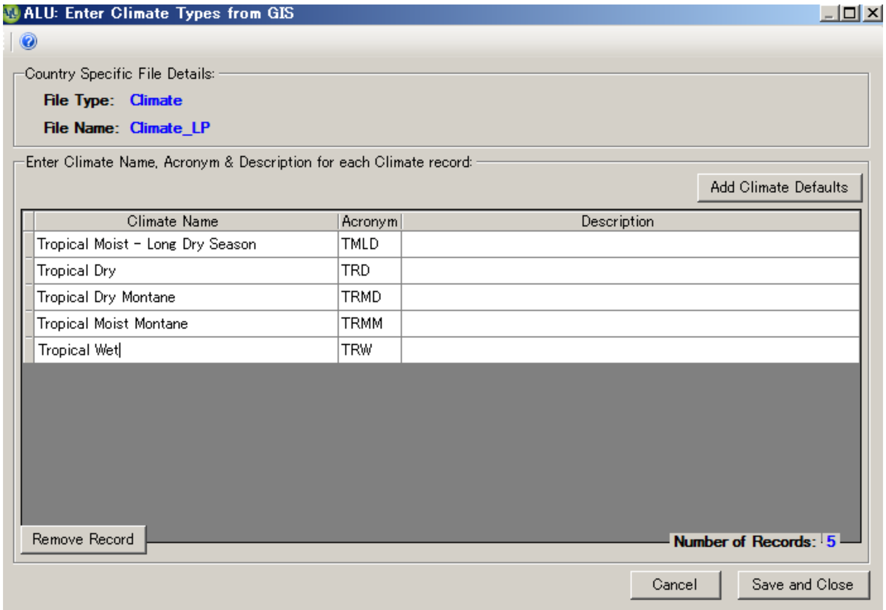
6. Select GIS text file (csv format)



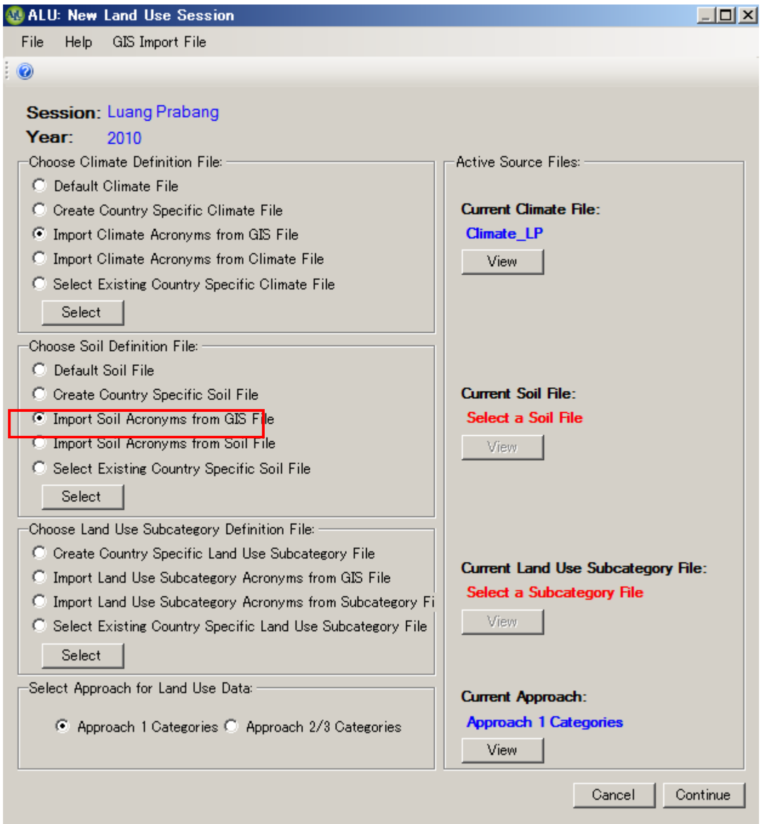
7. Acronym for climate type will be automatically filled in from GIS text file



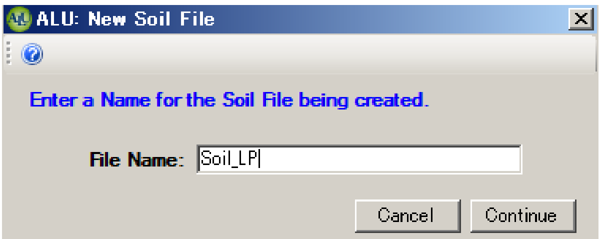
8. Fill in Climate Name for each acronym



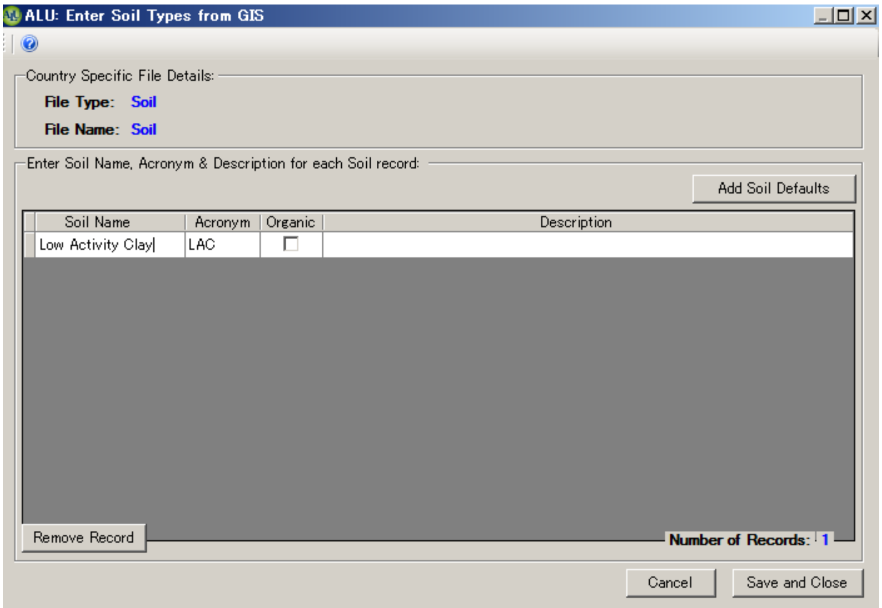
9. In Choose Soil Definition File, select Import Soil Acronyms from GIS file> Click Select



