Lao People's Democratic Republic
Department of Forestry, Ministry of Agriculture and Forestry

Lao People's Democratic Republic

The Capacity Development Project for Establishing National Forest Information System for Sustainable Forest Management and REDD+

(Phase Ⅱ)

Completion Report

2016 March

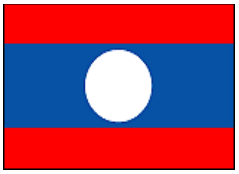
Japan International Cooperation Agency

Joint Venture
KOKUSAI KOGYO CO., LTD.
ASIA AIR SURVEY CO., LTD.

GED
JR
15-138

Location of the Project site

The Capacity Development Project for
Establishing National Forest Information System for
Sustainable Forest Management and REDD+



Lao People's Democratic

Republic

Resource : University of Texas

Photos of Activities
September 2013～March 2016

1st JCC

Explanation from Chief Advisor

Ground Truth Survey

Exchanging opinions with another donor

NFI Pilot Survey

Final Workshop

Acronyms

AGB	Above Ground Biomass
AFOLU	Agriculture, Forestry and Other Land Use
ASEAN	Association of Southeast Asian Nations
AWLCA	Ad hoc Working Group on Long-Term Cooperative Action
BGB	Below Ground Biomass
CIFOR	Center for International Forestry Research
CliPAD	Climate Protection through Avoided Deforestation Project
COP	Conference of the Parties
C/P	Counterpart
DAFO	District Agriculture and Forestry Office
DB	Database
DBH	Diameter at breast height
DFRM	Department of Forest Resource Management
DG/DGG	Director General / Deputy Director General
DOF	Department of Forestry
DOFI	Department of Forest Inspection
EDN	ESRI Developer Network
FAO	Food and Agriculture Organization (of the United Nations)
FCPF	Forest Carbon Partnership Facility
FFPRI	Forestry and Forest Products Research Institute
FIM	The Programme for Forest Information Management
FIP	Forest Investment Program
FIPD/DOF	Forest Inventory and Planning Division (Department of Forestry)
FOMIS	Forest Inventory and Management Information System
FPP	Forest Preservation Program
FRA	Global Forest Resources Assessments
FRIMS	Forest Resources Information Management System
FSCAP	Forest Sector Capacity Development Project
GIS	Geographic Information System
GIS/RS	Geographic Information System / Remote Sensing
GIZ	Gesellshaft fuer Internationale Zusammenarbeit
GOL	Government of Lao PDR
IFC	International Financial Cooperation
IT	Information Technology
ITTO	International Tropical Timber Organization
JICA	Japan International Cooperation Agency
JICS	Japan International Cooperation System
JV	Joint Venture
LEAF	Lowering Emission in Asia's Forest
MAF	Ministry of Agriculture and Forestry
MONRE	Ministry of Natural Resources and Environment
MRV	Measuring, Reporting and Verifying
NFCMs	National Forest Carbon Maps
NFI	National Forest Inventory
NFIDB	National Forest Information Database
NFIS	National Forest Information System
NFMS	National Forest Monitoring System
NTFP	Non-Timber Forest Product
NGD	National Geographic Department
PAFO	Provincial Agriculture and Forest Office
PaMs	Policy and Measures
PAREDD	Participatory Land-use and Management for Reducing Deforestation
R/D	Record of Discussion
REDD	Reducing Emissions from Deforestation and Forest Degradation
REDD+	Reducing Emissions from Deforestation and Forest Degradation and the role of conservation of forests and enhancement of forest carbon stocks

REL	Reference Emission Level
RL	Reference Level
R-PP	Readiness preparation proposal
RS	Remote Sensing
SG	Safeguards
SIDA	Swedish International Development Cooperation Agency
SBSTA	Subsidiary Body for Scientific and technological advice
SUFORD	Sustainable Forest and Rural Development (Project)
TA	Technical Assistance
TF	Task Force
TWG	Technical Working Group
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
VCS	Verified Carbon Standard
WCS	Wildlife Conservation Society
WG	Working Group
WS	Workshop

Outline

Annex

Chapter1 Overview of the Project

1.1 Background

In the Lao People's Democratic Republic (hereinafter Lao PDR), forest coverage which was 70% or more in the 1940's had declined to 47% in 1989 and 40% in 2010. The government of the Lao PDR (hereinafter GOL) endorsed the "Forestry Strategy 2020" with the objective of restoring a forest coverage of 70%. GOL also views REDD+ as valid means for strengthening of management capacities on all levels, increasing government revenues and improving the livelihood of local residents. . Therefore, GOL has been keen in preparations for implementation of REDD+ including establishment of a REDD+ Task Force (TF) while receiving support from many donors including Japan.

On the other hand, in order to promote forest conservation through REDD+, while the development of forest resource information with high accuracy using satellite information analysis and other means is indispensable, the hardware / software processing capability and capacity that are required for forest resource information management are inadequate, and human resources that perform collection / analysis of related information are in extremely short supply in the Lao PDR, meaning that the infrastructure to further forest conservation through REDD+ is weak.

Consequently, under the "Programme for Forest Information Management" (FIM) grant aid cooperation project, the hardware, software and other resources and equipment required for forest resource surveys and satellite image analysis, etc. have been provided and support has been provided to acquire the basic technology required for the utilization of these, and a "Forest Base Map" has been prepared as part of the outputs.

However, in order to deal with REDD+, which is still in the formulation process, in accordance with international discussions, the development of human resources to perform estimation of carbon stock volume utilizing forest information, conduct prediction of forest carbon dynamics prediction, forest resource monitoring and other related works is a pressing issue in the Lao PDR.

Under these circumstances, GOL made a request to the Government of Japan to implement this technical cooperation project. Upon receiving this request, JICA conducted a detailed planning survey in March 2013, and JICA and MAF concluded an R/D based on the results of this survey on May 20, 2013.

In accordance with this R/D, the counterpart for this work is the Department of Forestry at MAF, and through developing the main elements required for formulation of a national forest information system in the forestry sector in the Lao PDR, the capacities of the counterpart in the Lao PDR will be enhanced, with the objective of contributing to sustainable forest management and REDD+ preparation in the Lao PDR.

1.2 Objective and output

The Project overall goal, purpose, output and overview of activities are outlined below.

(1) Overall Goal

National Forest Information System (NFIS) of Lao PDR is established.

(2) Project Purpose

Essential components for the establishment of NFIS are in place.

(3) Outputs

1. Information on forest carbon dynamics at national level is compiled.
2. Prototype of National Forest Information Database (NFIDB) is designed.
3. The next round of National Forest Inventory (NFI) is designed.
4. Other relevant information required for REDD+ is compiled.

(4) Activities

1.1 Verify accuracies of national forest type maps as of year 2010, which is a base map, and as of years 2005 and 2000.

1.2 Revise national forest type maps based on the results of verification 1.1 above.

1.3 Identify highly co-related factors with carbon stock, e.g. species, region and elevation, based on the relevant information including past NFI data and inventory data obtained through the Programme for Forest Information Management in Lao PDR (FIM).

1.4 Decide methodology for stratification of forests for producing National Forest Carbon Map (NFCM) based on the result of activity 1.3 above (e.g. species, region and elevation).

1.5 Produce NFCM s (for years 2010, 2005 and 2000) based on the result of activity 1.4 above.

2.1 Analyze and compile existing forest information data, such as FIM, Forest Preservation Programme (FPP) and other projects.

2.2 Examine functions and specifications for statistics and reporting needed for internationally and domestically.

2.3 Identify necessary forest information data and their specifications.

2.4 Design NFIDB based on the results of 2.1, 2.2 and 2.3 above.

3.1 Review the results of past NFIs including FIM.

3.2 Study methodology of the next NFI (e.g. sampling method, plot design, inventory items) based on the result of activity 3.1 above.

3.3 Consider institutional set up of the next NFI.

3.4 Revise the NFI manual.

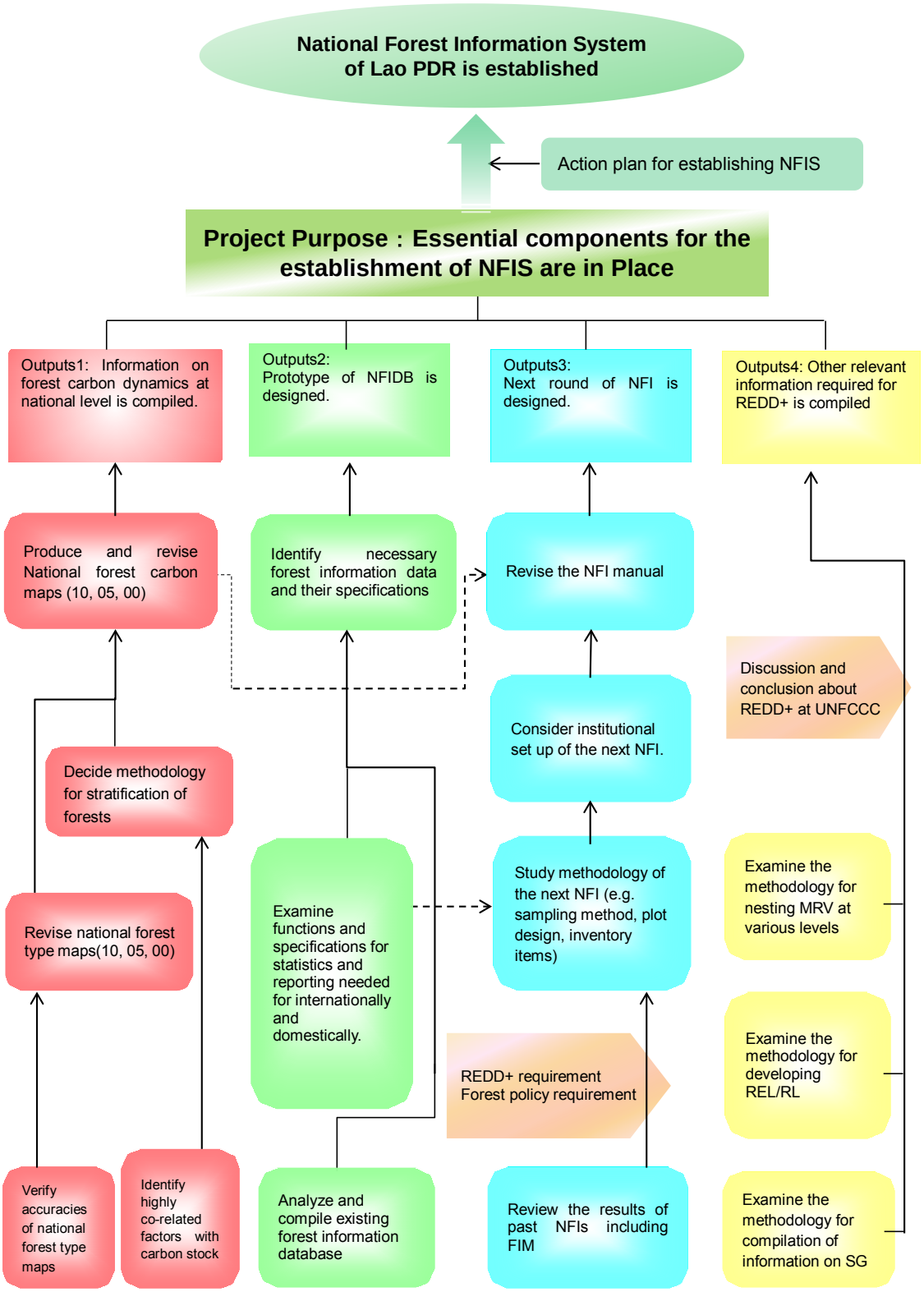
4.1 Examine the methodology for developing REL/RL for REDD+.

4.2 Examine coordination of Measurement, Reporting and Verification (MRV) for the levels of national, sub-national and project.

4.3 Study methodology for compilation of information on safeguards.

1.3 Flow of Main Components

The flow of this project is as follows



The "National Forest Information System" established as the overall goal of this project is defined as an "Information system for comprehensive management (including periodical update) of relevant information and data required for sustainable forest management and REDD+" and includes information and data related to forest management such as satellite images, inventory and other data, and logging information as well as information required for REDD+ such as carbon stock changes, REL/RL, and safeguards.

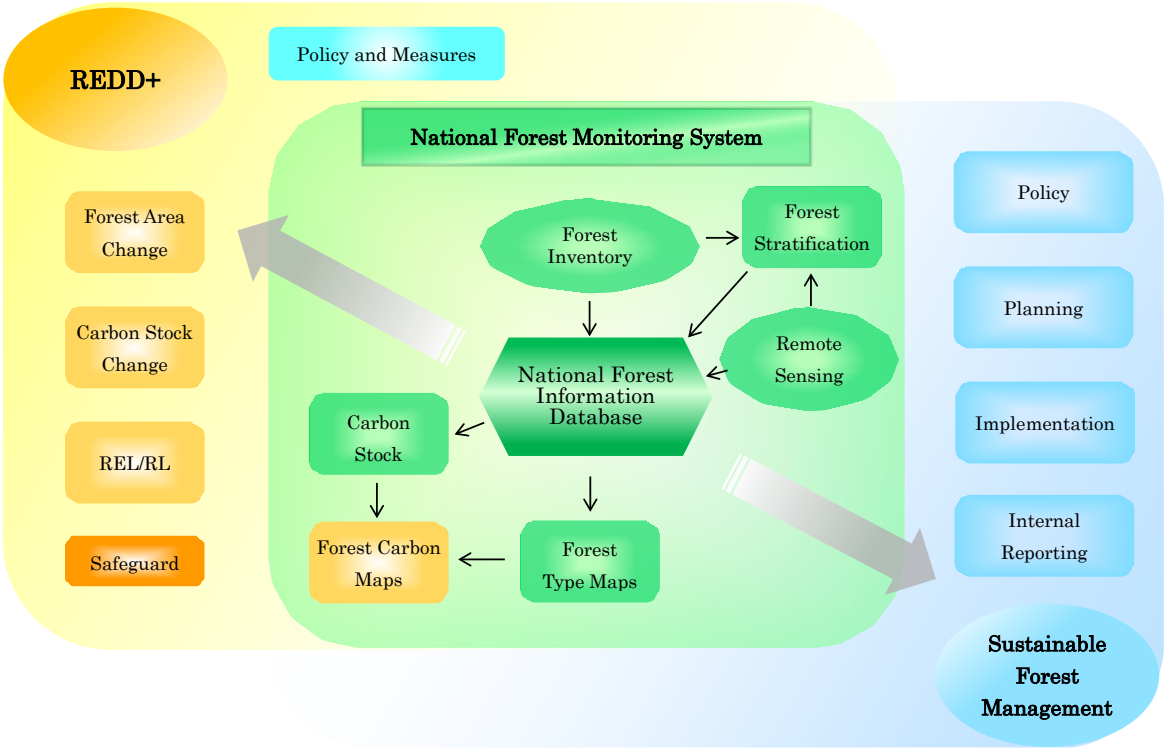


Figure 1-1 Conceptual Figue of National Forest Information System (NFIS)

Chapter2 Main Activities Implemented (Sep2013~Sep 2015)

2.1 Work

Main Activities implemented during the 1st Phase are as follows.

Table 2-1 Work Process Overview

September 2013～September 2015
Activities related to Common Items
【1】Organization and analysis of existing documents/reports
【2】Confirmation and detailed consideration of survey methodology
【3】Preparation of Inception Report
【4】Explanation and discussion of Inception Report
【5】Preparation of Technical Transfer Plan (draft)
【6】Explanation of draft version and consultation to finalize the Technical Transfer Plan
【7】Collection and analysis of existing information
【8】Explanation and exchange of opinions on Inception Report in workshops
【9】Review of other donors' activities and consideration of policy on integration of such activities in this Project
【10】Discussion and consideration regarding collaboration with other donors
【11】Development of training plan for counterparts
【12】Report on results of first field survey in Laos
【13】Preparation and discussion of First Work Completion Report.
【14】Preparation for and start of second year surveys and activities
【15】Report to JICA on progress made on first year activities in Laos
【16】Explanation and discussion of the result of 1st year's activities
【17】Preparation the concept of 2nd year activities and technical transfer policy
【18】Report the result of second year activities and implementation the technical transfer seminar
【19】Report the progress of second year activities to JICA Laos office
【20】Preparation of Action plan for National Forest Monitoring System and Work Completion report(Draft)
【21】Preparation of Final Wok report
Activities related to Output1: Information on Forest Carbon Dynamics at national level is compiled.
【22】Accuracy assessment of forest distribution map (2000, 2005, 2010)
【23】Revision of forest distribution map (2000, 2005, 2010)
【24】Identification of potential variables of high correlation with carbon volume
【25】Identify the forest stratification
【26】Preparation of National forest carbon map
Activities related to Output 2 :Prototype of National Forest Information Database (NFIDB) is designed.
【27】Organization and analysis of existing forest information database
【28】Consideration of functions and specifications for statistical/reporting purposes, etc.
【29】Determination of data types and specifications of forest information
【30】Design of national forest information database
【31】Preparation of Report for National Forest Information Database(prototype)
Activities related to Output 3 :Next round of National Forest Inventory (NFI) is designed.
【32】Review of design, methods, implementation and results of national forest inventories
【33】Consideration of objectives, design and survey methods for the next national forest inventory
【34】Consideration of institutional set-up for implementation of the next national forest inventory
【35】Revise and completion the National Forest Inventory Manual
Activities related to Output 4 :Other relevant information required for REDD+ is compiled.
【36】Consideration of methods of preparing REL/RL
【37】Consideration of methods for nesting MRV at various scales
【38】Consideration of methods of creating information system regarding safeguards etc.
【39】Participation in UNFCCC negotiations on REDD+
【40】Preparation and completion of the report include abovementioned result

2.2 Common Items for All Outputs

2.2.1 Organization/Analysis of Existing Materials, etc.

Existing and collected materials, etc. were organized/analyzed, and materials that can be used and materials that are to be collected in the first field survey were clarified.

2.2.2 Confirmation of Work Plan and Review of Details

The overall work plan was prepared and the details of the work plan and methods were reviewed.

2.2.3 Preparation of Inception Report

Draft inception report was prepared.

2.2.4 Explanation/Discussion of Draft Inception Report

Before planned activities were started, explanations/discussions concerning the content of the draft inception report were made to/held with the counterpart agency at a first joint coordination committee meeting, and agreement was obtained on the basic project implementation policy, work plan content/methods, technology transfer implementation policy, items for which facilitative assistance is to be provided and other details, and the content of discussions were compiled in the minutes of the meeting.(Annex 1-1)

2.2.5 Preparation of Technology Transfer Plan (Draft)

A technology transfer plan (draft) was prepared. This plan includes the following items.

Technology transfer policy, methods, content and timing
Persons in charge of performing technology transfer, and counterparts that will receive technology
Technology transfer program
Technology dissemination seminars (proposed) to be implemented in the second year
Other issues related to technology transfer

2.2.6 Explanation of Technology Transfer Plan (Draft) / Discussions / Preparation of Technology Transfer Plan

The technology transfer plan (draft) was explained to the C/P organization, discussions were held to gather the views of the C/P, and a final technology transfer plan was prepared together with the C/P organization.

2.2.7 Collection/Analysis of Existing Information

Collection / analysis of existing information (current status of forest management systems, status of forest utilization, related laws and regulations/systems, status and activities of REDD+ TF, activities of other donors, etc.) were implemented.

2.2.8 Explanation of Inception Report at Workshop / Exchange of Views

Workshop was held to explain the inception report to other concerned donors/projects and exchange of views was conducted (Annex 1-2).

2.2.9 Review of Activity Implementation by Other Donors and Review of Activity Policy for This Survey

Activity implementation by other related donors were reviewed and the output / problems / other issues were organized. This information was used for efficient implementation of the Project activities.

2.2.10 Discussion / Review of Coordination with Other Donors

Coordination with other related donors was discussed/reviewed.

2.2.11 Formulation of Training Plan for Counterparts

Regarding training that is conducted to enhance the capacities as part of the activities related to each output, the learning level of the counterparts in Laos were confirmed, and this information was used to formulate an appropriate training plan.

2.2.12 Review of First Year Results (Output)

Report meetings were held with the counterpart government on March 14 and 19, 2014 based on the results of the first field survey when the first field survey ended. The names of the various participants are shown in Annex 3, and included Mr. Khamphay who is Acting Director General of DOF, Mr. Linthong (Project Director) who is Director of FIPD and Mr. Soukanh (Project Manager) who is Deputy Director of FIPD.

2.2.13 Preparation/Discussion of Work Completion Report (First Year)

The results of the first year activities and the review meeting on 2.2.12, was taken into consideration when preparing the Work Completion Report (first year), and agreement on the content was obtained through discussion with the counterpart agency.

2.2.14 Starting off or Preparations for Survey Work/Activities in Second Year

For the work that will be conducted in the second year, surveys, starting of activities or preparations were implemented for work that can be started during the first year.

2.2.15 Report to JICA on Progress of First Field Survey

A report was made to the JICA Laos Office on the progress of the first year activities.

2.2.16 Explanation and discussion of the result of 1st year's activities

Explanation and discussion of the result of 1st year's activities was done with C/P

2.2.17 Preparation the concept of 2nd year activities and technical transfer policy

The concept of 2nd year activities and technical transfer policy were prepared.

2.2.18 Report the result of second year activities and implementation the technical transfer seminar

The workshop for reporting the result of all activities and technical transfer seminar were held.

2.2.19 Report the progress of second year activities to JICA Laos office

Progress of all activities was reported to JICA Laos office.

2.2.20 Preparation of Action plan for National Forest Monitoring System and Work Completion report(Draft)

Action plan for National Forest Monitoring System and Work completion report (draft) were prepared/

2.2.21 Preparation of Final Wok report

Final work completion report was prepared.

2.3 Activities related to Output 1

2.3.1 Accuracy Assessment of Forest Type Maps (2000, 2005 and 2010)

With respect to the forest type maps of 2010 that serve as the forest base map, accuracy assessment was carried out before the revision. Also, training in Japan was implemented concerning accuracy assessment of the forest type maps. (Training outline: Annex 3) Based on the assessment results, the method to revise the forest type maps, which serve as the forest base maps, was developed and discussions were held with the C/P to obtain their agreement on it. In addition, the definition of forests and the national level classification system in the Lao PDR were reviewed and reorganized from the viewpoint of national forest policy and international reporting, and discussions were held with the involvement of the whole forest sector, including the C/P and other donors, and agreement was obtained within the forest sector.

After preparing the forest type maps of 2000, 2005 and 2010 as described in 2.3.2, accuracy assessment was performed for the forest type map of each year.

2.3.2 Revision of Forest Type Maps (2000, 2005 and 2010)

Ground truth surveys and training necessary for the revision work were implemented. In order to reduce the variation in the classification results caused by the difference of interpretation ability between the technical experts, based on the results of the ground truth survey, interpretation cards and interpretation keys were prepared and developed for each classification item and each satellite image (RapidEye, SPOT multi-spectral, LANDSAT).

Also, lectures with the objective of improving the knowledge of the theory concerning satellite image analysis were implemented as follows. According to the original schedule, the first series of lectures were on the basic theory of remote sensing and the second series consisted of theoretical lectures on stratification analysis. However, as it turned out that the content of the lectures on stratification analysis had been mostly covered by OJT and that although the first series of lectures helped in promoting the understanding of the basic theory of remote sensing, the time for practical training to practice the theory in connection with the

actual operation was not enough, it was decided that the second series of lectures should also address the basic theory of remote sensing (Theory of Remote Sensing – Part 2), allocating more time on practical training to make the training more practical.

In accordance with the revision method agreed on as described in Section 2.3.1, the forest type maps of 2010 were revised. Also, a new method for the preparation of forest type maps of 2000 and 2005 based on change extraction was developed and agreed with the C/P after discussions. The forest type maps of 2000 and 2005 were prepared in accordance with the new method.

2.3.3 Identification of Carbon Stock and Factors of a High Level of Correlation with Carbon Stock

Factors effective for carbon stratification were studied by performing correlation analysis of average carbon volume per unit area of each plot, existing GIS data (regional data, elevation, Ecoregion, etc.) and data such as canopy cover ratio. Also, the uncertainty of average carbon volume per unit area of each forest type was calculated and the result showed that the uncertainty was not high for any of the forest types.

2.3.4 Determination of Forest Stratification Method

Based on the results of 2.3.3, it was determined that it was not necessary to divide the items any further as far as the carbon volume is concerned. On the contrary, integration of the items was studied instead. Based on the existing data, uncertainty of average carbon volume per unit area and uncertainty of classified area were calculated and overall uncertainty of each forest type and that in the case of integrating the items were tentatively assessed, respectively. Although the assessment was performed only tentatively due to unavailability of the information internationally required for the assessment of comprehensive uncertainty, discussions were held with the C/P with this as a tentative forest stratification proposal to obtain their understanding. It was decided that the final forest stratification should be studied again and determined after preparing the forest type map of 2015 and implementing the NFI in the next phase to obtain the necessary data.

2.3.5 Preparation of National Forest Carbon Maps

Based on the forest stratification proposal studied as described in Section 2.3.4 and the conventional forest classification, forest carbon maps of 2000, 2005 and 2010 were prepared. Also, based on these maps, uncertainty of the changes in total carbon stock was calculated for each, and the uncertainty thus calculated was taken as an alternative to the accuracy assessment results of the forest carbon map.

2.4 Activities related to Output 2

2.4.1 Analysis/Organization of Existing Forest Information Database

The forest management information system (FOMIS) that is being operated by the DOF with the support of SUFORD, Department of Forestry Reporting System (DOF Reporting System) and previous NFI database (ForestCalc) were analyzed. Since the JV that is implementing FPP technical support has organized the existing databases other than Forest Calc, this work was reviewed, with the focus of analysis placed on Forest Calc. Furthermore, the statuses of database assistance by the donor projects were organized based on discussion with the persons in charge.

2.4.2 Review of Functions and Specifications for Statistics/Reporting, etc.

Regarding international reports, review was conducted of country-by-country reports / biennial reports for international organizations such as UNFCC, FRA2015 scheduled to be implemented by FAO, for which support was requested by the DOF in the past. Regarding the data and functions to be stored in NFIDB, the future directions were organized in terms of collection and storage of survey data, available allometric equations, and definitions of average biomass and carbon stocks. Regarding domestic reports, review was conducted on the types of reports made by concerned offices, which were organized through FPP/TA2 activities.

2.4.3 Identification of Types/Specifications of Forest Information Data

Based on the output of 2.4.1 and 2.4.2, identification of the following items were performed: Items that can be used for support with existing forest information (and corresponding statistics), items required for organization/review of statistical/calculation methods, items needed for collection of information from other government organizations (MAF, MONRE, National Geographic Department [NGD], etc.) and projects (SUFORD, CliPAD, etc.), items that can be used for generation of data/specifications from satellite images and geographic/other data, and items for which it will be difficult to perform collection/generation immediately. In addition, the data sources were reviewed in preparation for future international reports to organize the current response statuses and the future response possibilities.

2.4.4 Design of National Forest Information Database (Outline Proposal)

Based on the results of 2.4.1, 2.4.2, and 2.4.3, the relationship with the National Forest Monitoring System (NFMS) was organized, the roles of NFIDB in UNFCCC report and the Global Forest Resources Assessments (FRA) were defined, and the user interfaces (proposal) of NFIDB were reviewed. Regarding the report related to the prototype of the National Forest Information Database, a data product specification (proposal) and a functional requirement definition (proposal) were reviewed and put together.

2.5 Activities Related to Output 3

2.5.1 Review of Past National Forest Inventories

Review was conducted for the past NFI including FIM, from the perspectives of objectives, design, inventory items and implementation system.

2.5.2 Study of Next National Forest Inventory

Requirements and conditions, etc. that need to be considered in the designing of next period NFI from the perspective of REDD+ and sustainable forest management (macro management policy) were to be reviewed, and the options and overview of survey methods were to be studied. Due to the dispatch of Inventory Expert in the 2nd Phase (Apr 2014 to Sep 2015), however, these will be implemented in the 2nd Phase.

2.5.3 Study of Implementation Arrangement for Next National Forest Inventory

The survey system and capacity, etc. related to the FIPD and related local organizations were to be investigated/checked, and the implementation system was to be studied according to the options for the above survey methods. Due to the dispatch of Inventory Expert in the 2nd Phase (Apr 2014 to Sep 2015), however, these will be implemented in the 2nd Phase.

2.5.4 Revise and finialize the Next Natinal Forest Inventoy manual

Draft NFI manual which was created based on the above-mentioned activities wss revised and finalized based on the Pilot survey.

2.6 Activities Related to Output 4

2.6.1 Review of Existing REL/RL Preparation Methods

International trends concerning preparation methods were analyzed/organized based on the case studies such as guidelines concerning preparation of REL/RL at a sub-national/national level (VCS, FCPF, Carbon Fund, etc.) and negotiations/conclusions concerning REL/RL at the UNFCCC.

2.6.2 Review of existing data and initiatives related to MRV at Various Scales

Regarding REDD+ activities that are being formulated/implemented in the Lao PDR on a sub-national/project level, information concerning MRV methodology/content, and in particular, carbon pools, forest classifications, emissions/removals factors and other such data were collected, and harmonization with the national level was examined.

2.6.3 Review of ongoing activities and processes concerning Safeguards (SG) and SG Information System (SIS)

Decisions made at COP19 on Safeguards and SG initiatives of multi-processes such as FCPF and UN-REDD were collected and analyzed. Esp., the status of SG in R-PP of Lao PDR, which is the one of first 14 countries admitted to FCPF, was analyzed. A survey was also conducted as to the safeguards related components in the current legal documents.

2.7 Personnel Deployment

The Experts were deployed as follows.

	Title of Work	Name	From	2014 4	5	6	7	8	9	10	11	12	2015 1	2	3	4	5	6	7	8	9	15/10~16/3	M/M Laos	Japan
Work	Chief Adviser/REDD+	Noriyoshi KITAMURA	Kokusai Kogyo	20 29 10	7 31 18	1 10 7		8 22 15	1 5 5		3 28 20		12~16,26~30 10	23 27 5	2 13 10		11 22 10	1 12 10	13 24 10	3 14 7			6.35	0.33
	Deputy Chief Adviser/Forest GIS /Database1	Masamichi HARAGUCHI	Kokusai Kogyo		7 16 10	3 13 11									3 13 11		25 30 6		6 18 12				1.67	0.00
	Forest GIS/Database2	Toru FURUYA	Asia Air Survey					17 31 15				7 21 15						1 15 15					1.50	0.00
	Forest Remote Sensing1	Mitsuru NASU	Asia Air Survey				20 31 12	1 2 2							2 17 16								1.00	0.00
	Forest Remote Sensing2	Ryota KAJIWARA	Kokusai Kogyo	21 25 5	7 31 25	16 30 30	1 5 5	11 31 21	1~6,29~30 8	1 25 25		8 27 20	13 17 5	16 28 13	1 7 7		13 19 7	29 30 2	1 17 17	27 31			6.17	0.50
	Forest inventry	Sarah Walker	Winrock International		28 31 4	1 12 12			13 30 18	1 3 3					2 9 6		2 10 9		5 17 13				1.97	0.30
	Forest Monitoring	Takayuki NAMURA	Kokusai Kogyo															7~17 7	18~30 1 13	17 17			1.00	0.35
	Cordinator/Forest Inventry Assistance	Yuta MORIKAWA	Kokusai Kogyo				21 31 11	1 2 2	15 30 16	1 11 11		7 27 21				27 30 4	1 15 15	29 30 2	1 18 16				3.27	0.00
																							22.92	1.48

Report/Meeting			
	Reort	Deadline of Submission	Work Plan ▲ ; Work Completion Report ▲
	Training in Japan	Schedule	
	Seminar／Debrief meeting／Technical Workshop	Schedule	Tech WS ▲ ▲ ; Tech WS ▲ ; Tech WS ▲ ; Final WS ▲
	JCC	Schedule	2nd JCC ▲

Works in Lao

Works in Japan/USA

Consultant burden

Chapter3 Results and Achievements by Output

3.1 Achivement of Project goal and outcome of C/P

Objectives and output which were mentioned on 1.2 were completed. The details are descrived in followings.

3.2 Output 1

The work related to output 1 can roughly be divided into accuracy assessment, carbon stratification and correction of the forest type maps and an overview of the respective workflow (Figure 3-1). Accuracy assessment, a portion of carbon stratification and the ground truth survey for correction of the forest type map consist of work content conducted in the first year.The work carried out in the second year consists of final accuracy assessment, partial carbon stratification, preparation and revision of the forest type maps of 2000, 2005 and 2010 and preparation of the forest carbon maps.

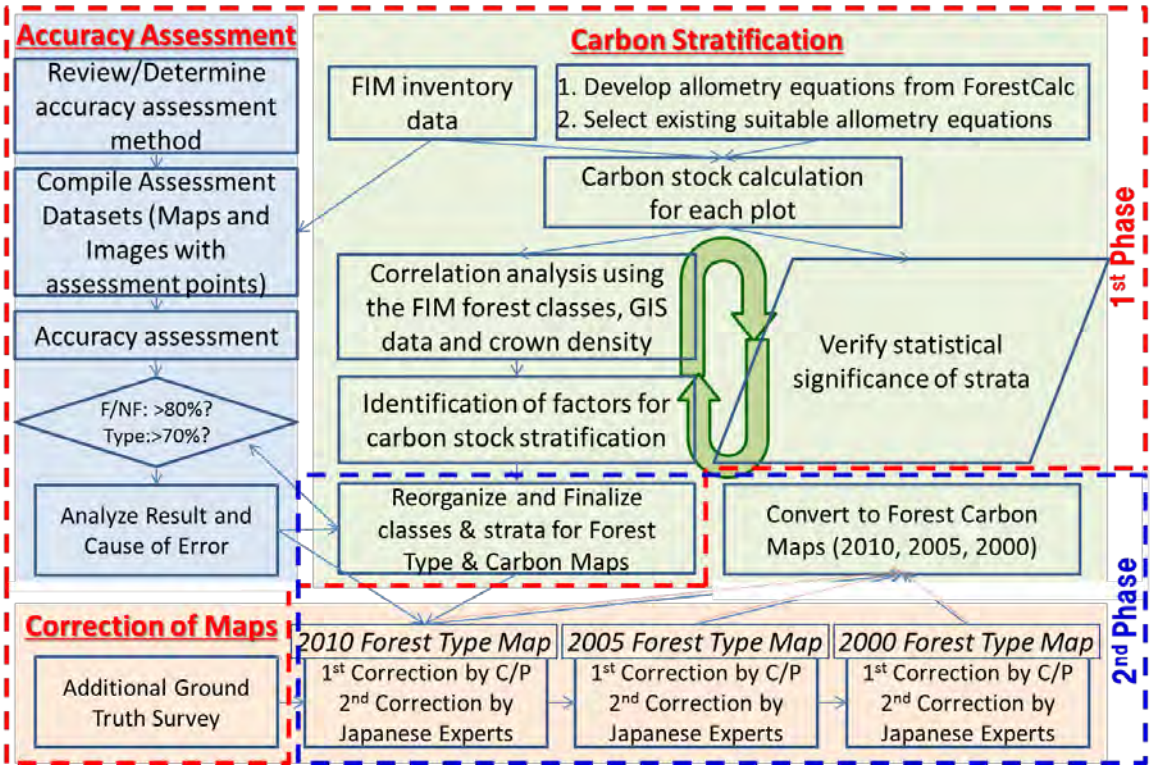


Figure 3-1 Work Flow Related to Output 1

3.2.1 Accuracy assessment of Forest Type Map (2010)

The accuracy assessment methodologies for the 2010 forest type map which will become the forest base map were determined after discussions with the C/P. The work flow related to accuracy assessment is shown in Figure 3-2.

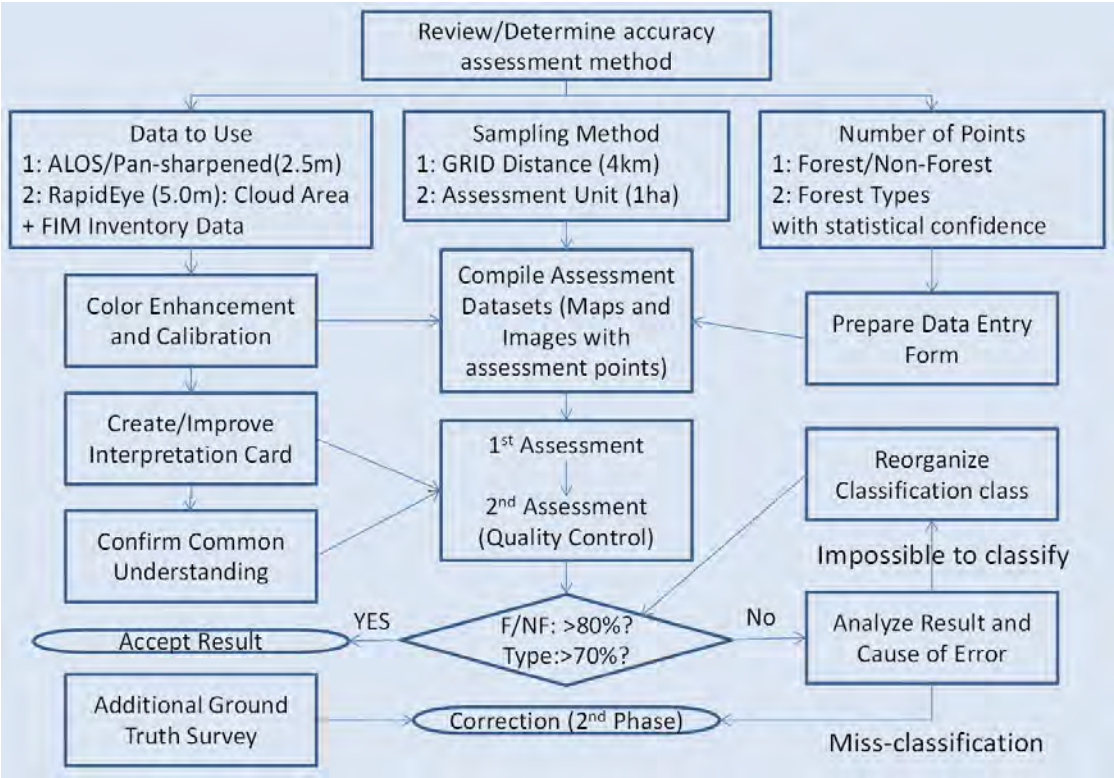


Figure 3-2 Work Flow Related to Accuracy assessment

The decision was made to generate points on a 4 km grid (Figure 3-3) and use this as the accuracy assessment sampling methodology, which is the methodology that is adopted by Japan and many other countries, calculate the number of samples required statistically, and select them randomly.

When the number of samples statistically required was calculated with an existing calculation formula1, it was found that 100 points per classification class would be adequate, including spare points. Since there are 13 classification classes, this results in a total of 1,300 points. The number of samples in each province and each classification class were calculated (Table 3-1) by multiplying the area of each province and each classification class by the ratio that the area accounts for out of the total area of the country. However, due to the fact that experience indicates that 75 sample points are required per classification class when the target area is wide ranging[1], the number of samples for classification classes for which the calculated number of sample was less than 75 was increased to 75 sample points (blue numbers in Table 3-1), and for classification classes for which the total number of points on the 4 km grid was less than 75 points, the decision was made to sample all points on the 4 km grid (red numbers in Table 3-1). After this, as shown in Figure 3-4, the numbers of samples calculated from the points on the 4 km grid were randomly selected.