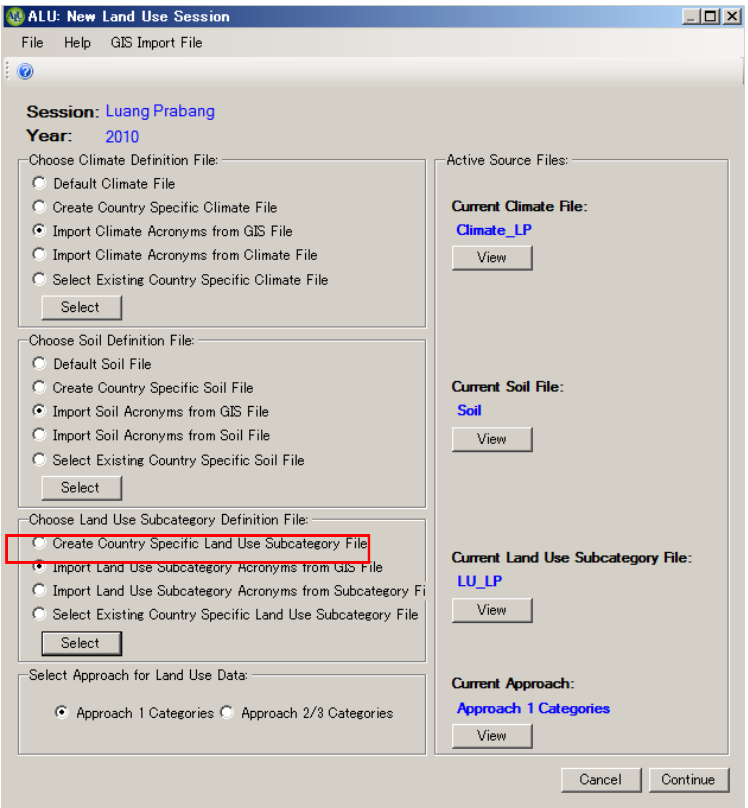
10. Enter File Name



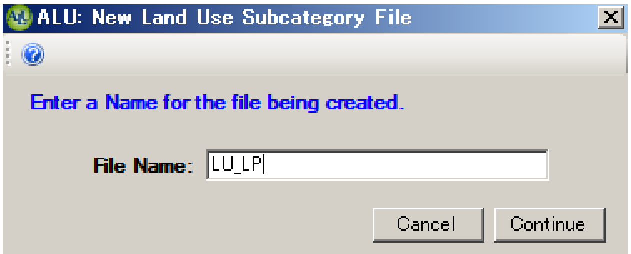
11. Fill in Soil Name for each Acronym



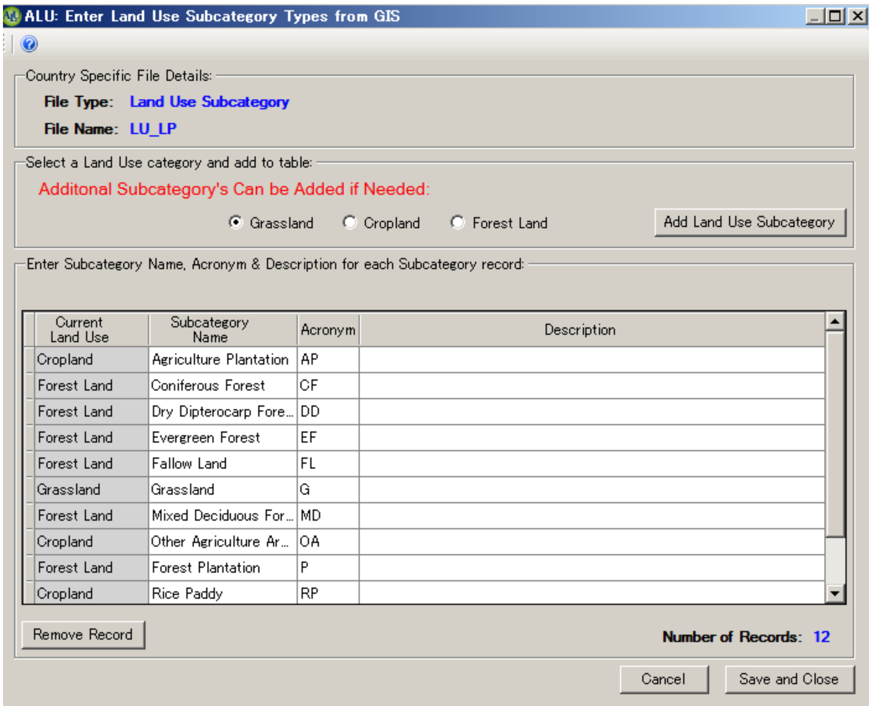
12. In Choose Land Use Subcategory Definition File, select Import Land Use Subcategory Acronyms from GIS file> Click Select



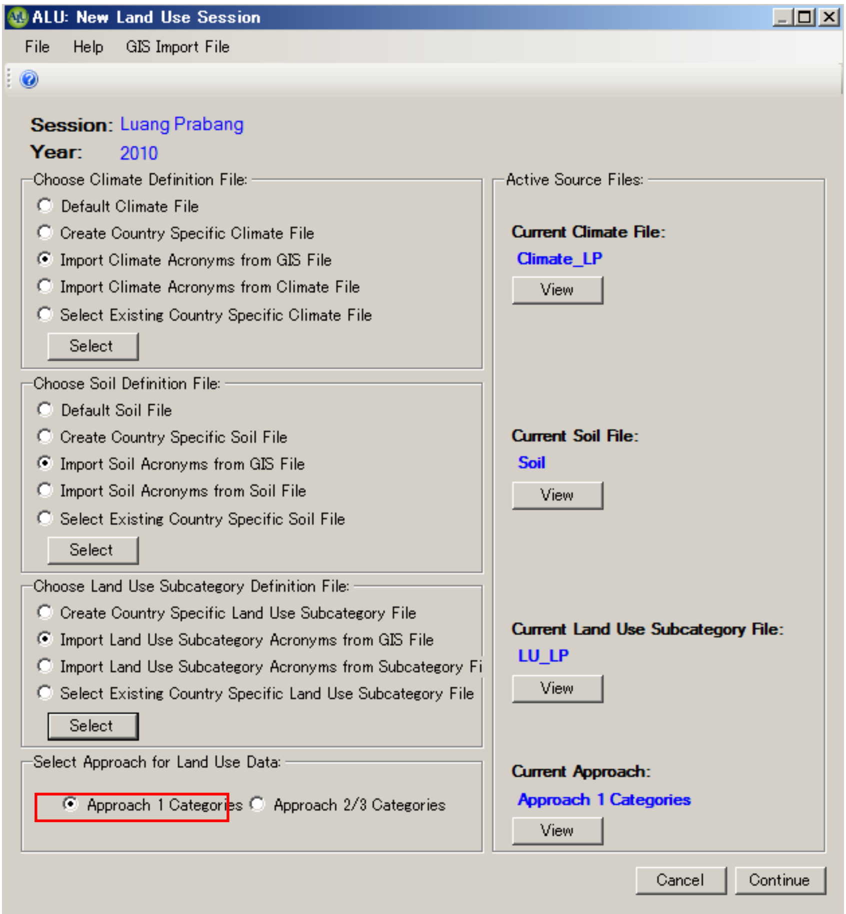
13. In the same way as climate and soil, choose land use subcategory definition file from GIS file> Enter File Name



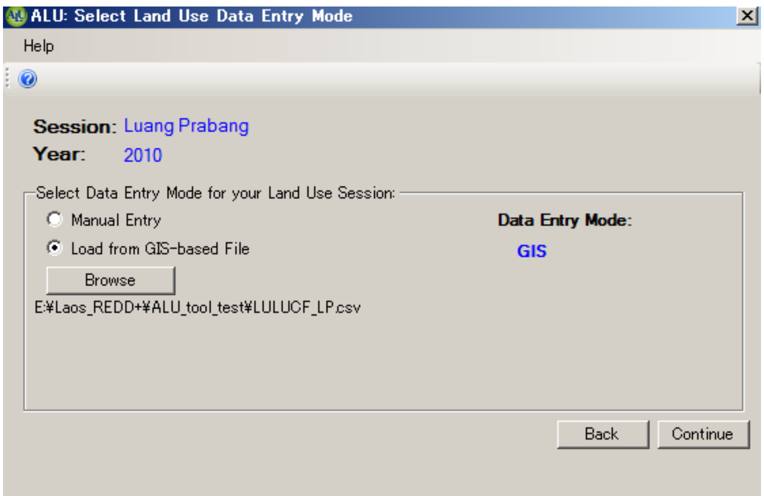
14. Fill in Subcategory Name for each acronym



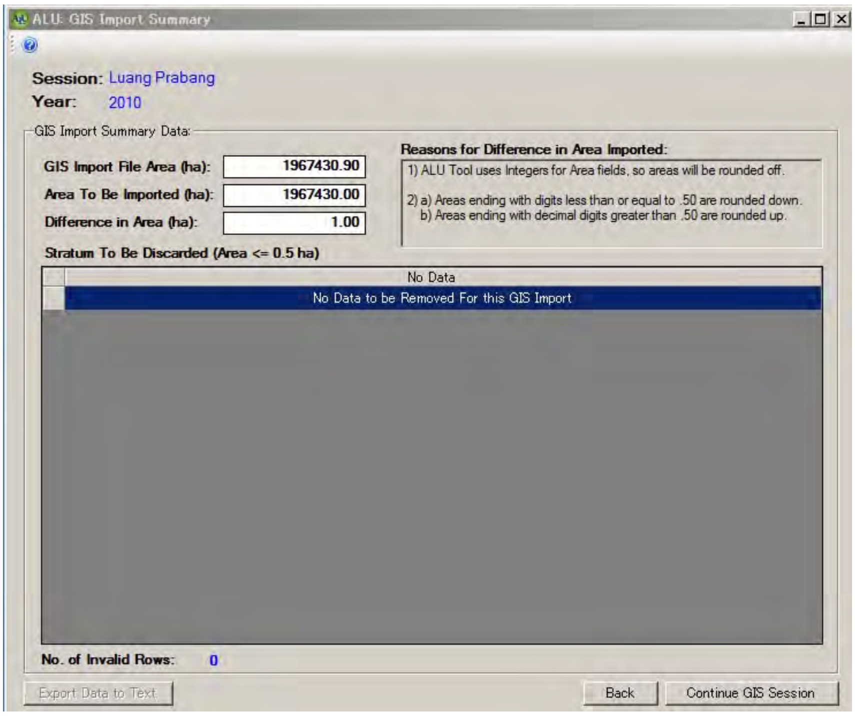
15. Choose Approach 1 or 2/3 categories. In this case, approach 1 was selected since the GIS text file was created using data from only year 2010> Click Continue



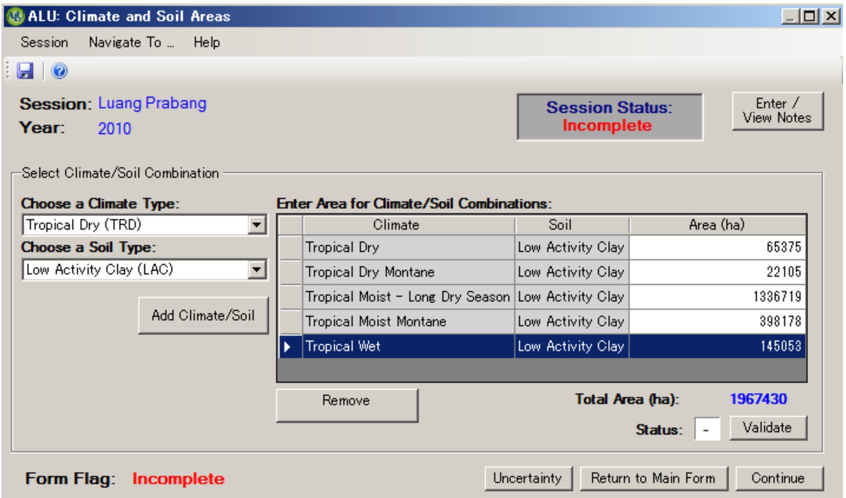
16. Check if GIS file is loaded or not. If not loaded, choose the GIS text file from Browse> Click Continue