[1] Congalton RG, Green K (1999) Assenssing the accuracy of remotely sensed data: principles and practices, CRC Press

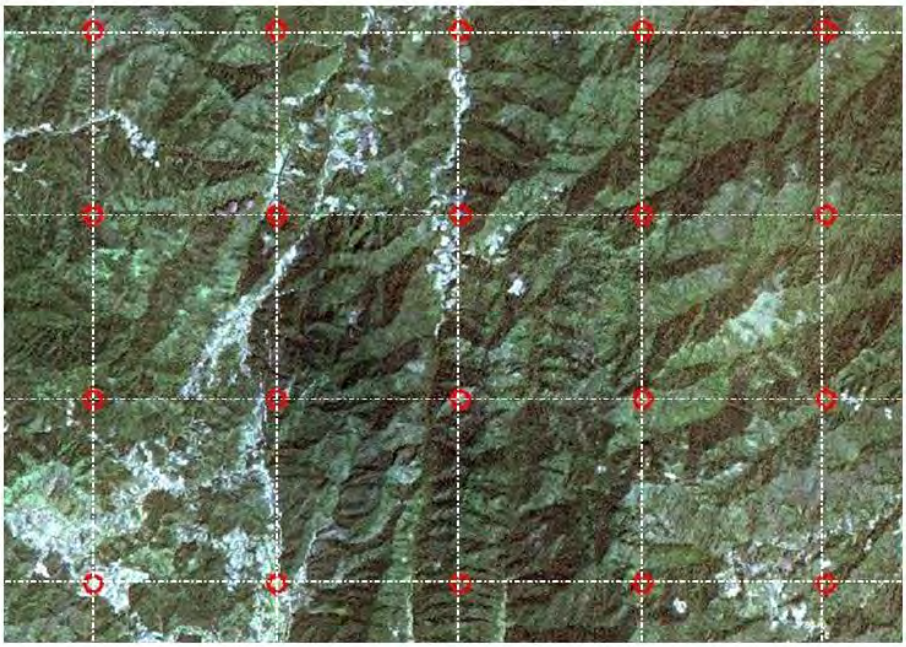


Figure 3-3 4 km Interval Grid Points Made on Satellite Image

Table 3-1 Calculation of Number of Sample Points

Rate of occupied area by each provinces and classes in whole country

	Current Forest								Potential Forest				NF
	EF	DF	MED	CF	MCB	DD	EP	DP	B	OF	YF	SB	
Phongsaly	0.2%	1.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.1%	0.5%	0.2%	0.4%
Luangnamtha	0.3%	2.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.2%	0.1%	0.2%	0.1%
Oudomxay	0.4%	2.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	0.1%	0.3%	0.1%
Luangprabang	0.5%	3.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	3.1%	0.2%	0.4%	0.5%
Houaphanh	0.0%	3.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	2.7%	0.1%	0.3%	0.4%
Bokeo	0.2%	1.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%	0.1%	0.1%	0.2%
Xiengkuang	0.2%	2.7%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%	0.1%	1.9%	0.2%	0.1%	0.7%
Xayaboury	0.6%	3.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	1.4%	0.7%	0.2%	0.5%
Vientiane	1.2%	3.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	1.3%	1.0%	0.2%	1.3%
Bolikhamxay	0.9%	3.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	1.5%	0.3%	0.1%	0.6%
Vientiane Capital	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.3%	0.0%	0.6%
Khammuane	0.9%	1.9%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	2.3%	0.3%	0.1%	1.6%
Savannakhet	0.0%	3.0%	0.0%	0.0%	0.0%	1.5%	0.0%	0.1%	0.0%	2.8%	0.1%	0.3%	1.4%
Saravane	0.0%	1.8%	0.0%	0.0%	0.0%	0.9%	0.0%	0.0%	0.0%	0.5%	0.1%	0.0%	1.0%
Sekong	0.1%	2.1%	0.0%	0.1%	0.0%	0.2%	0.0%	0.0%	0.0%	0.8%	0.0%	0.1%	0.2%
Champasak	0.1%	3.1%	0.0%	0.0%	0.0%	1.7%	0.1%	0.0%	0.0%	0.2%	0.1%	0.0%	1.2%
Attapeu	0.1%	2.7%	0.0%	0.0%	0.0%	0.5%	0.0%	0.0%	0.1%	0.6%	0.0%	0.0%	0.4%

Number of sampling points for accuracy assessment

	Current Forest								Potential Forest				NF
	EF	DF	MED	CF	MCB	DD	EP	DP	B	OF	YF	SB	
Phongsaly	3	17	0			0		1	0	53	10	5	6
Luangnamtha	5	29	0			0			2	16	1	5	2
Oudomxay	5	28	0			0			0	27	2	7	2
Luangprabang	7	50	0			0		0	4	41	4	11	7
Houaphanh	0	48	0		0	0			21	35	2	9	6
Bokeo	2	21	0			0			2	12	1	3	2
Xiengkuang	3	35	0	1	1	0			10	24	4	3	11
Xayaboury	8	43	0			0			6	18	13	6	7
Vientiane	16	40	0	0	0	0			19	17	18	6	19
Bolikhamxay	12	42	0		0	0		0	4	20	6	3	9
Vientiane Capital	0	6	0		0	0		0	1	4	5	1	8
Khammuane	11	24	0	3	0	0		0	0	30	5	3	24
Savannakhet	0	39	0			23		1	0	37	2	8	21
Saravane	0	23	0	0		14	0	0	0	7	1	1	16
Sekong	1	27	0	1		4	0		0	11	0	3	3
Champasak	1	40	0			26	1		2	3	1	0	18
Attapeu	1	35	0	0		8	1		4	7	0	1	5
	75	547	0	49	17	75	19	21	75	362	75	75	166	1556

Calculating

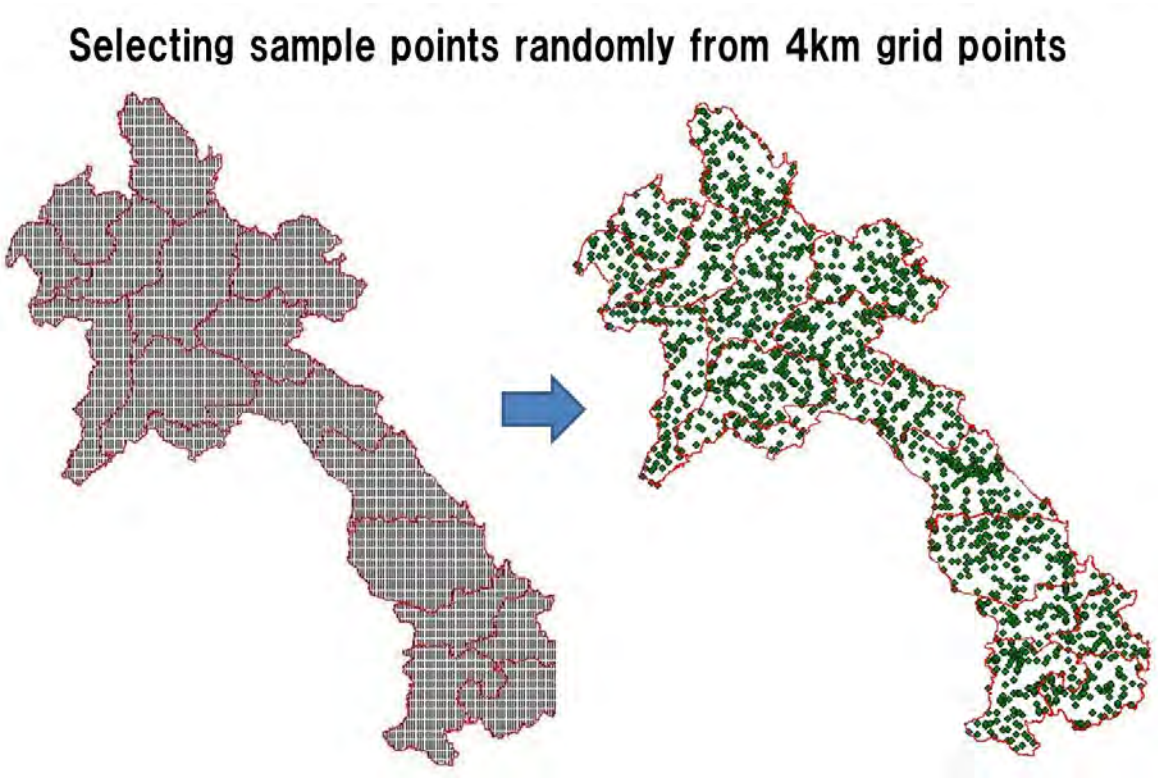


Figure 3-4 Allocation of Samples

The 2010 forest type map which was the subject of accuracy assessment was prepared using RapidEye images captured in 2010. The reference images used for accuracy assessment should be high resolution images. Due to the fact that the only images available which cover the entire country of Laos other than RapidEye images that were captured at the same time are the ALOS Pansharpen images captured in 2010, these images were mainly used as the reference images, and RapidEye images were substituted for images for which the time the images were captured differed (yellow frame in diagram) or locations where there were clouds (Figure 3-5). The difference in resolution of ALOS Pansharpen images and RapidEye images is shown in Figure 3-6. In addition, when an image is used for reference purposes, due to the fact that there are differences due to the impact from clouds and atmosphere when the images were captured, it is difficult to perform accuracy assessment in an appropriate manner without performing tone correction since the images appear different when displayed. In order to unify the tone of all images to the extent possible so the quality of accuracy assessment results is uniform, tone correction of all images was performed as shown in Figure 3-7.

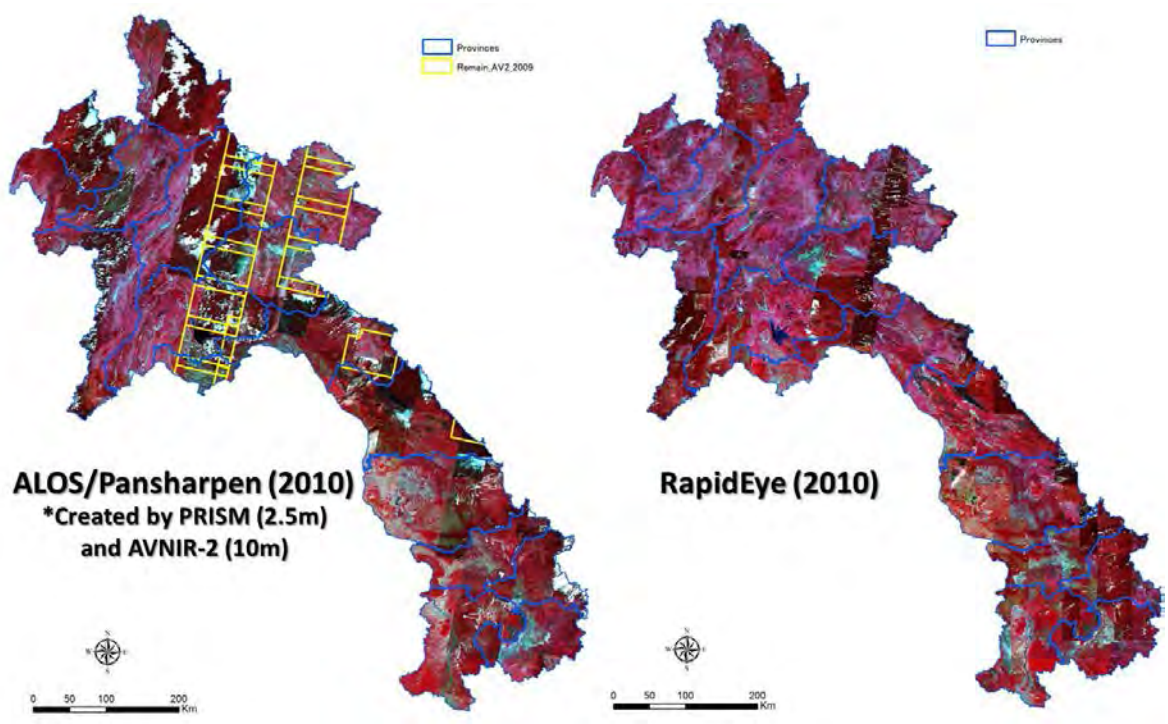


Figure 3-5 Satellite Images Used for Accuracy assessment (Left: ALOS Pansharpen, Right: RapidEye)

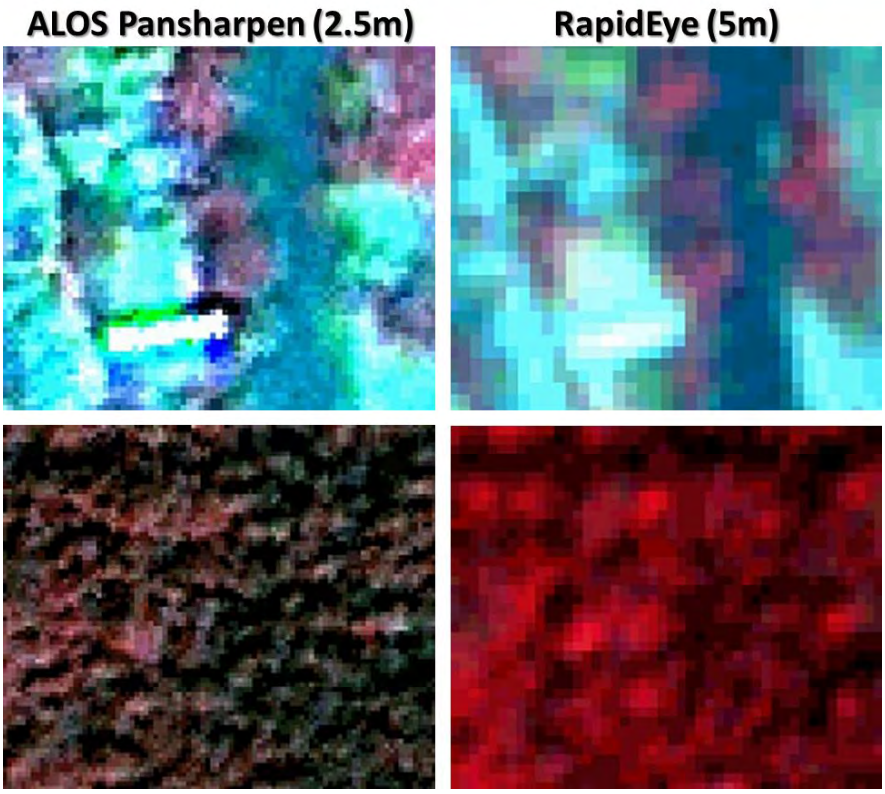


Figure 3-6 Difference in Resolution of Satellite Images Used for Accuracy assessment (Upper: Trees and village along river, Lower: Forest)

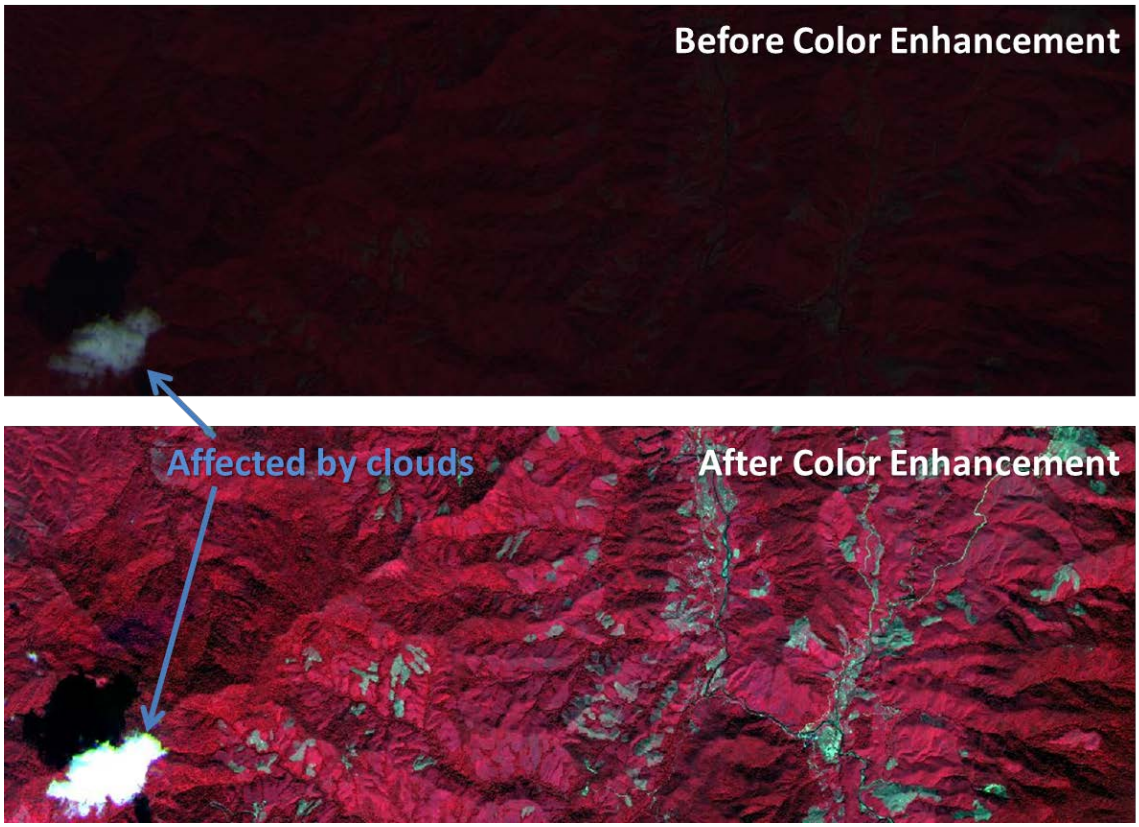


Figure 3-7 Tone Correction Image

The work flow for accuracy assessment is shown in Figure 3-8, and the implementation system is shown in Figure 3-9. The table in the upper part of Figure 3-9 shows the implementation system for the first accuracy assessment, the table in the middle part shows the implementation system for the second accuracy assessment, and the table in the lower part shows the allocation of provinces handled by each team. "FIM Inventory" in the tables in the upper / middle part of the diagram indicates the respective province when the FIM inventory study was performed, and "Assess" indicates the province for which work was performed during this accuracy assessment process. As shown in Figure 3-8 and Figure 3-9, the first accuracy assessment work was conducted by the C/P RS/GIS technical experts, and the second accuracy assessment work was conducted by senior RS/GIS technical experts with an advanced level of technology and wealth of experience in an effort to upgrade the quality. Furthermore, technical experts who worked on the forest study conducted during the FIM project who have a good knowledge of local conditions were designated as the persons in charge, and the technical experts were placed in charge of accuracy assessment of the province that they were actually in charge of at that time. In addition, the Japanese RS/GIS technical experts conducted final third accuracy assessment work, with a focus on sample points for which the reliability was thought to be low during the first / second accuracy assessment in an effort to further boost quality. Furthermore, at the end of each work day, some of the work results of that day were checked by all staff in an effort to share interpretation standards to facilitate quality management (Figure 3-10).

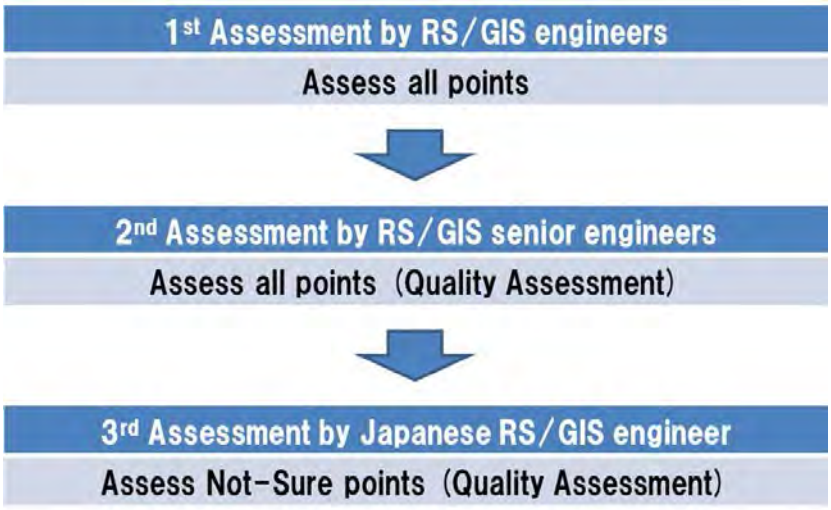


Figure 3-8 Accuracy assessment Work Flow

Team	1st Assessor	FIM Inventory	Assess	Supporter
1	Phouthone	1	1	Chansamouth
2	Keovilay	2	2	Khamsouk
3	Kongsy	0	3	Bounthanome
4	Souvanna	6	4	Khamkhong
5	Piya	5	5	Onkeo
6	Somxay	6	6	Amphaivanh
	Siamphone	0	6	

Team	2nd Assessor	FIM Inventory	Assess
1	Chansamouth	1	1
2	Khamsouk	2	2
3	Bounthanome	3	3
4	Khamkhong	4	4
5	Onkeo	5	5
6	Amphaivanh	6	6

Team	Provinces for each teams			
1	Ponsaly	Oudomxay		
2	Xaybuly	Luannamtha	Bokeo	
3	Luangphabang	Xienkuang	Houaphang	
4	Vientian C	Vientiane	Bolikamxay	Xaisomboune
5	Khamouan	Swamnakeht	Salavang	
6	Champasak	Sekong	Attaphou	

Figure 3-9 Accuracy assessment Implementation System

Figure 3-10 Accuracy assessment of the day's results checked by all staff members

The thinking on the target range of judgments on interpretation when accuracy assessment was performed was determined as shown in Figure 3-11 after discussions with the C/P. First, the uniform land cover / usage range that included the selected sample points was referred to, and when the area of this range was 0.5 ha or more (one forest definition in Laos), this range was judged as a target area. However, when the area of this range was less than 0.5 ha, the decision was made to use the adjoining area in this range with uniform land cover / usage for which the borderline is the longest and the area is 0.5 ha or more. The reason for this is that polygons which were less than the Lao's forest definition and minimum mapping unit definition of 0.5 ha were integrated with adjacent polygons with the ArcGIS elimination process, and an algorithm was used to integrate polygons that were integrated by this process with an adjacent polygon that has the longest shared borderline.

The judgment procedure consisted of first making the judgment as to whether an area is forest or non-forest, and next making the judgment on the respective forest type (Figure 3-12). The reason for this is that the decision was made that the judgment of forest / non-forest is more important since the national level forest type map accuracy that is currently required internationally is forest / non-forest classification accuracy. Regarding the judgment of forest type, while the classification class that belongs to the Current Forest group which currently satisfies the forest definition of Laos does not include shifting cultivation areas, since there

have been discussions on whether or not shifting cultivation land which belongs to the Potential Forest group should be considered forests, when reported internationally, the decision was made to make judgments of these areas as a precautionary measure. The decision was also made to lump together all other classification classes as non-forest areas.

In addition, after discussions with the C/P, the decision was made to make a judgment at two scales as shown in Figure 3-13: 1/25,000 and 1/5,000. Details can be confirmed at a scale of 1/5,000, but by also confirming the land use status in the surrounding area, the accuracy of judgments can be enhanced. When the scale is not predetermined, it would mean that judgments would be made at each scale separately, and this causes fluctuations in the quality of judgment results. Therefore, the scale when judgments are made should be fixed.

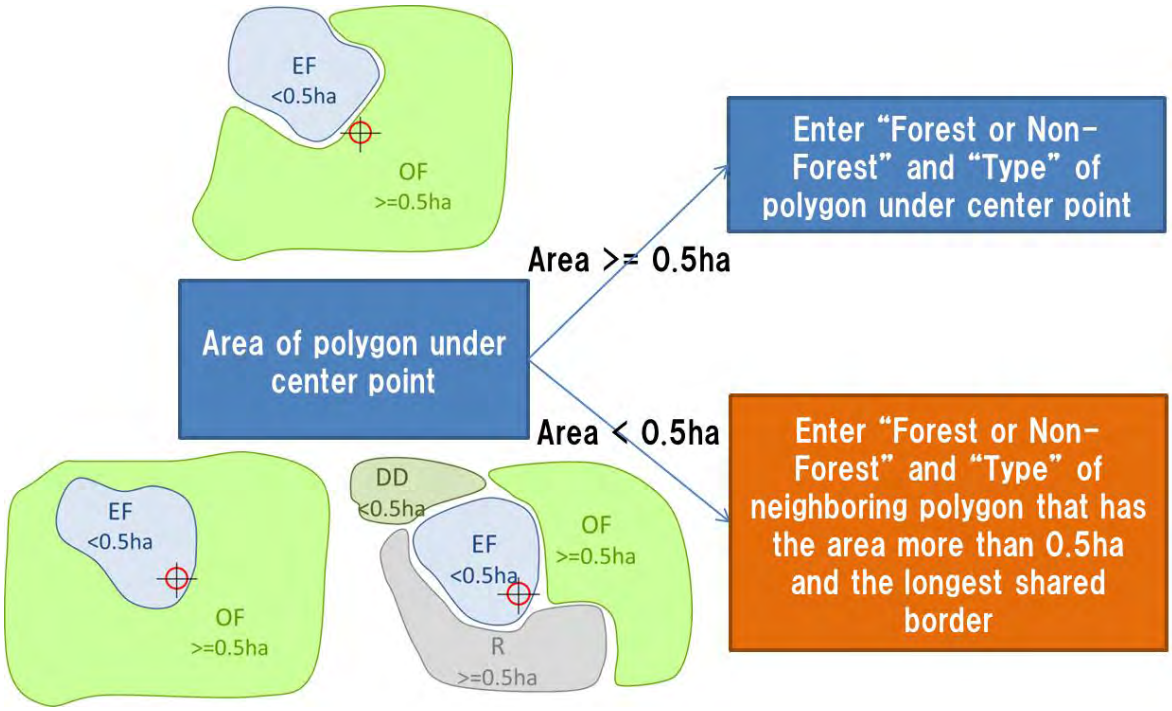


Figure 3-11 Approach to Target Range Judged

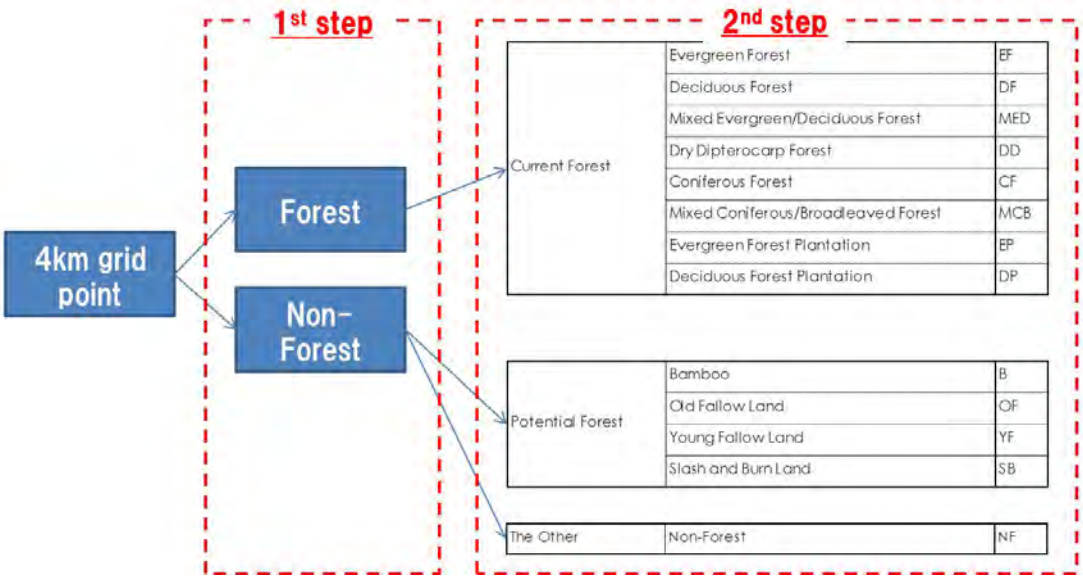


Figure 3-12 Judgment Steps

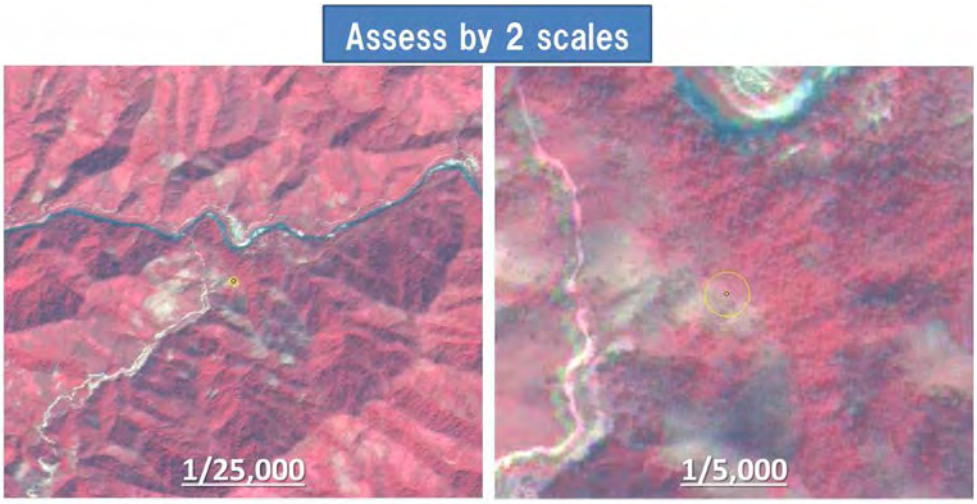


Figure 3-13 Scale Used for Judgment

The work flow after accuracy assessment is performed is shown in Figure 3-14. When the accuracy assessment results do not have an accuracy of 80% or more for forest / non-forest classification, and when the classification accuracy of forest types specifically mentioned in the specifications does not have an accuracy of 70% or more, the cause for the low level of classification accuracy is to be analyzed. When the cause is a judgment mistake, efforts are made to boost the judgment capacity based on the results of the ground truth survey conducted in the first year, and judgment correction of the forest type map is performed in the second year. However, when the judgment is made that classification is difficult with only the information that can be obtained from the images and field knowledge of the C/P, integration with other classification classes needs to be performed in an effort to boost classification accuracy.

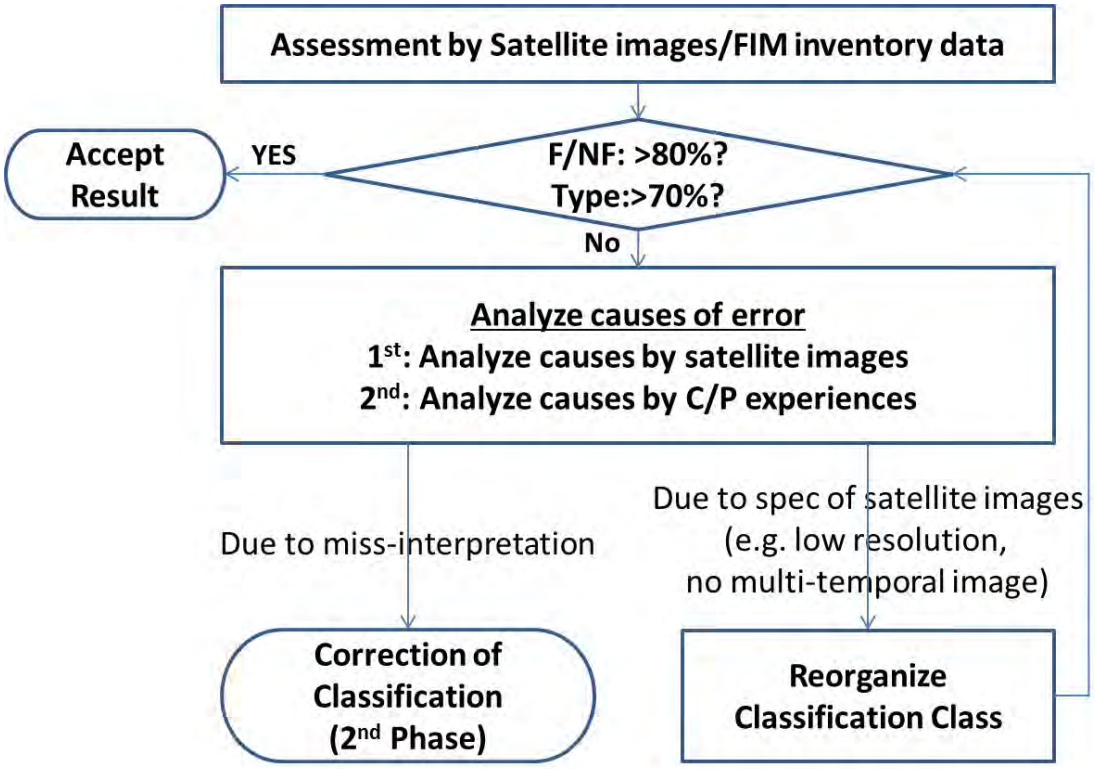


Figure 3-14 Work Flow after Accuracy assessment Performed

Training that included practical training was implemented for the accuracy assessment methodologies that had been determined, and a simple test was given in an attempt to judge the level of understanding by the trainees. Training in Japan was first conducted for four senior technical experts, and after that, training was conducted locally for the other technical experts. The test results improved after training compared to before training, indicating that a certain extent of progress was made with technology transfer as a result of training. In addition, continued OJT practical training was performed after this to further enhance the level of technology.

The verification results of the forest / non-forest classification accuracy on the 2010 forest type map that was inferred in accordance with the above described accuracy assessment methodologies is shown in Table 3-2, Error Matrix for Forest / Non-Forest Classification. Due to the fact that the Shifting cultivation land classification class in the Potential Forest group is defined at this point in time as non-forest in Laos, it was treated as non-forest during this accuracy assessment. This resulted in an overall accuracy of 72.8% in the classification of forest / non-forest areas. While this is lower than the forest / non-forest classification accuracy of 80% that was specially designated for this project, it is a figure that can most likely be achieved by means of the correction work in the second year.

Table 3-2 Error Matrix for Forest / Non-Forest Classification

		Assessment data			
		Forest	Non-Forest	Total	U.A
Map	Current Forest	530	213	743	71.3%
	Potential Forest	147	379	526	74.5%
	NF	28	131	159	
	Total	705	723	1428	
	P.A	75.2%	70.5%		
Overall Accuracy		72.8%			

The verification results for forest type classification accuracy of the 2010 forest type map are shown in Table 3-3, Error Matrix for Forest Type Classification. As mentioned above, due to the fact that the Shifting cultivation land classification class in the Potential Forest group is defined at this point in time as non-forest in Laos, it was treated as non-forest along with other such classification classes. This resulted in an overall accuracy of 61.8% in the classification of forest types. While this is lower than the forest type classification accuracy of 70% that was the goal for this project, it is a figure that can most likely be achieved by means of integration of sorting items and correction work in the second year.

Table 3-3 Error Matrix for Forest Type Classification

			Assessment data									
			Current Forest							NF	Total	U.A
			EF	DF	MED	DD	CF	MCB	EP	DP	NF		
Map	Current Forest	EF	15	48							5	68	22.1%
		DF	35	291		20	3	1			147	497	58.6%
		MED									0	0	
		DD		9		34			1		31	75	45.3%
		CF	1	15		4	15	3			11	49	30.6%
		MCB		2			8	5			2	17	29.4%
		EP							15		4	19	78.9%
		DP		5					2		11	18	0.0%
	NF	NF	15	117	0	34	5	2	2	2	508	685	74.2%
	Total		66	487	0	92	31	11	20	2	719	1428	
	P.A		22.7%	59.8%		37.0%	48.4%	45.5%	75.0%	0.0%	70.7%		
Overall Accuracy			61.8%										

In order to allow analysis of the verification results of the forest type classification accuracy in further detail, the accuracy assessment results including the Shifting Cultivation area classes in the Potential Forest group are shown in Table 3-4, Error Matrix regarding the classification classes for which a User Accuracy (U.A.) of 70% was not achieved that indicates the level of conformity with the classification class judged in classification class accuracy assessment of the forest type map, the causes were analyzed.

Table 3-4 Error Matrix for Forest Type Classification, Including Potential Forest Classes

			Assessment data														
			Current Forest								Potential Forest				NF	Total	U.A
			EF	DF	MED	DD	CF	MCB	EP	DP	B	OF	YF	SB	NF		
Map	Current Forest	EF	15	48							1	4				68	22.1%
		DF	35	291		20	3	1			22	103	6	5	11	497	58.6%
		MED														0	
		DD		9		34			1			9	1		21	75	45.3%
		CF	1	15		4	15	3			1	10				49	30.6%
		MCB		2			8	5							2	17	29.4%
		EP							15						4	19	78.9%
		DP		5					2			5	3		3	18	0.0%
	Potential Forest	B	2	17				1			19	17	6		8	70	27.1%
		OF	10	77		21	2				27	141	16		27	321	43.9%
		YF	1	5		1	1	1		2	4	19	11	3	23	71	15.5%
		SB		3		3	1				2	5	13	13	24	64	20.3%
	NF	NF	2	15		9	1	0	2	0	2	6	6	1	115	159	72.3%
	Total		66	487	0	92	31	11	20	2	78	319	62	22	238	1428	
	P.A		22.7%	59.8%		37.0%	48.4%	45.5%	75.0%	0.0%	24.4%	44.2%	17.7%	59.1%	48.3%		

3.2.2 Method of Integration and Revision for Improvement of Classification Accuracy

As a result of the analysis in Section 3.2.1, the accuracy improvement method was studied as described in Table 3-5 and discussions were held with the C/P to obtain their agreement. Detailed description of the method is as follows.

Table 3-5 Method of Integration and Revision for Improvement of Classification Accuracy

Methods to Improve Accuracy of Classification

	Difficult Classification	Priority	Which Team?	Specific Method	Order of Correction
Aggregation	DF/MED			Aggregate to MD	
	EP/DP			Aggregate to P	
	OF/YF/B			Aggregate to FL -> C/P required that B should be distinguished.	
Correction	EF/MD	4	Every Teams	1) Create EF zone data. (NBCA: existing, Near border/Far from Shifting Cultivation: need to be created.) 2) To correct EF in zone area, if there is MD. 3) To correct MD in the other area, if there is EF.	2nd
	MD/FL	1	Every Teams	1) PALSAR data is pre-processed. (Japanese Expert) 2) To correct by interpretation refered PALSAR data.	
	CF/MCB	5	Team A (Sekong, Khamuane) Team B (Bolikhamsay) Team C (Houaphang, Xiengkuang, (Phonsaly))	1) Create CF zone data. 2) To correct CF/MCB in zone area. 3) To correct CF/MCB in the other area.	
	DD/NF (SA, SR, RP)	2	Team A (Every Provinces) Team B	1) To correct by interpretation refered interpretation cards.	3rd 4th 1st
	CF/MD, FL	3	Team A (Sekong, Khamuane) Team B (Bolikhamsay) Team C (Houaphang, Xiengkuang, (Phonsaly))	1) Create CF zone data. 2) To correct CF/MCB in zone are. 3) To correct CF/MCB in the other area.	
	FL, SB/NF (RP, etc)	6	Every Teams	1) PALSAR data is pre-processed. (Japanese Expert) 2) To correct by interpretation refered PALSAR data, slope information and shape of object.	

Integration

DF （Deciduous Forest） / MED （Mixed Evergreen and Deciduous Forest）

MED areas are not classified on the forest type map, and it became clear after checking with the C/P that these areas were classified as MD (Mixed Deciduous Forest), which is a previous classification class that combines DF and MED. In practice, it is difficult to distinguish between DF and MED, and since it is considered practical to integrate these classes as MD, a proposal was made to integrate them that was agreed to.

EP （Evergreen Forest Plantation） / DP （Deciduous Forest Plantation）

Many DP areas are incorrectly classified as DF or OF areas. Experience up until now during preparation of the forest type maps and discussions with the C/P indicate that DP areas are obviously different in color tone from DF or OF areas. As such, it is considered that this incorrect classification is caused by interpretation error. On the other hand, although it was perceived that DP areas in the Lao PDR were only teak forests, it was confirmed during the ground truth survey conducted in the first year that rubber forests in the northern part of the country were deciduous. Since rubber forests in the central and southern parts were not deciduous,

they were classified as EP, but as it became clear that some rubber forests are deciduous as described above, it is difficult to strictly distinguish EP and DP. Therefore, a proposal was made to integrate them as P (Forest Plantation) that was agreed to.

OF（Old Fallow Land）/ YF（Young Fallow Land）/ B（Bamboo）

Many OF areas are incorrectly classified as DF areas and many YF areas are incorrectly classified as OF or NF areas. With respect to OF areas and DF (MD) areas, it is possible to improve the accuracy by revision as described later. However, as shown in Figure 3-15, YF areas and OF areas are similar to each other in terms of color tone and texture, which makes it difficult to classify between them. Therefore, a proposal was made to integrate OF and YF into FL (Fallow Land) that was agreed to. In addition, it is presumed that NF areas that were incorrectly classified as YF areas were, in fact, OA (Other Agriculture) or G (Grassland) areas, but since the distribution areas of these areas are different from that of YF areas, it is considered possible to improve the accuracy by revision.

On the other hand, with respect to B areas, many of them are incorrectly classified as DF or OF areas. From the experience of preparing the forest type maps and discussions with the C/P, it is known that classification between B areas and OF areas is particularly difficult. Also, it was reconfirmed on site during the ground truth survey implemented in the first year that although the difference can be seen on the super high resolution satellite image as shown in

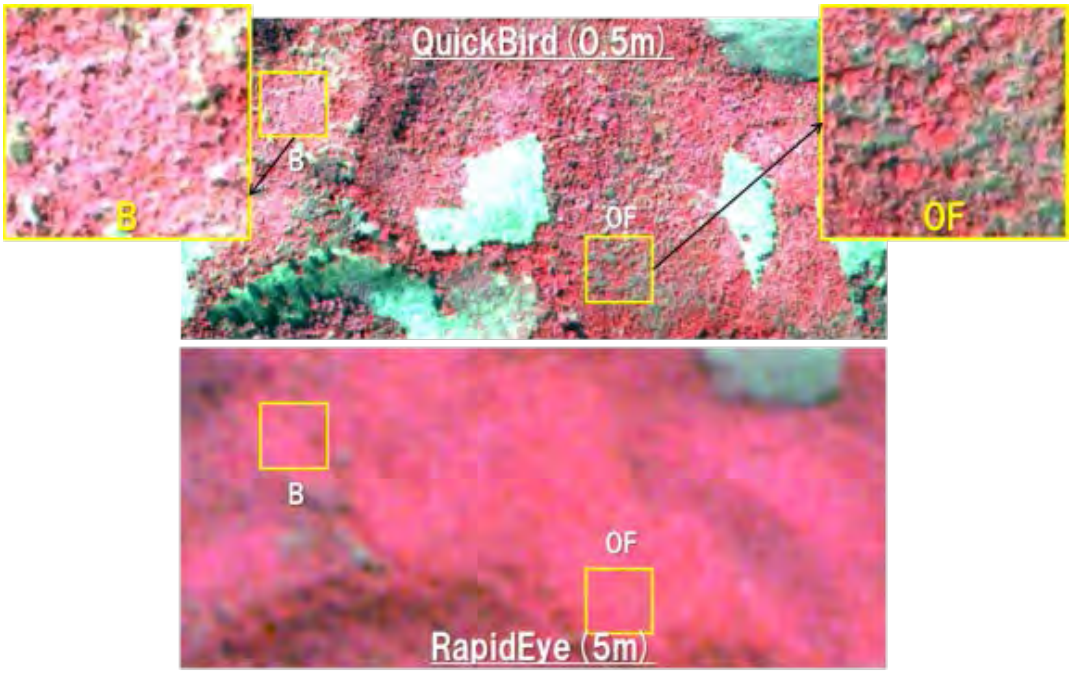


Figure 3-16, they look similar in terms of color tone and texture on the RapidEye image and it is difficult to distinguish them. Moreover, since most B areas are distributed in slash and burn areas mixed with OF and YF areas, it is considered desirable to integrate FL, which is a combination of OF and YF, with B. However, as a result of discussions with the C/P, this proposal was not accepted for the reason that B areas are important vegetation for the Lao PDR, as they are subject to research, and it was decided that they should

remain classified. As it is difficult to classify them on images, it was decided to classify these areas based on the information on the distribution of B areas retained by the C/P.