17. Check the area of GIS data to be imported> Click Continue GIS session



18. GIS file is imported



19. Move to further analysis using the imported GIS data

(2) 確認が必要な事項

① Soil データ、Climate データ作成に用いる元データの選定

ラオス政府が作成した土壌図、降水量データが入手可能かどうかを確認し、確認の上でどのデータを使って Soil データを Climate データを作成するかの検討が必要となる。今回は暫定的に HWSD や TRMM データを使用した。標高データは SRTM を使用したが、NGD から DEM が得られればそちらでも良いと思われる。

② ラオスの土地利用・被覆区分に相当する IPCC LULUCF クラスの確認

添付のエクセルファイルに今回のテストで用いた暫定的な LULUCF クラスをのせたが、これで良いか確認が必要である（過去の National Communication の際はどうしたかを確認する）。

(3) その他・所感

今回は 2010 年森林図データからルアンプラバンの範囲のみを切り出して GIS データの csv ファイルを作成し、ALU データへのインポートを試みた。別添資料のルアンプラバンの csv ファイル（LULUCF_LP.csv：98122 レコード）は 3.4MB ほどとなっている（シェープファイル全体は約 300MB）。ALU ソフトは Access MDB を使うので、1 テーブルあたり 1GB まではインポートができるので、全国データでも一度 csv ファイルを作成すればインポートは可能と判断される。

ただし、CSV ファイルの作成には、上記に記載したように森林図、Soil データ、Climate データの 3 つの GIS データをインターセクトする必要がある。全国の森林図データをマージするとデータ量が膨大になりますので、インターセクト処理にはかなりの時間がかかると想定される。

今後構築する DB システム上では、事前に作成した全国のインターセクトデータからユーザーが指定するエリア（province、district、project エリア等）でデータの切り出しを行い、CSV ファイルを作成する機能を構築出来れば都合がよいと思われる。

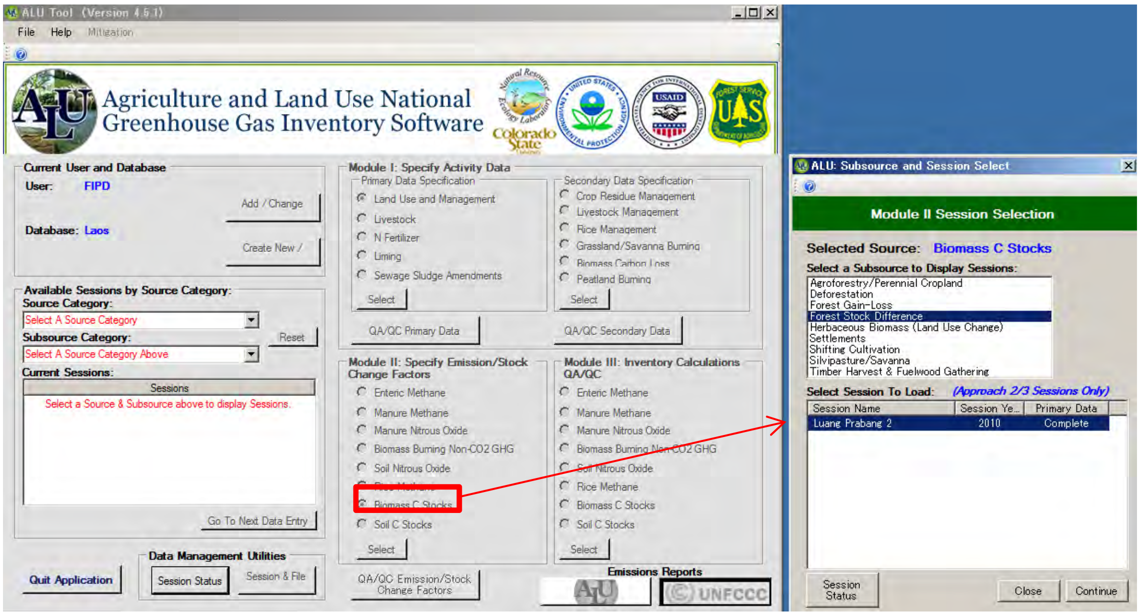
2.2 Apporach2/3（Tier2/3 レベル）での個別の EF の設定

Tier2,3 での報告の際には個別の EF を設定する必要があるが、ALU では Approach2/3 を選択すると、土地利用（森林）/土壌/気候/樹種区分（strata）に応じた EF を設定することができる。

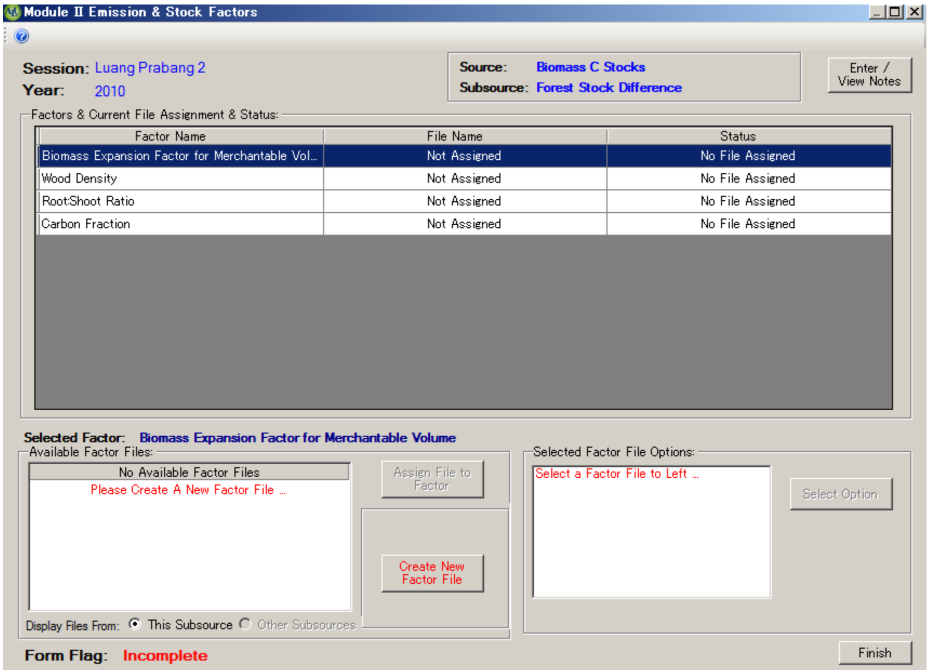
下記に Approach2/3 でのダミーデータを使って EF(carbon fraction, biomass expansion factors, wood density)の設定メニューの表示した例を載せた。

Setting emission/stock change factors in ALU in case of forest stock difference method

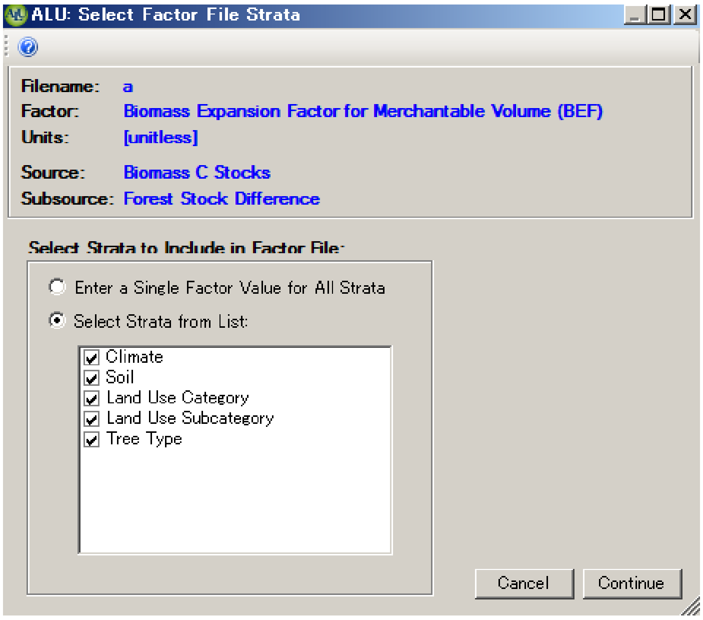
1. After complete the setting of Module I (Specify Activity Data), select Biomass C Stock in Module II (Specify Emission/Stock Change Factors)



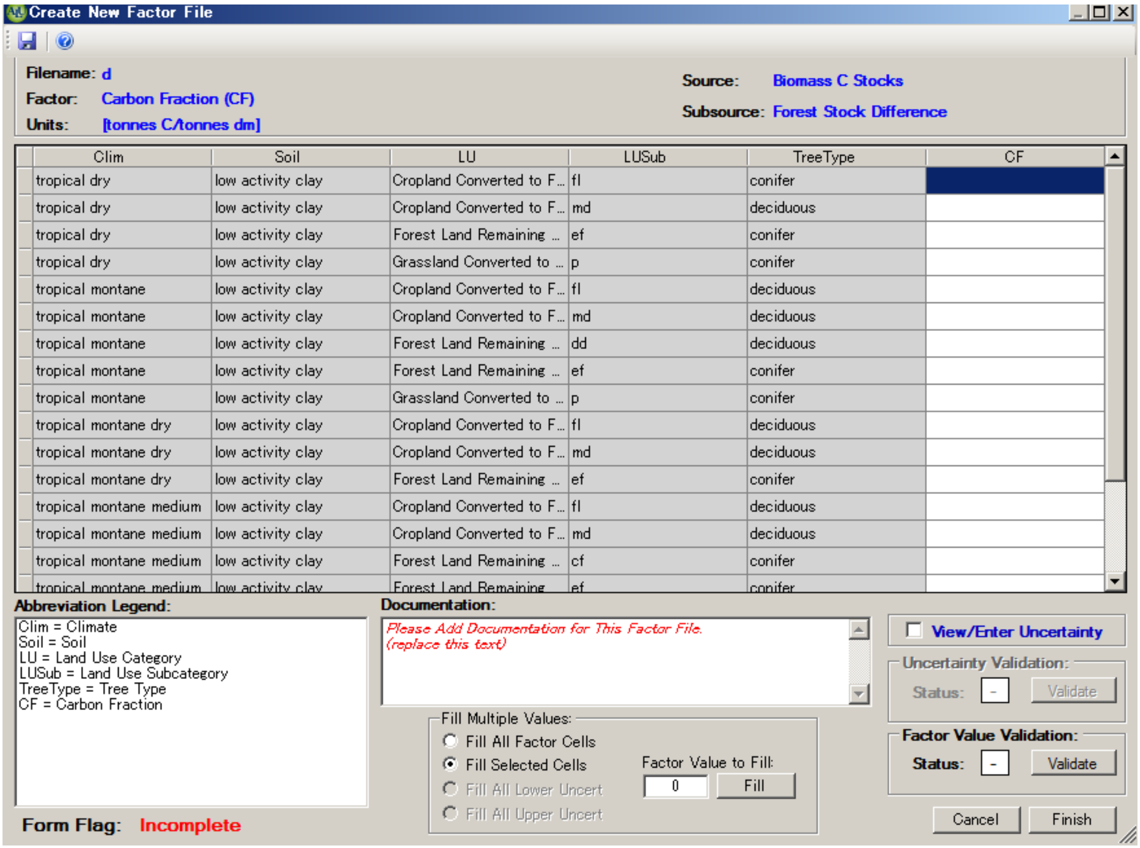
2. Specify one of the factor name

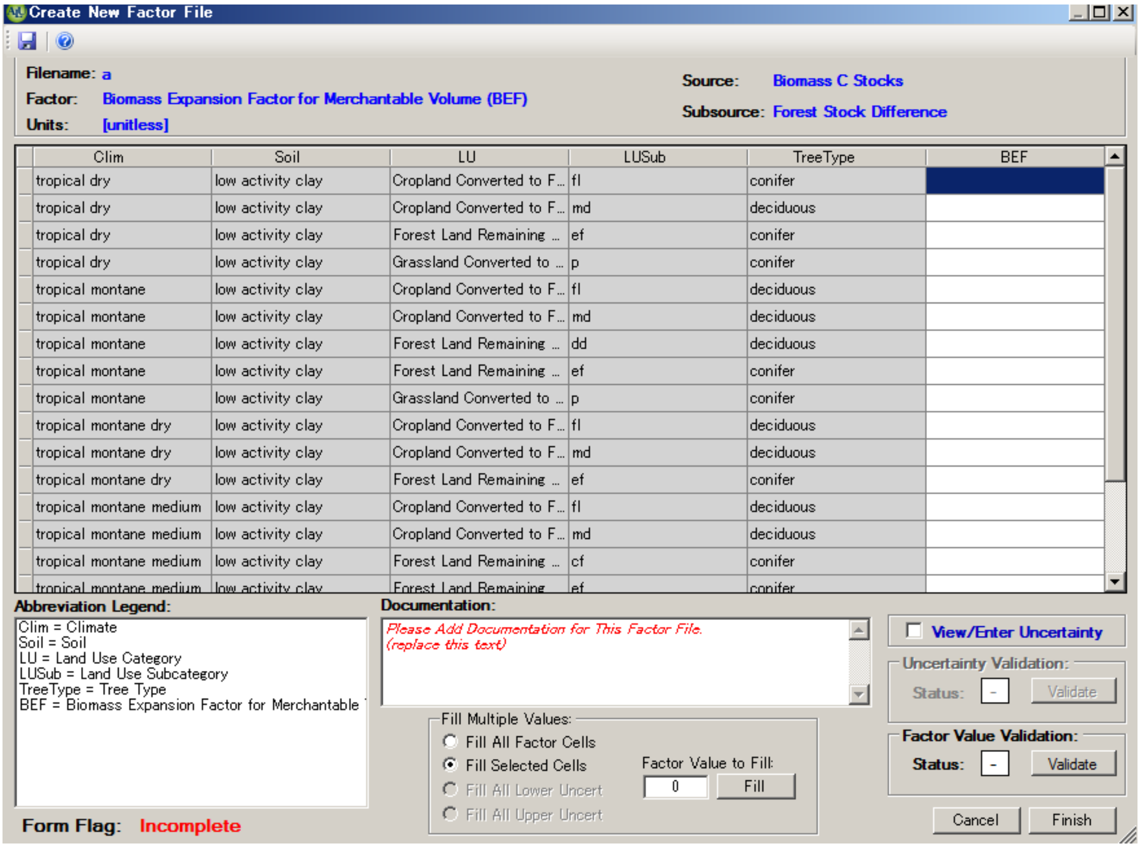


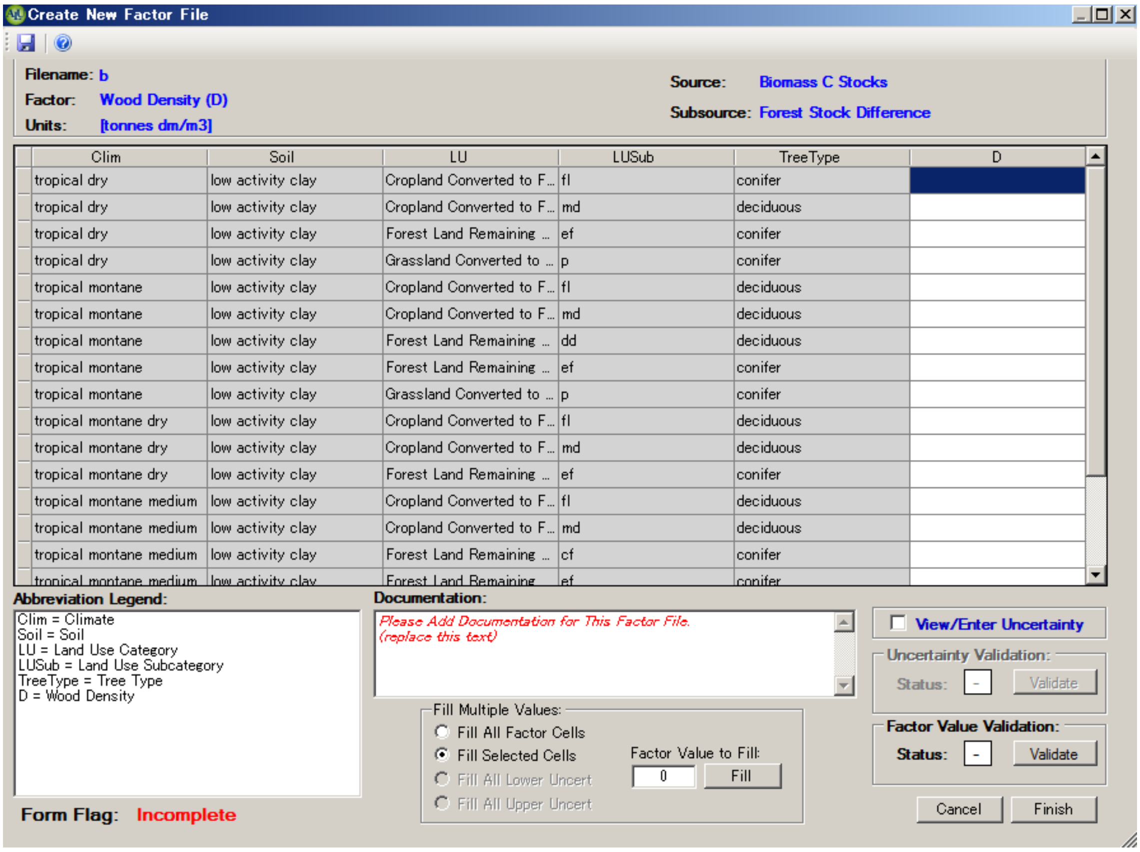
3. Specify strata for the emission/stock change factors