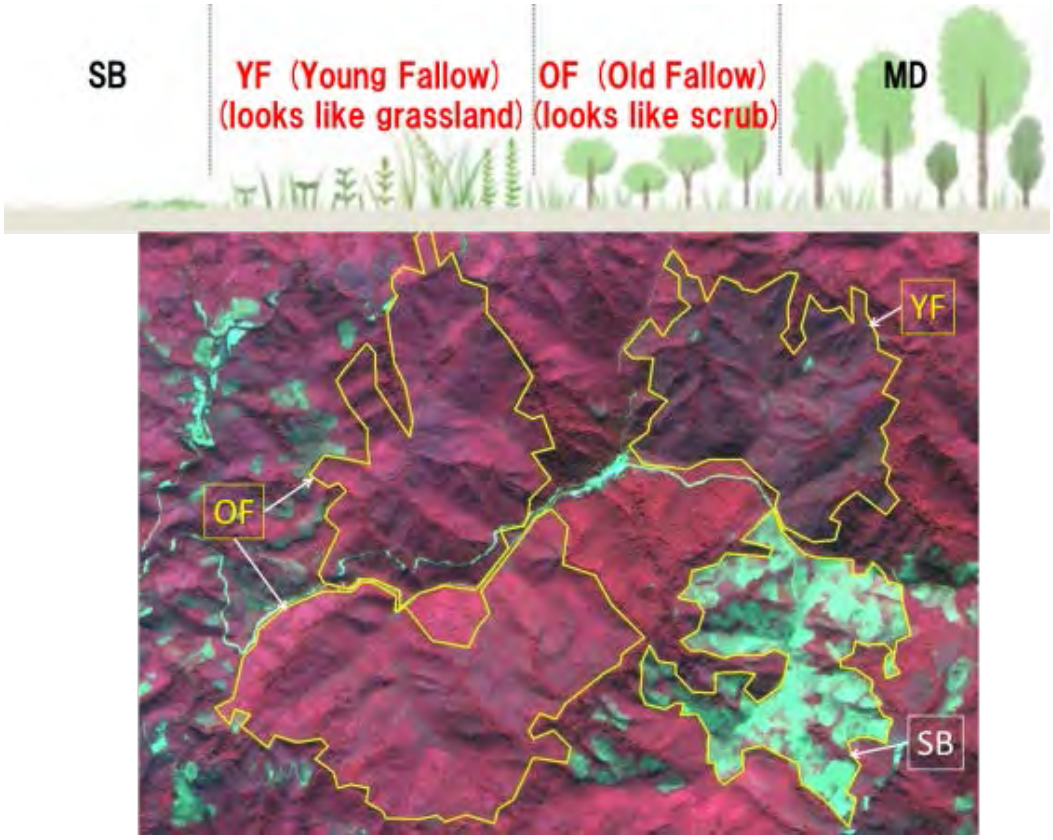


Figure 3-15 OF and YF on RapidEye Image

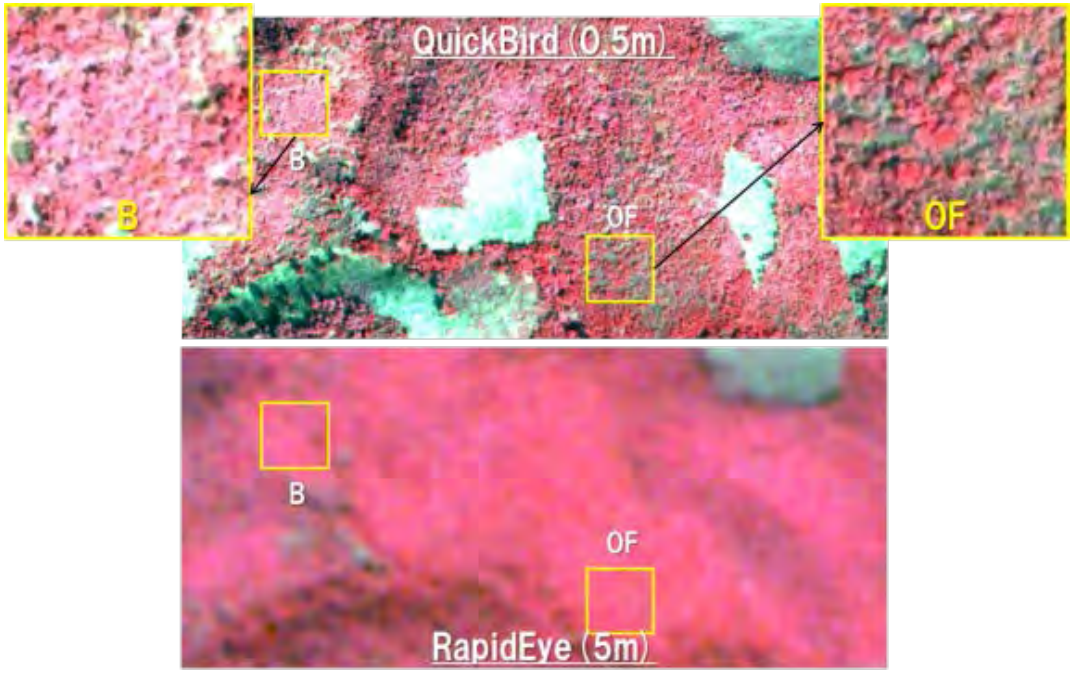


Figure 3-16 B and OF on QuickBird and RapidEye Images

Revise

EF （Evergreen Forest） /MD （Mixed Deciduous Forest）

Many EF areas are incorrectly classified as MD (DF) areas. Difficulty in the classification between EF and MD areas has been reported in Luang Prabang Province and it was also confirmed during the ground truth survey implemented in the first year. However, as described later in "3.2.9 Identification of Factors with a High Correlation with Carbon Stock", there is a clear difference in the amount of biomass between EF and MD and since the C/P strongly requested that they should remain classified, a revision method using the existing GIS data was studied.

As a result of discussions with the C/P, distribution area information, elevation and precipitation were pointed out as candidate information that may contribute to the improvement of accuracy. First, with respect to elevation and precipitation, the relationship with the distribution area of EF and MD was analyzed as shown in Figure 3-17 and Figure 3-18. As a result, no significant difference between EF and MD was identified for any of the indicators. On the other hand, it is known that EF areas are mostly distributed to NBCA (National Biodiversity Conservation Area), mountainous areas along the national border and remote areas that are not influenced by people (hereinafter referred to as EF zone). As EF and MD have similar color tones and textures on satellite image, classification at a high accuracy takes time since it requires careful interpretation of patterns (in most cases, EF has no human influence on the periphery, while MD has human influence on the periphery). Therefore, it was decided to focus on the EF zone to interpret patterns to achieve efficiency in revision.

First, a senior technical expert who is familiar with the site roughly marked the EF zone. Next, MD areas in the marked EF zone were extracted using the search function and correctness of the interpretation was checked for revision. Finally, EF areas outside the EF zone were extracted using the search function and correctness of the interpretation was checked for revision.

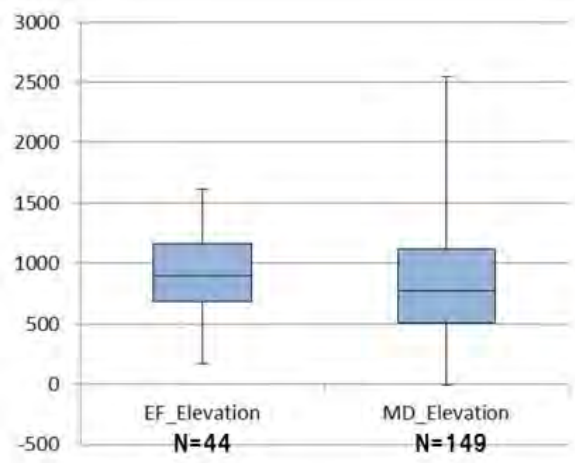


Figure 3-17 Elevation of Distribution Areas of EF and MD

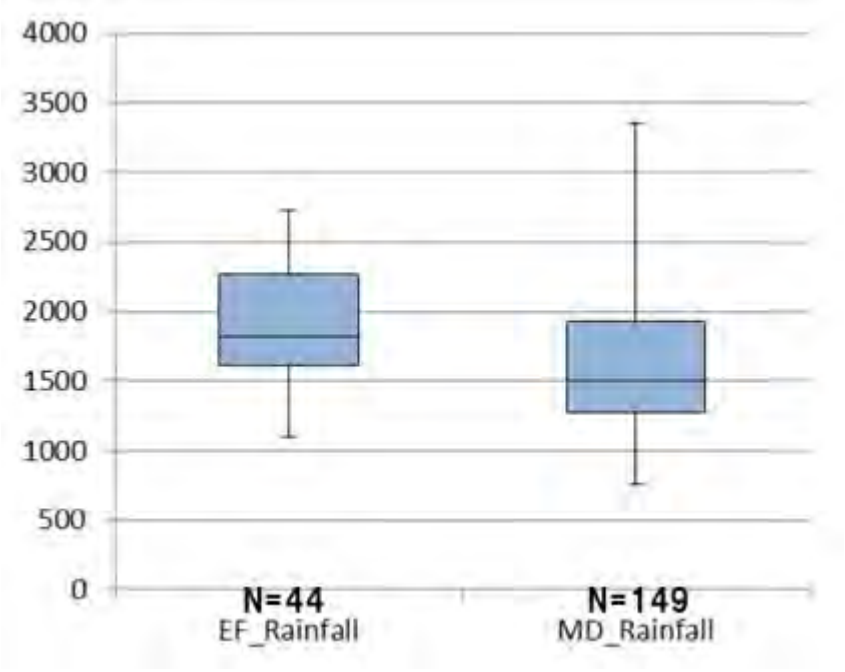


Figure 3-18 Annual Precipitation of Distribution Areas of EF and MD

MD（Mixed Deciduous Forest）/FL（Fallow Land）

Many MD (DF) areas are incorrectly classified as FL (OF). Since the area of MD and FL combined accounts for more than 70% of the national land of the Lao PDR, improvement of its classification accuracy was defined to be the most important revision work, as it can greatly improve the overall classification accuracy. Since MD and FL have continuous transitional stages as shown in

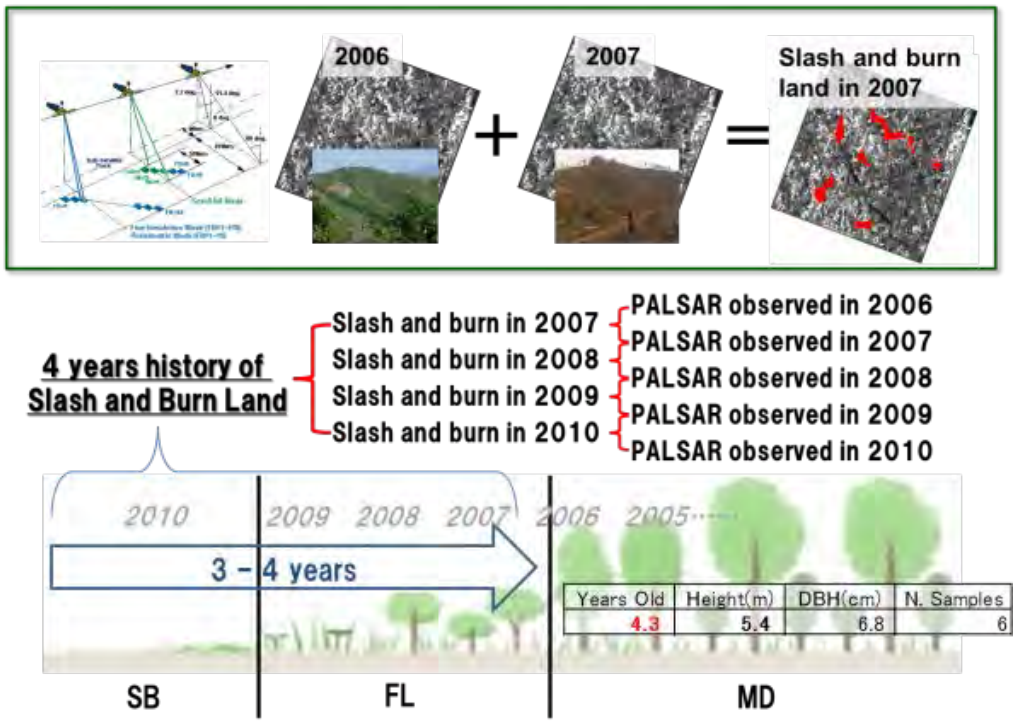


Figure 3-19 it is very difficult to classify them near the threshold value of these boundaries. It was decided to adopt change extraction using ALOS/PALSAR to improve the classification accuracy between them. ALOS/PALSAR is a kind of synthetic aperture radar (SAR) sensor and it can measure the physical property of substances on the ground surface and easily extract the areas that underwent changes by measuring the same ground surface at different timings. First, as shown in

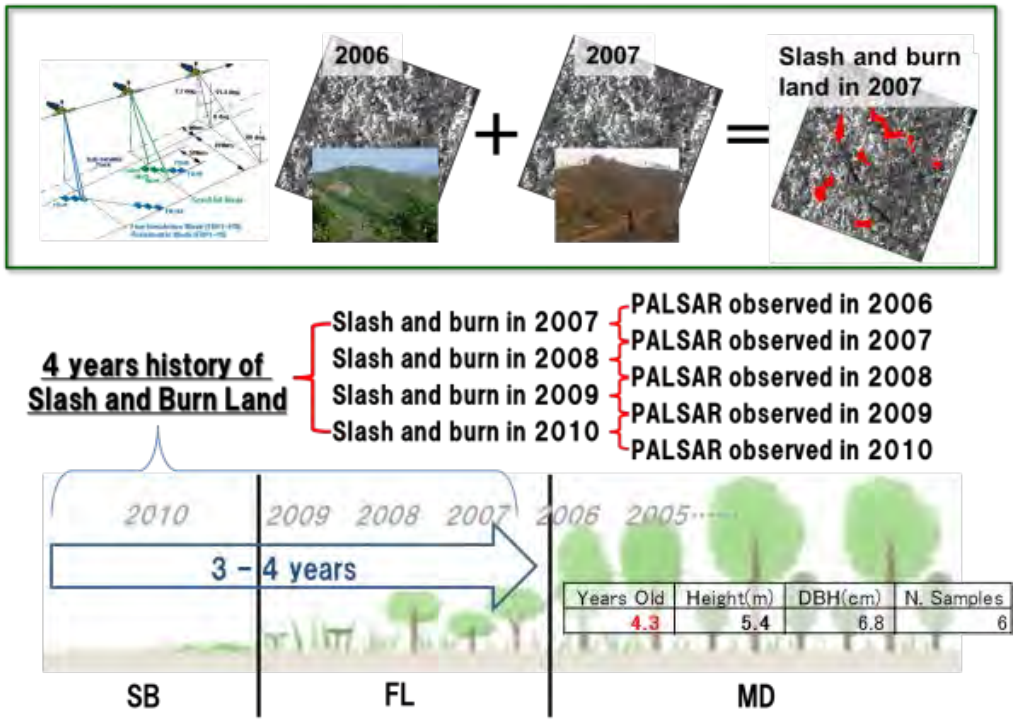
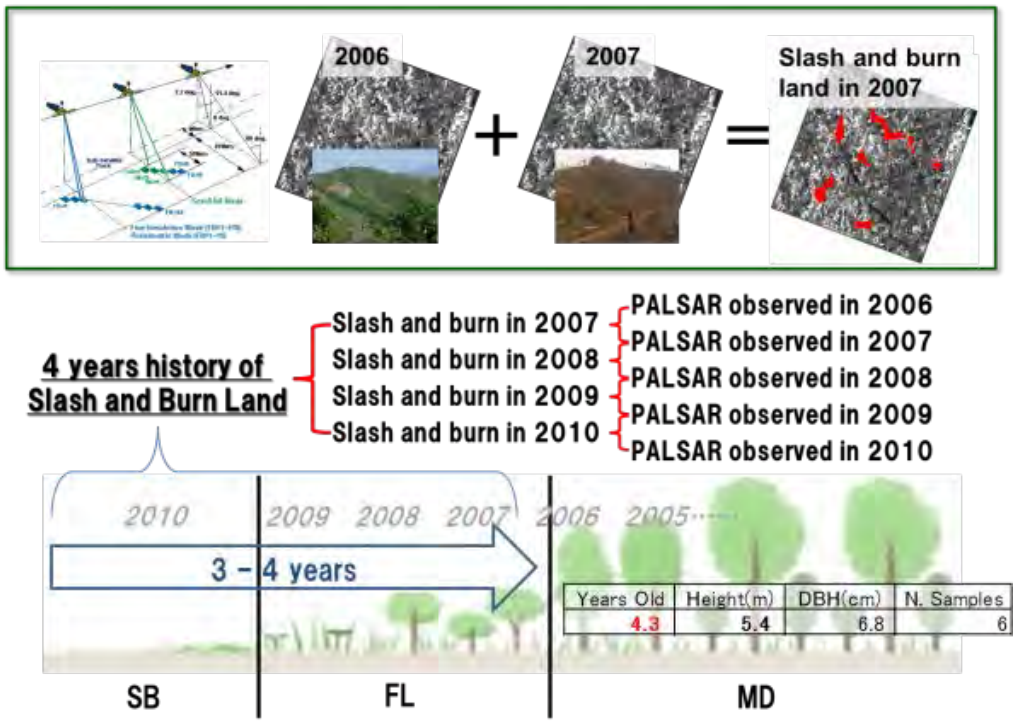
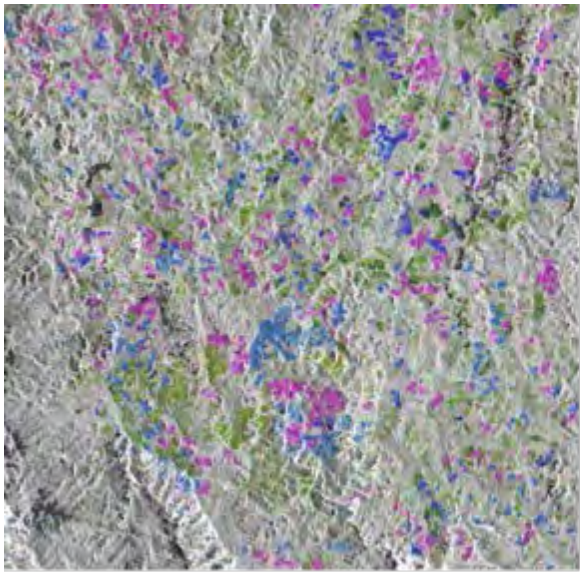


Figure 3-19

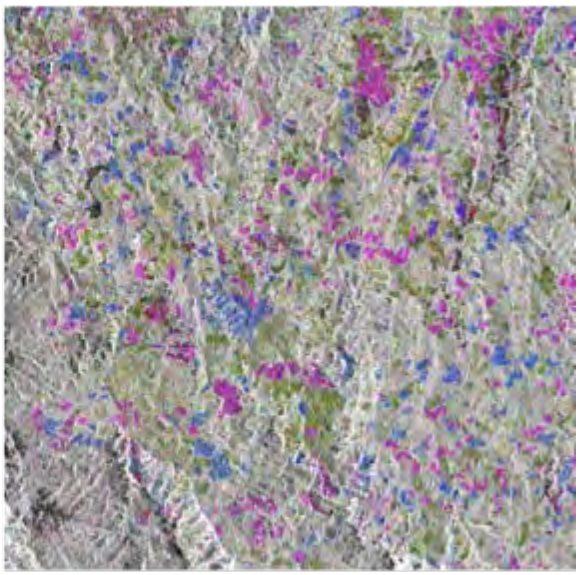


, SB that occurred in four years was captured by extracting changes in five years (2006 – 2010) using PALSAR. It is said that if slash and burn land is abandoned for about four years after burning and cultivation, the land reaches the threshold value of a land defined as forest and although the number of surveyed samples is small, a field survey confirmed that such land returns to forest after an abandonment period of about 4.3 years. Therefore, areas where no SB occurred in four years may be largely regarded as forests (MD) and areas where SB occurred at least once in four years may be mostly considered to be SB or FL areas. Using this principle, revision work was carried out as follows.

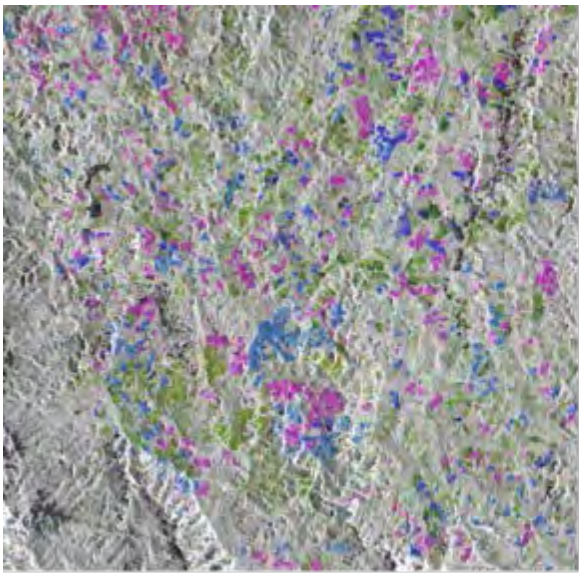
Figure 3-20 explains the meaning of each color on synthetic images, taking an example of a synthesis of backscattering coefficient images captured by PALSAR from 2006 to 2008. Also,



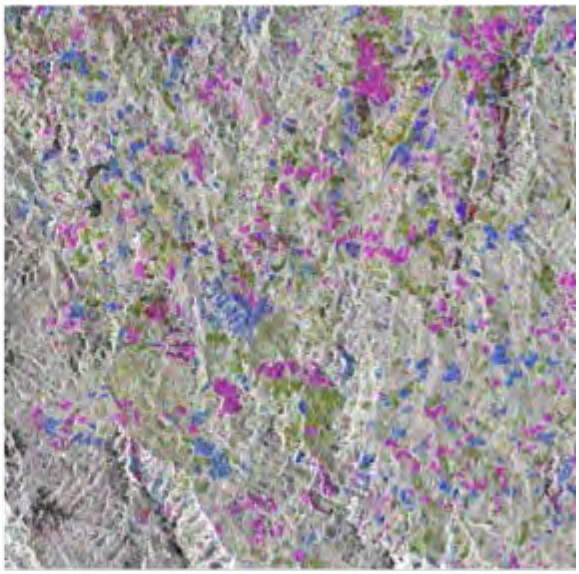
R:G:B=2007:2008:2006



R:G:B=2009:2010:2008



R:G:B=2007:2008:2006



R:G:B=2009:2010:2008

is a synthesis of backscattering coefficient images captured by PALSAR from 2006 to 2008 and from 2008 to 2010. With respect to these images, areas in cyan and magenta are the areas where SB occurred in 2007 and 2009 and in 2008 and 2010, respectively. In other words, areas in cyan and magenta are considered to be SB or FL, because SB occurred at least once in the past in these areas. Based on these characteristics, polygons in the cyan and magenta areas that had been classified as MD were revised to be FL or SB and polygons out of the cyan and magenta areas that had been classified as FL were revised to be MD. The revisions were carried out while checking the RapidEye image captured in 2010.

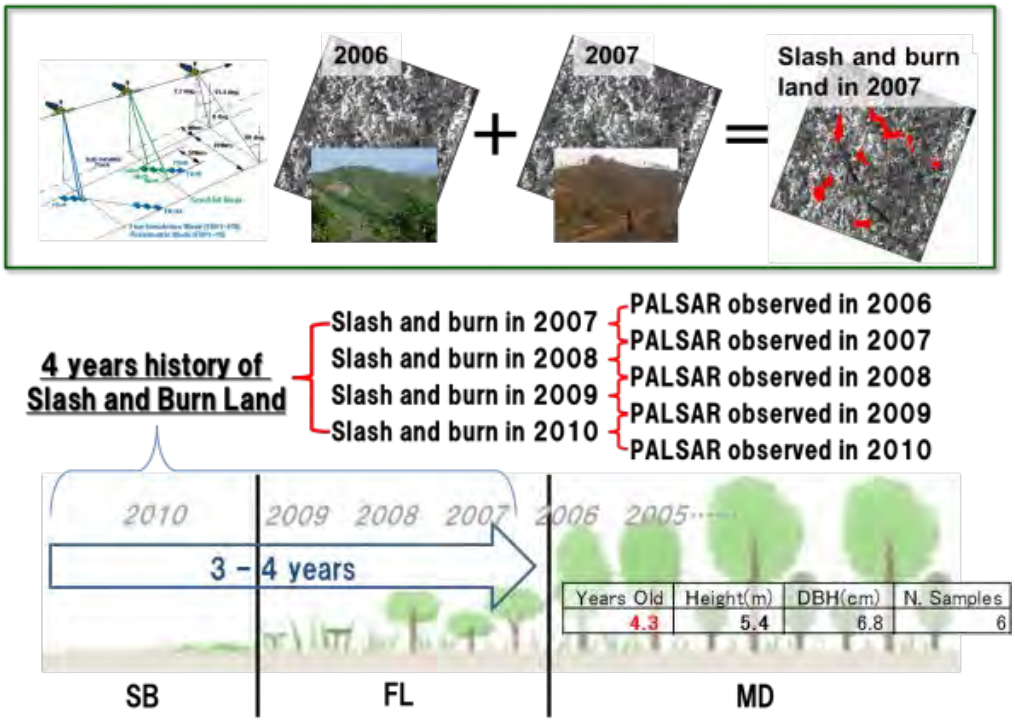


Figure 3-19　Revision Method of MD and FL Using Change Extraction by PALSAR

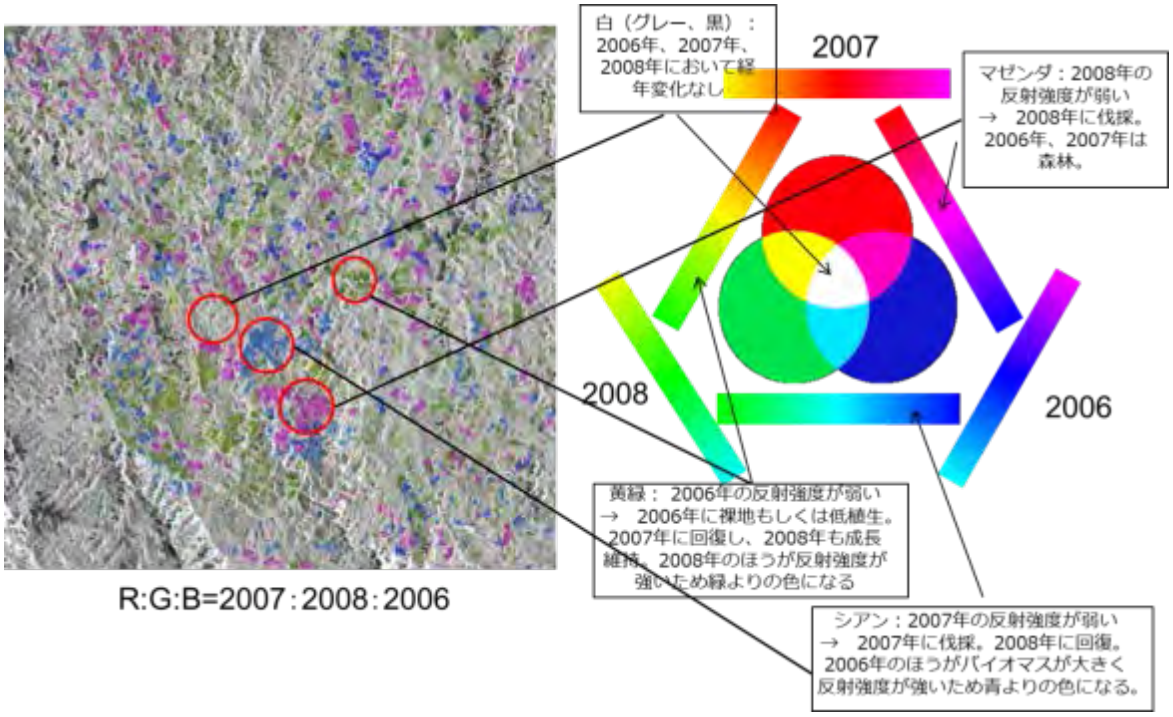


Figure 3-20　Meanings of Color Tone on Synthesis of PALSAR Backscattering Coefficient Images at Different Timings

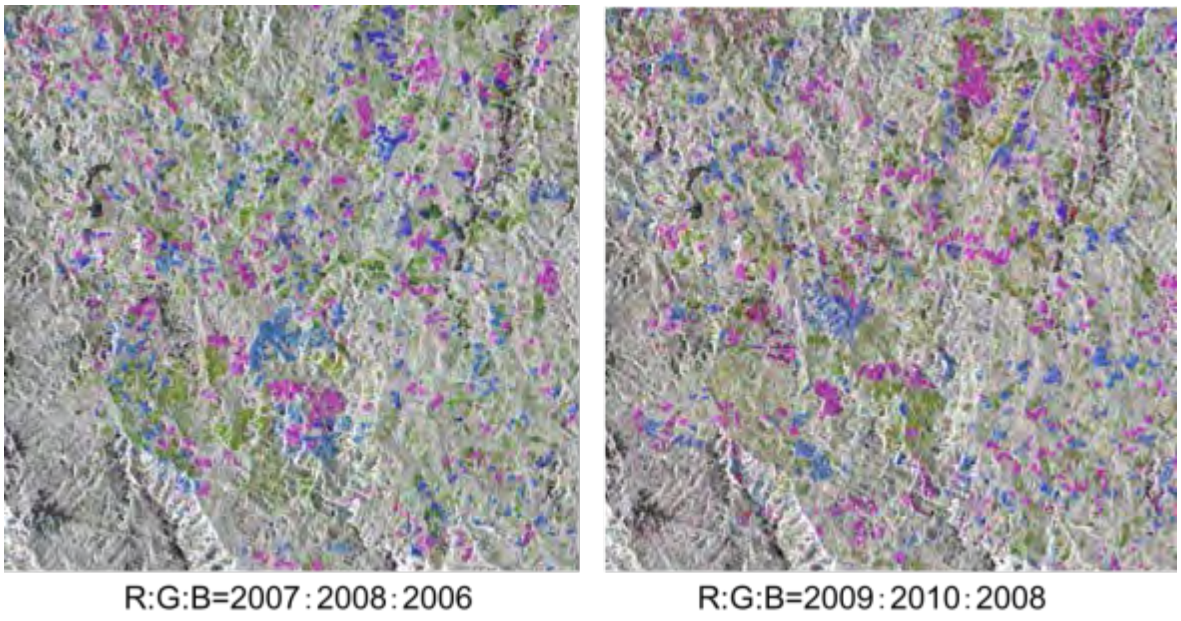


Figure 3-21 Synthesis of PALSAR Backscattering Coefficient Images from 2006 to 2008 (Left) and from 2008 to 2010 (Right)

DD（Dry Dipterocarp Forest）/NF（Non-Forest）

Many DD areas are incorrectly classified as NF areas, which is most likely the result of incorrect classification as Scrub, Savanna or Rice Paddy which have the same distribution area. As they have similar color tones, classification at a high accuracy takes time since it requires careful interpretation. DD areas are widely distributed to the central and southern parts of the country, but it is possible to narrow down the distribution area (hereinafter referred to as DD zone) to a certain extent. Therefore, it was decided that the interpretation should focus on the DD zone to achieve efficiency in revision. Although DD zone spreads widely, since many technical experts mostly have captured the distribution area, no marking was made in particular and each technical expert identified the DD zone on the satellite image to interpret and revise intensively.

MCB（Mixed Coniferous and Broadleaved Forest）/CF（Coniferous Forest）/MD/FL

Many MCB areas are incorrectly classified as CF and many CF areas are incorrectly classified as MD or FL. As shown in the capture of Figure 3-22, they have similar color tones and textures on the satellite image and classifying them at a high accuracy requires careful interpretation and takes time. However, since the distribution area of CF and MCB (hereinafter referred to as CF zone) is limited, it was decided to revise efficiently by focusing the interpretation on this zone.

First, a senior technical expert who is familiar with the site roughly marked the CF zone. Next, it was decided that the interpretation and revision should be carried out only on the marked CF zone. Finally, CF and MCB areas out of the CF zone were extracted using the search function and correctness of the interpretation was checked for revision.

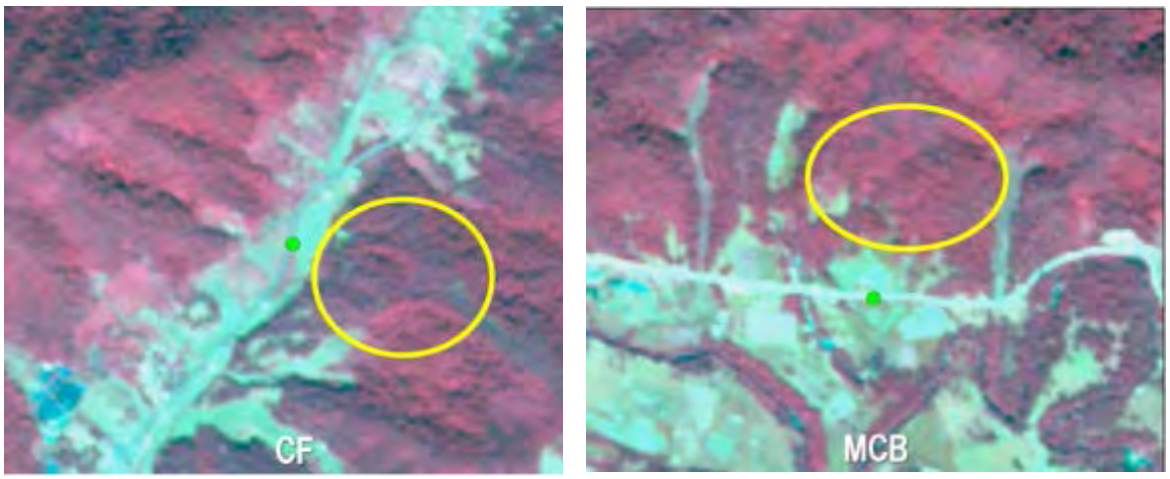


Figure 3-22　CF and MCB on RapidEye Satellite Image

SB/RP（Rice Paddy）

It is not difficult to classify SB areas from other vegetation, since they look like bare land on the images for classification, which are captured in the dry season after harvest. However, they are liable to be incorrectly classified as RP areas, since the harvest is mostly over in dry season and accordingly, the color tones of RP areas are similar to those of SB areas after harvest. As such, it was decided to raise the classification accuracy by making revisions by referring to the information on slopes, topography and landforms by focusing on the fact that while many SB areas are on mountain slopes, RP areas are located in valleys or on flat land.

3.2.3 Ground Truth Survey

Regarding the ground truth survey that is required for correction work, training on an overview and planning was conducted on January 31st and February 19th, and training on implementation was conducted on February 20th (Figure 3-23). There were 12 and 11 participants respectively. Training on implementation was only conducted one day this time, and a comment was obtained during a discussion with Mr. Soukanh when the ground truth survey was performed that some of the technical experts had limited experience in field surveys, making it difficult for them to accurately judge the forest type, and that training was required in accordance with the vegetation in each area. In addition, since a similar comment was made by Mr. Khamphay at the report meeting on the results of the first field survey, it was designated as an issue to be addressed in the future.

Figure 3-23 Training on Overview / Planning (Left)　Training on Implementation (Right)

After training was conducted, a study team was formulated as shown in Figure 3-24, and a ground truth survey was performed. The provinces that each FIPD team was in charge of are shown in the bottom portion of Figure 3-24. The decision was made to have the Japanese team travel throughout the country of Laos. Each FIPD team was allocated provinces for which the FIPD team members would actually be in charge of performing correction work for the forest type map, and since the Japanese technical experts were in charge

of correction work for the entire country, the scope of their study was the entire country. Furthermore, Ms. Takanushi on the Japanese team was added to the study in preparation for domestic correction work (in Japan), with the cost being covered by Kokusai Kogyo Co., Ltd. The itinerary for the Japanese team is shown in Table 3-6. In addition, the objectives of the ground truth survey conducted this time are described below.

(1) Confirm land cover / use for uncertain areas on satellite images in order to correct the forest type map.

(2) Confirm typical land cover / use throughout Laos to allow Japanese technical experts to conduct domestic correction work.

(3) Measure the canopy diameter of trees in areas defined as minimum forest size in Laos (Tree height 5m, etc.).

(4) Confirm locations where there is uncertainty in accuracy assessment work.

The field notebook shown in Figure 3-25 was used to conduct the study. The main objectives of this study are described in item (1) and (2) above, but in order to confirm whether or not the trees defined as the minimum size in Laos can be seen on the satellite images, in addition to the objective described in item (3), the decision was made to include "3. Measure Trees of Minimum Size of Forest" in the field notebook. In addition, an overall map and detailed maps were prepared to view satellite imagery in the field. In order to provide an understanding of how the overall map changed, 2005 and 2000 version maps were prepared.

FIPD Teams

	FIPD (Leader)	FIPD				
1	Chansamouth (1)	Piya (5)	Driver	PAFO	DAFO	Villager
2	Khamsouk (2)	Keovilay (2)	Driver	PAFO	DAFO	Villager
3	Sombath (*)	Kongsy (*)	Driver	PAFO	DAFO	Villager
4	Khamkhong (4)	Souvanna (6)	Driver	PAFO	DAFO	Villager
5	Onkeo (5)	Phouthone (1)	Driver	PAFO	DAFO	Villager
6	Amphaivanh (6)	Siamphone (*)	Driver	PAFO	DAFO	Villager

Japanese Teams

	FIPD	Japanese 1	Japanese 2		
1	Soukanh	Kajiwara	Takanushi	Driver	PAFO
2	Khamma	Nasu	Furuya	Driver	

Provinces for each FIPD Teams

1	Phonsaly	Oudomxay		
2	Xayabuly	Luangnamtha	Bokeo	
3	Luangprabang	Xiengkuang	Houaphang	
4	Vientian C	Vientiane	Bolikamxay	Xaisomboune
5	Khamouan	Svannahket	Saravane	
6	Champasak	Sekong	Attapeu	

Figure 3-24 Study Implementation System

Table 3-6 Japanese Team Itinerary

GT Survey Schedule for Japanese Teams

Date			Transfer		GT Survey	Accomodation	Nasu	Furuya	Kajiwara	Takanushi
2/24	Mo	AM	Vientiane to Oudomxay	Airplane		Oudomxay Hotel	○	○	○	○
		PM	Airport to Oudomxay Hotel	4WD						
2/25	Tu	AM	Oudomxay Hotel to Luangnamtha Hotel	4WD		Luangnamtha Hotel	○	○	○	○
		PM		4WD	Nam Ha NBCA					
2/26	We	AM	Luangnamtha Hotel to south Luangnamtha	4WD		Luangnamtha Hotel	○	○	○	○
		PM		4WD	South Luangnamtha					
2/27	Th	AM	Luangnamtha Hotel to Oudomxay Hotel	4WD		Oudomxay Hotel	○	○	○	○
		PM		4WD	South Oudomxay					
2/28	Fr	AM	Oudomxay Hotel to Nong Khiaw	4WD	Oudomxay to Houaphang	Viang Thong Hotel	○	○	○	○
		PM	Nong Khiaw to Viang Thong Hotel	4WD	Oudomxay to Houaphang					
3/1	Sa	AM	Viang Thong Hotel to Xam Nua Hotel	4WD		Xam Nua Hotel	○	○	○	○
		PM		4WD	Houaphang					
3/2	Su	AM	Xam Nua Hotel to Phonsavan Hotel	4WD	Houaphang to Xiengkuang	Phonsavan Hotel	○	○	○	○
		PM	Xam Nua Hotel to Phonsavan Hotel	4WD	Houaphang to Xiengkuang					
3/3	Mo	AM	Phonsavan Hotel to south Luangphabang	4WD		Phonsavan Hotel	○	○	○	○
		PM		4WD	South Luangphabang / Xiengkuang					
3/4	Tu	AM	Xiengkuang to Vientiane	Airplane		Vientiane Hotel	○	○	○	○
		PM	Airport to Vientiane Hotel	Hotel pick-up						
3/5	We	AM	Organize the data	4WD		Vientiane Hotel	○	○	○	○
		PM	Organize the data	4WD						
3/6	Th	AM	Vientiane Hotel to Savannakhet Hotel	4WD	VTE to SVK by car	Savannakhet Hotel	○	○	○	○
		PM	Vientiane Hotel to Savannakhet Hotel	4WD						
3/7	Fr	AM	Savannakhet Hotel to Phou Xang He NBCA?	4WD		Savannakhet Hotel	○	○	○	○
		PM		4WD	Phou Xang He NBCA					
3/8	Sa	AM	(SVK to VTE by airplane for Nasu)	Airplane	Savannakhet to Pakse	Pakse Hotel	○	○	○	○
			Savannakhet Hotel to Pakse Hotel	4WD						
		PM	Savannakhet Hotel to Pakse Hotel	4WD	Savannakhet to Pakse					
3/9	Su	AM	Pakse Hotel to Pakxong	4WD	Bolaven Highland	Attapu Hotel		○	○	○
		PM	Pakxong to Attapu Hotel	4WD	Bolaven to Attapu					
3/10	Mo	AM	Attapu Hotel to Pakse Hotel	4WD	Attapu to Pakse	Pakse Hotel		○	○	○
		PM	Attapu Hotel to Pakse Hotel	4WD	Attapu to Pakse					
3/11	Tu	AM	Pakse to Vientiane	Airplane		Vientiane Hotel		○	○	○
		PM	Airport to Vientiane Hotel	Hotel pick-up						
3/12	We	AM	Vientiane Hotel to Thaphabath	4WD		Vientiane Hotel		○	○	○
		PM		4WD	Thaphabath					
3/13	Th	AM	Vientiane Hotel to Vientiane Province	4WD	Vientiane	Vientiane Hotel		○	○	○
		PM		4WD	Vientiane					

FIELD NOTE of Ground Truth Survey (NFIS)

0. General Information

Waypoint No.	:	Date	:
Province	:	Surveyor	:
District	:	Lat / Lon	: ° ' " × ° ' "
Village	:	Elevation	: m

1. Forest land

Main Species & Comment

Type	:	EF	MD	CF	MCB	DD	P
Density	:	Dense		Medium		Sparse	
Another	:						

2. Non-Forest land

Main Crops & Comment

Land use	:	B	SB	YF	OF	SA	SR	RP	AP
		OA	G	SW	R	U	W	O	
Another	:								

3. Measure Trees of Minimum Size of Forest (NOT every plots, only 3plots per provinces)

Comment

Years Old	:	years	SB in 2010 / Minimum Size of Forest		
Height	:	m	m	m	m
D. B. H.	:	cm	cm	cm	cm
Crown Diameter	:	m	m	m	m

4. Photo/Sketch/Memo

Photo No.	:	,	,	,	,	,	,
Direction	:	,	,	,	,	,	,
Condition	:	View / Zoom,	View / Zoom,	View / Zoom,	View / Zoom,	View / Zoom,	View / Zoom,

Sketch/Memo

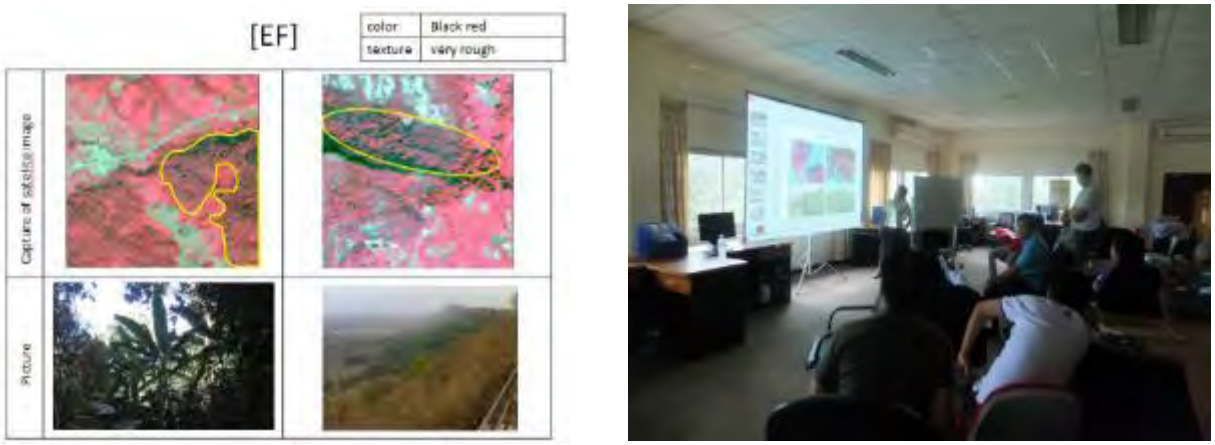
Figure 3-25 Field Notebook Used for Study

3.2.4 Development of Interpretation Keys and Interpretation Cards

The forest type maps of 2010, 2005 and 2000, which are the outputs of this project, were prepared based on various satellite images. It is necessary to interpret the satellite images and correctly judge the land cover and usage of a given area of land in preparing the maps, but ample experience in the interpretation of satellite images and field survey is needed for this purpose. In addition, the criteria for judgment of land cover and usage greatly vary in accordance with the experience of each individual. As such, it is not easy to prepare forest type maps of uniform quality. Although the satellite image interpretation skills of the C/P have improved through FIM and technical assistance provided through this project, there is still a large difference between the experience of each individual (particularly between old and new C/P). Therefore, it was decided to prepare interpretation keys and interpretation cards based on the results of ground truth survey to standardize the interpretation criteria. The interpretation key is a table organizing the features of each land cover and usage on each satellite image (RapidEye, SPOT multi-spectral and LANDSAT), such as color tone, texture and landform and the interpretation card is a collection of cases of each land cover and usage on each satellite image. It is expected that the use of these keys and cards in the interpretation of satellite images will minimize the impact of the difference in the experience of individuals and enable the determination of land cover and usage based on uniform interpretation criteria.