4. Specify carbon fraction, biomass expansion factors and wood density




Create New Factor File
Filename: a
Factor: Biomass Expansion Factor for Merchantable Volume (BEF)
Units: [unitless]
Source: Biomass C Stocks
Subsource: Forest Stock Difference
Clim | Soil | LU | LUSub | TreeType | BEF
tropical dry | low activity clay | Cropland Converted to F... | fl | conifer
tropical dry | low activity clay | Cropland Converted to F... | md | deciduous
tropical dry | low activity clay | Forest Land Remaining ... | ef | conifer
tropical dry | low activity clay | Grassland Converted to ... | p | conifer
tropical montane | low activity clay | Cropland Converted to F... | fl | deciduous
tropical montane | low activity clay | Cropland Converted to F... | md | deciduous
tropical montane | low activity clay | Forest Land Remaining ... | dd | deciduous
tropical montane | low activity clay | Forest Land Remaining ... | ef | conifer
tropical montane | low activity clay | Grassland Converted to ... | p | conifer
tropical montane dry | low activity clay | Cropland Converted to F... | fl | deciduous
tropical montane dry | low activity clay | Cropland Converted to F... | md | deciduous
tropical montane dry | low activity clay | Forest Land Remaining ... | ef | conifer
tropical montane medium | low activity clay | Cropland Converted to F... | fl | deciduous
tropical montane medium | low activity clay | Cropland Converted to F... | md | deciduous
tropical montane medium | low activity clay | Forest Land Remaining ... | cf | conifer
Abbreviation Legend:
Clim = Climate
Soil = Soil
LU = Land Use Category
LUSub = Land Use Subcategory
TreeType = Tree Type
BEF = Biomass Expansion Factor for Merchantable
Documentation:
Please Add Documentation for This Factor File.
(replace this text)
View/Enter Uncertainty
Uncertainty Validation:
Status: -
Validate
Fill Multiple Values:
Fill All Factor Cells
Fill Selected Cells
Fill All Lower Uncert
Fill All Upper Uncert
Factor Value to Fill:
0
Fill
Factor Value Validation:
Status: -
Validate
Form Flag: Incomplete
Cancel
Finish


Create New Factor File
Filename: b
Factor: Wood Density (D)
Units: [tonnes dm/m3]
Source: Biomass C Stocks
Subsource: Forest Stock Difference
Clim | Soil | LU | LUSub | TreeType | D
tropical dry | low activity clay | Cropland Converted to F... | fl | conifer
tropical dry | low activity clay | Cropland Converted to F... | md | deciduous
tropical dry | low activity clay | Forest Land Remaining ... | ef | conifer
tropical dry | low activity clay | Grassland Converted to ... | p | conifer
tropical montane | low activity clay | Cropland Converted to F... | fl | deciduous
tropical montane | low activity clay | Cropland Converted to F... | md | deciduous
tropical montane | low activity clay | Forest Land Remaining ... | dd | deciduous
tropical montane | low activity clay | Forest Land Remaining ... | ef | conifer
tropical montane | low activity clay | Grassland Converted to ... | p | conifer
tropical montane dry | low activity clay | Cropland Converted to F... | fl | deciduous
tropical montane dry | low activity clay | Cropland Converted to F... | md | deciduous
tropical montane dry | low activity clay | Forest Land Remaining ... | ef | conifer
tropical montane medium | low activity clay | Cropland Converted to F... | fl | deciduous
tropical montane medium | low activity clay | Cropland Converted to F... | md | deciduous
tropical montane medium | low activity clay | Forest Land Remaining ... | cf | conifer
Abbreviation Legend:
Clim = Climate
Soil = Soil
LU = Land Use Category
LUSub = Land Use Subcategory
TreeType = Tree Type
D = Wood Density
Documentation:
Please Add Documentation for This Factor File.
(replace this text)
View/Enter Uncertainty
Uncertainty Validation:
Status: -
Validate
Fill Multiple Values:
Fill All Factor Cells
Fill Selected Cells
Fill All Lower Uncert
Fill All Upper Uncert
Factor Value to Fill:
0
Fill
Factor Value Validation:
Status: -
Validate
Form Flag: Incomplete
Cancel
Finish

３．別添資料

IPCC_Soil.pdf

IPCC_climate.pdf

Elevation.pdf

Precipitation.pdf

LULUCF_LP.csv

森林クラス_変換テーブル_LULUCF_ラオス森林クラス_仮.xls

ラオス人民民主共和国

ラオス国持続可能な森林経営及びREDD+のための国家

森林情報システム構築に係る能力向上プロジェクト

（第2年次）

業務完了報告書

添付資料１９：NFI Pilot R Script Technical Summary

Technical Summary Report

JICA/KKC NFIS - National Forest Inventory of Lao PDR

Summary of "NFI-Calc" R-Script for Rapid Forest Carbon and Inventory Analysis

FOREST CARBON

Report prepared for:	Kokusai Kogyo LTD/JICA – NFIS Project, Lao PDR
Date	22nd July, 2015
Version:	1.0
About Forest Carbon:	Forest Carbon is a Southeast Asian-based firm that addresses the need for a regionally focused team capable of providing technical services for carbon forestry projects in tropical rainforest countries. Our team of experts works one-on-one with governments, non-profits and private sector clients across Asia, Africa and South America on the development of field-level projects and jurisdictional programs for reducing emissions from deforestation and degradation including reforestation, conservation and sustainable management of forests (REDD+). This work was undertaken in collaboration with members of Winrock International and Kokusai Kogyo Ltd.

1 TABLE OF CONTENTS

2 INTRODUCTION

2.1 BACKGROUND

Lao-Japanese National Forest Information System (NFIS) Project, supported by JICA, is a multi-year project being implemented in Lao PDR by Kokusai Kogyo Co., LTD(KKC) and Asia Air Survey Co., LTD. The NFIS Project supports a wide range of different activities in forest information management for Lao PDR, including the establishment of the procedures and piloting of the 2nd National Forest Inventory (NFI) of Lao PDR, anticipated to commence in 2016. The implementing team, KKC, has acquired the support of Forest Carbon Partners and Winrock International who have previously collaborated on subnational forest inventories in Lao PDR.

During the 2015 piloting, the implementation team decided to undertake inventory data collection using a tablet-based approach with a customized, on-board form, which synchronizes data collection to a secure cloud server. While this process was highly streamlined from a data collection standpoint, during piloting it was discussed to develop the work-flow process one step further through the development of an automated data analysis script. This script would make it possible to process and analyze the vast amounts of NFI data that will be collected in 2016 in an extremely short period of time, reducing error and streamlining the inventory process.

Under the NFIS project, Forest Carbon Partners developed a script-based data analysis software tool using the open-source statistical program, “R”. This tool, named “NFI-Calc” has been expanded from an original draft to incorporate anticipated data analysis needs for the full National Forest Inventory, anticipated to commence in 2016.

Previously, inventories have estimated minimum numbers of required plots and the amount of time and budget to complete an inventory and were unaware if inventory sampling was sufficient until field teams returned from the field. This often lead to long time delays with hand-calculating results in Microsoft Excel, and often resulting in under sampling and/or a need to return the following field season for additional data collection. The introduced tool by Forest Carbon is intended to give inventory managers at the Forest Inventory and Planning Division (FIPD) and their advisors the ability to assess the statistical status of the NFI inventory data collection process. Past data analysis techniques can take weeks when done by hand and are error prone. When done with paper, time to completion can last months, with even more introduced error. Among a wide variety of features and analysis, the script takes under 1 minute to complete its analysis. Since field data is immediately accessible once collected by field teams, this means that data can be analyzed “on the fly”. For example, a FIPD technician in Vientiane can run the script every day after the field teams have finished collecting their data and know immediately if the threshold number of plots has been reached for a certain inventory stratum.

The script is intended to be an easy-to-use tool[1] and give immediate results to inform decision makers about whether or not a statistically sufficient number of plots have been collected in each forest/management strata of interest to the NFI or if additional plots should be acquired.

2.2 FUNCTIONALITY

NFI-Calc uses the raw data from the piloting study without modifications, and outputs the following files:

1. Tables:
    - Carbon (C) stocks (t/ha) for each carbon pool and stratum using simplified cluster analysis
    - Carbon (C) stocks (t/ha) for each carbon pool and stratum using comprehensive cluster analysis
    - Total C stock for each stratum
    - Mean sampling time per stratum

[1] While useful, the script is not a substitute for knowledge and capacities on the underlying calculations and dynamics of forest biomass calculations.

- Stand tables for each nest class
- Stand tables for each DBH class
- Simplified data results tables:
    i. Plot level summary table
    ii. Raw data summary table

All tables include means, sample sizes, standard deviations, and standard errors. In the two C stock tables also confidences intervals (at 95%, and 90%), Uncertainties, minima, maxima and percentages are included.

2. Figures:
    - Histograms for each stratum and nest class
    - Histograms for each stratum and DBH class
    - Box and Whisker plots for each stratum and plot
    - Box and Whisker plots for each stratum and nest class
    - Box and Whisker plots for each stratum and DBH class

3 NOTES ON THE STATISTICAL PROGRAM R/ USER MANUAL

3.1 SIMPLE QUICKSTART MANUAL AND WORKFLOW

3.1.1 START

The statistical program R (www.r-project.org) is a script based, open source data analysis program. For user friendliness we used the program R Studio (www.rstudio.org), which runs R in the background. R Studio is divided in four different panels (Fig. 1). In the upper left panel the script is displayed, in the lower left panel the console, where the script lines are run, in the upper right panel the data, values and functions are displayed in different tabs, and in the lower left panel the files, plots, packages, help and viewer are displayed in different tabs.

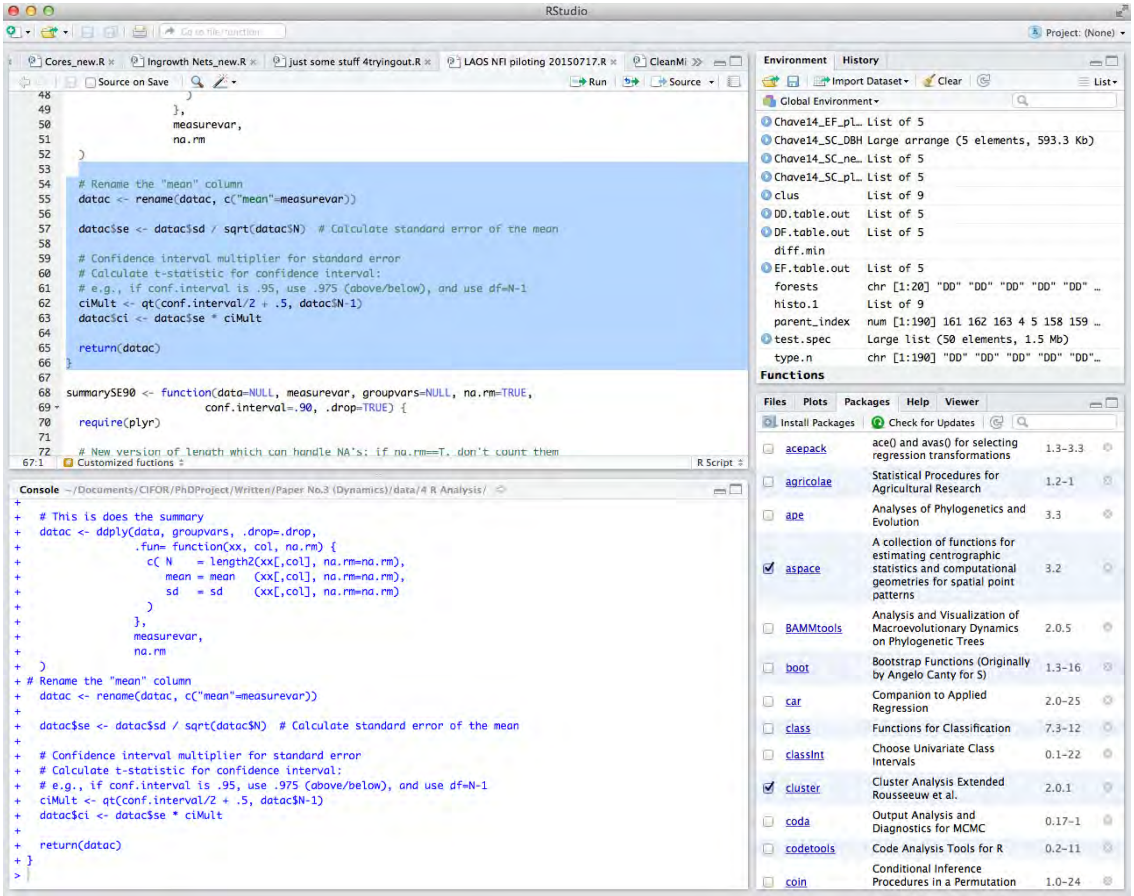


Figure 1: Screenshot of R studio

Stepwise implementation of NFI-Calc:

1. Install “R” and “R Studio”.
2. Import script via *File/Open file…*
3. Remove the “#” in front of the “install.packages” command lines (lines 6,7, and 8). Once the packages are install the “#” can be put back for subsequent runs of the script.
4. Set the working directory (i.e. the location of the raw data files) by removing the “#: and inserting the location manually in line 19 (“setwd…”)
   OR by selection the working directory via *Session/Set Working directory*.
5. Run the analysis by selecting the entire script (e.g. via “command + a”) and press “enter”.

All outputs will be saved in the aforementioned working directory.

3.1.2 ERROR CHECKING FUNCTION

To ensure that no sampling errors were made, we implemented an error checking function that tests is all trees (dead and alive) are in the appropriate nest class, i.e. trees with a diameter at breast height (i.e. 1.3 m; DBH) ≤ 30 cm are within the radius of 6m, trees with a DBH ≤ 40 cm are within the radius of 15 m, and trees with a DBH > 40 cm are within a radius of 20 m. All trees that are not in the appropriate nest class will be excluded from the analysis and saved in a separate .csv-file for further checking.

3.1.3 FORMULAE

The script uses the following formulas to calculate the different stocks:

Living trees and Class 1 dead standing trees (Chave et al, 2005[2]):

$$Biomass(kg/tree) = 0.6 \times \exp\left(-1.499 + 2.148 \times \ln\left(DBH\right) + 0.207 \times \ln\left(DBH\right)^2 - 0.0281 \times \ln\left(DBH\right)^3\right)$$

Living trees (Chave et al., 2014[3]):

$$Biomass(kg/tree) = \exp\left(-1.803 - 0.976 \times E + 0.976 \times \ln\left(0.57\right) + 2.673 \times \ln\left(DBH\right) - 0.0299 \times \ln\left(DBH\right)^2\right)$$

where E is an “environmental stress variable” set to 0.2822, 0.268, and 0.2357 for the dry dipterocarp forest stratum, the mixed deciduous forest stratum, and the evergreen forest stratum, respectively[4]. For Shrub it is set at 0.2587.[5]

Bamboo (Phuong et al., 2012[6]):

$$Biomass(kg/tree) = 0.1006 \times DBH_{mean}^{2.222} \times N_{stems}$$

where DBH_{mean} is the mean DBH of five bamboo stems, and N_{stems} is the number of stem in the bamboo patch.

Deadwood: Class 1 Dead Standing Trees (Chave et al, 2005[7]):

$$Biomass(kg/tree) = 0.6 \times \exp\left(-1.499 + 2.148 \times \ln\left(DBH\right) + 0.207 \times \ln\left(DBH\right)^2 - 0.0281 \times \ln\left(DBH\right)^3\right)$$

Deadwood: Class 2 Dead Standing Trees (Goslee et al., 2014[8]):

$$Biomass(kg/tree) = \frac{1}{3} \times \pi \times H \times D^2 \times 0.6 \times 0.001$$

where H is the height of the dead tree and D the diameter at ground level.

Deadwood: Stumps:

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[2] Chave J, Andalo C, Brown S et al. (2005) Tree allometry and improved estimation of carbon stocks and balance in tropical forests. Oecologia, 145, 87–99.
[3] Chave J, Réjou-Méchain M, Búrquez A et al. (2014) Improved allometric models to estimate the aboveground biomass of tropical trees. Global Change Biology (2015), 20, 3177-3190.
[4] see NFI Pilot Biomass Technical Summary for details.
[5] E values derived as the average E value from Chave et al 2014 found across the strata of interest.
[6] Phuong, V.T., Inoguchi, A., Birigazzi, L., Henry, M., Sola, G., Introduction and Background of the study, Vietnam, in (Eds) Inoguchi, A., Henry, M. Birigazzi, L. Sola, G. Tree allometric equation development for estimation of forest above-ground biomass in Viet Nam (Part A), UN-REDD Programme, Hanoi, Viet Nam.
[7] Chave J, Andalo C, Brown S et al. (2005) Tree allometry and improved estimation of carbon stocks and balance in tropical forests. Oecologia, 145, 87–99.
[8] Goslee, K, Walker, SM, Grais, A, Murray, L, Casarim, F and S Brown. 2014. Module C-CS: Calculations for Estimating Carbon Stocks, LEAF TECHNICAL GUIDANCE SERIES FOR THE DEVELOPMENT OF A FOREST CARBON MONITORING SYSTEM FOR REDD+. Winrock International.

$$Biomass(kg/stump) = \left(\frac{DBH_{mean}}{2}\right)^2 \times \pi \times H \times 0.57 \times 0.001$$

where DBH_{mean} is the mean if the diamters at the bottom and top of the stump, and H is the height of the stump.