The interpretation keys and the interpretation cards were prepared in the steps as described below. The interpretation keys that were prepared are shown in Table 3-7 and samples of the interpretation cards are shown in Figure 3-26 and Figure 3-27.

① Select capture images and photos of the site for each land cover and usage on each satellite image and organize and compile the material.

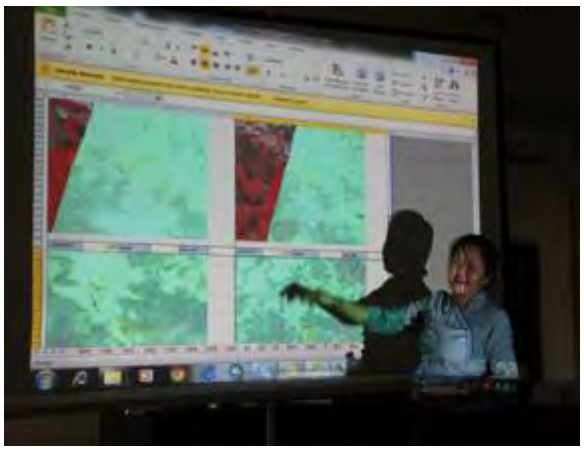


Organized Capture Images and Photos of the Site (Left) and Presentation (Right)

② Determine the features of each land cover and usage (color tone, texture, landform, location) on each satellite image after discussions based on ① and summarize them as interpretation key tables.


Discussion on Interpretation Keys

③ Select capture images on each satellite image and photos of the site for each interpretation key to prepare interpretation cards.

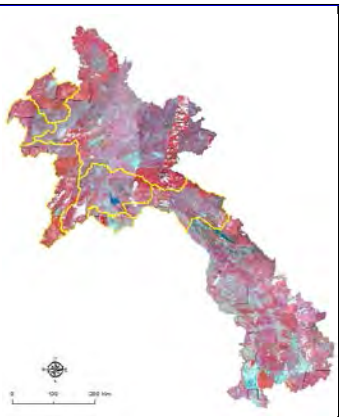



Training in Preparation of Interpretation Card (Left) and Presentation after Preparation (Right)

Table 3-7 The list of interpretation key

Group	Class		RapidEye 2010			LANDSAT 2014/2000		SPOT 2005		Location	Shape	Reference Data
			Difference	Color	Texture	Color	Texture	Color	Texture			
Current Forest	EF	–	Dense	Dark deep red	Very rough	Dark deep red	Rough	Dark deep red	Very rough	NBCA, Near national border, Far from shifting cultivation area	Natural	NBCA, 1992 or/and 2002 Maps
			Medium	Dark red	rough	Dark red	A bit rough	Dark red	Rough	NBCA, Near national border, Far from shifting cultivation area		
	MD	1	Old	Dark red	rough	Dark red	A bit rough	Dark red	A bit rough	Anywhere of accessible area (Shifting cultivation area, Logging area)	Natural	–
		2	Young	Red	A bit rough	Red	Smooth	Red	A bit rough	Anywhere of accessible area (Shifting cultivation area, Logging area)	Natural	–
	DD	1	Central/South area	Gray mixed with light red	Rough dott	Gray mixed with light red	Mottled	Gray mixed with light red	Indistinct dott	Plane of Central/South area	Natural	–
		2	Luangphabang	Gray mixed with light red	Rough dott	Gray mixed with light red	Mottled	Gray mixed with light red	Indistinct dott	Mountain of Luang Phabang Province	Natural	–
	CF	–		Dark gray/Gray	Rough dott	Dark gray/Gray	Indistinct dott	Dark gray/Gray	Indistinct dott	Specific area of Houapanh/Xiengkuang/??? Provinces	Natural	Specific zone data (will be created)
	MCB	–		Red/Dark red mixed with dark gray	Rough mixed with dott	Red/Dark red mixed with dark gray	Mottled	Red/Dark red mixed with dark gray	Rough mixed with dott	Specific area of Houapanh/Xiengkuang/??? Provinces	Natural	Specific zone data (will be created)
	P	1	Teak plantation in North area	Dark gray	Rough	Dark gray	Smooth	Dark gray	Smooth	Along road or river	Artificial	Concession data (will be acquired)
		2	Rubber plantation in North area	Bright red/Gray	Smooth	Bright red/Gray	Smooth	Bright red/Gray	Smooth	Mountain of North area	Natural	Concession data (will be acquired)
		3	Rubber/Eucariptus plantation in Central/South area	Bright red/Gray	Smooth	Bright red/Gray	Smooth	Bright red/Gray	Smooth	Plane of Central/South area	Artificial	Concession data (will be acquired)
Potential Forest	FL	1	Depend on – years old – color enhancement – aspect of slope	Bright pink	Smooth	Bright pink	Smooth	Bright pink	Smooth	Anywhere of accessible area (Shifting cultivation area, Logging area)	Natural	
		2		Red	Smooth	Red	Smooth	Red	Smooth	Anywhere of accessible area (Shifting cultivation area, Logging area)	Natural	
		3		Bright red	Smooth	Bright red	Smooth	Bright red	Smooth	Anywhere of accessible area (Shifting cultivation area, Logging area)	Natural	
		4		Dark red	Smooth	Dark red	Smooth	Dark red	Smooth	Anywhere of accessible area (Shifting cultivation area, Logging area)	Natural	
		5		Light red/pink on gray	Smooth	Light red/pink on gray	Smooth	Light red/pink on gray	Smooth	Anywhere of accessible area (Shifting cultivation area, Logging area)	Natural	
	SB	1	Depend on – color enhancement – aspect of slope	Bright gray	Smooth	Bright gray	Smooth	Bright gray	Smooth	Upland (Shifting cultivation area)	Natural	
		2		Gray	Smooth	Gray	Smooth	Gray	Smooth	Upland (Shifting cultivation area)	Natural	
		3		Dark gray	Smooth	Dark gray	Smooth	Dark gray	Smooth	Upland (Shifting cultivation area)	Natural	
Other Wooded Area	SA	–		Gray	Sparse dott	Gray	Smooth	Gray	Sparse Indistinct dott	South plane area	Natural	
	SR	1	on Plane	Dark gray	Smooth	Dark gray	Smooth	Dark gray	Smooth	South plane area	Natural	
		2	on Rock	Red	Rough	Red	Smooth	Red	A bit rough	On Rock	Natural	
Permanent Agriculture Area	RP	1	Depend on – color enhancement	Bright gray	Smooth	Bright gray	Smooth	Bright gray	Smooth	Lowland (near river, valley)	Artificial	
		2		Dark gray	Smooth	Dark gray	Smooth	Dark gray	Smooth	Lowland (near river, valley)	Artificial	
	AP	1	Tea, Mango, Longan, Banana, Oil Parm, etc. Depend on – growth – color enhancement	Bright red	Smooth	Bright red	Smooth	Bright red	Smooth	Tea (Phonsaly)	Artificial	Concession data (will be acquired)
		2		Dark red	Smooth	Dark red	Smooth	Dark red	Smooth	Mango (Houaphang, etc.)	Artificial	Concession data (will be acquired)
		3		Light red on gray	Smooth	Light red on gray	Smooth	Light red on gray	Smooth	Longan (Houaphang, etc.)	Artificial	Concession data (will be acquired)
		4		Bright gray	Smooth	Bright gray	Smooth	Bright gray	Smooth	Banana (North area)	Artificial	Concession data (will be acquired)
		5		Dark gray	Smooth	Dark gray	Smooth	Dark gray	Smooth	Oil Parm (Bolikamsay, etc.)	Artificial	Concession data (will be acquired)
		6	Coffee	Mix colors (Red/Light red on gray/Gray)	Mix textures (smooth/rough)	Mix colors (Red/Light red on gray/Gray)	Mix textures (smooth/rough)	Mix colors (Red/Light red on gray/Gray)	Mix textures (smooth/rough)	Boraven Highland	Artificial	Concession data (will be acquired)
	OA	1	Cone, Casava, Sugarcane, Pineapple, Water Melon, Cucamber, etc. Depend on – growth – color enhancement	Bright red	Smooth	Bright red	Smooth	Bright red	Smooth	Along road or river	Artificial	
		2		Dark red	Smooth	Dark red	Smooth	Dark red	Smooth	Along road or river	Artificial	
		3		Light red on gray	Smooth	Light red on gray	Smooth	Light red on gray	Smooth	Along road or river	Artificial	
		4		Bright gray	Smooth	Bright gray	Smooth	Bright gray	Smooth	Along road or river	Artificial	
		5		Dark gray	Smooth	Dark gray	Smooth	Dark gray	Smooth	Along road or river	Artificial	
		6		Mix colors (Red/Light red on gray/Gray)	Smooth	Mix colors (Red/Light red on gray/Gray)	Smooth	Mix colors (Red/Light red on gray/Gray)	Smooth	Along road or river	Artificial	
Other Non-Forest Area	G	1	Depend on – growth – color enhancement	Dark gray	Smooth	Dark gray	Smooth	Dark gray	Smooth	Top of mountain, Jars Plane, Specific area	Natural	
		2		Light red on gray	Smooth	Light red on gray	Smooth	Light red on gray	Smooth	Top of mountain, Jars Plane, Specific area	Natural	
		3		Dark green	Smooth	Dark green	Smooth	Dark green	Smooth	Top of mountain, Jars Plane, Specific area	Natural	
	SW	1	Depend on – season	Dark deep gray (nearly black)	Smooth	Dark deep gray (nearly black)	Smooth	Dark deep gray (nearly black)	Smooth	Lowland (near river)	Natural	
		2		Dark deep red/pink	Smooth	Dark deep red/pink	Smooth	Dark deep red/pink	Smooth	Lowland (near river)	Natural	
	R	–		Nearly Black	Irregular	Nearly Black	Irregular	Nearly Black	Irregular	Bolikhamsay, Khamuane, Savannakeht, Sekong, Attapue, Houaphang, Xiengkuan, Luangphang, etc.	Natural	
	BL	1	Sandbar in river, Mining area, etc. Depend on – color enhancement	White	Smooth	White	Smooth	White	Smooth	Sandbar in river, Mining area, etc.	Natural	
		2		Bright gray	Smooth	Bright gray	Smooth	Bright gray	Smooth	Sandbar in river, Mining area, etc.	Natural	
		3		Dark gray	Smooth	Dark gray	Smooth	Dark gray	Smooth	Sandbar in river, Mining area, etc.	Natural	
	U	–	City, Village	Mix many colors	Mix many textures	Mix many colors	Mix many textures	Mix many colors	Mix many textures	Anywhere	Artificial	
Other Land	O	–	Road, Airport, Stadium, the others.	Many patterns	Many patterns	Many patterns	Many patterns	Many patterns	Many patterns	Anywhere	Artificial (Natural?)	

0. General Information							
Primary ID or Waypoint No.	TR_110501-1	Date	24/03/2011	Lat	104.66135	Elevation(m)	513
Province	Borikhamxay	Surveyor	Khamkhong	Lon	18.2841	Team No.	4
1. Forest		2. Non-Forest		3. Measure Trees of Minimum Size of Forest			
Type	EF	Land use		Height	-	-	-
Density	93.75	Another		DBH	-	-	-
Another				Crown Diameter	-	-	-



4. Characteristics					
Satellite	Color	Texture	Shape	Location	Comment
RapidEye 2010	Dark deep red	Very rough	Natural	NBCA, Near national border, Far from shifting cultivation	
SPOT 2005	Dark deep red	Rough	Natural	NBCA, Near national border, Far from shifting cultivation	
LANDSAT 2000	Dark deep red	Very rough	Natural	NBCA, Near national border, Far from shifting cultivation	
5. Other				6. Comment for years gap	0

7. Picuture & sketch

Direction	S	Direction	
Type/Landuse	EF	Type/Landuse	

Direction	N	Direction	E
Type/Landuse	EF	Type/Landuse	EF

Figure 3-26 Sample of Interpretation card

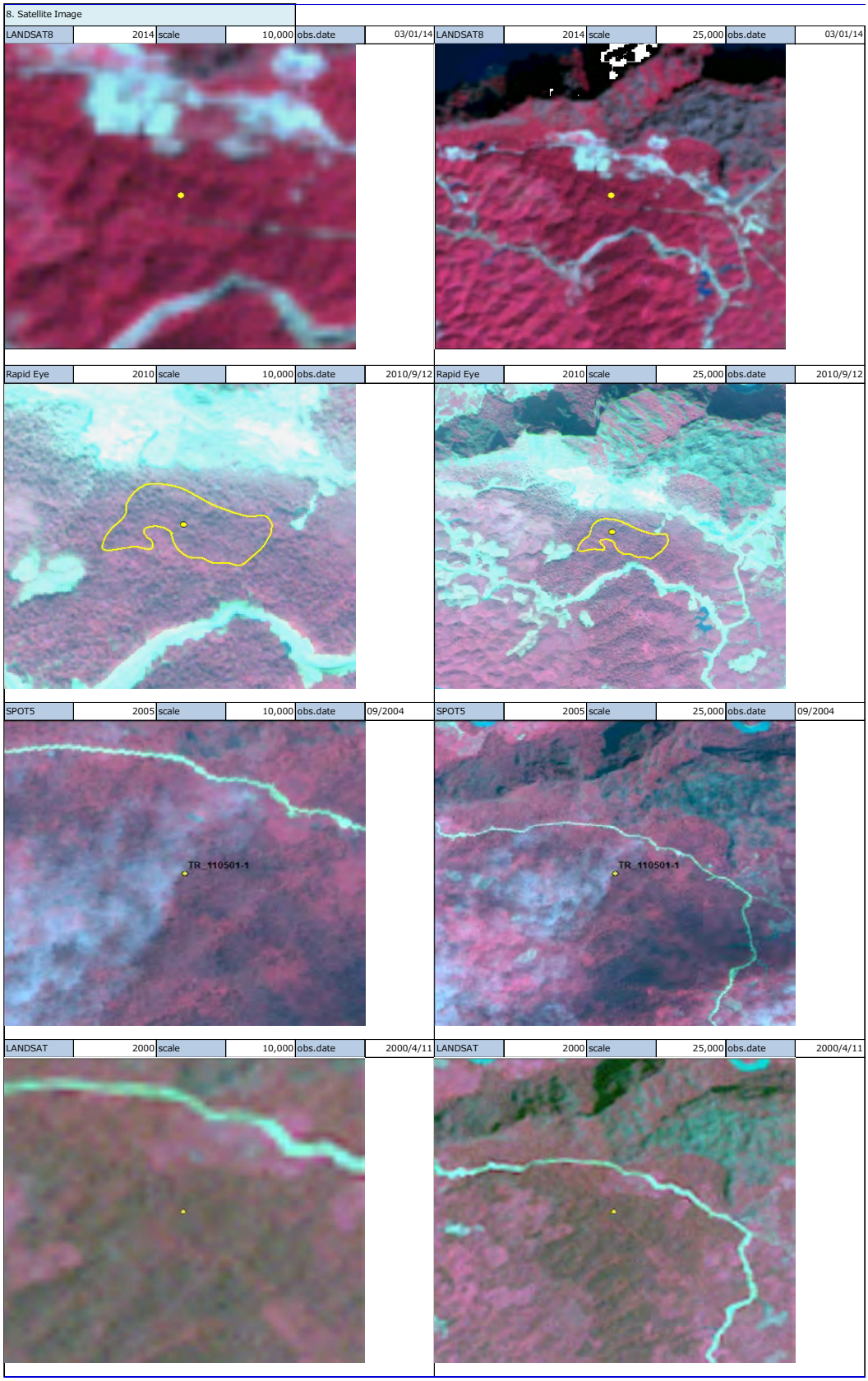


Figure 3-27 Sample of Interpretation card

3.2.5 Lectures on Theory of Remote Sensing

The C/P staffs have improved their capabilities for image processing and GIS software operation by receiving practical training to analyze remote sensing images to conduct forest survey. However, their understanding of the theory and principles behind these operations needed to be further improved. In this project, the GIS/RS section staff attended a lecture series entitled "Theory of Remote Sensing" and received OJT training on creating image interpretation keys.

① Implementation Schedule

The schedule for implementation of the work was as follows.

Monday, July 21st	Preparation of lecture materials
Tuesday 22nd	Meeting with FIPD and delivery of lecture
Wednesday 23rd	Lecture (a.m.), OJT (p.m.)
Thursday 24th	Lecture (a.m.), OJT (p.m.)
Friday 25th	Lecture (a.m.), OJT (p.m.)
Saturday 26th	Preparation of lecture materials
Sunday 27th	Preparation of lecture materials
Monday 28th	Lecture (a.m.), OJT (p.m.)
Tuesday 29th	Lecture (a.m.), OJT (p.m.)
Wednesday 30th	Lecture (a.m.), OJT (p.m.)
Thursday 31st	Lecture (a.m.), OJT (p.m.)
Friday, August 1st	OJT (a.m.), OJT (p.m.)

② Outline of basic theory of remote sensing lecture course

The main themes of the Theory of Remote Sensing lecture course were as follows.

(1) Introduction

- Principles of surveying by remote sensing
- Position of lecture on theory of remote sensing

(2) Basics of Radiation Physics for Forest Remote Sensing

- Properties of electromagnetic waves used for information collection in remote sensing surveys
- Classification according to type and wavelength of electromagnetic waves
- Nature of sunlight, a major source of electromagnetic waves
- Attenuation due to interaction of the electromagnetic waves from the sun with the atmosphere
- Types of substances in the atmosphere
- Types and sizes of substances in the atmosphere and law of dispersion of electromagnetic wavelengths
- Atmospheric window

- Atmospheric correction methods (absolute correction, relative correction, and absolute correction using standard atmospheric model)

(3) Radiation Properties of Vegetation, Soil, and Water

- Interaction (reflection, absorption, and transmission) of electromagnetic waves on ground surface such as forests
- Nature of reflection on surface (complete reflection, Lambertian reflection, and polarizing reflection)
- Use of light in carbon dioxide assimilation
- Status of light reflection, absorption, and transmission in cells of plant leaves
- Characteristics of reflectances of electromagnetic waves by planimetric feature type
- Spectral characteristics by vegetation type
- Characteristics of electromagnetic wave reflection, absorption, and transmission by thickness of leaves in tree canopies
- Relative reflection characteristics of electromagnetic waves of vegetation and soil
- Nature of infrared and near-infrared images by moisture content and organic matter amount of soil
- Albedo (total reflectance) of ground objects
- LAI (leaf area index)
- Result of global survey of LAI
- Relationships between LAI and precipitation or soil fertility
- Deciduous trees in the Lao PDR and examples in Bolikhamsai Province where they are located
- Seasonal changes in LAI of deciduous trees
- Distribution of LAI by tree height
- Nature of surface reflection
- Nature of reflection directions and relationship with slope direction and solar irradiation
- Influence of tree crown shade
- Topographical correction methods and application examples

(4) Earth Observation Systems

- Outline of earth observation systems
- Types of small satellites
- Satellite observation system
- Concept of sensor design
- Spatial resolution, spectral resolution, radiometric resolution, and temporal resolution
- Examples of low, middle, and high-resolution images

- Types and natures of bands of LANDSAT-8
- Pixels
- Linear array sensors
- Principles of optical 3D sensor and 3D measurement
- SAR images
- SRTM project and global DEM
- Aircraft laser sensors and usage

(5) Processing of Optical Remote Sensing Data

- Overall flow of image analysis
- Methods of geometric correction
- Problem points of interpolation methods in image resampling
- Density slicing
- Creation of color composition images
- Color sensitivity of human eyes
- Characteristics of combinations of color composition and bands
- Types and characteristics of image enhancement
- Vegetation indices and characteristics
- Characteristics of NDVI, SVI, and EVI

(6) Use of Multispectral Information for Sensing Vegetation Properties and for Image Classification

- Methods for creating thematic maps
- Logics of image classification
- Image classification algorithms
- Expert systems
- Object-oriented classification method
- Naked-eye interpretation methods and advantages
- Evaluation of classification by evidence convergence
- Image interpretation keys
- Image interpretation factors

(7) Photo Interpretation Theory and Practice

- Actual operation of image interpretation
- Clarification of goals
- Understanding of characteristics of images
- Image interpretation factors
- Characteristics of planimetric features on various images (Comparison of LANDSAT2000, SPOT2005, RapidEye2010, LANDSAT2014, and aerial photographs)

- Examples of satellite images of Khamkeut District, Bolikhamsai Province and Pakseng District, Luang Prabang Province
- Comparison of color composition images of different bands
- Comparative analysis of images of Savannakhet production forest (Comparison of existing forest type maps, LANDSAT2000, SPOT2005, RapidEye2010, LANDSAT2014, and aerial photographs)

(8) Sampling, Errors and Accuracy Analysis

- General method of accuracy assessment of output analyzed by remote sensing
- Sampling theory
- Histograms
- Error factors of thematic maps
- Sampling methods and characteristics
- Wall-to-wall and sampling
- Normal distribution
- Nature of normal distribution
- Chi-square distribution and chi-square test
- Method for determining sample size
- Symbols used in mathematics
- Specific method for deriving number of samples
- Error matrix
- Kappa analysis

(9) DEM Use of SRTM

- SRTM - Creation of 3D display image of ground truth using ArcScene

Scene from Lecture

③ Summary of evaluation of the training results

Evaluation of the training results was implemented using an evaluation questionnaire (Figure 3-28) among the trainees. The results are shown in Table 3-8.

Questionnaire for the Training (Theory of Remote Sensing)
Instructor: Mitsuru NASU, Ph.D.

Trainee's Name: _____

You have completed your training session. Please answer the following questions relevant to this training. **(Please circle the appropriate number below and comment)**.

Q1. The objective of the training "Theory of Remote Sensing" is to provide you broad knowledge of theoretical bases of forest remote sensing technology.

Did you achieve the objective?

Unachieved				fully achieved
1	2	3	4	5

Q2. What is your overall evaluation for the contents of the training?

Poor	Rather poor	Good	Fair	Very good
1	2	3	4	5

Q3. How do you think of the material (text) of the training ?

Poor	Rather poor	Good	Well prepared	Very well prepared
1	2	3	4	5

Q4. How well could you understand the contents of the lecture? Evaluate yourself and choose level of understanding for each topic.

1. Basics of Radiation Physics of Forest Remote Sensing:
1-Very difficult 2-Difficult 3-Understood 4-Well understood 5-Very well understood

2. Radiation Properties of Vegetation, Soil, and Water:
1-Very difficult 2-Difficult 3-Understood 4-Well understood 5-Very well understood

3. Earth Observation Systems:
1-Very difficult 2-Difficult 3-Understood 4-Well understood 5-Very well understood

4. Processing of Optical Remote Sensing Data:
1-Very difficult 2-Difficult 3-Understood 4-Well understood 5-Very well understood

5. Use of Multi-spectral Information for Sensing Vegetation Properties and for Image Classification:
1-Very difficult 2-Difficult 3-Understood 4-Well understood 5-Very well understood

6. Theory of Image Interpretation and comparison of various remote sensing images:
1-Very difficult 2-Difficult 3-Understood 4-Well understood 5-Very well understood

7. Sampling, Errors, and Accuracy Analysis:
1-Very difficult 2-Difficult 3-Understood 4-Well understood 5-Very well understood

Q5. How do you think of the duration of the training?

Too short	Short	Too long	Long	Good
1	2	3	4	5

Any comment and/or advices on the training "Theory of Remote Sensing". (In any languages)

……
…

Figure 3-28 Evaluation Questionnaire

Table 3-8 Evaluation of Training Contents (Numerals are number and ratio of responses, number of trainees = 17)

Question	Evaluation Score E	Evaluation Score D	Evaluation Score C	Evaluation Score B	Evaluation Score A
1．Achievement of Training Purpose	Poor	Rather poor	Good	Fair	Very good
	0	0	4（23%）	9(53%)	4(24%)
2．Evaluation of Training Contents	Poor	Rather poor	Good	Fair	Very good
	0	0	7(41%)	7(41%)	3(18%)
3．Evaluation of Training Text book	Poor	Rather poor	Good	Fair	Very good
	0	0	7(41%)	9(53%)	1(6%)
4．Understandings for Each Training （Achievement） （Regarding theme（T 1～T 7）, please refer to Figure 3－28）	Very difficult	Difficult	Understood	Well understood	Very well understood
	T1: 0	0	2(12%)	15(88%)	0
	T2: 0	0	6(35%)	10(59%)	1(6%)
	T3: 0	0	7(41%)	7(41%)	3(18%)
	T4: 0	0	1(6%)	14(82%)	2(12%)
	T5: 0	0	5(29%)	11(65%)	1(6%)
	T6: 0	1(6%)	5(29%)	11(65%)	0
	T7: 0	1(6%)	6(35%)	8(47%)	2(12%)
5．Time length of Training	Too short	Short	Too long	Long	Good
	0	4(24%)	0	0	13(76%)

The following may be concluded from the training evaluation results shown in the above table.

1. Degree of attainment of the training objective: 77% responded positively, proving that the training objectives were attained.
2. Evaluation of the training contents: “Good” and “Very good” were half-and-half so that the contents were mostly approved.
3. Evaluation of the text: “Good” and “Fair” were half-and-half so that the text was mostly approved.
4. Degree of understanding (degree of attainment) for each training theme: The degrees of understanding of the lecture for each theme were evaluated. For the relatively basic themes from Themes 1 to 5, many responded “Understood” to “Very well Understood”. For Theme 6, image interpretation, and Theme 7, errors and accuracy analysis, one each responded “Difficult”, showing a tendency towards relative difficulty.

5. For the training period, 76% responded "Good", indicating that it was an appropriate duration.
6. Free comments and opinions

Twelve of the 17 trainees provided some kind of comment or opinion. The following are several of the comments.

- The training was useful for understanding how to handle and utilize satellite images and make interpretation cards.
- It would be better if hands-on training were provided in addition to the theory of remote sensing.
- I hope that the training will be longer the next time, if any.
- It would be better if there was an interpreter with better understanding of remote sensing.

As described so far, the contents of the training were favorably evaluated in general, demonstrating that this training was meaningful to the trainees.

However, this evaluation contained many responses of self-evaluation. Furthermore, in view of the considerably high levels of lecture contents, it is necessary to repeat in-depth training combined with hands-on training in order to raise the theory and actual capabilities to a practical level.

In this training, a senior counterpart was requested to interpret between English and Lao but it is necessary to review how interpretation should be done the next time. Lecture materials were prepared in English as shown in Annex 8. Although belatedly, the lecture materials were translated into Lao after the lecture and handed over to C/P.

Figure 3-29 Award of the Completion Certificates

3.2.6 Lectures on Theory of Remote Sensing – Part 2

The initial schedule was that the first lecture course would be on the basic theory of remote sensing, and the second course would be a theoretical lecture course on stratification analysis. However, the contents of the lecture course on stratification analysis was virtually covered through OJT, and although understanding of

the most important basic theory of remote sensing was deepened as a result of the first course, it was not possible to obtain sufficient practice time to connect this theory to actual operations. Therefore the second lecture course was changed to basic theory of remote sensing lecture course 2, with an emphasis on more practice including on site.

This lecture course was held in July 2014 for staff members of the GIS/RS section entitled "Theory of Remote Sensing" and a continuation of the OJT was held as "Theory of Remote Sensing – Part 2", the field survey training being held at the Phou Khao Khouay National Park on the outskirts of Vientiane.

① Implementation Schedule

The schedule for implementation of the work was as follows.

Tuesday, March 3rd	Meeting, preparations
Wednesday 4th	OJT (a.m.), Lecture (p.m.)
Thursday 5th	OJT (a.m.), Lecture (p.m.)
Friday 6th	OJT (a.m.), Lecture (p.m.)
Saturday 7th	Practice on site
Sunday 8th	Preparation of lecture materials
Monday 9th	Preparation of lecture materials
Tuesday 10th	OJT (a.m.), Lecture (p.m.)
Wednesday 11th	OJT (a.m.), Lecture (p.m.)
Thursday 12th	OJT (a.m.), Lecture (p.m.)
Friday 13th	Training summary meeting

② Outline of basic theory of remote sensing lecture course

This training course included review and update of the previous training contents, and focused on spectroscopic characteristics and vegetation indices in connection with land-use and land coverage which is considered to be particularly important. The training included the principles and methods of analysis of spectroscopic characteristics and vegetation indices using actual Laotian data (RapidEye and LANDSAT-8 in Bolikhamsai, Vientiane and Savannakhet Provinces, and some existing aerial photographs and forest type maps, etc.), while asking specific questions. The response of the trainees to the questions was extremely positive, and there were interesting exchanges of opinions.

The main themes of the Theory of Remote Sensing – Part 2 lecture course were as follows.

(1) Introduction

- Principles of surveying by remote sensing
- Factors to be considered when analyzing land cover by remote sensing images (topography, geology and soils, land usage, vegetation, climate/seasons/rainfall, etc.)

(2) Basics of radiation physics for forest remote sensing

- Properties of electromagnetic waves used for information collection in remote sensing surveys, and classification according to type and wavelength of electromagnetic waves
- Effect of attenuation due to interaction of the electromagnetic waves from the sun with the atmosphere, etc.

(3) Earth observation systems (update)

- Recent trends in earth observation remote sensing systems
- The arrival of video imaging
- Trends in micro-satellites
- Spatial resolution, resolution of spectral measurements, time resolution
- Results of the acquisition of actual satellite images and examples of cloud cover
- Multi-temporal satellite images and changes in land coverage and vegetation, etc. (examples from Japan)
- Trade-offs between spatial resolution, resolution of spectral measurements, and time resolution in design of sensors
- Observation characteristics according to sensor wavelength band (using the optical sensors of LANDSAT-8 as an example)

(4) Methods of topographical analysis in the survey region

- Interpretation and analysis of topography
- Image tone and interpretation of topography
- Water system patterns
- Interpretation of forms of gully erosion
- Interpretation of boundary forms
- Interpretation of water system patterns and determination of local characteristics (training using images of Bolikhamsai Province)

(5) Radiation properties of vegetation, soil, and water

- Interaction of electromagnetic waves with forests, etc., on the ground surface (reflection, absorption, transmission)
- Properties of ground reflections (total reflection, Lambert reflection, polarized reflection)
- Status of reflection, absorption, and transmission of light in the cells of the leaves of vegetation
- Properties of the reflectance of electromagnetic waves according to the type of feature
- Spectroscopic characteristics of each type of vegetation
- Properties of reflection, absorption, and transmission of electromagnetic waves according to the thickness of the tree canopy (leaves)
- The relative electromagnetic wave reflection properties of vegetation and soil
- Properties of infrared and near-infrared images according to the water content of soil or

quantity of organic matter

- Albedo (reflectivity) of each type of ground feature

(6) Analysis of the spectroscopic characteristics of actual forests and ground use/ground cover

- Analysis of the spectroscopic characteristics of each type of cover using data for the Siet Ban Han production forest, Savannakhet Province
- Topographical and land-use maps, forest type maps, ortho images (1/5,000 aerial photographic images), field survey data
- Methods of analyzing spectroscopic characteristics
- Preparation of multi-temporal LANDSAT-8 images (7 scenes)
- Georeference using ArcGIS for superimposing various types of data
- Preparation of spectroscopic characteristic graphs for mixed deciduous forest, dry dipterocarp forest, fallow land, rice paddy, savannah, water, and comparison of changes
- Preparation and analysis of the characteristics of color composite images obtained by superimposing LANDSAT-8 images in each band

(7) Field survey at Phou Khao Khouay National Park and analysis of results

- Field survey (Saturday, March 7th: 10 participants)
- Implementation of plot survey at four locations (topography and soils of dry dipterocarp forest, bamboo, and the old Mekong River flooding area, their characteristics, and confirmation of the change in form of land-use to rubber plantation at the sites and using satellite images)
- Summary of the results of the field identification, and analysis of the characteristics on RapidEye images and LANDSAT-8 images
- Preparation and analysis of spectroscopic characteristic graphs for each survey point
- Characteristics of the RapidEye 4 band (red edge) and investigation of the effects on forest surveys in the survey region
- Preparation of water system maps and estimation of the topographical characteristics
- Summary of the field survey and results of image analysis by the trainees

(8) Analysis of vegetation indices (NDV) and related matters

- Vegetation indices (NDVI, etc.) and analysis of the relationship of the vegetation indices to the types and status of the various types of land cover
- What is the basic leaf area index (LAI)?
- The relationship between LAI used in forestry and the NDVI in remote sensing
- The ecological basis of NDVI
- Relationship between LAI, NDVI and SVI
- Extent of drying of leaves and spectroscopic characteristics (experimental example)
- Research example of LAI and the properties of the spectroscopic characteristics for a

Scandinavian coniferous forest from the LANDSAT ETM+ band

- Analysis of the change in NDVI using multi-temporal satellite images in the Savannakhet production forest
- What is the ground truth of vegetation indices (quantity of biomass, tree canopy density, tree height, LAI, etc.)
- The necessity of sampling surveys
- Example of the forest plot survey in the Savannakhet production forest and its results
- Methods of estimating the biomass and carbon stock on the ground from the results of a forest plot survey
- Examples of allometry equation (the Dr. Kiyono model in the Lao PDR, the general IPCC tropical forest equation)
- Methods of analyzing the relationship between terrestrial biomass and vegetation indices such as NDVI
- Analysis of the relationship between tree canopy density (%) obtained from aerial photography and NDVI
- Comparison of aerial photography, NDVI (from LANDSAT-8 images), RapidEye images, and LANDSAT-8 images
- Results of analysis of the relationship between NDVI and tree canopy density

(9) Summary of training

- Summary of the aims and results of this training
- The necessity of continuous autonomous learning in the future, in particular the potential for collection of research results in each specialist field using the internet and the necessity for advanced knowledge

(10) Training Completion Meeting and award of completion certificates

Training completion certificates were awarded to 9 trainees. Also, a Training Completion Meeting was held on Friday, March 3rd attended by trainees and other relevant persons.

A photograph showing the scene of the training and the award of the completion certificates is shown in Figure 3-30.

Figure 3-30 Scenes from Lecture, Field Survey, and Completion Ceremony

③ Summary of evaluation of the training results

Evaluation of the training results was implemented using an evaluation questionnaire (Figure 3-31) among the trainees. The results are shown inTable 3-9.

Questionnaire for the Training (Theory of Remote Sensing-Part 2)
Instructor: Mitsuru NASU, Ph.D.

Trainee's Name: _____

You have completed your training session. Please answer the following questions relevant to this training. **(Please circle the appropriate number below and comment)**.

Q1. The objective of the training "Theory of Remote Sensing-Part 2" is to provide you broad knowledge of theoretical and technical bases of forest remote sensing technology.
Did you achieve the objective?

Unachieved				fully achieved
2	2	3	4	5

Q2. What is your overall evaluation for the contents of the training?

Poor	Rather poor	Good	Fair	Very good
2	2	3	4	5

Q3. How do you think of the material (text) for the training?

Poor	Rather poor	Good	Well prepared	Very well prepared
1	2	3	4	5

Q4. How well could you understand the contents of the lecture and the field survey?
Evaluate yourself and choose level of understanding for each topic.

1. Process and Elements of Remote Sensing Survey (Chapter 1):
1-Very difficult 2-Difficult 3-Understood 4-Well understood 5-Very well understood

2. Characteristics of the Light (Sun light) for Forest Remote Sensing (Chapter 2)
1-Very difficult 2-Difficult 3-Understood 4-Well understood 5-Very well understood

3. Earth Observation Systems-Up-dated information and concept of multi-spectral, multi-resolution, multi-temporal remote sensing (Chapter 3):
1-Very difficult 2-Difficult 3-Understood 4-Well understood 5-Very well understood

4. Terrain and Landform Interpretation (Chapter 4)
1-Very difficult 2-Difficult 3-Understood 4-Well understood 5-Very well understood

5. Field Survey at the Phou Khao Khouay National Park and Analysis of the Results (Additional material)
1-Very difficult 2-Difficult 3-Understood 4-Well understood 5-Very well understood

6. Radiation Properties of Vegetation, Soil, and Water (Chapter 5):
1-Very difficult 2-Difficult 3-Understood 4-Well understood 5-Very well understood

7. Understanding Actual Spectral Characteristics of Forest and Land-cover Features in Lao PDR (Chapter 6)
1-Very difficult 2-Difficult 3-Understood 4-Well understood 5-Very well understood

8. Analyses of Multi-temporal Remote Sensing Imageries (at Savannakhet province) (Additional material):
1-Very difficult 2-Difficult 3-Understood 4-Well understood 5-Very well understood

9. Understanding Vegetation Indices of Forest and Various Land-Cover Features (Chapter 7):
1-Very difficult 2-Difficult 3-Understood 4-Well understood 5-Very well understood

Q5. How do you think of the duration of the training?

Too short	Short	Too long	Long	Good
1	2	3	4	5

Any comment and/or advices on the training “Theory of Remote Sensing-Part 2”. (In any languages)
……
…

Figure 3-31 Evaluation Questionnaire

Table 3-9 Evaluation of Training Contents (Numerals are number and ratio of responses, number of trainees = 9)

Question	Evaluation Score E	Evaluation Score D	Evaluation Score C	Evaluation Score B	Evaluation Score A
1. Achievement of Training Purpose	Poor	Rather poor	Good	Fair	Very good
	0	1(11%)	5 (56%)	2(22%)	1(11%)
2. Evaluation of Training Contents	Poor	Rather poor	Good	Fair	Very good
	0	0	6(67%)	2(22%)	1(11%)
3. Evaluation of Training Text book	Poor	Rather poor	Good	Fair	Very good
	0	0	4(44%)	3(33%)	2(22%)
4. Understandings for Each Training (Achievement) (Regarding theme (T1～T7), please refer to Figure 3-31) 5. Time length of Training	Very difficult	Difficult	Understood	Well understood	Very well understood
	T1: 0	0	5(56%)	3(33%)	1(11%)
	T2: 0	2(22%)	4(44%)	2(22%)	1(11%)
	T3: 0	1(11%)	4(44%)	3(33%)	1(11%)
	T4: 0	0	7(78%)	1(11%)	1(11%)
	T5: 0	1(11%)	3(33%)	3(33%)	2(22%)
	T6: 0	1(11%)	4(44%)	3(33%)	1(11%)
	T7: 0	0	6(67%)	1(11%)	2(22%)
	T8: 0	0	4(44%)	4(44%)	1(11%)
	T9: 0	1(11%)	4(44%)	3(33%)	1(11%)
Question	Too short	Short	Too long	Long	Good
	0	7(78%)	0	0	2(22%)

The following may be concluded from the training evaluation results shown in the above table.

1. Degree of attainment of the training objective: In terms of general attainment, the response of 89% was that the training objective was generally achieved, but the response in terms of the higher-level attainment was 33%, which was somewhat low.
2. Evaluation of the training contents: 100% responded that the training was good or better, so it can be generally concluded that the training was good.
3. Evaluation of the text: 100% responded that the training was good or better, so it can be generally concluded that the training was good.
4. Degree of understanding (degree of attainment) for each training theme: The results of

evaluation of the degree of understanding for each theme of the lectures was overall mostly Understood to Very well Understood. However, basic themes such as Theme 1 Factors for remote sensing surveys, Theme 2 Properties of light, Theme 5 Properties of radiation, etc., were Difficult, so these tended to be somewhat difficult.

5. Training period:

Regarding the training period, the largest response was Short at 78%, so it is inferred that people were busy with other work, and found it difficult to ensure sufficient time for the lectures. Also, as a result of this situation the amount by which the training hours were shortened during weekdays was compensated for with the weekend field identification.

6. Free comments and opinions

Five of the 9 trainees provided some kind of comment or opinion. The following are several of the comments.

- As a result of the training my knowledge on how to interpret the color of satellite images has improved compared with previously.
- The lecture course and the field identification in the National Park were extremely good. I would also like training regarding measurement of biomass.
- I would like training on how to obtain data after field plot survey data.
- I would like more time to be allocated.

It is considered that valid evaluation results were obtained for the contents of this training, and that this training was significant for the trainees. Also, in particular the trainees were advised regarding the necessity of continuous self-training.

For the future, it is necessary that the junior technical experts have continuous similar basic training while accumulating experience through work and the intermediate and senior technical experts have fundamental training by collecting related knowledge through academic papers, etc., and improve their capabilities in the technologies that are proven by theory.

3.2.7 Investigation of Forest Definitions and National Level Classification System, and Consistency with Sub-national Level Classification System

Since 2011 there have been discussions among the Department of Forestry and donors regarding the forest definitions that should be used in the UNFCCC reports and national level classification system, in order to apply REDD+. In this project, it is desirable that there be agreement among those involved regarding forest definitions and national level classification system, in order to prepare the envisaged national level forest type maps and forest carbon maps applying REDD+. Also, from the point of view led by the discussions

regarding forest definitions and national level classification system helps to date, it was considered that the Japanese team had a responsibility to hold a series of discussions leading to a certain conclusion, although it was recognized that this activity was beyond the scope of the work specification. On several occasions technical workshops were held and individual discussions were held, as a result of which agreement was obtained among those concerned in the form of the minutes of the meetings.

① Technical Workshop (jointly held with CliPAD)

On June 10th, 2014 a technical workshop was held jointly with CliPAD. In this workshop, discussions were held regarding consistency between national and sub-national level forest definitions and classification system, national and sub-national level carbon stratification and carbon stock estimation, and the development of national and sub-national level databases. This workshop was attended by 47 persons from various ministries, departments, and donors, which indicates the level of interest in this topic. The items agreed in this workshop were the classification items scheme (except for bamboo) used for forest type maps prepared by NFIS that were rearranged based on the results of accuracy assessment, and to provisionally replace "trees of height 5 m or higher", which is one of the factors of the forest definitions, with "diameter at breast height of 10 cm or higher".

② Follow-up technical workshop

Next, a follow-up technical workshop was held on June 24th, 2014. At this workshop the consistency between national and sub-national level forest definitions and classification system was discussed. In order to have a more specific and detailed discussion, the team was limited to national and sub-national level forest definitions and classification systems, and the number of participants was limited to 17 from various ministries, departments, and donors. In this workshop, although agreement was obtained regarding the classification item for bamboo, which was held over from the previous discussion, agreement regarding consistency in national and sub-national level classification systems was postponed as a task for the future. Also, it was decided that the forest definition for slash and burn land under UNFCCC will be discussed in the next meetings.

③ Technical workshop regarding classification

In addition a technical workshop regarding classification was held on October 21st, 2014. At this workshop, there was further discussion regarding consistency in national and sub-national level forest definitions and classification systems, and the forest definition for slash and burn land under UNFCC. This workshop was attended by about 30 persons from various ministries, departments, and donors. At this workshop, agreement was obtained regarding consistency of national and sub-national level classification items, but regarding national level classification system and the forest definition for slash and burn land under UNFCCC, separate discussions were held including with Mr. Khamphay, Acting Director General of the Department of Forestry. The consistency between the national and sub-nation departmental level classification items are as shown in Table 3-10.

Table 3-10 Consistency between the National and Sub-national Level of Classification Items

National Level 2010 Forest Type Map (NFIS)			Sub-National Level 2012 Forest Type Map in Houaphan Province (CliPAD)		
Class Groups	Class Items		Aggregated Class Name	Detailed (Level 2) Classification	Overall Class Name
Current Forest	Evergreen Forest	EF	Evergreen Forest	Evergreen Forest, Medium Density	Natural Forest
				Evergreen Forest, High Density	
	Mixed Deciduous Forest	MD	Deciduous Forest	Deciduous Forest, Medium Density	
				Deciduous Forest, High Density	
	Dry Dipterocarp Forest	DD	-	-	
	Coniferous Forest	CF	Coniferous Forest	Coniferous Forest, Medium Density	
	Mixed Coniferous/Broadleaved Forest	MCB	-	-	
	Forest Plantation	P	Plantation	Plantation (2010 Cleared, 2012 Planted)	Plantation Forest
Potential Forest	Fallow Land	FL	Swidden Agriculture	Swidden Agriculture (2010 Forest/Shrub, 2012 Planted)	Lowland and Upland Agriculture
			Upland Agriculture	Upland Agriculture (2010 Cleared, 2012 Planted)	
				Upland Agriculture (2010 Planted, 2012 Planted)	
			Bamboo / Shrub	Bamboo or Shrub (Old Fallow)	Non-Forest Vegetation
			Scrub	Scrub (Young Fallow)	
	Slash and Burn Land	SB	Swidden Agriculture	Swidden Agriculture (2010 Forest/Shrub, 2012 Cleared)	Lowland and Upland Agriculture
			Upland Agriculture	Upland Agriculture (2010 Cleared, 2012 Cleared)	
				Upland Agriculture (2010 Planted, 2012 Cleared)	
Other Wooded Area	Savannah/Open Woodland	SA	-	-	
	Scrub, Heath	SR	Scrub	Scrub (Young Fallow)	Non-Forest Vegetation
Permanent Agriculture Area	Rice Paddy	RP	Lowland Agriculture	Lowland Agriculture (2010 Cleared, 2012 Cleared)	Lowland and Upland Agriculture
	Other Agriculture Area	OA		Lowland Agriculture (2010 Planted, 2012 Cleared)	
				Lowland Agriculture (2010 Planted, 2012 Planted)	
	Agriculture Plantation	AP	-	-	
Other Non-Forest Area	Grassland	G	Permanent Grassland	Permanent Grassland	Non-Forest Vegetation
	Swamp	SW	-	-	
	Rock	R	-	-	
	Barren Land	BL	Bare Land	Bare Land (2010 Cleared, 2012 Cleared)	Non-Forest Non-Vegetation
				Bare Land, Earth Road	
				Bare Land, Logging Yard	
				Bare Land, Paved Road	
				Bare Land, Sand Bar	
	Urban Area	U	Settlement	Settlement, Town	
				Settlement, Village	
Water	Water	W	Water	Water	
Other Land	Other Land	O	-	-	
Other	Cloud	CL	Cloud Affected	Cloud or Cloud Shadow	
	Shadow	SH			

④ Discussion regarding National Level Forest Definitions and Classification System

Finally, separate discussions were held regarding national level classification system and the forest definition far slash and burn land under UNFCCC with Mr. Khamphay, Mr. Somchay, Deputy Directors General of the Department of Forestry, and Mr. Linthong, Director of the Forest Inventory and Planning Division, and agreement was obtained in the form of minutes of the meetings. The agreed minutes of meetings are included in Annex 2-2. Among them, the agreed national level classification system is shown in Table 3-11, and the forest definitions are shown in Table 3-12.

Regarding the national level classification items, the Level 1 and 2 classification items are to be applied to all levels, and the Level 3 classification items can be flexibly used at sub-national and project level. Also, regarding the forest definition for slash and burn land under UNFCCC, cultivated land after burning, which to date has been treated as slash and burn land, was renamed as Upland Crop, and is treated as agricultural land under the IPCC land-use classification. In addition land abandoned after cultivation, which to date has been treated as Fallow Land, has been renamed to Regenerating Vegetation, and is treated as fallow land under the IPCC land-use classification. In addition, regarding bamboo, although it had been agreed in the technical workshop on classification held on October 21st, 2014 to include this in Fallow Land, there was a request that it be classified again as this was an important research matter, so it was decided to continue to classify it.

In summary, forest and land cover is Level 1 Current Forest, and forest land as land-use is Forest Land in accordance with the IPCC definition. Also, REDD+ is applied to forest land, a change from forest land to another IPCC definition reduces the amount of forest, and a change within forest land is a degradation of the forest.

Note that as stated in the minutes of meetings, the Department of Forestry will discuss the details of this agreement with other relevant ministries and departments, and work towards formal definitions, and this project will also be supported as necessary.

Table 3-11 Classification system for National level

Land/Forest Classification at National Level for Lao PDR

Land/Forest Classification at National Level for Lao PDR is shown below in comparison with IPCC land use categories.
'Level 1' have to be used for any level of map.
'Level 2' should be used for any level of map.
'Level 3' can be used for Sub-National/Project Level.

IPCC Definition	*National Level Classification System for Lao PDR*				
	Level 1	*Level 2*		*Level 3*	
Forest Land	**Current Forest**	Evergreen Forest	EF	High Density Evergreen Forest	HEF
				Low Density Evergreen Forest	LEF
		Mixed Deciduous Forest	MD	High Density Mixed Deciduous Forest	HMD
				Low Density Mixed Deciduous Forest	LMD
		Dry Dipterocarp Forest	DD	High Density Dry Dipterocarp	HDD
				Low Density Dry Dipterocarp	LDD
		Coniferous Forest	CF		
		Mixed Coniferous and Broadleaved Forest	MCB		
		Forest Plantation	P	Evergreen Forest Plantation	EP
				Deciduous Forest Plantation	DP
	Regenerating Vegetation	Bamboo	B	Bamboo	B
		Regenerating Vegetation	RV	Fallow Land	FL
				Degraded Forest	DF
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		

Table 3-12 Each minimum threshold value in revised forest definition

Minimum Threshold of Forest Definition		
DBH	Crown Density	Area
10cm	20%	0.5ha

3.2.8 Revision of Forest Type Maps (2000, 2005, 2010)

Development of the methods of preparing the new 2000 and 2005 forest type maps has been discussed and agreed with the C/P. The agreed work flow for preparing the 2000 and 2005 forest type maps is shown in Figure 3-32. In this method basically the change between each two points in time (first the change from the 2010 RapidEye to the 2005 SPOT, and then the change from the 2005 SPOT to the 2000 LANDSAT) are interpreted, and locations that have changed only are interpreted visually. The unit of classification is the polygon, for which basically those of the 2010 forest type maps will be used. However, changes in the boundary lines for classification will occur between two points in time, so in that case the new boundary lines will be added manually. However, for Upland Crop (UC) new boundary lines will certainly occur between each point of time, so adding all the boundaries manually will have poor efficiency. Therefore, for UC only the individual polygons will be prepared and extracted for 2000 and 2005, and the work of preparation will be started after overlaying onto the 2010 forest type maps. In addition, the maps were revised for the changes that could not have realistically occurred between each pair of points in time.

The 2000, 2005, and 2010 forest type maps were prepared in accordance with the method of revision of the 2010 forest type maps agreed in Section 3.2.2, and the method of preparing the forest type maps of 2000 and 2005. Table 3-13 shows the organization of work. Also, each of the forest type maps prepared are shown in Figure 3-33 to Figure 3-35, and the area of coverage of each type of forest in the forest type maps are shown in Table 3-14. The area of Current Forest that satisfied the forest definition of Laos decreased slightly between 2000 and 2010, from 13,915,062 ha (60.4%) in 2000, to 13,797,575 ha (59.8%) in 2005, and 13,430,740 ha (58.3%) in 2010. The area of Regenerating Vegetation, which mainly consists of abandoned slash and burn farmland excluding Upland Crop, also decreased slightly in the same period, from 6,231,011 ha (27.0%) in 2000, to 6,079,325 ha (26.4%) in 2005, and 5,523,443 ha (24.0%) in 2010. Meanwhile, the area of Cropland including Upland Crop increased between 2000 and 2010, from 1,811,945 ha (7.9%) in 2000, to 2,076,163 ha (9.0%) in 2005, and 2,538,589 ha (11.0%) in 2010. These changes suggest the potential progress of the conversion of forestland into cropland during this period. However, the increase in Upland Crop between 2005 and 2010 can be partly attributed to the following fact: it is difficult to distinguish UC and newly developed Cropland of the other types or Plantation from interpreting an image taken at a certain point of time. It was possible to distinguish these two on the images taken in 2000 and 2005 because the images taken later were available for comparison to identify the changes that occurred since 2000 and 2005, respectively. However, it was not possible to do so with the images taken in 2010 because images taken later were not available and, therefore, it was not possible to verify the changes that occurred after 2010. Thus, when it was not possible to confidently interpret whether a certain area was newly developed Cropland/Plantation or Upland Crop on an image taken in 2010, the area concerned was classified as Upland Crop. While it is considered possible to correct the classification by verifying images

taken after 2010, a study will have to be conducted on the way to handle such cases when new data (of 2015) are to be created. As the area of Cloud and Shadow accounted for 2.4% of the area covered by the images taken in 2010, the accuracy of the forest type data will have to be improved by referring to images taken after 2010. This improvement may change the figures of the areas mentioned above.

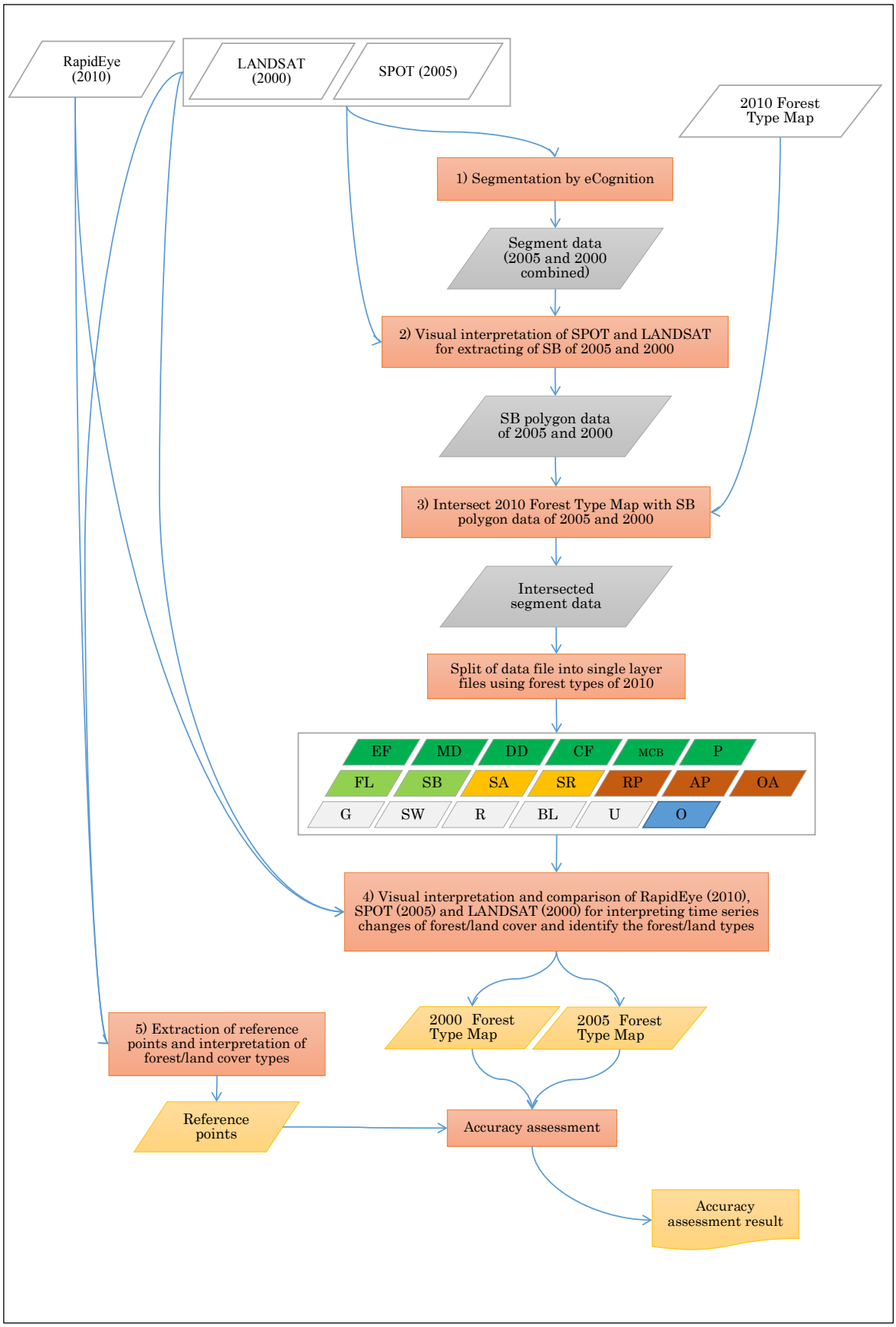


Figure 3-32 Work flow of developing forest type map in 2000 and 2005

Table 3-13 Organization for revising

Correction Team	Survey Team	Leader	Sub Leader	Staff	Senior Engineer
A	5&6	Onkeo	Amphayvanh	Piya	Bounthanome
B	2&4	Khamkhong	Khamsouk	Keovilay	Chansamouth
C	1&3	Kongsy	Phouthone	Somxay	Sombath
Correction Team	Survey Team	Provinces for each teams			
A	5	Khammuane	Savannakhet	Saravane	
	6	Champasak	Sekong	Attapeu	
B	2	Xayaboury	Luangnamtha	Bokeo	
	4	Vientiane C	Vientiane	Bolikhamxay	Xaisomboune
C	1	Phongsaly	Oudomxay		
	3	Luangprabang	Xiengkuang	Houaphanh	

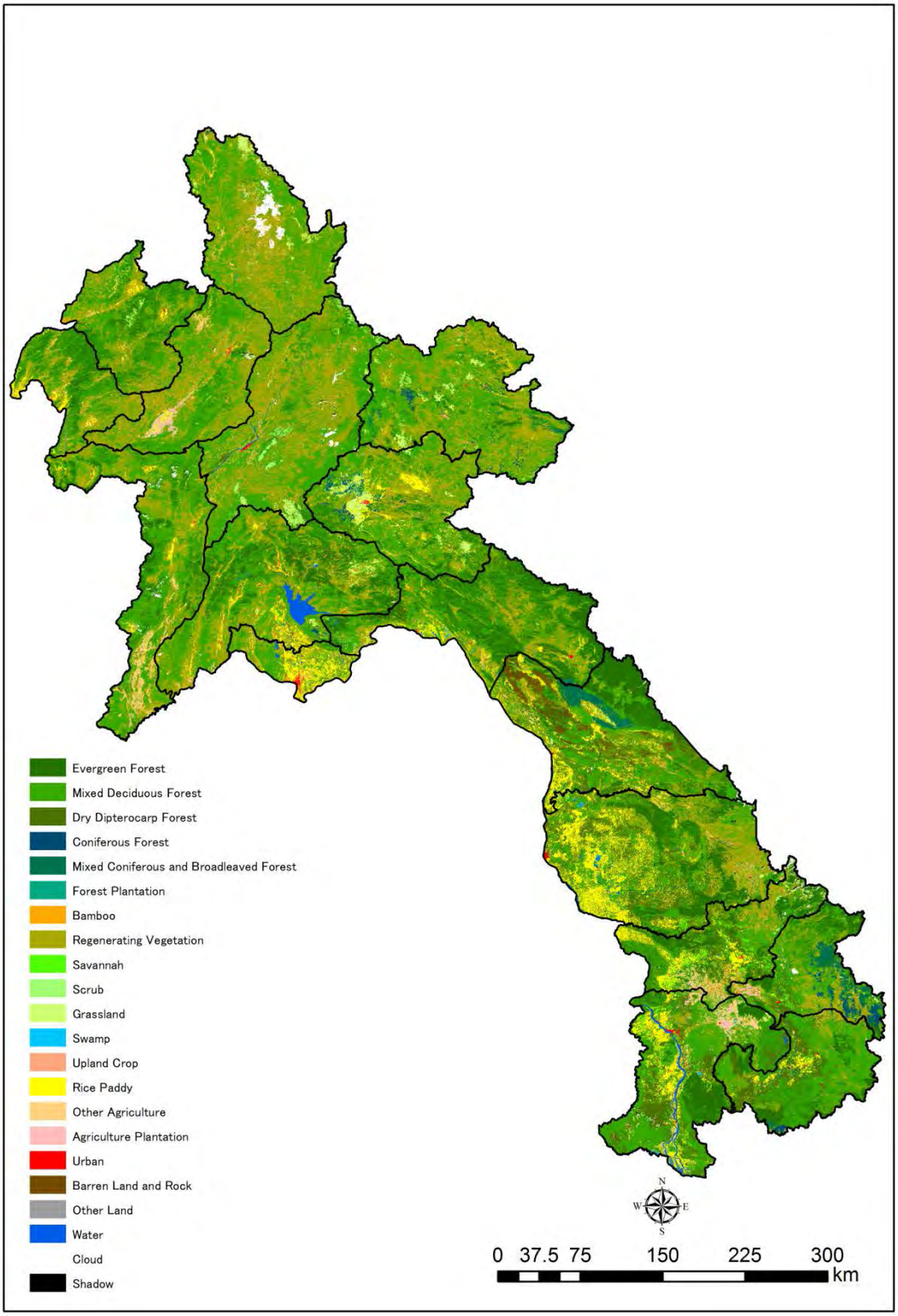


Figure 3-33 Forest type map in 2000

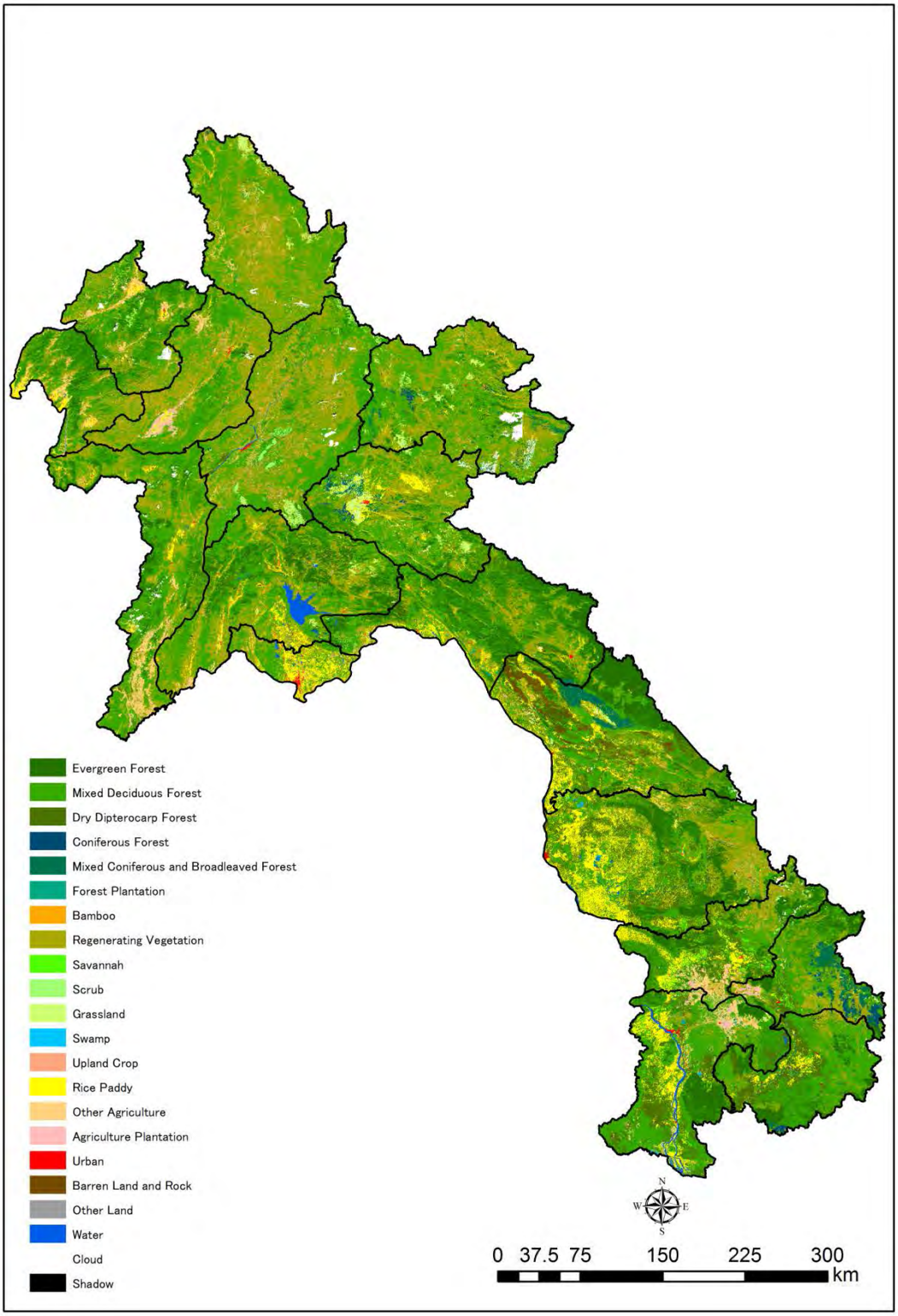


Figure 3-34 Forest type map in 2005

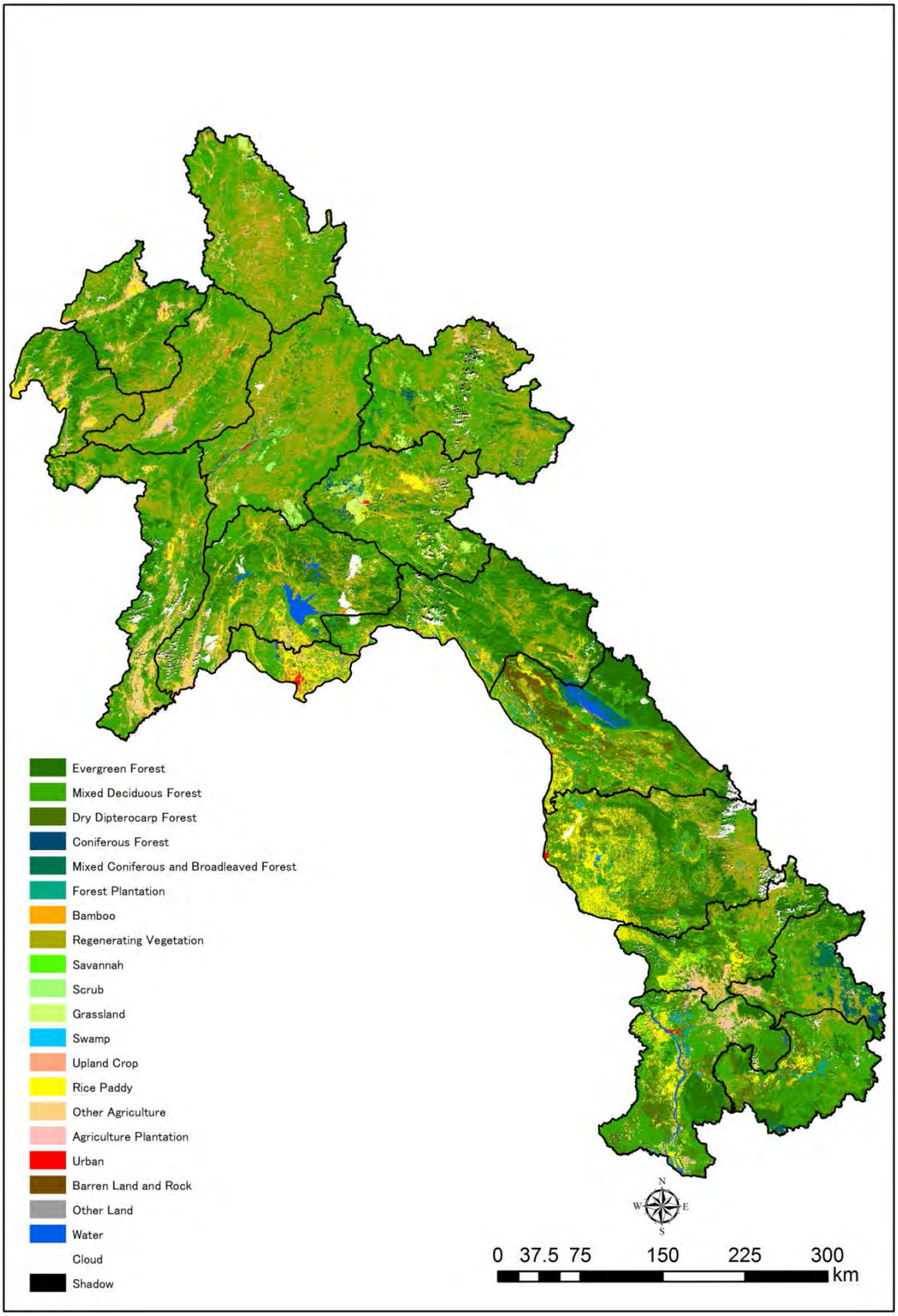


Figure 3-35 Forest type map in 2010

Table 3-14 Area for each Classification in 2000, 2005 and 2010

National Level Classification System for Lao PDR			2010		2005		2000	
Level 1	Level 2		ha	%	ha	%	ha	%
Current Forest	Evergreen Forest	EF	2,984,601		3,055,050		3,047,762	
	Mixed Deciduous Forest	MD	8,827,908		9,097,006		9,215,611	
	Dry Dipterocarp Forest	DD	1,205,454		1,293,013		1,301,558	
	Coniferous Forest	CF	86,270		86,646		87,997	
	Mixed Coniferous and Broadleaved Forest	MCB	218,932		244,121		244,439	
	Forest Plantation	P	107,575	58.3%	21,738	59.8%	17,695	60.4%
Regenerating Vegetation	Bamboo	B	87,517		68,491		63,343	
	Regenerating Vegetation	RV	5,435,926	24.0%	6,010,834	26.4%	6,167,668	27.0%
Other Vegetated Areas	Savannah	SA	103,998		106,643		107,786	
	Scrub	SR	24,626		27,623		27,489	
	Grassland	G	245,150		272,691		283,065	
	Swamp	SW	10,187	1.7%	9,685	1.8%	11,156	1.9%
Cropland	Upland Crop	UC	441,336		238,892		196,960	
	Rice Paddy	RP	1,187,568		1,178,021		1,152,985	
	Other Agriculture	OA	844,124		609,283		414,027	
	Agriculture Plantation	AP	65,561	11.0%	49,967	9.0%	47,973	7.9%
Non Vegetated	Urban	U	72,224		64,280		63,776	
	Barren Land and Rock	BR	182,691	1.1%	184,365	1.1%	183,322	1.1%
Other Land	Other Land	O	20,310	0.1%	19,181	0.1%	18,994	0.1%
Water	Water	W	342,776	1.5%	277,043	1.2%	276,151	1.2%
Other	Cloud	CL	400,276		129,225		113,249	
	Cloud Shadow	SH	159,216	2.4%	10,427	0.6%	11,220	0.5%
SUM			23,054,225	100%	23,054,225	100%	23,054,225	100%

① Progress control

Progress was controlled by each team preparing a progress control Table 3-15 and an overall progress

Table 3-16, these tables were updated every day by the team leaders, And once a week these were reported to the manager and Japanese consultants. This method was also used for FIM, and although this did not function very well during FIM, in this project reporting was carried out almost every week, so it was confirmed that the progress control capability of the C/P had improved.

Table 3-15 Process management table

Information			Correction							
			1. [CF/MCB], [CF/MD,FL]							
Observed Date	Mosaic ID	Shape file ID	Create CF zone		Correct CF/MCB in CF zone		Correct CF/MCB in other area		Check between scenes	
			Date	Person	Date	Person	Date	Person	Date	Person
20101105	20101105t044948_01_or_mo	t044948_01	14/07/2014	Sombath	07/08/2014	Phouthone	07/08/2014	Phouthone	17/09/2014	kongsy
20101108	20101108t043432_03_or_mo	t043432_03	14/07/2014	Sombath	21/07/2014	Somxay	21/07/2014	Somxay	24/09/2014	Yomala
20101108	20101108t043432_04_or_mo	t043432_04	14/07/2014	Sombath	06/08/2014	Phouthone	06/08/2014	Phouthone	30/09/2014	Phouthone
20101108	20101108t043432_05_or_mo	t043432_05	14/07/2014	Sombath	07/08/2014	Phouthone	07/08/2014	Phouthone	14/08/2014	kongsy
20101108	20101108t045545_01_or_mo	t045545_01					07/08/2014	kongsy	14/10/2014	kongsy
20101108	20101108t045545_02_or_mo	t045545_02					07/08/2014	kongsy	10/09/2014	kongsy
20101108	20101108t045545_03_or_mo	t045545_03					08/08/2014	kongsy		
20101109	20101109t043506_03b_or_mo	t043506_03b					08/08/2014	kongsy	18/08/2014	kongsy
20101109	20101109t043506_05a_or_mo	t043506_05a					08/08/2014	kongsy	01/09/2014	kongsy
20101109	20101109t043506_05b_or_mo	t043506_05b					08/08/2014	kongsy	02/09/2014	kongsy
20101113	20101113t043919_02_or_mo	t043919_02					08/08/2014	kongsy	03/09/2014	kongsy

Table 3-16 Progress aggregating table

Correction																	
1. [CF/MCB], [CF/MD,FL]						2. [EF/MD]						Check between scenes		4. [MD/FL], [SB,FL/RP] by PALSAR		Check between scenes	
Create CF zone		Correct CF/MCB in CF zone		Correct CF/MCB in other area		Create EF zone		Correct EF in EF zone		Correct MD in other area							
done	all	done	all	done	all	done	all	done	all	done	all	done	all	done	all	done	all
14	14	14	14	47	47	18	18	18	18	44	47	44	47	25	47	0	47
100%		100%		100%		100%		100%		94%		94%		53%		0%	

② Quality control

Quality control was carried out as follows.

As shown in Figure 3-36, overall meetings were held at the beginning of the week, and leaders meetings were held at the end of the week, in order that the results of the revision work and any issues could be confirmed between each team leader and their senior technical experts in weekly units, to enable course correction to be made promptly. Also, after completion of the revision work of (1) to (3) and the revision work of (4), work was carried out to ensure that there was no inconsistency between scenes, and efforts were made to minimize any variation in quality between scenes. In addition, quality control was carried out by the Japanese consultants carrying out checking for consistency and making modifications, etc., after the revision work by the C/P.

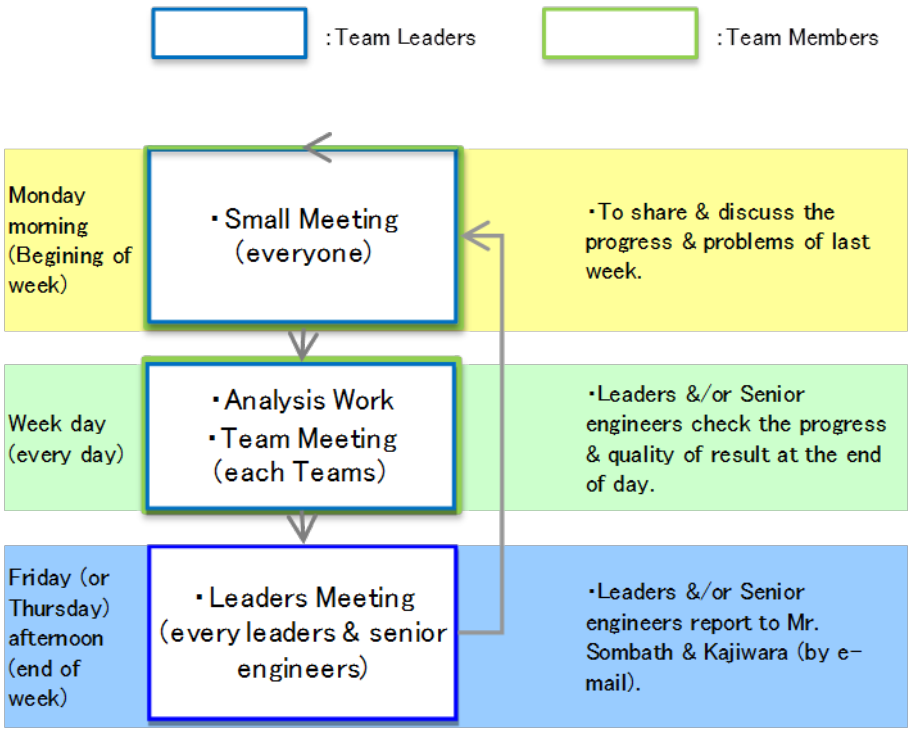


Figure 3-36 Week work flow

3.2.9 Final Accuracy Assessment of Forest Type Maps (2000, 2005, 2010)

The final accuracy assessment of the prepared 2000, 2005, and 2010 forest type maps was performed. There were two objectives of the accuracy assessment: the first was assessment that the target accuracy for forest/non-forest and each forest type set for the forest type maps was achieved, and the second was to calculate the uncertainty, which is required for international reporting. The assessment items were arranged as shown in Table 3-17 in order to satisfy the objectives. With respect to the 2010 forest type map, since the target accuracy has been set not only for forest and non-forest but also for the forest type, it was decided to perform assessment, which is necessary for the calculation of the uncertainity for all the items of forests and for the IPCC land-use classification for non-forests. In the case of the 2000 and 2005 forest type maps, an accuracy target was not required for the forest type, so in order to confirm achievement of the accuracy target for forest/non-forest, forests were grouped together as a single item, and non-forests were classified according to the IPCC land-use classification for the purposes of assessment. Note that the reference data for 2010 forest classification was already prepared, but the non-forests were grouped together. Therefore reinterpretation was carried out with the IPCC land-use classifications, and the 2000 and 2005 forest type map reference data was newly prepared by interpretation after confirming whether or not there was a change between each of the points of time in accordance with the items of Table 3-17, at the same points as the reference data for the 2010 forest type maps. As the work, described above, confirmed that part of the data had been misinterpreted, such data were reviewed.

Table 3-17 Items to be verified for forest distribution map

LULUCF Categories	Forest Cover Map Classes		Accuracy Assessment 2010		Accuracy Assessment 2005/2000	
Forest Land	Evergreen Forest	EF	Evergreen Forest	EF	Forest Land	F
	Mixed Deciduous Forest	MD	Mixed Deciduous Forest	MD		
	Dry Dipterocarp Forest	DD	Dry Dipterocarp Forest	DD		
	Coniferous Forest	CF	Coniferous Forest	CF		
	Mixed Coniferous/ Broadleaved Forest	MCB	Mixed Coniferous/ Broadleaved Forest	MCB		
	Forest Plantation	P	Forest Plantation	P		
	Bamboo	B	Bamboo	B		
	Fallow land	FL	Fallow land	FL		
Cropland	Slash and Burn Land	SB	Cropland	C	Cropland	C
	Rice Paddy	RP				
	Agriculture Plantation	AP				
	Other Agriculture Area	OA				
Grassland	Savannah/Open Woodland	SA	Grassland	G	Grassland	G
	Scrub, Heath	SR				
	Grassland	G				
Wetlands	Swamp	SW	Wetlands	W	Wetlands	W
	Water	W				
Settlements	Urban Area	U	Settlements	S	Settlements	S
Other Land	Rock	R	Other Land	O	Other Land	O
	Barren Land	BL				
	Other Land	O				
	Cloud	CL	Cloud and Shadow	CL	Cloud and Shadow	CL
	Shadow	SH				

The results of the final accuracy assessment of the 2000, 2005, and 2010 forest type maps are shown in Table 3-18 to Table 3-25. Table 3-18 to Table 3-21 show the results of the final accuracy assessment in accordance with the classification system adopted during the initial phase of this project, and Table 3-22 to Table 3-25 show the results of the final accuracy assessment in accordance with the classification system that was finally agreed to within the forest sector through this Project, which is reported in 3.2.7.

Although the target accuracy shown in the special specification was set at the beginning of this Project for the initial classification system, it was decided to perform assessment for both classification systems. The difference between these classification systems is that while the initial system did not include land abandoned after slash and burn (RV) and bamboo forest (B) in forests, the final classification system includes RV and B in forests. The issue of classification of RV and MD, which are often formed in transition after deforestation to UC and are considered to be a type of forest degradation as they are changes to another item of forests, was analyzed by performing accuracy assessment in accordance with the final classification system.

The target accuracy shown in the special specification was 70% or more for the forest type classification accuracy in the 2010 forest type map. As the overall accuracy for forest type in the 2010 forest type map was 72.7% (Table 3-18), the target was achieved. With respect to the target classification accuracy of 80% or more for forest and non-forest in the 2010, 2005, and 2000 forest type maps, which was independently set in this Project, the overall accuracy for forest and non-forest in the 2010 forest type map was 81.2% (Table 3-19) and so the target was achieved. However, the overall accuracy for forest and non-forest in the 2005 and 2000 forest type maps was 78.6% (Table 3-20) and 78.6% (Table 3-21), respectively, which were slightly lower than the target.