4 OUTPUT

4.1 TABLES

4.1.1 CARBON POOLS PER STRATUM (SIMPLIFIED CLUSTER ANALYSIS[6])

The first output of the script is the detailed table of all C pools per strata (see “Strata_C_Pools_simple.csv”), which has the following columns:

File Column	Variable
B	Stratum (forest type)
C	C pool
D	N (sample size)
E	Carbon (C stock in tones/ha)
F	S.D. (standard deviation)
G	S.E. (standard error)
H	CI (95%) (Confidence interval at 95%)
I	Uncertainty (at 95% CI)
J	CI (90%) (Confidence interval at 90%)
K	Uncertainty (at 90% CI)
L	Cmin (Minimum carbon stock per plot, tones/ha)
M	Cmax (Maximum carbon stock per plot, tones/ha)
N	perCent_Chave2005 (percentage of each C pool to the total C stock calculated with the allometry from Chave et al., 2005)
O	perCent_Chave2014 (percentage of each C pool to the total C stock calculated with the allometry from Chave et al., 2014)

4.1.2 CARBON POOLS PER STRATUM (COMPREHENSIVE CLUSTER ANALYSIS[6])

The second output of the script is the detailed table of all C pools per strata (see “Strata_C_Pools_comprehensive.csv”), which has the following columns:

File Column	Variable
B	Stratum (forest type)
C	C pool
D	N (sample size)
E	Carbon (C stock in tones/ha)

F	S.E. (standard error)
G	CI (95%) (Confidence interval at 95%)
H	Uncertainty (at 95% CI)
I	CI (90%) (Confidence interval at 90%)
J	Uncertainty (at 90% CI)
K	Cmin (Minimum carbon stock per plot, tones/ha)
L	Cmax (Maximum carbon stock per plot, tones/ha)
M	perCent_Chave2005 (percentage of each C pool to the total C stock calculated with the allometry from Chave et al., 2005)
N	perCent_Chave2014 (percentage of each C pool to the total C stock calculated with the allometry from Chave et al., 2014)

4.1.3 TOTAL CARBON STOCK PER STRATUM

The third output of the script is the detailed table of the total C stock per stratum ("Strata_Stocks.csv"), which has the following columns:

File Column	Variable
B	Equation (allometry used for calculations)
C	Stratum (forest type)
D	N (sample size)
E	Carbon (C stock in tones/ha)
F	S.D. (standard deviation)
G	S.E. (standard error)
H	CI (95%) (Confidence interval at 95%)
I	Uncertainty (at 95% CI)
J	CI (90%) (Confidence interval at 90%)
K	Uncertainty (at 90% CI)
L	Cmin (Minimum carbon stock per plot, tones/ha)
M	Cmax (Maximum carbon stock per plot, tones/ha)

4.1.4 MEAN SAMPLING TIME

The fourth output of the script is the mean sampling time per subplot per stratum ("time.table.csv"), which has the following columns:

File Column	Variable
B	Time (all measured time, or all time less than 2 hrs)
C	Stratum (forest type)
D	N (sample size)
E	Mean time (min/subplot)
F	S.D. (standard deviation)
G	S.E. (standard error)
H	CI (95%) (Confidence interval at 95%)

4.1.5 STAND TABLE FOR EACH NEST CLASS

The fifth output of the script is stand table per nest class per stratum ("Stand_Table_nestclass.csv"), which has the following columns:

File Column	Variable
B	Stratum (forest type)
C	Nest class 1 (Nest with a radius of 6 m)
D	Nest class 2 (Nest with a radius of 15 m)
E	Nest class 3 (Nest with a radius of 20 m)

Each stratum has the following rows:

1) Trees_per_ha (number of trees/ha)
2) Chave_2005_Carbon_per_ha (Carbon stock in t/ha using Chave et al., 2005)
3) Chave_2005_Percentage (percentage carbon of the total carbon stock using Chave 2005)
4) Chave_2014_Carbon_per_ha (Carbon stock in t/ha using Chave et al., 2014)
5) Chave_2014_Percentage (percentage carbon of the total carbon stock using Chave 2014)

4.1.6 STAND TABLE FOR EACH DBH CLASS

The sixth output of the script is stand table per DBH class per stratum ("Stand_Table_DBHclass.csv"), which has the following columns:

File Column	Variable
B	Stratum (forest type)
C	10 to 20 (DBH > 10 cm to ≤ 20 cm)
D	20 to 30 (DBH > 20 cm to ≤ 30 cm)
E	30 to 40 (DBH > 30 cm to ≤ 40 cm)
F	40 to 50 (DBH > 40 cm to ≤ 50 cm)

G	50 to 60 (DBH > 50 cm to ≤ 60 cm)
H	60 to 70 (DBH > 60 cm to ≤ 70 cm)
I	70 to 80 (DBH > 70 cm to ≤ 80 cm)
J	80 to 90 (DBH > 80 cm to ≤ 90 cm)
K	90 to 100 (DBH > 90 cm to ≤100 cm)
L	more (DBH > 100 cm)

Each stratum has the same rows as the stand table for the each nest class.

4.1.7 SIMPLIFIED DATA RESULTS TABLES

4.1.7.1 PLOT LEVEL SUMMARY TABLE

The seventh output of the script is plot level summary table (“Simplified_Plot_summary.csv”). The columns are the same as in the “carbon pools per stratum” table.

File Column	Variable
B	Plot number
C	Latitude
D	Longitude
E	Slope
F	Stratum (forest type)
G	AGB_Chave2005 (tC/ha) (Aboveground carbon stock of living trees using Chave et al. 2005)
H	S.E. (Standard Error of AGB_Chave2005)
I	BGB_Chave2005 (tC/ha) (Belowground carbon stock of living trees using Chave et al. 2005)
J	S.E. (Standard Error of BGB_Chave2005)
K	AGB_Chave2014 (tC/ha) (Aboveground carbon stock of living trees using Chave et al. 2014)
L	S.E. (Standard Error of AGB_Chave2014)
M	BGB_Chave2014 (tC/ha) (Belowground carbon stock of living trees using Chave et al. 2014)
N	S.E. (Standard Error of BGB_Chave2014)
O	Bamboo (tC/ha) (bamboo carbon stock)
P	S.E. (Standard Error of Bamboo)
Q	Deadwood_Trees (tC/ha) (Dead tree carbon stock)
R	S.E. (Standard Error of Deadwood_Trees)
S	Deadwood_stump (tC/ha) (Stump carbon stock)

T	S.E. (Standard Error of Deadwood_stump)
U	Deadwood_lying (tC/ha) (Lying deadwood carbon stock)
V	S.E. (Standard Error of Deadwood_lying)
W	Total Carbon (tC/ha)
X	S.E. (Standard Error of Total Carbon)
Y	Trees/ha
Z	S.E. (Standard Error Trees/ha)
AA	Trees/plot
AB	AB) S.E. (Standard Error of Trees/plot)
AC	AC) Stumps/plot
AD	AD) S.E. (Standard Error Stumps/plot)

4.1.7.2 RAW DATA SUMMARY TABLE

The eighth output of the script is raw data summary table ("Simplified_Raw_data.csv"), which has the following columns:

File Column	Variable
B	Stratum (forest type)
C	Plot number
D	Subplot
E	DBH (cm)
F	Height (m)
G	Dead tree class
H	Stump volume (cm^3)
I	Nest radius (m)
J	Living/dead tree

4.2 GRAPHS

NFI-Calc generates two kinds of graphs for each stratum. Firstly two kinds histograms are generated, showing number of trees per ha in each for each nest class (Figure 2), and for each DBH class (Figure 3), respectively.

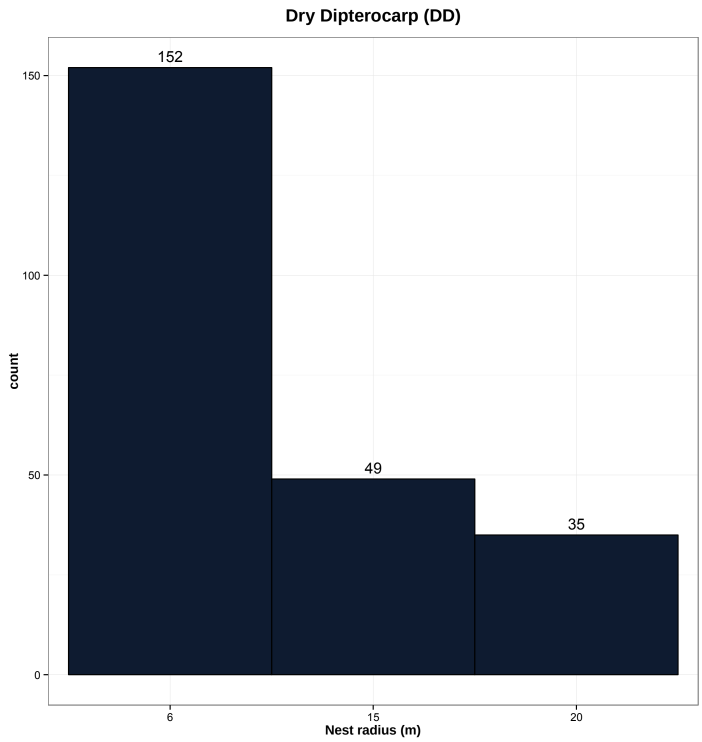

Figure 2: Histogram for dry dipterocarp forest (Nest classes)