With respect to the classification accuracy in accordance with the classification system agreed in this Project, while the overall accuracy of forest and non-forest in the 2010, 2005, and 2000 forest type maps was 91.2% (Table 3-23), 88.4% (Table 3-24) and 90.3% (Table 3-25) respectively, which was higher than the VCS and other international standards, the overall accuracy of forest type in the 2010 forest type map was 66.9% (Table 3-22), which was lower than 70%. It is considered that the classification accuracy of forest type was low because the newly agreed classification system includes MD and RV, covering the majority of the land of Lao PDR and changing drastically and being difficult to classify, in the forests (treating them as forest degradation). In fact, Table 3-22 shows that the user accuracy of MD and RV, which account for about 60% of all the assessment points, are 60.8% and 62.7%, which are not high, even though these have been improved from the user accuracy before the modification. As described in 3.2.2, it is not easy to classify MD and RV on satellite images captured in a period of time. As such, in order to improve the accuracy further, it is necessary to further clarify the definitions and the operation and assessment methods based on the premise that chronological data are used. Since various chronological global data sets have been developed, they should be utilized, and at the same time, continuous efforts should be made to address improvements with

accuracy to reduce uncertainty and combat forest degradation as part of the activities to formulate the reference emission level. Also, the user accuracy of CF (52.2%) and B (21.7%) are much lower than 70%, although the number of their assessment points is small. It was revealed from this study that it is difficult to clearly classify CF and MCB on images, since they are formed as a result of continuous transformation of the same vegetation combination. While each classification is to be kept for forest management, it should also be considered to treat them as the same item in the evaluation of overall uncertainty in the carbon stock calculation. With respect to B, after verification based on the results of this study, it was presumed that the main cause is the lack of uniform perception among the operators concerning the appearance on images and the distribution range. Examinations should be carried out to determine whether or not to leave it as an item after identifying the distribution range by utilizing aerial photographs that have become available in Lao PDR and verifying how it looks on satellite images.

Table 3-18 Error Matrix for Forest Type Classification of 2010 Forest Type Map (Past Classification System)[2,3]

2010				Reference data								
				Forest						NF	Total	U.A
				Current Forest								
				EF	MD	DD	CF	MCB	P			
Map	Forest	Current Forest	EF	**121**	28	2				11	162	74.7%
			MD	40	**293**	18	3	3	1	124	482	60.8%
			DD		7	**48**			1	13	69	69.6%
			CF		3		**12**	3		5	23	52.2%
			MCB	2	6	2	1	**29**		1	41	70.7%
			P		1				**22**	6	29	75.9%
	NF			9	82	9	1	1	7	**513**	622	82.5%
		Total		172	420	79	17	36	31	673	1428	
		P.A		70.3%	69.8%	60.8%	70.6%	80.6%	71.0%	76.2%		
Overall Accuracy				**72.7%**								

[2] U.A: User's accuracy、P.A: Producer's accuracy

[3] Overall accuracy is the ratio of total points (in blue) that matched between the map and the reference data to the total assessment points.

Table 3-19 Error Matrix for Forest / Non-Forest Classification of 2010 Forest Type Map (Past Classification System)[2,3]

2010		Reference data			
		Forest	Non-Forest	Total	U.A
Map	Forest	646	160	806	80.1%
	Non-Forest	109	513	622	82.5%
	Total	755	673	1428	
	P.A	85.6%	76.2%		
Overall Accuracy		81.2%			

Table 3-20 Error Matrix for Forest / Non-Forest Classification of 2005 Forest Type Map (Past Classification System)[2,3]

2005		Reference data			
		Forest	Non-Forest	Total	U.A
Map	Forest	636	177	813	78.2%
	Non-Forest	128	487	615	79.2%
	Total	764	664	1428	
	P.A	83.2%	73.3%		
Overall Accuracy		78.6%			

Table 3-21 Error Matrix for Forest / Non-Forest Classification of 2000 Forest Type Map (Past Classification System)[2,3]

2000		Reference data			
		Forest	Non-Forest	Total	U.A
Map	Forest	639	179	818	78.1%
	Non-Forest	126	484	610	79.3%
	Total	765	663	1428	
	P.A	83.5%	73.0%		
Overall Accuracy		78.6%			

Table 3-22 Error Matrix for Forest Type Classification of 2010 Forest Type Map (New Classification System)[2,3]

2010				Reference data										
				Forest Land								NF	Total	U.A
				Current Forest						Potential Forest				
				EF	MD	DD	CF	MCB	P	B	RV			
Map	Forest Land	Current Forest	EF	**121**	28	2					11		162	74.7%
			MD	40	**293**	18	3	3	1	4	101	19	482	60.8%
			DD		7	**48**			1		2	11	69	69.6%
			CF		3		**12**	3			4	1	23	52.2%
			MCB	2	6	2	1	**29**				1	41	70.7%
			P		1				**22**		3	3	29	75.9%
		Potential Forest	B	2	8					**5**	7	1	23	21.7%
			RV	6	66	2	1	1	2	7	**224**	48	357	62.7%
	NF			1	8	7	0	0	5	1	19	**201**	242	83.1%
		Total		172	420	79	17	36	31	17	371	285	1428	
		P.A		70.3%	69.8%	60.8%	70.6%	80.6%	71.0%	29.4%	60.4%	70.5%		
Overall Accuracy				**66.9%**										

Table 3-23 Error Matrix for Forest / Non-Forest Classification of 2010 Forest Type Map (New Classification System)[2,3]

2010		Reference data			
		Forest	Non-Forest	Total	U.A
Map	Forest	**1102**	84	1186	92.9%
	Non-Forest	41	**201**	242	83.1%
	Total	1143	285	1428	
	P.A	96.4%	70.5%		
Overall Accuracy		**91.2%**			

Table 3-24 Error Matrix for Forest / Non-Forest Classification of 2005 Forest Type Map (New Classification System)[2,3]

2005		Reference data			
		Forest	Non-Forest	Total	U.A
Map	Forest	1112	124	1236	90.0%
	Non-Forest	42	150	192	78.1%
	Total	1154	274	1428	
	P.A	96.4%	54.7%		
Overall Accuracy		88.4%			

Table 3-25 Error Matrix for Forest / Non-Forest Classification of 2000 Forest Type Map (New Classification System)[2,3]

2000		Reference data			
		Forest	Non-Forest	Total	U.A
Map	Forest	1156	101	1257	92.0%
	Non-Forest	38	133	171	77.8%
	Total	1194	234	1428	
	P.A	96.8%	56.8%		
Overall Accuracy		90.3%			

3.2.10 Identifyig Factors with a High Correlation with Carbon Stock

In order to review factors that have a high correlation with carbon stock, the carbon stratification analysis methodology was determined after discussions with the C/P. The work flow related to carbon stratification is shown in Figure 3-37.

To investigate the carbon stratification, national level inventory data is necessary, and the existing inventories are the 1st NFI implemented between 1991 and 1999, and the FIM inventory implemented between 2010 and 2011, as shown in Table 3-26 Existing National Level Inventory Data In the 1st NFI data, the quantity of biomass was calculated using unique conversion coefficients, whose values are comparatively close to the IPCC default values. On the other hand, the FIM inventory data was converted to the quantity of biomass using a sub-allometric equation, which had extremely small values when compared with the IPCC default values. However, the FIM inventory was carried out over a comparatively short period of time in recent years and the positional information of the survey area was recorded. In contrast the NFI inventory was surveyed over a period of nearly 10 years during the 1990s, and the accurate positional information has not been recorded. From the above, each of the inventory data as advantages and disadvantages, but for investigating carbon stratification positional information is essential for comparison with GIS data, so initially the investigation was started with the FIM inventory data.

First, the inventory data (including measurement of breast height diameter, tree height and crown ratio in survey of each tree) for each survey plot implemented with FIM was converted into biomass using allometric equation. However, since a unique allometric equation does not exist in Laos, (1) a pseudo allometric equation will need to be prepared by using biomass data calculated using past NFI data in Laos, or (2) work will need to be performed to adapt one of the existing allometric equations developed / formulated by surrounding countries or IPCC among which it can be used in Laos. FIM inventory data which has been converted into biomass will be compared / examined with existing GIS data that potentially has a correlation with carbon stock, and the existence of a correlative relationship will be verified. After this, the significance when carbon stratification is performed will be examined, and whether or not the required accuracy is satisfied will be confirmed. During the first year, a portion of the existing GIS data was used to review the correlative relationship.

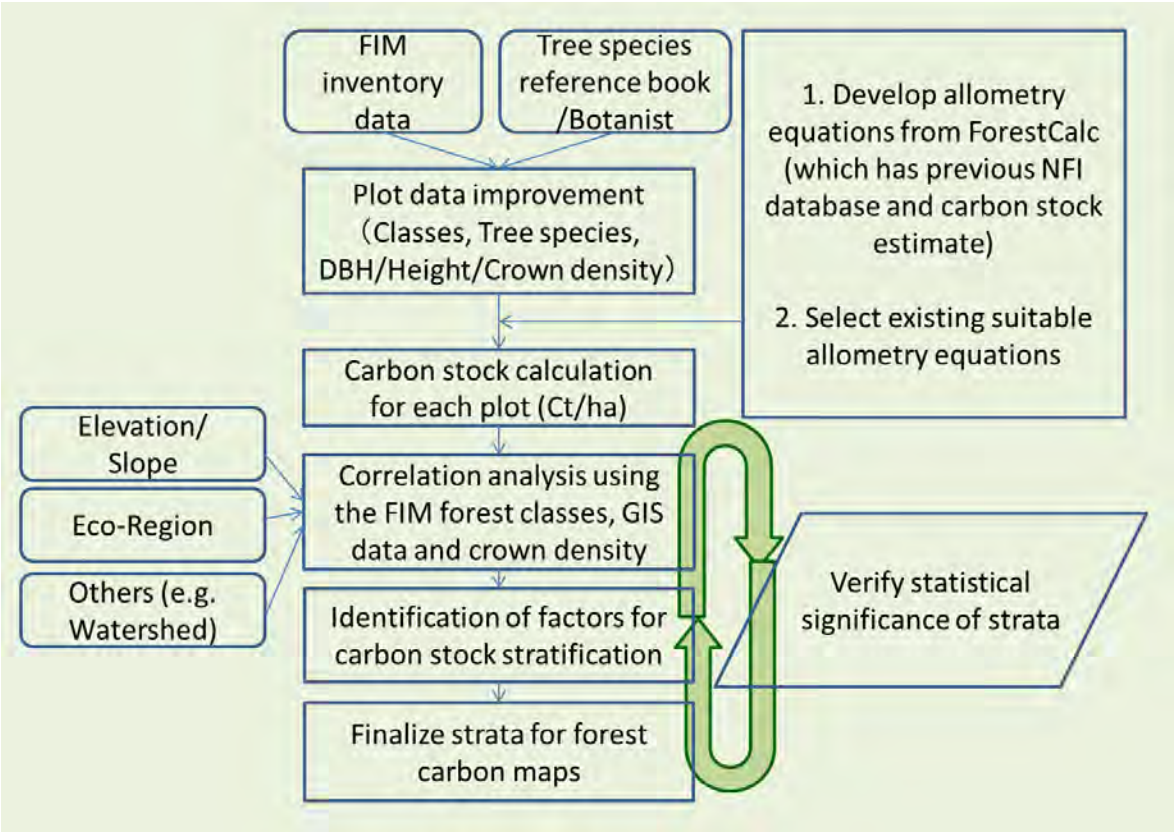


Figure 3-37 Work Flow Related to Carbon Stratification

Table 3-26 Existing National Level Inventory Data

	1st NFI	FIM inventory
Year	1991-1999	2010-2011
Location information	No	Yes
Estimated amount of biomass	Similar with IPCC default	Very lower than IPCC default

As stated above, since there is not a unique allometric equation in Laos, review on an applicable allometric equation was conducted with the two methodologies described below.

(1) Preparation of a pseudo allometric equation by using past NFI biomass data in Laos

(2) Adapt an existing allometric equation developed / formulated by surrounding countries or IPCC for use in Laos

For item (1), since the details are described later in "Section 3.2.1 Analysis / Organization of Existing Forest Information Database", the details of item (2) will be described here.

The allometric equations from Vietnam and Cambodia were reviewed as allometric equations from surrounding countries (Figure 3-38). When the allometric equations from surrounding countries share the same characteristics specified by WWF for Ecoregions[4] as areas in Laos, the decision was made to adopt the equation. Allometric equations have been developed by UN-REDD for the various areas in Vietnam[5], and the Evergreen Forest (EF) allometric equation for the North East, North Central Coast and South Central Coast overlaps with common Ecoregions in Laos, so the decision was made to adopt it. Normally, the equation should only be applicable to Evergreen Forests, but since there is not an allometric equation for the Mixed Deciduous Forest (MD) forest type, the decision was made to tentatively adopt the above Evergreen Forest allometric equation. Next, the decision was made to adopt allometric equation developed as a general purpose equation in Cambodia[6] for Ecoregions that are shared with Cambodia. In addition, since there is not suitable allometric equation for Dry Dipterocarp Forest (DD) areas in Laos, the decision was made to tentatively adopt the allometric equation that can be applied to tropical climate forests in the Indochina region[7].

For the remaining Coniferous Forest (CF), Mixed Coniferous and Broadleaved Forest (MCB) and Plantation Forest (P) areas, the allometric equations developed as general purpose equations by IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry were adopted. The allometric equation from the IPCC guidance for Temperate/tropical pines was adopted for Coniferous Forest areas, and the allometric equations from Vietnam and IPCC guidance for Temperate/tropical pines were adopted for Mixed Coniferous and Broadleaved Forest areas. The Eucalyptus sp. and Tectona grandis b allometric equation was adopted for Plantation Forest areas.

The adopted allometric equations are organized in Table 3-27 and Table 3-28. As stated above, the allometric equations developed / formulated by surrounding countries and the IPCC are not a good match for Mixed Deciduous Forest and Dry Dipterocarp Forest, and this resulted in issues that need to be addressed, such as tentative adoption of the allometric equations for other forest types. However, as described later in "Section 3.3.1 Analysis / Organization of Existing Forest Information Database", the desk-based allometric equations formulated using past NFI data from Laos were successfully used to perform formulation for each province / forest type. According to C/Ps, there was a pronouncement that it was desirable to use an allometric equation adjusted from Lao PDR's own NFI data, and therefore it was decided to use the allometric equation (Figure

[4] http://wwf.panda.org/about_our_earth/ecoregions/about/
[5] Tree allometric equation development for estimation of forest above-ground biomass in Viet Nam, UN-REDD PROGRAMME, October 2012
[6] Kiyono Y. (2010) Carbon Stock Estimation by Forest Measurement Contributing to Sustainable Forest Management in Cambodia, JARQ 44 (1), 81 - 92
[7] Monda 式, REDD-Plus Cookbook, REDD Research and Development Center

3-60) that was adjusted on a desk basis using the first NFI data.

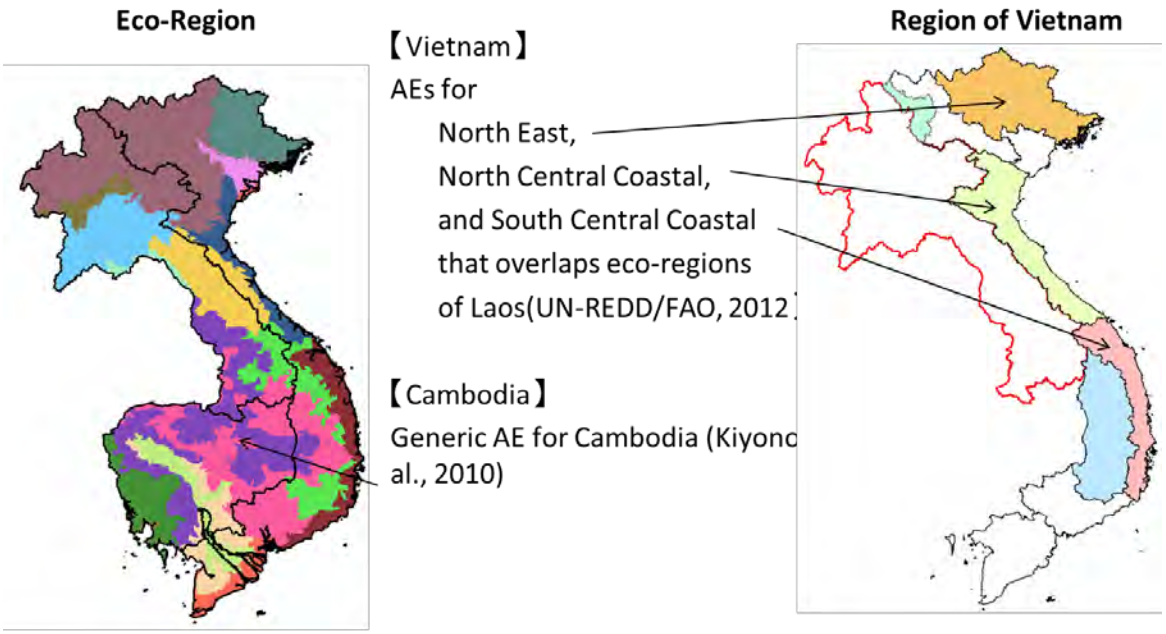


Figure 3-38 Allometric Equations from Surrounding Countries Applicable in Laos

Table 3-27 Allometric Equations Formulated in Surrounding Countries and by IPCC Applicable to Laos Ecoregions and Forest Types: Set 1

Eco-region		Ecoregions in Laos							
		0137	0139	0121	0138	0136	0202	0152	0210
		Northern Indochina Subtropical Forests	Northern Thailand-Laos Moist Deciduous Forests	Luang Prabang Montane Rain Forests	Northern Khorat Plateau Moist Deciduous Forests	Northern Annamites Rain Forests	Central Indochina Dry Forests	Southern Annamites Montane Rain Forests	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

Table 3-28 Allometric Equations Formulated in Surrounding Countries and by IPCC Applicable to Laos Ecoregions and Forest Types: Set 2

	Model	Equation	Variable	Applicable Area	Applicable Forest Type
1)	UN-REDD: Vietnam North East	$AGB = 0.1142*DBH^{2.4451}$	DBH = diameter at breast height (cm)	Northern Indochina Subtropical Forests Northern Thailand-Laos Moist Deciduous Forests	Evergreen Forest
2)	UN-REDD: Vietnam North Central Coast	$AGB = 0.1245*DBH^{2.4163}$	DBH = diameter at breast height (cm)	Luang Prabang Montane Rain Forests Northern Khorat Plateau Moist Deciduous Forests Northern Annamites Rain Forests	Evergreen Forest
3)	UN-REDD: Vietnam South Central Coast	$AGB = \exp(-2.24267+2.47464*\ln(DBH))$	DBH = diameter at breast height (cm)	Southern Annamites Montane Rain Forests	Evergreen Forest
4)	Kiyono equation	$W\ (stem) = 2.69*ba^{1.29}*WD^{1.35}$ $W\ (branch) = 0.217*ba^{1.26}*WD^{1.48}$ $W\ (leaf) = 173*ba^{0.938}$	ba = basal area of a stem at 1.3m height (m2) WD = basic density of stem wood (kg/m3)	Central Indochina Dry Forests Southeastern Indochina Dry Evergreen Forests in neighboring country of Cambodia	Tropical and subtropical dry land forest
5)	Monda equation	$AGB = 0.3510*DBH^{2.3655}*WD^{1.7827}$	DBH = diameter at breast height (cm) WD = basic density of stem wood ()	Indochina area	Tropical and seasonal deciduous forest
6)	IPCC: Temperate/tropical pines	$AGB\ (kg/tree) = 0.887+[(10486*(DBH)^{2.84})/((DBH)^{2.84}+3$	DBH = diameter at breast height (cm)	Temperate/tropical area	Pine forest
7)	IPCC: Eucalyptus sp.	$AGB\ (kg/tree) = 1.22*DBH^{2}*H*0.01$	DBH = diameter at breast height (cm) H = total height of tree (m)	Tropical area	Eucalyptus forest
8)	IPCC: Tectona grandis [b]	$AGB\ (kg/tree) = 0.153*DBH^{2.382}$	DBH = diameter at breast height (cm)	Tropical area	Teak forest

Next, the set of allometric equations organized in 3.3.1 for the FIM inventory data were used to perform conversion into biomass (Table 3-29). The sections for the FIM inventory study were circular plots with a radius of 25 m as shown in Figure 3-39. Trees within a small circular area with a radius of 5 m that had a breast height diameter of less than 10cm were measured, and trees in other areas with a breast height diameter of 10cm or more were measured. Since the NFI only measured trees with a breast height diameter of 10cm or more in the past, trees with a check height diameter less than 10cm were excluded from the FIM inventory to allow comparison to be performed, and the small circular survey partition area with a radius of 5m was excluded when calculation was performed.

The FIM inventory data converted to biomass was compared with the Ecoregions / province / forest type / canopy cover ratio, and the correlative relationship between the respective items was considered. A comparison of the FIM biomass volumes with provinces / forest types is shown in Table 3-30, a comparison with Ecoregions / Forest Types is shown in Table 3-31, and a comparison with canopy cover ratio / forest types is shown in Figure 3-40 and Table 3-32.

When the average biomass volume for the different forest types is examined, it is found that it is large for Evergreen Forest (EF) areas, amounting to approximately three times the volume of Mixed Deciduous Forest (MD) or Dry Deputerocarp Forest (DD) areas. Due to the fact that a large portion of Evergreen Forest areas are located in high altitude regions with high humidity and a high amount of rainfall, it is thought that the stock volume is comparatively large. However, on the other hand, Mixed Deciduous Forests often grow in low to medium altitude regions that are dry, and Dry Dipterocarp Forests often grow in locations where the soil conditions are not good. Consequently, the trees do not grow that high, and the stock volume is comparatively low. In addition, there was a difference of between approximately three to four times the volume for Coniferous Forest (CF) and Mixed Coniferous and Broadleaved Forest (MCB) areas. This may result from the fact that there are not that many samples for Coniferous Forest areas, but the same tendency was found in past NFI biomass volume that is described later. When checking was performed in the field during the ground truth survey implemented in the first year, it was found that Coniferous Forests produce low volume of biomass as they often grow in locations where the soil conditions are poor in which it is difficult for other types of vegetation to grow, with burning being periodically performed to provide a supply of grass. The biomass volume is low also because of the low tree density. On the other hand, it can be seen that Mixed Coniferous and Broadleaved Forests grow in soil that is good compared to areas where Coniferous Forests grow, which allows the penetration of broadleaf tree species. Therefore, there is dense growth of Coniferous and Broadleaved species, resulting in high tree density, which increases the biomass volume.

Looking at the average quantity of biomass according to regions such as Ecoregions, provinces, etc., no clear trend in difference in quantity of biomass was found according to region.

While there is a certain amount of correlation with Mixed Coniferous and Broadleaved Forest areas, with a correlative factor of 0.5074 between the forest type and canopy cover ratio, almost no correlative relationship was found for other types.

Table 3-29 Conversion of FIM Inventory Data into Biomass (Sample)

959 plots

Primary_ID	DBH (cm)	Province	Forest Type	Allometric Equation	AGB/Plot	AGB/Plot/ha
TR_0704003-4	201	Houaphane	EF	$(AGB)=0.0002\times(DBH)^{2.4655}$	95.40	506.13
TR_1209002-3	157	Khammuane	DF	$(AGB)=0.0002\times(DBH)^{2.4673}$	26.18	138.88
TR_1004004-3	146	Vientiane	EF	$(AGB)=0.0002\times(DBH)^{2.4629}$	42.82	227.15
TR_1106002-4	130	Bolikhamxay	EF	$(AGB)=0.0002\times(DBH)^{2.4578}$	15.69	83.24
TR_1106002-4	130	Bolikhamxay	EF	$(AGB)=0.0002\times(DBH)^{2.4578}$	15.69	83.24
TR_1102007-2	130	Bolikhamxay	DF	$(AGB)=0.0002\times(DBH)^{2.4995}$	19.22	101.98
TR_1304007-4	130	Savannakhet	DF	$(AGB)=0.0002\times(DBH)^{2.5018}$	19.44	103.12
TR_0708003-3	129	Houaphane	EF	$(AGB)=0.0002\times(DBH)^{2.4655}$	31.97	169.59
TR_1704002-3	125	Attapeu	DF	$(AGB)=0.0002\times(DBH)^{2.5285}$	20.05	106.35
TR_0102001-3	123	Vientiane Capital	DF	$(AGB)=0.0002\times(DBH)^{2.4498}$	26.36	139.82
TR_1103002-5	120	Bolikhamxay	EF	$(AGB)=0.0002\times(DBH)^{2.4578}$	12.89	68.38
TR_1104006-4	120	Bolikhamxay	EF	$(AGB)=0.0002\times(DBH)^{2.4578}$	12.89	68.38
TR_1102003-5	120	Bolikhamxay	EF	$(AGB)=0.0002\times(DBH)^{2.4578}$	12.89	68.38
TR_1102001-4	120	Bolikhamxay	EF	$(AGB)=0.0002\times(DBH)^{2.4578}$	12.89	68.38

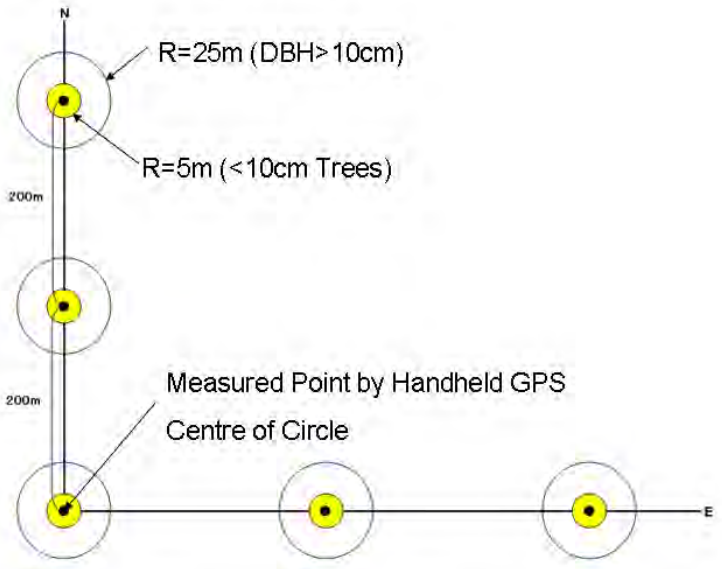


Figure 3-39 Study Plot Design for FIM Inventory Study

Table 3-30 Average Biomass Volume and Standard Deviation for Each Province / Forest Type

Forest Type	EF		MD		DD		CF		MCB		Average	
Province	Average of AGB/ha	Standard Diviation of AGB/ha	Average of AGB/ha	Standard Diviation of AGB/ha	Average of AGB/ha	Standard Diviation of AGB/ha	Average of AGB/ha	Standard Diviation of AGB/ha	Average of AGB/ha	Standard Diviation of AGB/ha	Average of AGB/ha	Standard Diviation of AGB/ha
Phongsaly	144.87	27.51	32.27	34.05							37.64	41.42
Luangnamtha	38.08	0.00	10.88	6.38							11.44	7.39
Oudomxay	88.24	78.80	22.59	23.31							27.28	35.13
Bokeo			9.68	9.52							9.68	9.52
Luangprabang	119.23	93.52	8.61	9.56	88.85	0.00					45.95	71.55
Houaphane	92.34	104.99	38.49	26.32					10.51	5.79	76.26	94.04
Xayaboury			13.42	13.31	11.49	7.86					12.82	11.93
Xiengkouang	55.37	34.17	24.87	38.76			6.80	0.00	26.86	18.90	40.58	34.94
Vientiane	168.23	90.80	32.07	19.78							73.13	81.64
Vientiane Capital			65.32	53.14							65.32	53.14
Bolikhamxay	98.37	48.96	34.95	26.61							58.41	47.65
Khammuane			37.25	44.12	12.70	8.19					35.40	42.97
Savannakhet	79.34	0.00	53.10	47.73	33.77	26.89					45.11	41.19
Saravane			52.80	46.05	50.13	34.22					51.49	40.72
Sekong			26.59	24.03	18.21	7.04					24.12	20.90
Champasak			31.39	20.70	17.18	13.87					24.19	18.96
Attapeu			60.20	52.49	34.03	35.23					51.00	48.78
Average	102.27	85.31	32.31	35.88	27.99	27.46	6.80	0.00	24.14	18.45	39.70	49.20

Table 3-31 Average Biomass Volume and Standard Deviation for Each Ecoregion / Forest Type

Forest Type	EF		MD		DD		CF		MCB		Average	
Eco-Region	Average of AGB/ha	Standard Diviation of AGB/ha	Average of AGB/ha	Standard Diviation of AGB/ha	Average of AGB/ha	Standard Diviation of AGB/ha	Average of AGB/ha	Standard Diviation of AGB/ha	Average of AGB/ha	Standard Diviation of AGB/ha	Average of AGB/ha	Standard Diviation of AGB/ha
Northern Indochina Subtropical Forests	95.42	97.99	22.65	26.31					10.51	5.79	34.00	52.84
Northern Thailand-Laos Moist Deciduous Forests	96.81	98.24	10.17	10.20	16.73	25.87					16.42	34.29
Luang Prabang Montane Rain Forests	102.84	79.94	30.55	29.78	13.65	8.48	6.80	0.00	26.86	18.90	52.68	62.23
Northern Khorat Plateau Moist Deciduous Forests	120.10	7.65	32.21	25.22							37.09	31.77
Northern Annamites Rain Forests	129.74	47.04	40.96	44.91	29.59	19.90					48.70	51.24
Central Indochina Dry Forests	79.34	0.00	48.28	40.46	31.62	28.21					40.60	36.19
Southern Annamites Montane Rain Forests			20.67	19.88	20.69	4.77					20.67	18.49
Southeastern Indochina Dry Evergreen Forests			54.80	49.97	27.43	29.97					41.68	43.79
Average	102.27	85.31	32.31	35.88	27.99	27.46	6.80	0.00	24.14	18.45	39.70	49.20

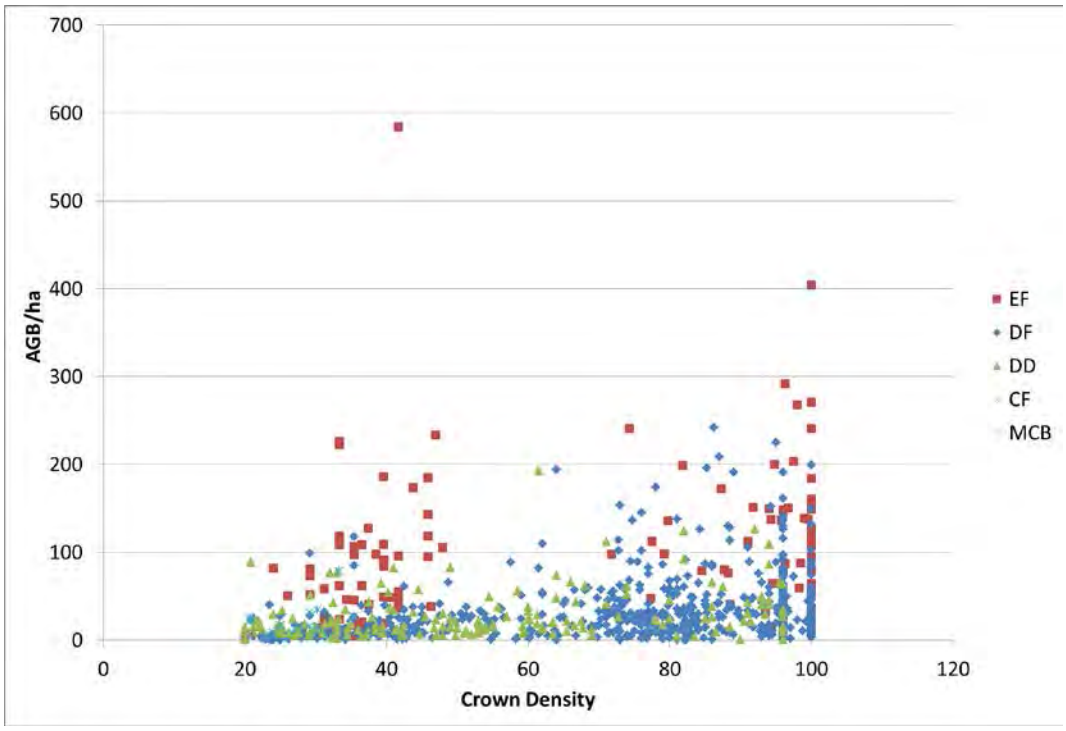


Figure 3-40 Canopy Cover Ratio and Average Biomass Volume Scatter Diagram for Each Forest Type

Table 3-32 Canopy cover Ratio and Average Biomass Volume Correlation Factor for Each Forest Type

EF (Number of sample: 114)	Crown Density
AGB/ha	0.2942

MD (Number of sample: 656)	Crown Density
AGB/ha	0.3566

DD (Number of sample: 176)	Crown Density
AGB/ha	0.3243

MCB (Number of sample: 12)	Crown Density
AGB/ha	0.5074

Lastly, the FIM inventory data that was converted to biomass volume and past NFI data that was converted to biomass volume were respectively converted to CO2t/ha, and a comparison of these values is shown in Table 3-33.

In order to convert the past NFI data into biomass volume, the past NFI database (ForestCalc) and NFI materials were analyzed. The past NFI data was obtained in a survey by establishing an L-shaped study tract consisting of A, B and C plots as shown in Figure 3-41. All trees were measured in plot A, trees with a breast height diameter of 30cm or more were measured in plot B, and trees with a breast height diameter of 60cm or more were measured in plot C. Past NFI biomass data made up of a plot group consisting of one plot A area, two plot B areas and one plot C area (red line in diagram) was used to perform calculation. In other words, all trees in the plot group with a breast height diameter of 60cm or more were measured, trees with a breast height diameter of 30 – 60cm were measured in plot A and plot B in the plot group, and trees with a breast height diameter of 10 – 30cm in plot A in the plot group were measured. Therefore, in order to calculate the biomass volume per hectare, since all trees with a breast height diameter of 60cm or more were measured in the 1 ha plot, the total biomass volume for all trees was used. The total biomass volume for trees with a breast height diameter of 30 – 60cm was divided by the 0.2 ha area consisting of plot A and B in the plot, and the total biomass volume for trees with a breast height diameter of 10 – 30cm was divided by the 0.04 ha area consisting of plot A in the plot group. Calculation was then performed by totaling all of these values. When Table 3-33 is examined, it can be seen that the FIM CO2-t/ha volume is lower compared to the past NFI CO2-t/ha volume. As shown in Table 3-34, the most likely cause for this is that more middle and large diameter trees were measured with past NFI compared to FIM, and there were fewer middle and large trees at the time of FIM compared to the past NFI due to continued forest degradation, but this is something that will continue to be examined in the future. In addition, blanks mean the item which was not acquired at past NFI or FIM.

Table 3-33 CO2-t/ha Volume for Each Province / Forest Type in Past NFI and FIM Data

Province	Forest Type	Past NFI	FIM NFI	Province	Forest Type	Past NFI	FIM NFI
Phonsaly	EF		265.59	Vientiane Capital	EF		
	MD	198.36	59.17		MD	183.65	119.75
	DD				DD	60.35	
	CF				CF		
	MCB				MCB		
Luang Namtha	EF		69.81	Bolikhamxay	EF		180.35
	MD	133.19	19.95		MD	194.09	64.08
	DD				DD	201.45	
	CF				CF		
	MCB				MCB		
Oudomxay	EF	433.99	161.78	Khammuane	EF	292.94	
	MD	114.08	41.41		MD	279.57	68.29
	DD				DD	165.18	23.28
	CF				CF		
	MCB				MCB	457.26	
Bokeo	EF			Savannakhet	EF	501.93	145.45
	MD	118.13	17.74		MD	184.04	97.36
	DD	15.88			DD	155.09	61.91
	CF				CF		
	MCB				MCB		
Luangprabang	EF		218.58	Saravane	EF	465.06	
	MD	36.17	15.79		MD	339.10	96.80
	DD	234.20	162.88		DD	242.87	91.90
	CF				CF		
	MCB				MCB	375.48	
Huaphane	EF		169.30	Sekong	EF	362.25	
	MD	148.81	70.56		MD	199.92	48.74
	DD				DD	178.26	33.38
	CF	133.52			CF	58.10	
	MCB	178.34	19.27		MCB		
Xayabury	EF	424.42		Champasak	EF	304.65	
	MD	232.92	24.60		MD	217.21	57.54
	DD	252.21	21.06		DD	131.05	31.49
	CF				CF		
	MCB				MCB	268.95	
Xiengkouang	EF		101.51	Attapeu	EF	253.22	
	MD	137.00	45.60		MD	297.19	110.36
	DD				DD	199.42	62.39
	CF	120.31	12.47		CF		
	MCB	113.11	49.25		MCB		
Vientiane	EF		308.42	Whole Country	EF	410.28	187.50
	MD	109.73	58.79		MD	220.43	59.23
	DD				DD	168.63	51.32
	CF				CF	118.63	12.47
	MCB				MCB	310.88	44.25

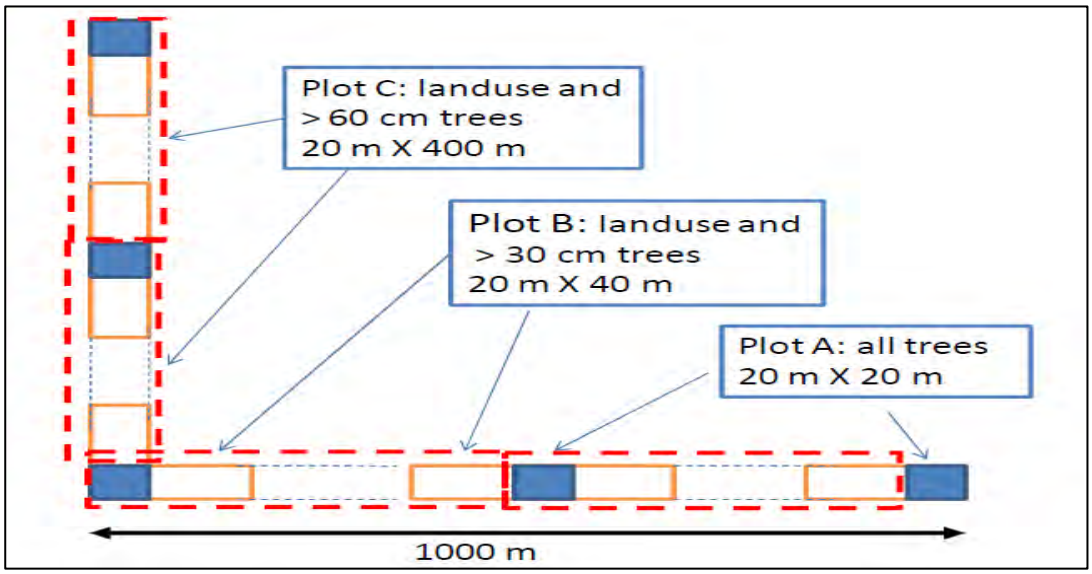


Figure 3-41 Past NFI Study Plot Design

Table 3-34 Number of Trees Measured in Past NFI and FIM for Each Diameter Class

	Past NFI		FIM NFI	
	Number	Rate	Number	Rate
10cm<=DBH<20cm	8178	33.92%	5194	42.41%
20cm<=DBH<30cm	3044	12.63%	3701	30.22%
30cm<=DBH<40cm	4617	19.15%	1856	15.15%
40cm<=DBH<50cm	2310	9.58%	795	6.49%
50cm<=DBH<60cm	1064	4.41%	324	2.65%
60cm<=DBH<70cm	1974	8.19%	190	1.55%
70cm<=DBH<80cm	1182	4.90%	83	0.68%
80cm<=DBH<90cm	725	3.01%	46	0.38%
90cm<=DBH<100cm	416	1.73%	32	0.26%
100cm<=DBH<110cm	209	0.87%	6	0.05%
110cm<=DBH<120cm	146	0.61%	5	0.04%
120cm<=DBH<130cm	88	0.37%	9	0.07%
130cm<=DBH<140cm	61	0.25%	5	0.04%
140cm<=DBH<150cm	32	0.13%		
150cm<=DBH<160cm	31	0.13%		
160cm<=DBH<170cm	19	0.08%		
170cm<=DBH<180cm	4	0.02%		
180cm<=DBH<190cm	6	0.02%		
190cm<=DBH<200cm	3	0.01%	1	0.01%
Total	24109	100.00%	12247	100.00%

Also, although there is no internationally recognized standard method of carbon stratification, there is a method that was developed by LEAF of USAID, so carbon stratification was also

investigated using this method. In this method, first the uncertainty is calculated for each of the six IPCC land use categories based on the existing NFI, and where the uncertainty is 20% or higher further stratification is carried out by national or sub-national level classification. For this also the uncertainty is calculated, and where this exceeds 20% further stratification is carried out using accessibility or land-use management classifications, etc., based on the opinions of specialists. However based on discussions with Winrock International and local consultants who were involved in its development, it was concluded that when an existing national level map had been developed, the start should be from the national level classification.

In the case of the Lao PDR, national level forest type maps have already been prepared through the support of JICA, and the uncertainty for each national level classification was calculated. The calculation results are shown in Table 3-35 . This shows that the uncertainty exceeds 20% only in the case of Mixed Coniferous and Broadleaved Forest (MCB), and this was caused by the number of samples being extremely low. Also, the number of samples for Coniferous Forests (CF) was 1, so calculation was not possible. In any case the distribution area for MCB and CF is extremely small, and further stratification is not practical. From the above, it can be judged that further stratification is not necessary for investigation using the FIM inventory data, so next it was decided to investigate integration of forest types.

Table 3-35 Evaluation of uncertainty of estimated carbon value for each forest types bsed on FIM inventory data

	Current Forest Classification				
	EF	MD	DD	CF	MCB
Mean AGB/ha	102.7	32.3	28.0	6.8	24.1
Standard Division	85.5	35.9	27.5	0.0	18.5
Number of data	113	656	176	1	12
90% CI	13.2	2.3	3.4	N/A	8.8
Uncertainty (%)	12.9	7.1	12.2	N/A	36.3

3.2.11 Determination of Forest Stratification Method

As stated above, the FIM inventory data was used in the initial carbon stratification investigation because national level inventory data with positional information was required. However if further detailed stratification is not necessary, then positional information is not necessarily required. Therefore, it was decided to investigate integration using the first NFI data, and not the FIM inventory data in which the estimated quantity of biomass was extremely low compared with the IPCC default values.

It is considered that evaluation of the overall uncertainty in investigation of integration of strata contributes to decision-making. Stratification is carried out in order to improve the accuracy (reduce the uncertainty) in the estimation of the quantity of reduction in GHG emissions, so if there was a high level of uncertainty, it would be necessary to conservatively evaluate the estimated reduction in quantity of GHG emissions. Also, the Lao PDR is currently planning to participate in the World Bank Forest Carbon Partnership Facility (FCPF) / Carbon Fund (CF), and in the FCPF/CF conservative factors are clearly defined in accordance with the value of the overall uncertainty as shown in Table 3-36. Conservative factors can be limited by minimizing the overall uncertainty, and a greater reduction in emissions can be reported. Therefore, it was considered that investigating whether the overall uncertainty can be reduced by integration can contribute to the decision-making of the C/P.

First the overall uncertainty was calculated before integration in accordance with Table 3-37. However, normally when calculating the overall uncertainty, it is necessary to perform the calculation using the actual activity data (AD) and emission factor (EF), but at this time the calculation was provisionally carried out using the accuracy assessment results of the 2010 forest type maps and the first NFI data, for which the data was available.

From this it was found that the overall uncertainty was about 16% when integration is not carried out. At this point in time the uncertainty in the CF and the MCB is high, but these are difficult to classify on a map, and the tree type composition also includes coniferous tree types so they have a point in common, so integration was attempted (Table 3-38). The uncertainty of the integrated CF/MCB was still high, so integration was attempted again for MD for which errors of interpretation were found on the maps and which has a point in common on the tree type composition (Table 3-39). Although the uncertainty of the integrated MD/CF/MCB was kept low, in this case the overall uncertainty was about 16%, so there was virtually no change in the overall uncertainty compared with when integration was not carried out. Therefore, next further integration was attempted with EF, for which the uncertainty was high (Table 3-40). This was because it is difficult to distinguish between EF and MD on maps, because they have many of the compositional tree types in common. As a result the overall uncertainty was reduced slightly to about 14%. This is because provisional data was used in the calculation, but according to Table 3-36 which shows the relationship to the FCPF/CF conservative factors, if the overall uncertainty is equal to or less than 15%, the estimated GHG emission reduction can be reported without conservative evaluation, so this integration scheme is beneficial for the Lao PDR.

The above result is a provisional evaluation because the information necessary for evaluation of the overall uncertainty as required internationally is not available at the present time. Integration

was investigated as one approach, that was discussed with the C/P and their understanding was obtained as a provisional carbon stratification scheme. However, ideally the next period NFI data will be used for the final carbon stratification, but at least it was decided to reinvestigate using the inventory data of each of the projects proceeding in the current forest survey (Finland/World Bank SUFORD-SU nationwide production forests, CliPAD of Germany in the northern provinces, this project in the central provinces with the NFI pilot, and the private sector SN-REDD in the southern provinces).

Table 3-36 Relationship between overall uncertainty value and conservative factors in FCPF/CF

Aggregate Uncertainty of Emissions Reductions	Conservativeness Factor
≤ 15%	0%
> 15% and ≤ 30%	4%
> 30 and ≤ 60%	8%
> 60 and ≤100%	12%
> 100%	15%

Table 3-37 Evaluation of overall uncertainty using the accuracy assessment results of the 2010 forest type maps and the first NFI data (before integration)

All		EF	MD	DD	CF	MCB	RV	Total
Uncertainty of area of map	90% CI	20%	5%	16%	47%	78%	6%	
− Number of classification data		68	497	75	49	17	462	1,168
− Number of reference data		66	487	92	31	11	459	1,146
− Map area (ha)		1,300,729	9,684,810	1,146,274	82,283	27,577	7,570,539	19,812,212
Uncertainty of carbon stock	90% CI	16%	4%	4%	25%	12%	21%	
− Mean (AGB/ha)		251	127	98	72	165	37	
− Standard Deviation		185	90	68	61	111	29	
− Number of plot		58	836	655	32	81	39	1,701
− Amount of Carbon (t)		163,370,728	616,799,529	56,137,576	2,975,023	2,273,617	134,453,192	976,009,665
Total Uncertainty	90% CI	25%	7%	17%	53%	79%	22%	
Overall Uncertainty	90% CI	**16%**						

Table 3-38 Evaluation of overall uncertainty using the accuracy assessment results of the 2010 forest type maps and the first NFI data (CF/MCB integrated)

Aggregation CF/MCB		EF	MD	DD	CF/MCB	RV	Total
Uncertainty of area of map	90% CI	20%	5%	16%	40%	6%	
− Number of classification data		68	497	75	66	462	1,168
− Number of reference data		66	487	92	42	459	1,146
− Map area (ha)		1,300,729	9,684,810	1,146,274	109,860	7,570,539	19,812,212
Uncertainty of carbon stock	90% CI	16%	4%	4%	12%	21%	
− Mean (AGB/ha)		251	127	98	139	37	
− Standard Deviation		185	90	68	108	29	
− Number of plot		58	836	655	113	39	1,701
− Amount of Carbon (t)		163,370,728	616,799,529	56,137,576	5,248,640	134,453,192	976,009,665
Total Uncertainty	90% CI	25%	7%	17%	42%	22%	
Overall Uncertainty	90% CI	**16%**					

Table 3-39 Evaluation of overall uncertainty using the accuracy assessment results of the 2010 forest type maps and the first NFI data (MD/CF/MCB integrated)

Aggregation MD/CF/MCB		EF	MD/CF/MCB	DD	RV	Total
Uncertainty of area of map	90% CI	20%	5%	16%	6%	
− Number of classification data		68	563	75	462	1,168
− Number of reference data		66	529	92	459	1,146
− Map area (ha)		1,300,729	9,794,670	1,146,274	7,570,539	19,812,212
Uncertainty of carbon stock	90% CI	16%	4%	4%	21%	
− Mean (AGB/ha)		251	129	98	37	
− Standard Deviation		185	93	68	29	
− Number of plot		58	949	655	39	1,701
− Amount of Carbon (t)		163,370,728	622,048,169	56,137,576	134,453,192	976,009,665
Total Uncertainty	90% CI	25%	6%	16%	22%	
Overall Uncertainty	90% CI	**16%**				

Table 3-40 Evaluation of overall uncertainty using the accuracy assessment results of the 2010 forest type maps and the first NFI data (EF/MD/CF/MCB integrated)

Aggregation EF/MD/CF/MCB		EF/MD/CF/MCB	DD	RV	Total
Uncertainty of area of map	90% CI	4%	16%	6%	
− Number of classification data		631	75	462	1,168
− Number of reference data		595	92	459	1,146
− Map area (ha)		11,095,399	1,146,274	7,570,539	19,812,212
Uncertainty of carbon stock	90% CI	4%	4%	21%	
− Mean (AGB/ha)		136	98	37	
− Standard Deviation		104	68	29	
− Number of plot		1,007	655	39	1,701
− Amount of Carbon (t)		785,418,897	56,137,576	134,453,192	976,009,665
Total Uncertainty	90% CI	6%	16%	22%	
Overall Uncertainty	90% CI	**14%**			

3.2.12 Preparation of National Forest Carbon Map

Forest carbon maps were prepared for 2000, 2005, and 2010 with the investigated carbon stratification scheme and the conventional forest categories. Also, the uncertainty in the change of each of the overall carbon cumulative stock was calculated based on this data, and this was used as an alternative to the forest carbon map accuracy assessment result. Table 3-41 shows carbon stock by forest type. It shows a decrease in carbon stock from 4,915,958,121 t CO_2 in 2000, to 4,885,205,583 t CO_2 in 2005, and 4,836,938,716 t CO_2 in 2010. As mentioned in 3.2.8, the area of Current Forest, which accounts for more than 90% of the carbon stock, is decreasing and the carbon stock is decreasing in proportion. The changes between MD and RV are expected to affect the change in the carbon stock the most for the following reasons: 1) The area of these two categories accounts for more than 60% of the territory of Laos; 2) The changes between MD and RV occur frequently because a large part of them are found where slash and burn farming is practiced; and 3) The difference in the carbon stock per unit area between the two is large. However, since it was difficult to distinguish the two as mentioned in 3.2.2 (note: with regard to MD and FL (Fallow land) in the original definition), the area of RV was underestimated intentionally in this study (by selecting only the areas interpreted and verified as such without doubt) in order to estimate greenhouse gas emissions and carbon stock conservatively. As mentioned in 3.2.9, it may become possible to identify more changes between MD and RV than those identified in this study by improving the accuracy of the classification of MD and RV using time series data in the process of analyzing forest degradation for the establishment of reference emission level. If more changes have been identified, the change in the carbon stock may become larger.

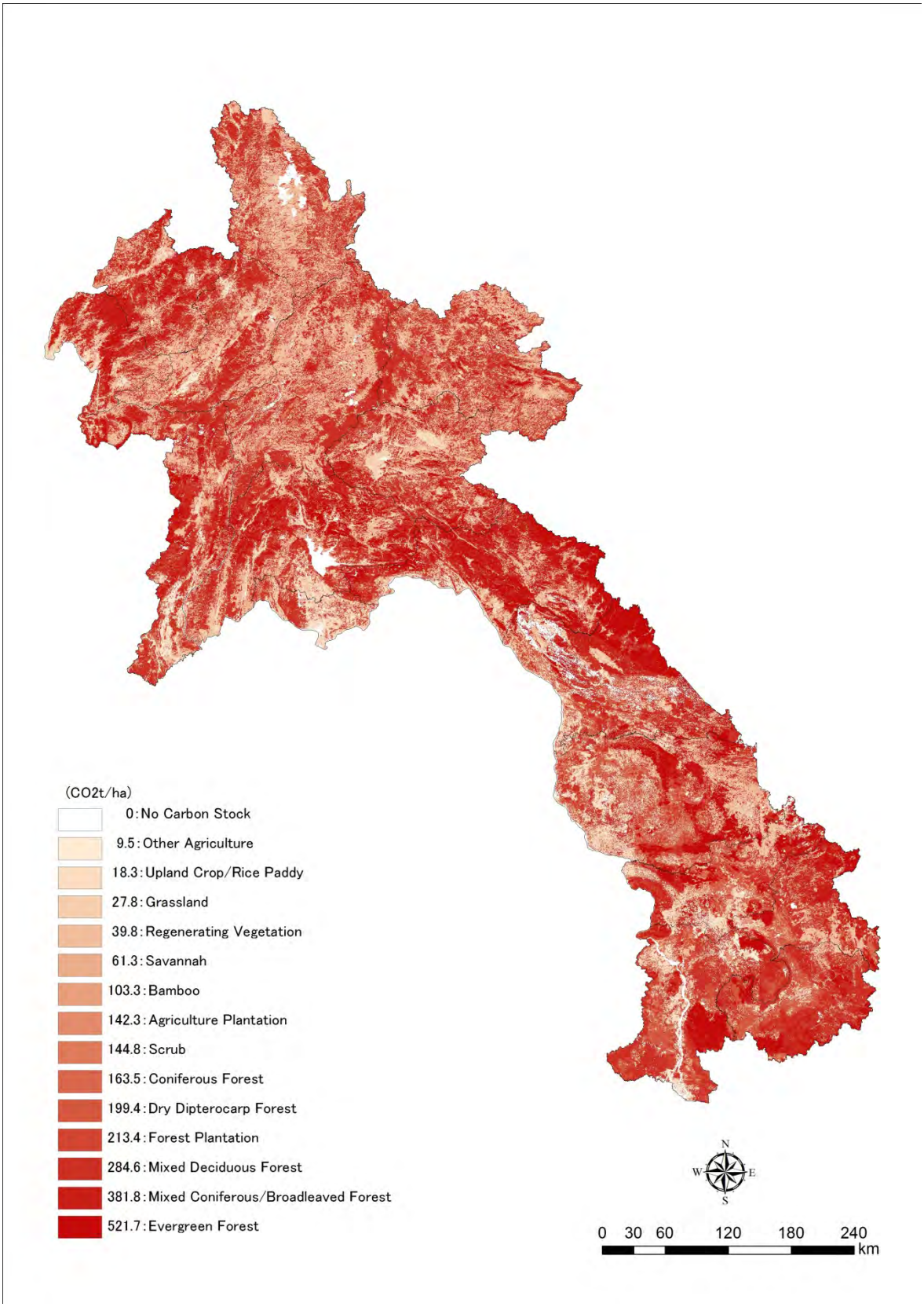


Figure 3-42 2000 Forest Carbon Map (Existing Classification)

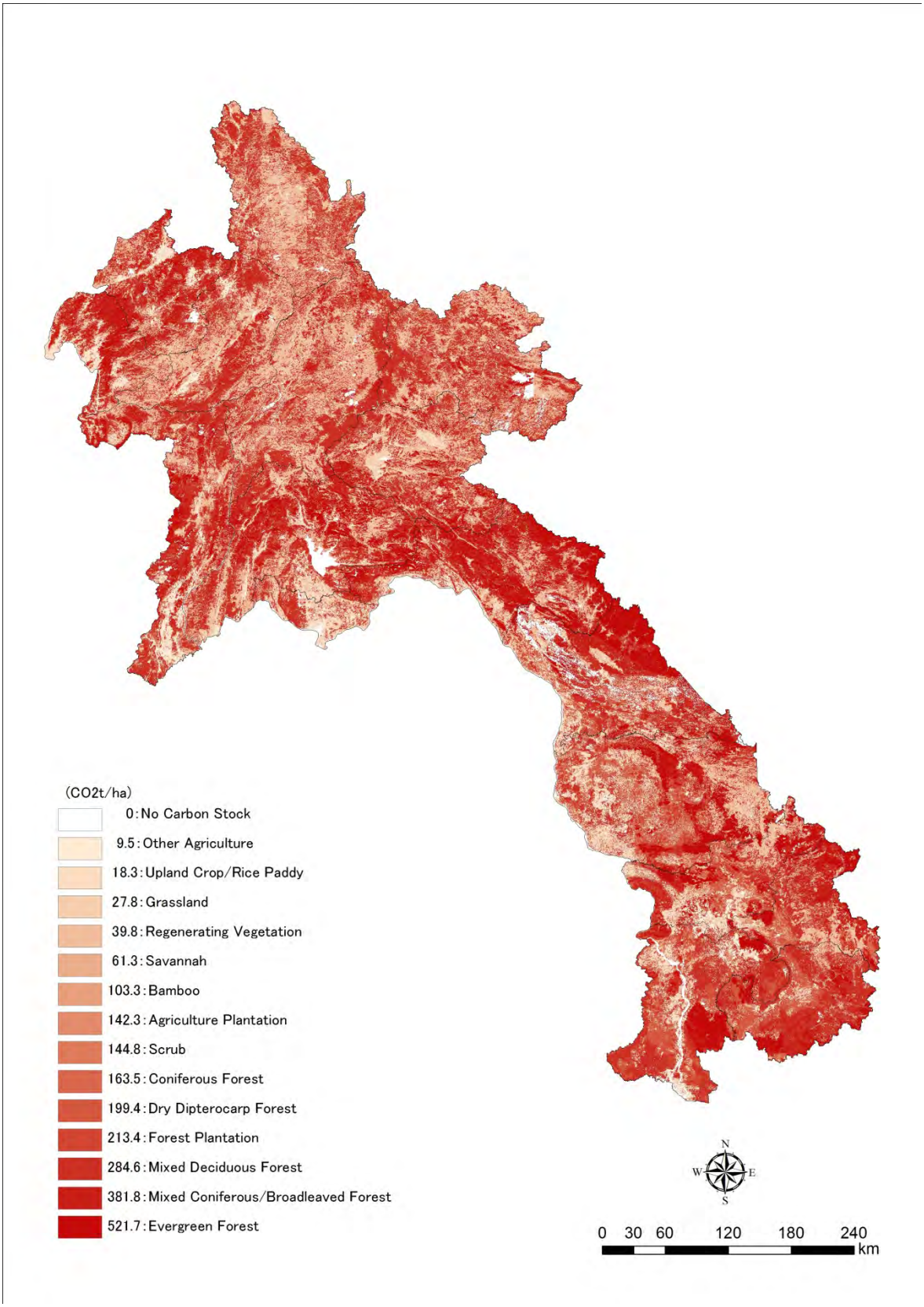


Figure 3-43 2005 Forest Carbon Map (Existing Classification)

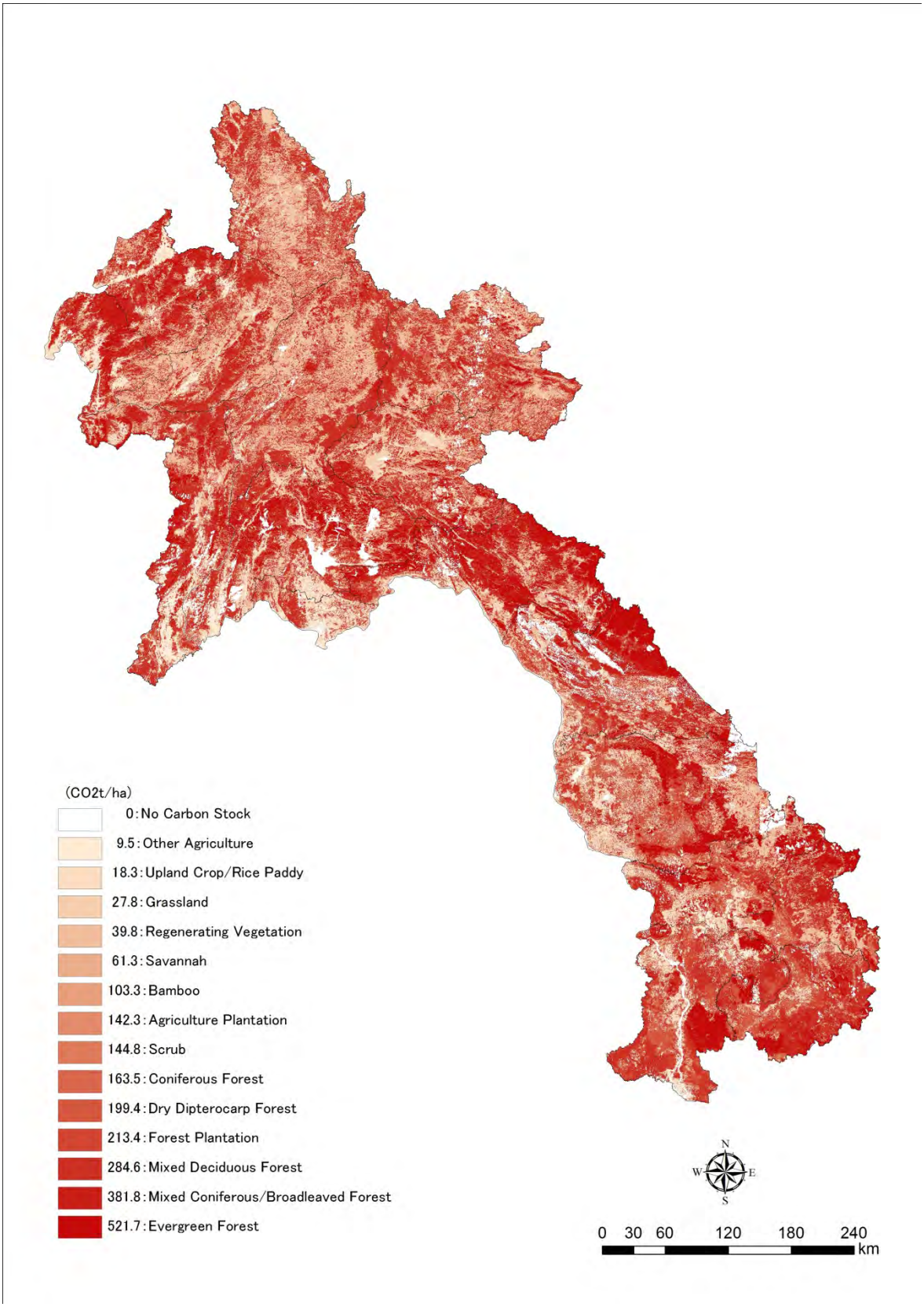


Figure 3-44 2010 Forest Carbon Map (Existing Classification)

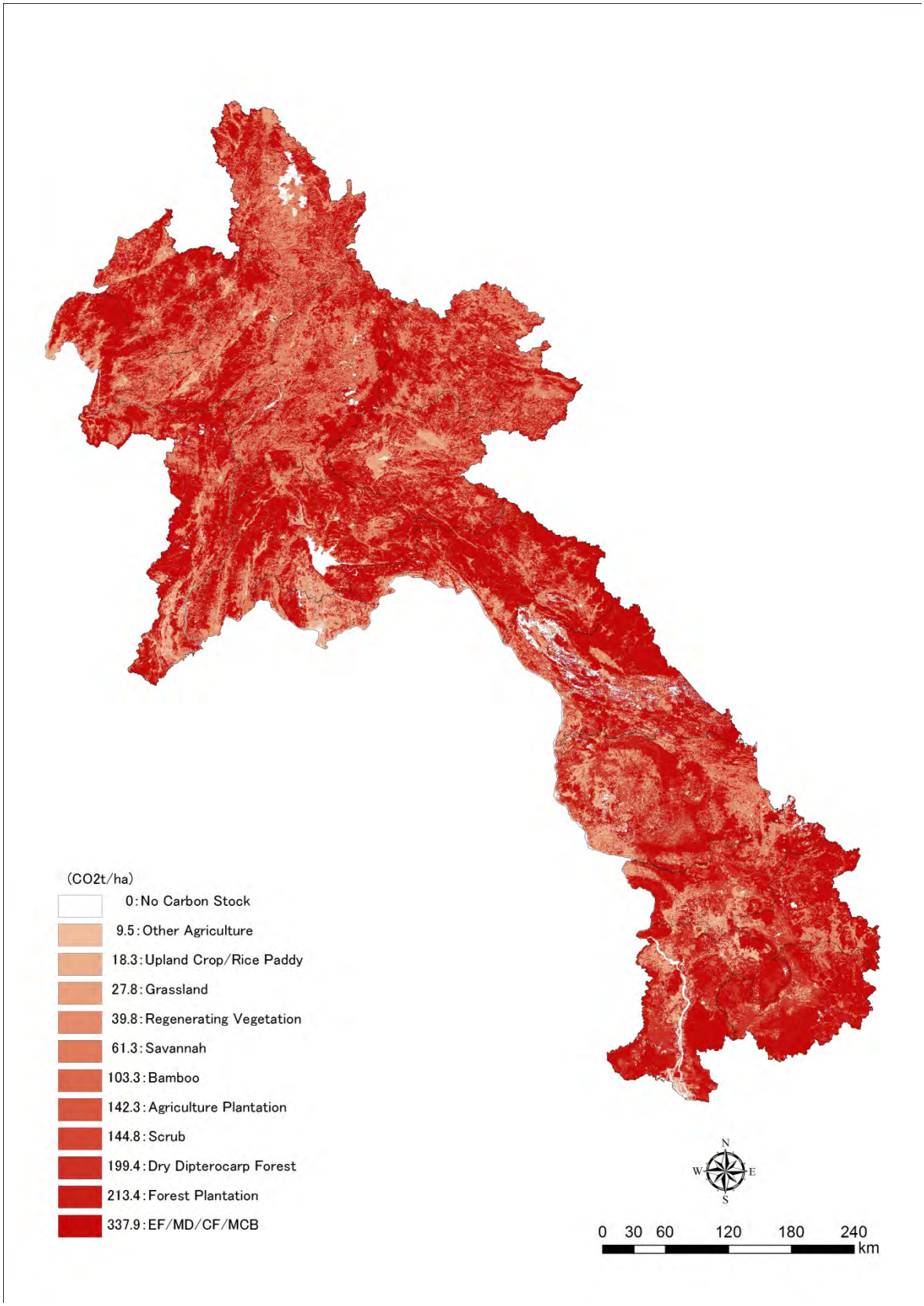


Figure 3-45 2000 Forest Carbon Map (Provisional Carbon Stratification)

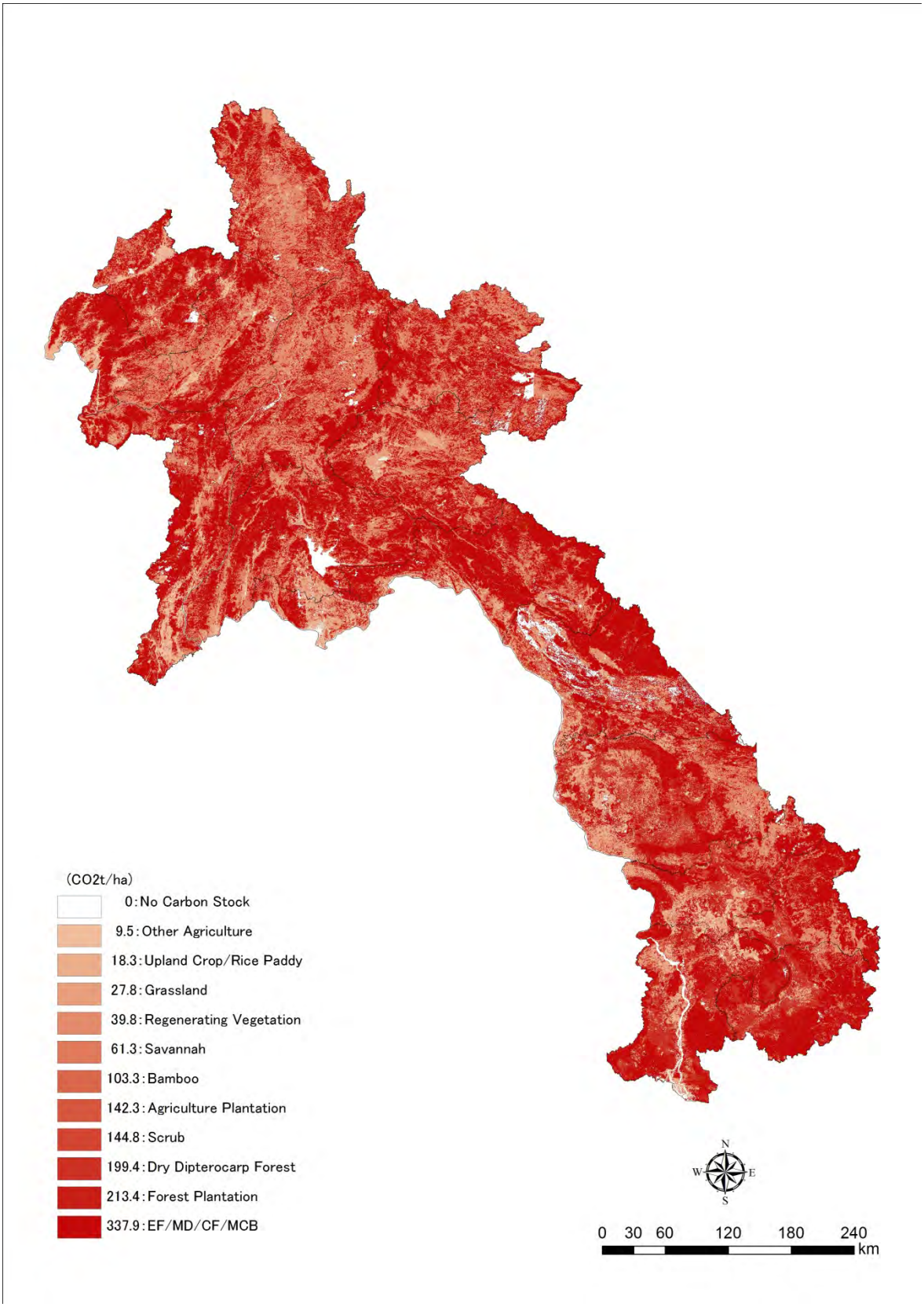


Figure 3-46 2005 Forest Carbon Map (Provisional Carbon Stratification)

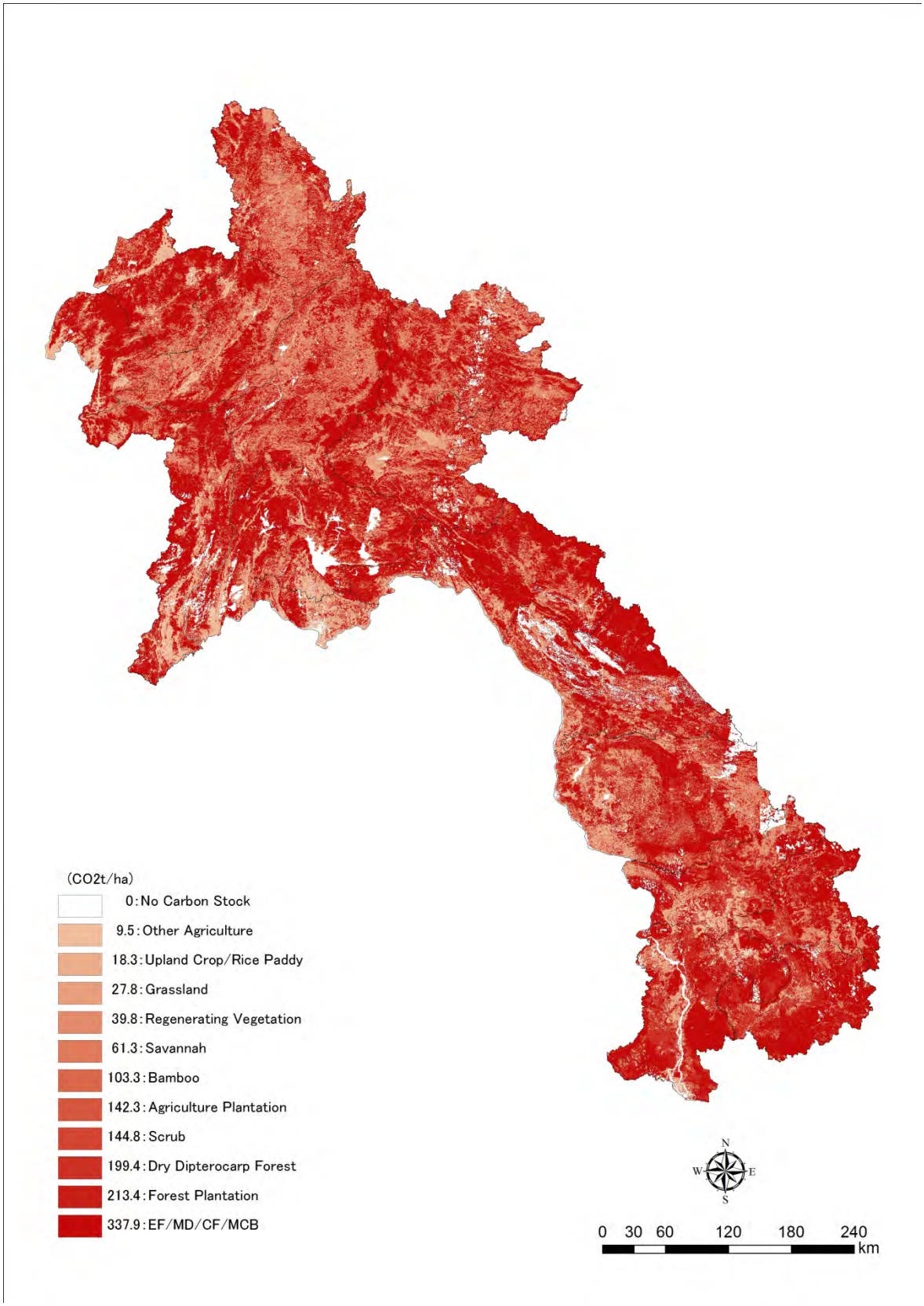


Figure 3-47 2010 Forest Carbon Map (Provisional Carbon Stratification)

Table 3-41 Estimated Amount of Carbon Stock for each Existing Classification and Provisional Carbon Stratification in 2000, 2005 and 2010

Existing Classification									
IPCC Definition	*National Level Classification System for Lao PDR*			2010		2005		2000	
	Level 1	*Level 2*		CO2t	%	CO2t	%	CO2t	%
Forest Land	Current Forest	Evergreen Forest	EF	1,595,792,303		1,603,531,861		1,598,647,348	
		Mixed Deciduous Forest	MD	2,574,800,540		2,604,673,871		2,636,885,869	
		Dry Dipterocarp Forest	DD	246,356,486		259,409,049		260,950,419	
		Coniferous Forest	CF	14,457,889		14,254,888		14,467,541	
		Mixed Coniferous and Broadleaved Forest	MCB	85,659,728		93,765,404		93,825,382	
		Forest Plantation	P	23,532,247	93.9%	4,668,211	93.8%	3,797,439	93.7%
	Regenerating Vegetation	Bamboo	B	9,268,068		7,120,305		6,580,742	
		Regenerating Vegetation	RV	221,493,781	4.8%	240,431,749	5.1%	246,541,711	5.1%
Grassland	Other Vegetated Areas	Savannah	SA	6,529,871		6,573,257		6,639,319	
		Scrub	SR	3,653,493		4,023,077		4,000,872	
		Grassland	G	6,979,692	0.4%	7,621,549	0.4%	7,906,256	0.4%
Cropland	Cropland	Upland Crop	UC	8,292,401		4,406,372		3,630,537	
		Rice Paddy	RP	22,313,602		21,728,679		21,252,795	
		Other Agriculture	OA	8,247,470		5,843,899		3,968,483	
		Agriculture Plantation	AP	9,561,147	1.0%	7,153,412	0.8%	6,863,409	0.7%
	SUM			4,836,938,716	100%	4,885,205,583	100%	4,915,958,121	100%

Provisional Carbon Stratification									
IPCC Definition	*National Level Classification System for Lao PDR*			2010		2005		2000	
	Level 1	*Level 2*		CO2t	%	CO2t	%	CO2t	%
Forest Land	Current Forest		EF/MD/CF/MCB	4,270,710,459		4,316,226,024		4,343,826,139	
		Dry Dipterocarp Forest	DD	246,356,486		259,409,049		260,950,419	
		Forest Plantation	P	23,532,247	93.9%	4,668,211	93.8%	3,797,439	93.7%
	Regenerating Vegetation	Bamboo	B	9,268,068		7,120,305		6,580,742	
		Regenerating Vegetation	RV	221,493,781	4.8%	240,431,749	5.1%	246,541,711	5.1%
Grassland	Other Vegetated Areas	Savannah	SA	6,529,871		6,573,257		6,639,319	
		Scrub	SR	3,653,493		4,023,077		4,000,872	
		Grassland	G	6,979,692	0.4%	7,621,549	0.4%	7,906,256	0.4%
Cropland	Cropland	Upland Crop	UC	8,292,401		4,406,372		3,630,537	
		Rice Paddy	RP	22,313,602		21,728,679		21,252,795	
		Other Agriculture	OA	8,247,470		5,843,899		3,968,483	
		Agriculture Plantation	AP	9,561,147	1.0%	7,153,412	0.8%	6,863,409	0.7%
	SUM			4,836,938,716	100%	4,885,205,583	100%	4,915,958,121	100%

Based on the argument mentioned above, the uncertainty of each forest carbon map was calculated and the obtained uncertainty figures were used as the results of the accuracy assessment. The Table 3-42 – Table 3-44 show the uncertainties of the forest carbon maps of 2010, 2005, and 2000, respectively. The accuracy assessment of the forest type maps of 2005 and 2000 was conducted using the land use classification of IPCC, a minimum requirement for an international report, while the forest types were used in the accuracy assessment of the forest type map of 2010. In order to make it possible to compare the uncertainties of the three forest type maps, the forest type map of 2010 was assessed with the land use classification of IPCC. Among the categories in the classification of land use of IPCC, only Forest Land, Grassland, and Cropland can stock carbon, thus the accuracy of the maps was assessed for them. The data of the first NFI were used in the calculation of the uncertainty of the emission factors. However, a biomass survey was not conducted in areas where the ground cover and use corresponding to Grassland and Cropland was found in the first NFI. Therefore, only the uncertainty of emission factor of Forestland, for which biomass data were available, was calculated. The uncertainties were assessed with the confidence intervals of 95% and 90%.

As shown in Table 3-42 – Table 3-44, the overall uncertainties of the forest carbon maps of the three years were larger than 20%. A conservativeness factor of 4% applies to the overall uncertainties of the three maps in accordance with the uncertainty assessment provided in the Carbon Fund of FCPF. However, it is considered necessary to re-assess the uncertainty of emission factors after the implementation of the next NFI because the NFI data used in this study were insufficient for the assessment of the uncertainty of emission factors, as mentioned above.

Table 3-42 Evaluation for Uncertainty of Estimated Amount of Carbon Stock in 2010

2010		Forest Land	Grassland	Cropland	Total
AD Uncertainty	95% CI	1.7%	27.7%	10.4%	
	90% CI	1.4%	23.1%	8.7%	
– Number of classification data		1,171	17	170	1,358
– Number of reference data		1,136	45	177	1,358
– Map area (ha)		18,954,183	373,774	2,538,589	21,866,547
EF Uncertainty	95% CI	7.9%	–	–	
	90% CI	6.6%	–	–	
– Mean (AGB/ha)		40	–	–	
– Standard Deviation		49	–	–	
– Number of plot		958	–	–	958
Total Uncertainty	95% CI	8.0%	27.7%	10.4%	
	90% CI	6.7%	23.1%	8.7%	
Overall Uncertainty	95% CI	**27.3%**			
	90% CI	**22.8%**			

Table 3-43 Evaluation for Uncertainty of Estimated Amount of Carbon Stock in 2005

2005		Forest Land	Grassland	Cropland	Total
AD Uncertainty	95% CI	2.0%	26.9%	11.8%	
	90% CI	1.6%	22.4%	9.8%	
– Number of classification data		1,220	19	129	1,368
– Number of reference data		1,145	49	174	1,368
– Map area (ha)		19,876,900	406,957	2,076,163	22,360,019
EF Uncertainty	95% CI	7.9%	–	–	
	90% CI	6.6%	–	–	
– Mean (AGB/ha)		40	–	–	
– Standard Deviation		49	–	–	
– Number of plot		958	–	–	958
Total Uncertainty	95% CI	8.1%	26.9%	11.8%	
	90% CI	6.8%	22.4%	9.8%	
Overall Uncertainty	95% CI	**26.5%**			
	90% CI	**22.2%**			

Table 3-44 Evaluation for Uncertainty of Estimated Amount of Carbon Stock in 2000

2000		Forest Land	Grassland	Cropland	Total
AD Uncertainty	95% CI	1.8%	27.3%	14.1%	
	90% CI	1.5%	22.8%	11.8%	
– Number of classification data		1,238	21	113	1,372
– Number of reference data		1,191	49	132	1,372
– Map area (ha)		20,146,073	418,340	1,811,945	22,376,357
EF Uncertainty	95% CI	7.9%	–	–	
	90% CI	6.6%	–	–	
– Mean (AGB/ha)		40	–	–	
– Standard Deviation		49	–	–	
– Number of plot		958	–	–	958
Total Uncertainty	95% CI	8.1%	27.3%	14.1%	
	90% CI	6.8%	22.8%	11.8%	
Overall Uncertainty	95% CI	**27.0%**			
	90% CI	**22.5%**			

3.3 Output 2

3.3.1 Analysis/Organization of Existing Forest Information Database

Proposal and Discussion of Future Directions of NFIS and NFIDB

At such opportunities as explanation of work plans in the first year and the technical workshops in the second year (the second session co-hosted with CliPAD), the concepts and future directions of NFIS and NFIDB and the association with existing forest information databases (DBs) were explained to have discussions and consultations with stakeholders. Furthermore, consultation was given in advance to the decision-makers who are the Project Director and Manager, and Director General of DOF to obtain approval on the future directions of NFIDB.

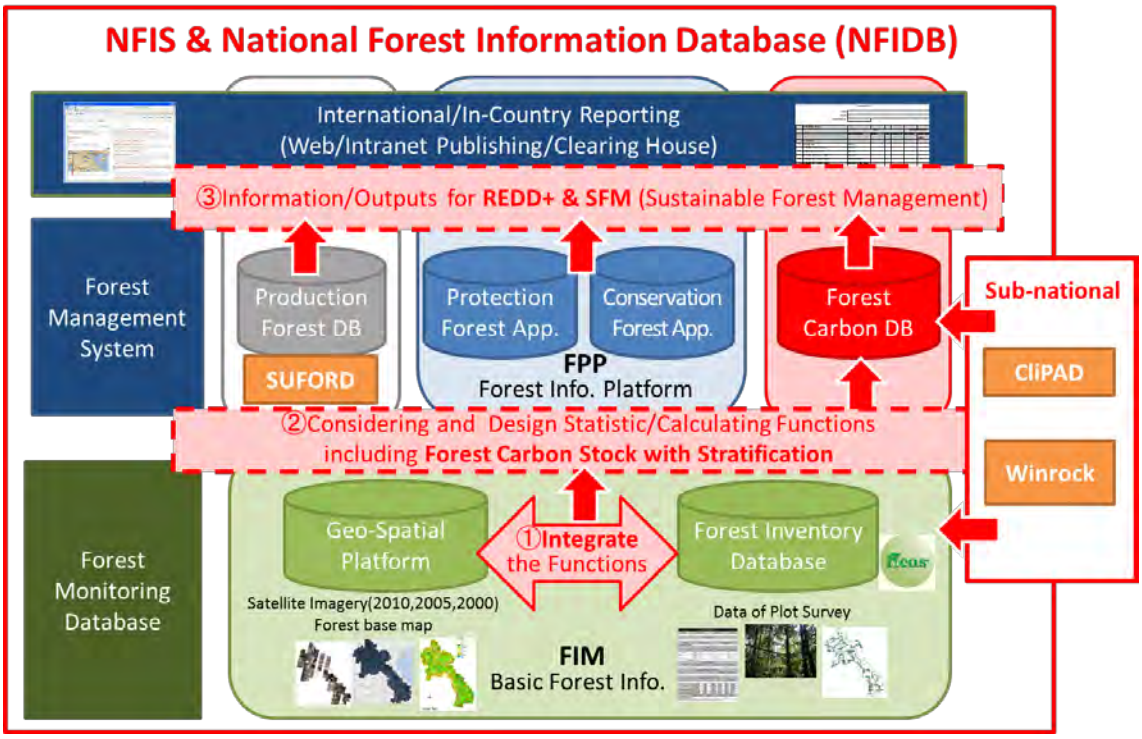


Figure 3-48 Outline and Future Directions of NFIS and NFIDB and Relationship with Existing Database

As the current-state analysis of Output 2 activities, the existing forest information databases were analyzed and organized, which include the geo-spatial information platform and forest inventory database (FoCAS) that have been developed by the FIM project in which a joint venture was engaged, forest management information system (FPP/TA2: renamed to the forest information platform), Department of Forestry Reporting System (DOF Reporting System), Forest Inventory and Management Information System (FOMIS), and first NFI database (ForestCalc).