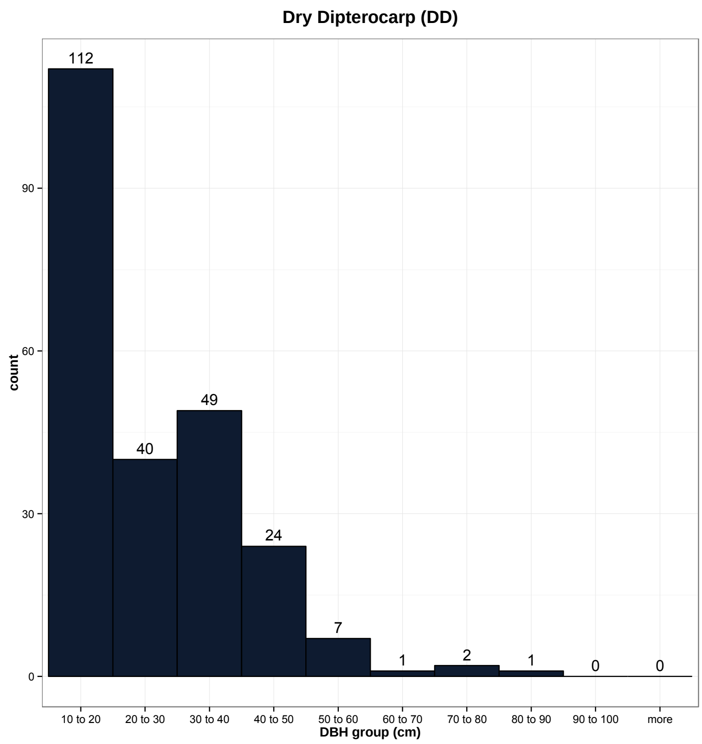

Figure 3: Histogram for dry dipterocarp forest (DBH classes

Secondly, three kinds of box- and whisker plots are generated, showing biomass in tones per ha for each plot (Figure 4), for each nest class (Figure 5), and for each DBH class (Figure 6). All three kinds of box- and whisker plot are generated for biomass calculated with Chave et al. (2005) and Chave et al. (2014), totaling 24 plots.

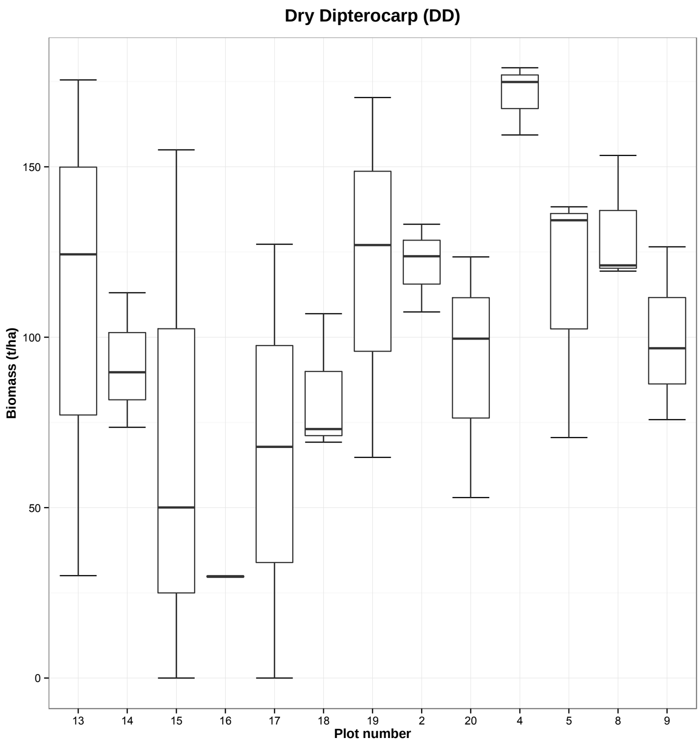

Figure 4: Box- and whisker plot for dry dipterocarp forest (Plot level)

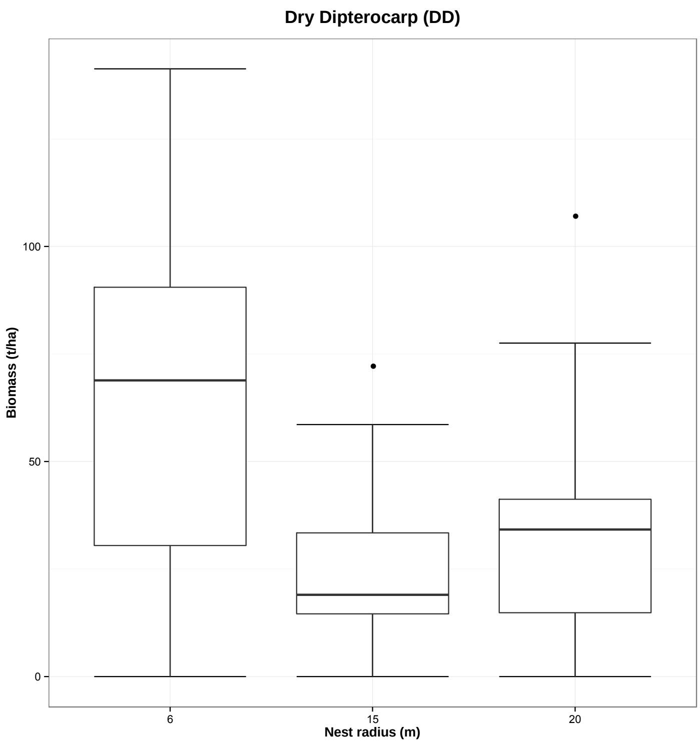

Figure 5: Box- and whisker plot for dry dipterocarp forest (Nest classes)

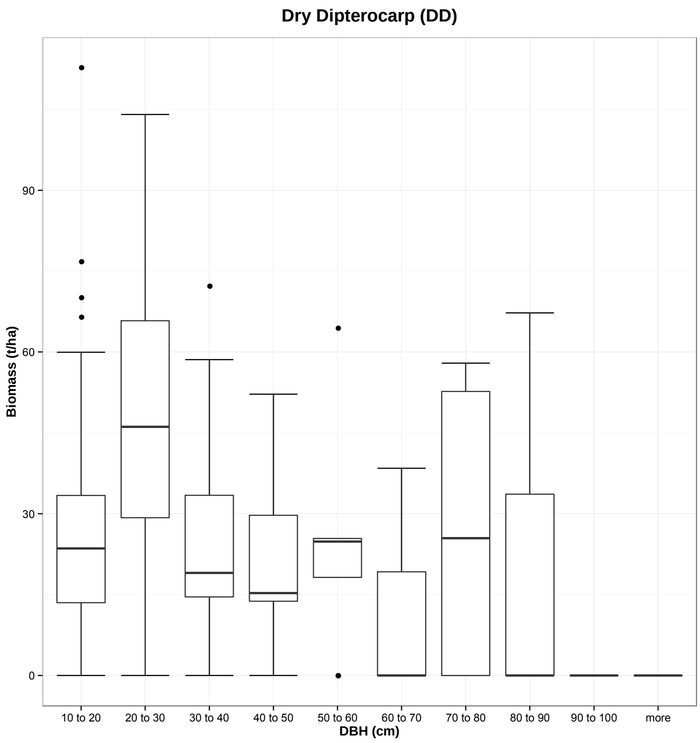

Figure 6: Box- and whisker plot for dry dipterocarp forest (DBH classes)

5 OBSERVATIONS AND RECOMMENDATIONS

The NFI-Calc has the ability to analyze data more efficiently and less error prone than previous analysis methods using e.g. Microsoft Excel. But as an easy-to-use care should be taken that project staff has proper training on the programming language to ensure that potential errors, which could occur, can be identified and solved independently. Below are some suggestions on potential uses of the tool to address certain immediate needs.

While the present version of NFI-Calc is written to analyze the data of the NFI piloting study and every attempt has been made to anticipate the final design of the NFI ahead of the 2016 season, for any changes made to the SOP, revisions may need to be made to the tablet-form design. Any changes made to the tablet form design will need to be reflected in the NFI-Calc code. The SOP, Tablet Form and NFI-Calc Script should thus be seen as one complete system. Thus, the code may need to be adjusted to take specifics of the final SOP of the 2nd NFI of Laos PDR or other inventories into account.

It is recommended that for the NFI, a complete, multi-day training course be provided *ahead of* or leading up to the next NFI, which walks participants through the manual calculation of biomass carbon stocks, as well as a training course on the uses of NFI-Calc at the end of the training course. This will re-enforce the underlying principles of how biomass and carbon stocks are calculated and if possible, integrated into the National REDD+ MRV system, as well as provide the inventory mangers with a powerful tool during the inventory.

Potential capacity building and practical uses of NFI-Calc for the upcoming NFI include:

- **Pre NFI 2016 Field Planning**
  - As a teaching tool for biomass data collection and calculation. E.g. by immediately showing teams the carbon stocks they have measured at the end of the day during a combined classroom/field-based training.
  - As an analysis/SOP correction tool to help define optimal living tree DBH/Nest size classes for tree plots based on sample data,
- **During NFI Field Season**
  - As a monitoring tool for inventory managers in Vientiane to assess key statistics of the inventory by getting a quick overview of carbon stocks, sampling intensity and sampling uncertainty for each stratum sampled. This could happen as often as every day after new tablet data has been collected or be done weekly. The added value here is that inventory managers can now determine in “real time” when a sufficient number of plots have been collected and inform field teams on the ground to shift to a new sampling region,
- **Post NFI Field Season**
  - To reliably calculate necessary key outputs from the NFI which can be used as inputs for national reporting on forest resources.
  - To create primary inputs relevant to the national MRV system, including establishing information on carbon stock density by carbon strata,
  - Providing the national government with standardized data collection and analysis tools which can be replicated for forest inventories across the country, regardless of the size.