Forest Inventory Database (FIM)

The FIM inventory data is stored in the relational database. The data input and browsing forms have been developed to eliminate input errors and redundancies. However, no geo-spatial information function is available.

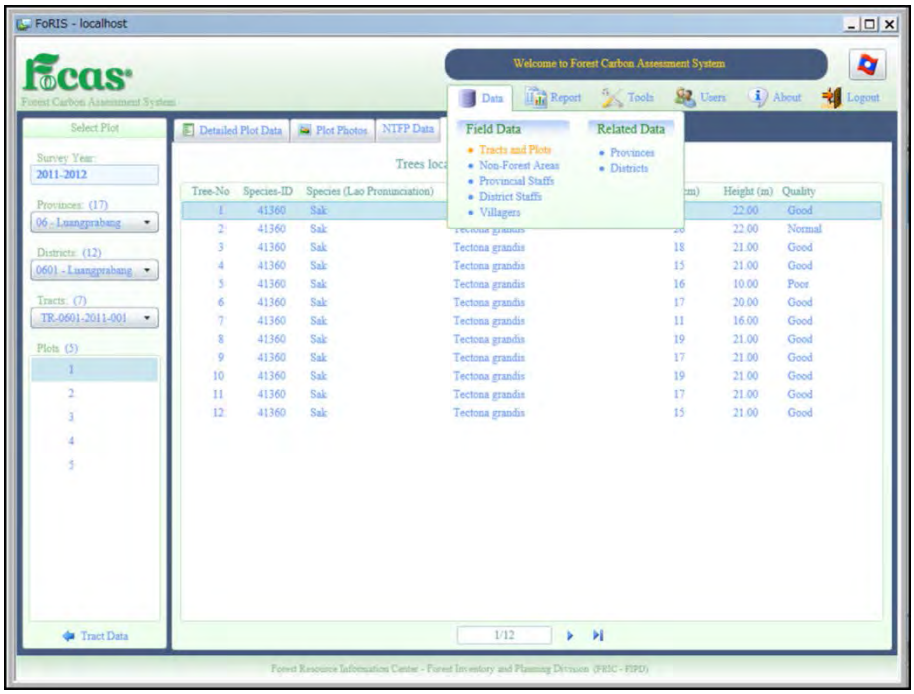


Figure 3-49 Input Screen for Inventory Database (FoCAS) Developed by FIM

Geo-spatial Information Platform (FIM)

FIM satellite image data and GIS data are stored. With rules established for file names and metadata, a system is available to store output data on the server according to a workflow.

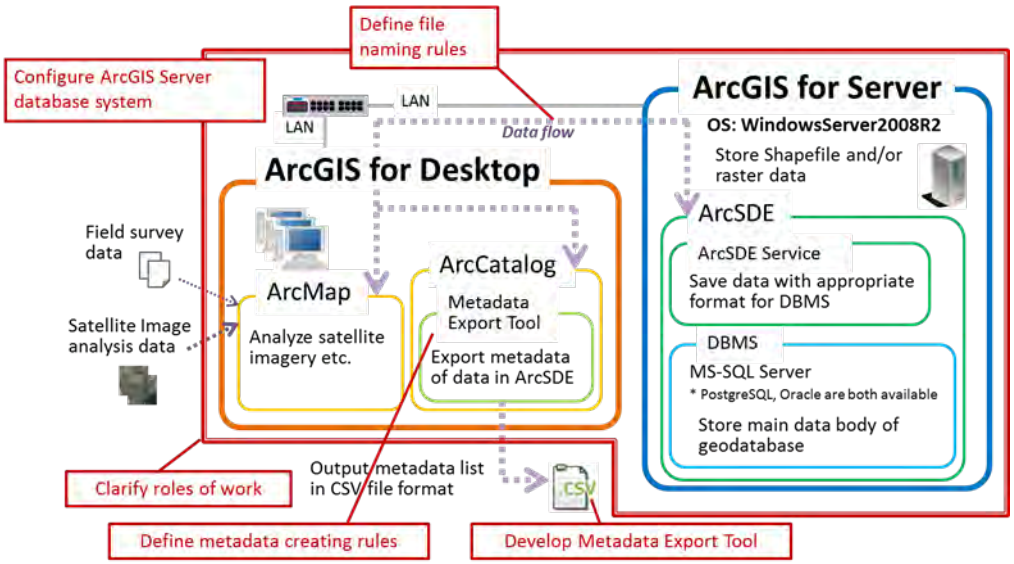


Figure 3-50 Outline of Geo-spatial Information Platform Developed by FIM

Forest Management Information System (FPP/TA2)

Progress and output of the FPP technical assistance activity (TA2) implemented by a joint venture were checked. The FPP/TA2 completed the forest management information system (beta version) in December 2013 and the system has been installed in FIPD and put to test operation in the DOF intranet environment. Later, the system was converted to a Lao version. With the remaining budget of FPP, preparations were made for constructing the same environment and system in DFRM.

This system is designed so that when a user of a department or a section of the DOF or DFRM logs in, a GIS portal site prepared for each department and section starts up and displays news/events, documents, project information and GIS map information required by the section.

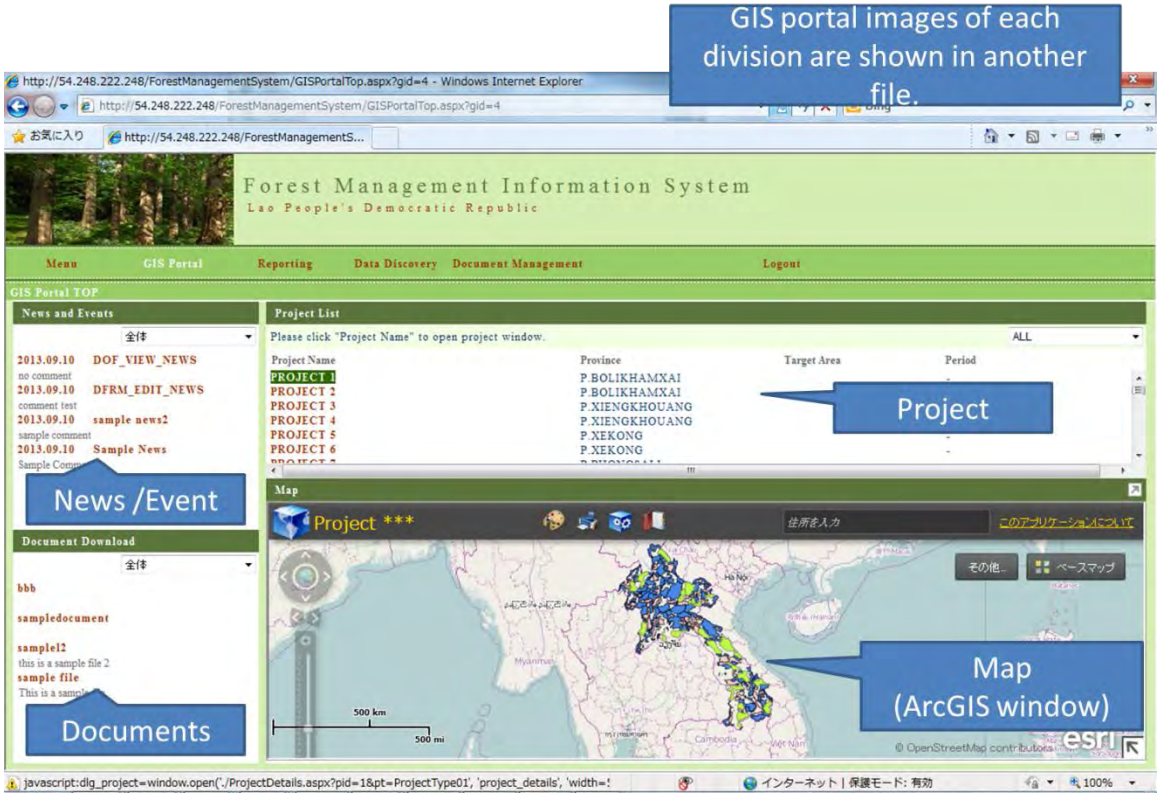


Figure 3-51 Top Page of Forest Management Information System (FPP/TA2)

This system, currently in a demonstration operation, stores some of the existing FIPD data and draft data created by FIM but has a problem of insufficient data and contents. However, data developed by NFIS and relevant projects can be added as needed. A platform for browsing and using information required for forest management is getting ready to be operative. This project has determined to focus on studying the data and estimation methods required to incorporate into this system a function for calculating the carbon stocks, which is necessary and important particularly for realizing REDD+. In addition to physical data such as carbon stocks, methods for organizing and providing information related to REDD+ PaMs and SG will be considered.

Department of Forestry Reporting System (DOF Reporting System)

The current situation and issues were grasped through discussions with DOF, the DFRM and SUFORD in collaboration with the FPP technical assistance activity (TA3), which was being implemented by a joint venture. As a result, the following points were confirmed. 1) The TA3 activity established a structure enabling the DOF Reporting System to function nationwide (structure for equipment procurement and training), 2) As the system covers not only the production forests that DOF is responsible for but also the protection forests and the conservation forests under the management of DFRM, the implementation structure needs to be reexamined and 3) The FPP technical assistance activity (TA2) has already completed verification with respect to the method and the structure for retrieval of information necessary for the implementation of Clearing House. It was also confirmed that there is a plan to study how to update the table attributes in this system by the DOF and DFRM officers in charge.

Forest Inventory and Management Information System (FOMIS)

It was once agreed that the system revision of FOMIS would be carried out in the course of the FPP/TA2 activities (first half of the second year). However, SUFORD's succeeding project (SUFORD SU) decided to study a production forest management database and monitoring system (middle of the second year). Therefore, a system of information exchange between the two databases will be discussed and coordinated in the design and development stages of this system (end of the second year).

1st NFI Database (ForestCalc)

In Laos, the NFI was implemented over a long period from 1991 to 2000 in all provinces with the support of Sweden. Also, from 2009 to 2010, SUFORD (World Bank/Finland) developed a database including raw data and biomass/carbon stock calculation functions (ForestCalc). First, in order to obtain the general idea, existing documents were reviewed to study the data and the functions of ForestCalc. Figure 3-52 shows a flowchart of biomass/carbon stock calculation by ForestCalc.

ForestCalc calculates biomass and carbon stock based on the result of a detailed study that had originally been conducted on stem volume, while referring to the review of local survey results on wood density, biomass expansion factor, carbon fraction, etc. as well as the IPCC default values.

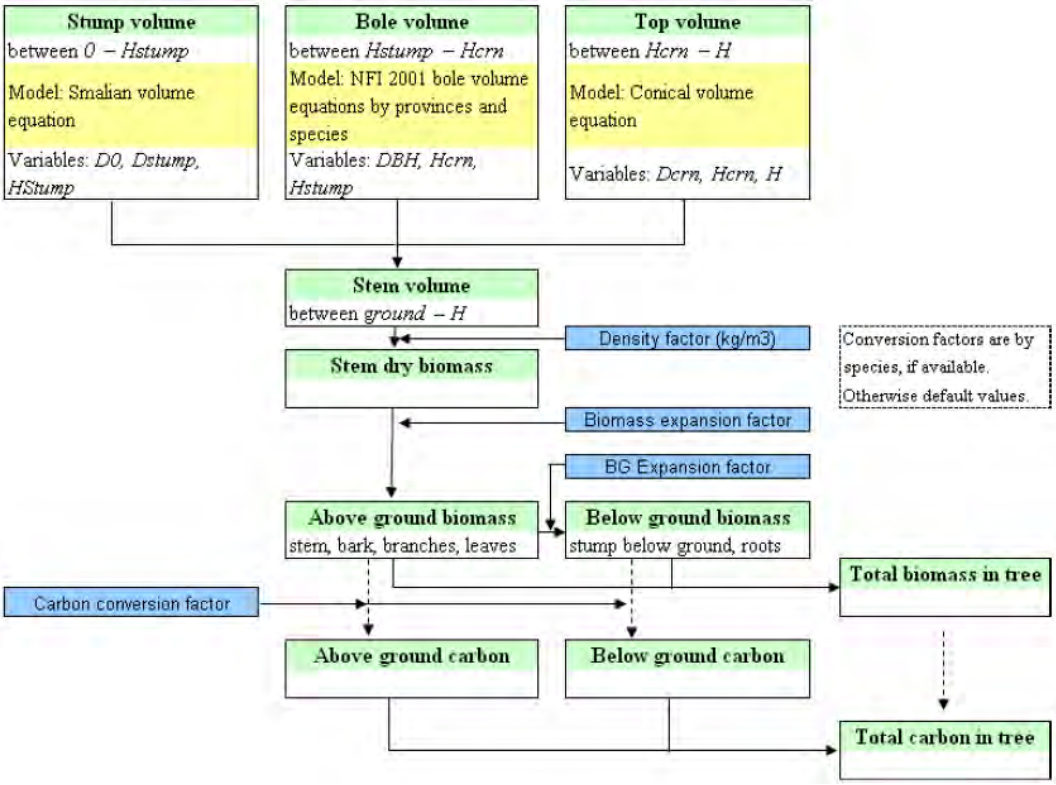


Figure 3-52 Biomass/Carbon Stock Calculation Flow of ForestCalc

This project has developed desk-based allometric equations for carbon stratification by analyzing the ForestCalc data to study the relationship between the amount of ground biomass calculated by ForestCalc and the diameter at breast height as well as the tree height for each province (region) and vegetation type. The analysis was conducted with the approval of the CTA of SUFORD, while communicating with the ForestCalc database developer as necessary.

Since factors highly correlated with the carbon amount are identified in the activities relating to the output 1, activities relating to the output 2 covered the process from the creation of queries (search requirements) to retrieve necessary data from the ForestCalc database to the development of allometric equations.

Example of Extracted/Summarized Information from ForestCalc

Province	Plot	Species	Landuse	D	H	Biomass_AG	Biomass_Total	Carbon_AG	Carbon_Total
1	110011801	142	106	33.8	31.1	6.89	8.61	3.45	4.31
1	110011801	142	106	21.2	26.1	11.85	14.81	5.92	7.40
1	110011801	142	106	14.6	12.7	2.58	3.23	1.29	1.62
1	110011801	142	106	31.8	22.5	3.61	4.52	1.81	2.26
1	110011801	142	106	14.2	12.4	2.42	3.02	1.21	1.51
1	110011801	999	106	11.5	7.6	1.35	1.69	0.67	0.84
1	110011801	999	106	12.0	8.0	1.48	1.86	0.74	0.93
1	110011801	999	106	10.0	6.6	0.86	1.08	0.43	0.54
1	110011801	999	106	11.1	7.4	1.23	1.54	0.62	0.77
1	110011801	999	106	13.7	9.1	2.07	2.59	1.04	1.30
1	110011801	999	106	24.0	15.3	8.71	10.88	4.35	5.44

Image & Step to develop tentative Carbon Stratified Map

1) (Tentative) Allometric Equation by Forest-Type/Province

Figure 3-53 Development Image of Desk-Based Allometric Equations for Each Province/Vegetation Type by ForestCalc

Development of Desk-Based Allometric Equations

Since forest classifications of ForectCalc do not completely conform to those of FIM, a correlation table was developed to identify the forest classifications for which allometric equations should be created (items in red).

Table 3-45 Comparison of Forest Classifications of ForestCalc and FIM and Identification of Allometric Equation Development Classifications

Code	LU_ForestCalc	LU_FIM_2010	For Allometry Equation
101	Lower evergreen	Evergreen Forest	Evergreen Forest
102	Upper evergreen		
103	Lower dry evergreen		
104	Upper dry evergreen	Mixed Evergreen and Deciduous Forest	
105	Lower mixed deciduous		Mixed Deciduous Forest
106	Upper mixed deciduous	Deciduous Forest	
107	Dry dipterocarp	Dry dipterocarp	Dry dipterocarp
108	Gallery forest	included in Evergreen～Deciduous	–
109	Coniferous	Coniferous	Coniferous
110	Mixed broadleaved and coniferous	Mixed broadleaved and coniferous	Mixed broadleaved and coniferous
111	Man-made, plantation	Evergreen Forest Plantation	Forest Plantation
		Deciduous Forest Plantation	
201	Pure bamboo	Bamboo	Bamboo
202	Unstocked	Old Fallow Land	Fallow Land
		Young Fallow Land	
204	Ray	Slash and Burn Land	Slash and Burn (No stock)
203	Natural regeration		
301	Savannah, open woodlands	Savannah/Open Woodland	Savannah/Open Woodland
302	Heath, stunted and scrub forest	Scrub, Heath	Scrub, Heath
401	Rice paddy	Rice Paddy	Rice Paddy
402	Fruit plantation	Agriculture Plantation	Agriculture Plantation
403	Other agriculture	Other Agriculture Area	Other Agriculture Area
501	Barren lands, rock	Barren Land	Barren Land
		Rock	Rock
502	Grassland	Grassland	Grassland
503	Swamps	Swamp	Swamp
504	Urban areas	Urban Area	Urban Area
505	Other land areas	Other Land	Other Land
506	Water	Water	Water

Single regression analysis of the correlation between the diameter at breast height and the ground biomass as well as between the tree height and the ground biomass revealed good correlations between the diameter at breast height and the ground biomass and outstanding variations with respect to the tree height. Therefore, it was decided that single regression analysis should be carried out with respect to the diameter at breast height and the ground biomass for each vegetation type and province in this analysis. The result of the single regression analysis is shown below.

*All figures are shown in Annex 7

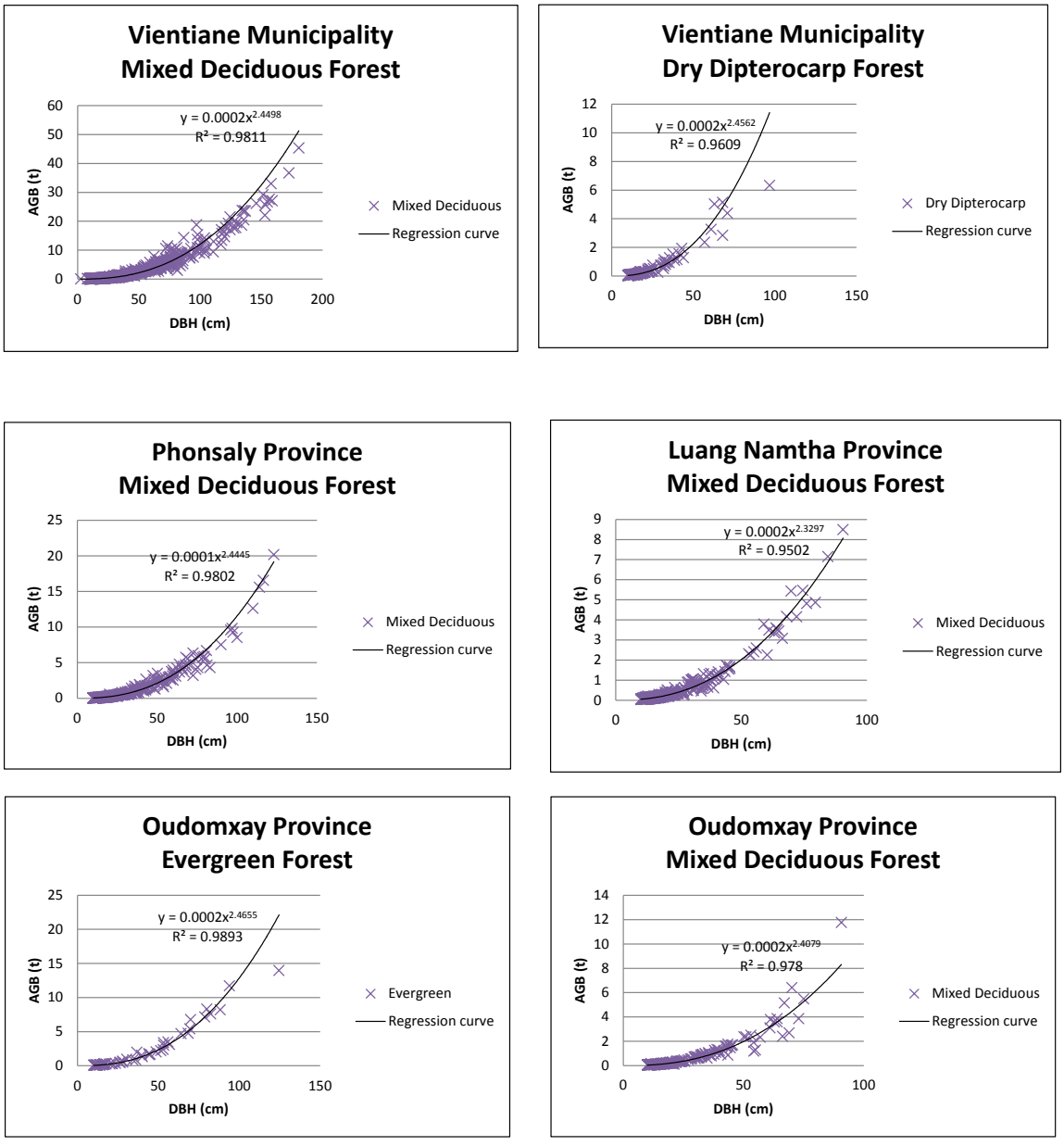


Figure 3-54 Single Regression Analysis between Diameter at Breast Height and Ground Biomass for Each Province /Vegetation Type (Sample)

Organization of Statuses of Database Assistance by Donor Projects

Discussion was held with the person in charge of database (DB) of each project providing assistance to DOF. Based on the result of discussion, the current statuses of DB assistance by donor projects were organized.

JICA (FIM) originally planned to use PostgreSQL, an open-source DB. However, Microsoft SQL Server, a commercial DB, is used as the inventory DB and the backend DB of the FPP/TA2 platform in consideration of experience and capabilities of local engineers as well as requests and recommendations from DOF and FIPD.

CliPAD is developing at the sub-national level a Standard Operating Procedure (SOP) for forest inventory survey and is utilizing a tablet-based survey tool. However, it is working together with JICA/NFIS to pursue integration with the national-level biomass DB so that it is planning to use MS-SQL Server as the backend DB.

SUFORD SU is designing a production forest management monitoring DB. It is considering using the same tablet-based survey application (ODK and FormHub) as CliPAD but is planning to customize it. The backend DB is going to be PostgreSQL, an open-source DB.

Furthermore, FAO has developed a pre-inventory analysis and field survey tool and a statistical analysis system, which is available free of charge and therefore can be used in Laos. However, PostgreSQL is used as the backend DB.

Table 3-46 Organization of Statuses of Database Assistance by Donor Projects

	CliPAD	JICA(NFIS)	SUFORD SU	FAO
Analysis Application	QGIS & IDRISI (FC) eCognition (Aruna)	ArcGIS eCognition	ArcGIS ERDAS	TerraAmazon
Mobile Application	ODK & FormHub(->Ona)		ODK & FormHub (customize)	OpenForis Collect
Survey Database	NoSQL (MangoDB)		PostgreSQL (new table for display)	SQLite/PostgreSQL
Back-end Database	MS SQL Server		PostgreSQL	PostgreSQL

As described so far, there appears to be too many DBs in use. However, the biomass DB and the production forest management DB under study by JICA and CliPAD need not necessarily be the same DB because they need information of vastly different types. Any DB that serves each of their purposes may be used for development. What is more important, as proposed by CliPAD in SOP, is the standardization of survey data and analysis methods. The data exchange between DBs does not pose any major problem because it can be technically solved only if the specifications and regulations for

input-output are determined. However, it is important for projects and engineers to have a good understanding of such circumstances and discuss and coordinate with each other as required.

3.3.2 Review of Functions and Specifications for Statistics/Reporting, etc

In order to enhance capacity of reporting (R) of MRV system, NFIDB needs to study the functions and specifications for supporting international reporting. DOF is currently responsible for compilation of National GHG Inventory in forestry sector as well as Country Report of Global Forest Resources Assessment (FRA). The international reporting support functions will be created in NFIDB to retrieve and summarize necessary information/data for compiling these reports.

Table 3-47 List of international reports responsible by DOF

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

Current State Analysis for UNFCCC Report

In Laos, first and second national communications (NC) were submitted to UNFCCC in 2000 and 2013 respectively. Now, Climate Protection through Avoided Deforestation (CliPAD) project funded by German Agency for International Development (GIZ) has started capacity building program on reporting national GHG inventory (compilation of NC and BUR to UNFCCC) in Agriculture, Forestry and Other Land Use (AFOLU) sector. It is considered that this program will enhance the capacity of GHG inventory component in NFMS of Laos (Table 3-20). This program will be mainly offered to the national focal point of UNFCCC in MONRE.

NFIS project reviewed the first and second NCs as well as participated in an inception workshop of the capacity building program held by CliPAD, and the following observations were found:

1) Based on the comparison of the second NC to UNFCCC and FRA 2015, it was observed that different activity data (AD) and emission factors (EFs) were used. As mentioned later, FRA 2015 used past inventory data (1982, 1992 and 2002) and Forest Cover Assessment data (2010) to estimate historical forest cover changes between 1990 and 2010. On the other hand, the second NC to UNFCCC used past inventory data (2002) and Five-Year Sustainable Forest Protection Action Plan (2006-2010) to report forest areas of 2000 and 2010. As a result,

while FRA 2015 shows a slightly decreasing trend in the forest area between 2000 and 2010 (app. 0.4% decrease per annum), the second NC shows increasing trend (app. 3.8% increase per annum) in the section "Mitigation Options and Potential, and slightly decreasing as BAU in the same time interval but the consistency of data development/organizing is well implemented.

2) In addition, EFs for estimating the amount of carbon emission or sequestration are different between NC and FRA 2015. While NC uses only default values from IPCC Good Practice Guidance (GPG) for LULUCF (Tier level 1), FRA 2015 uses combined values of default values from IPCC Guidelines and country specific values derived from national forest inventory data (Tier level 1/2).

Table 3-48 List of activity data and emission factors employed in FRA 2015 and Second National Communication to UNFCCC

	Activity Data	Emission Factors
Second National Communication to UNFCCC	NFI database (2002) Five-Year Sustainable Forest Protection Action Plan (2006-2010)	Default values from IPCC Good Practice Guidance for LULUCF
FRA 2015	NFI database (1982, 1992 and 2002)	NFI data: Growing stock
	Forest Cover Assessment (2010)	Default values from 2006 IPCC Guidelines: ・Biomass conversion and expansion factors (BCEF); ・Ratio of below ground biomass to above ground biomass (R); and ・ Carbon fraction (CF).

In the second NC to UNFCCC, the following issues are discussed in the implementation of the national GHG inventory in Laos. In the forest sector, the forest information to be output by NFIDB to be constructed by the next project is expected to be shared between different ministries/departments in pursuit of solutions of particularly the following issues 1, 2, 4, and 5 listed below.

(1) Inadequate and inaccurate information and activity data;

(2) Lack of local emission factors;

(3) Inadequate capacities of local researchers among relevant agencies;

(4) Poor database to support inventory activities;

(5) Insufficient coherence and coordination; and

(6) Development of regular inventory preparation programme.

Especially, tackling of issue 5 is crucial to make consistent international reports including National GHG Inventory reports and Country Report of FRA. As mentioned before, AD and EFs employed in NC and FRA are different, which resulted in reporting different scenarios from Lao PDR on the future CO2 emission or sequestration. That can be tackled by making closer coordination between different ministries/department associated with the national GHG inventory (e.g. MAF/DOF and MONRE in AFOLU sector). For example it seems necessary that establishing technical working groups constituted by the related ministries/department for every sector to discuss the methodology of GHG inventory and reporting, however, this is beyond the C/P and scope of this project. Therefore, this project examined the role to be served by the C/P (Forest Inventory and Planning Division, Department of Forestry).

Current State Analysis for FRA2015

Global Forest Resources Assessment (FRA), coordinated by FAO, was started in 1948, and is currently conducted in five year intervals to provide consistent datasets for describing the world's forest condition. The Assessment is based on two primary sources of data: Country Reports prepared by National Correspondents and remote sensing that is conducted by FAO together with national focal points and regional partners (FAO). In Lao PDR, DOF is the National Correspondent for FRA reporting. Since the Country Report is used internationally as official references for describing the forest condition of the country as well as basic information for international organizations to prepare assistance programs/projects in forest sector, it is very important to compile the report using updated and accurate information/data as far as possible. In Laos, DOF submitted the final draft of Country Report of FRA 2015 to FAO in December 2013. NFIS project supported FIPD on the collection of data sources and compilation of FRA 2015 in order to study the current condition/capacity on FRA reporting as well as to make basic design of NFIDB for the future FRA reporting.

While this project was assisting DOF on the collection of data and compilation of Country Report for FRA 2015, the following observations were found:

A) Information/data required for FRA reporting are dispersed in different ministries/departments;

B) Information are often compiled in analogue (sometimes hand-writing) format;

C) Information/data are often held by individuals and not shared among different ministries/departments;

D) Experiences to prepare the former FRA reports have not been transferred to the current staff member in DOF in charge of FRA reporting; and

E) There is no official framework on the collection and integration of information/data for FRA reporting. These works are currently done by an officer in FIPD in charge of FRA reporting.

Data and Functions to Be Stored in NFIDB

Both the UNFCCC report and the FRA report 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"

The results of studying about each of (a), (b), and (c) in this project are reported below.

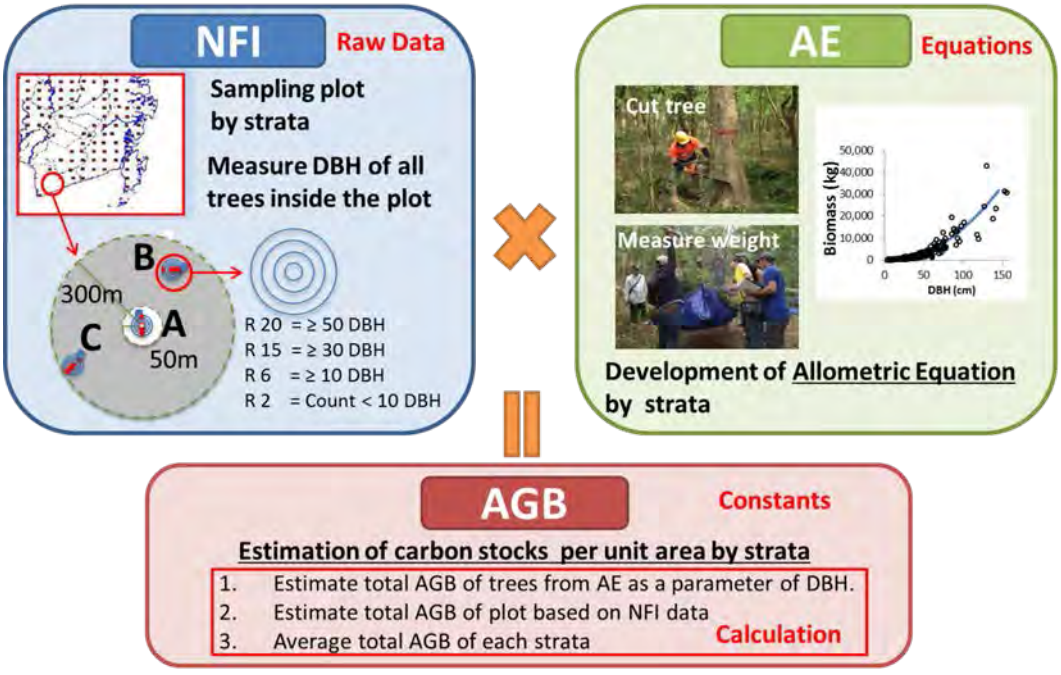


Figure 3-55 Outline of Data and Functions to Be Stored in NFIDB (*e.g.* Above-Ground Biomass (AGB))

(a) Collecting and storing “survey data (raw data)” efficiently without errors

As a means to collect survey data (raw data) efficiently without errors, this project 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.

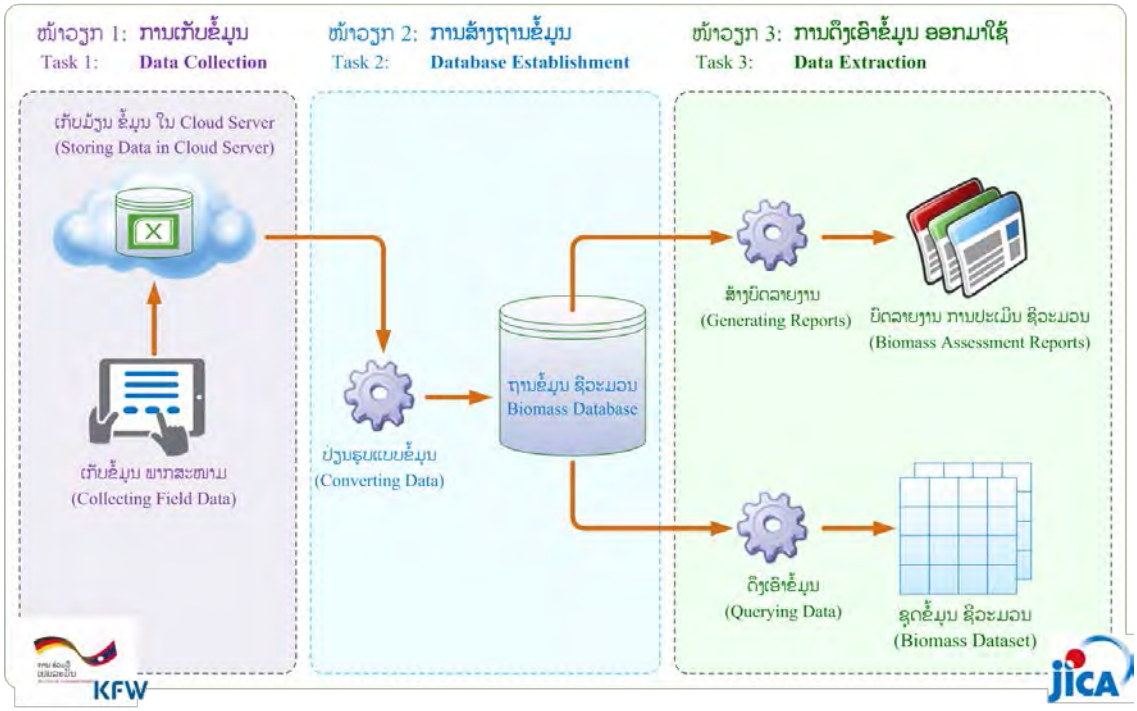


Figure 3-56 Outline of Collection, Storage, and Utilization of Forest Inventory Survey Data

Furthermore, 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 in this project was also conducted using the same format.

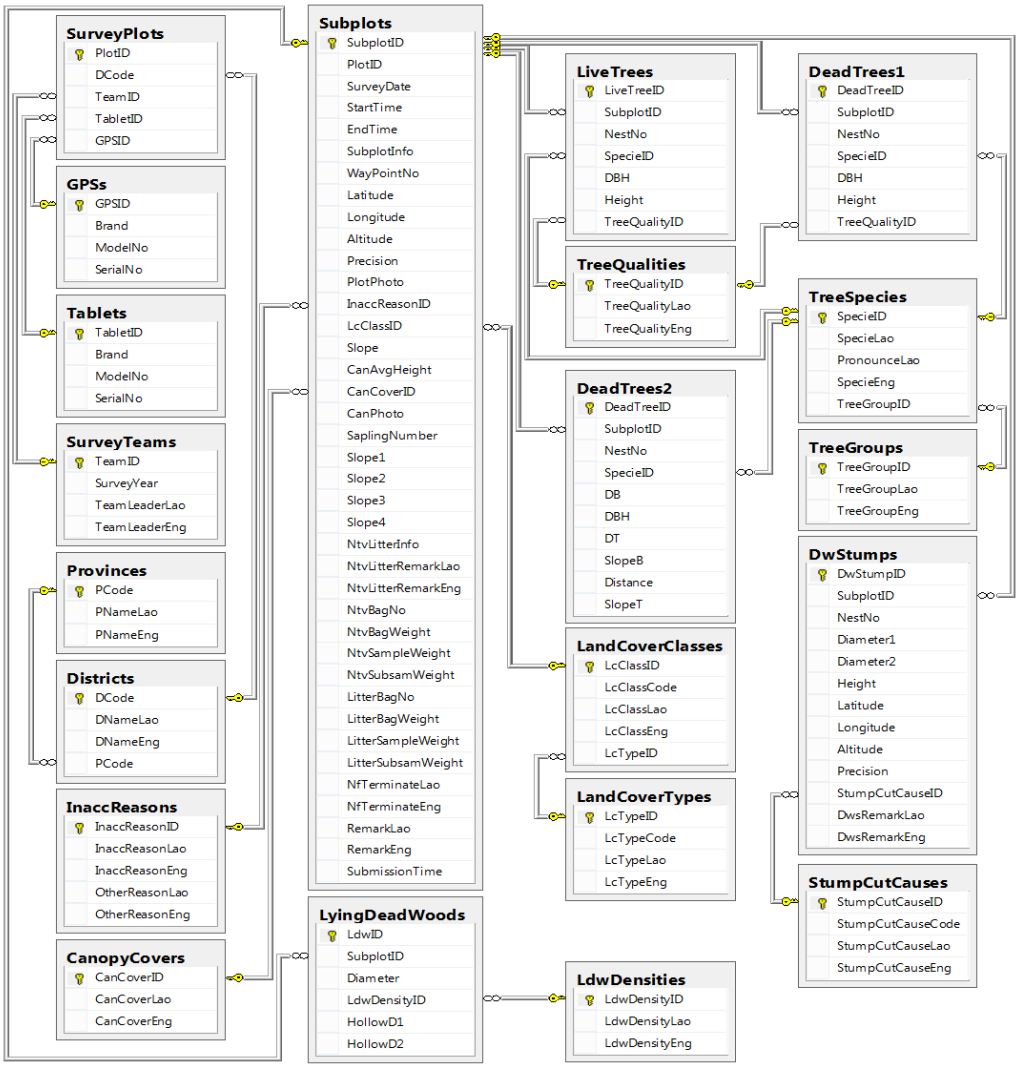


Figure 3-57 ER Diagram of Forest Inventory Biomass DB

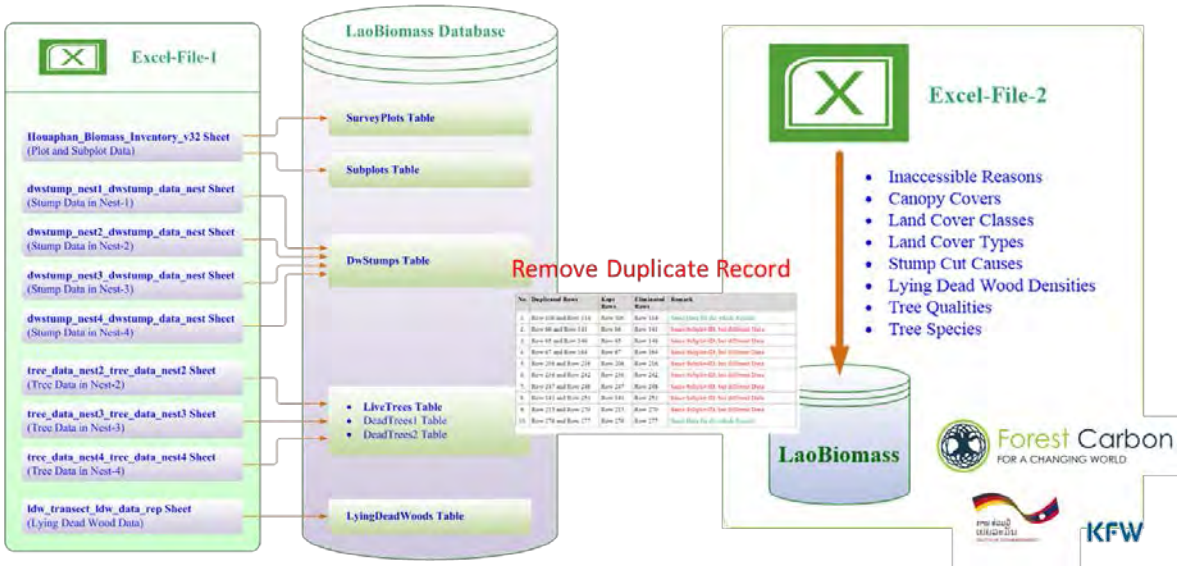


Figure 3-58 Outline of Conversion and Storage of Inventory Survey Data to Biomass DB

(b) 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)

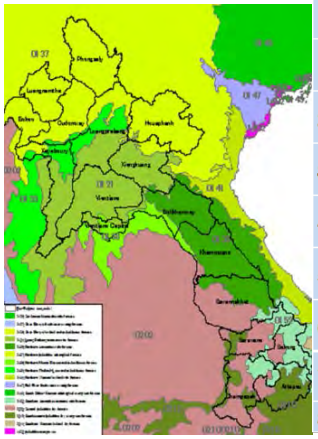
Option (3): Generic allometric equations (regardless of distinction of regions and forest types)

■ 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.

In other words, all of the options of currently available allometric equations will be less needed in about one year. Therefore, 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 1) UN-REDD: Vietnam North East	6) IPCC: Temperate/tropical pines 1) UN-REDD: Vietnam North East	6) IPCC: Temperate/tropical pines 2) UN-REDD: Vietnam North Central Coast	– –	6) IPCC: Temperate/tropical pines 2) UN-REDD: Vietnam North Central Coast	6) IPCC: Temperate/tropical pines 4) Kiyono equation	6) IPCC: Temperate/tropical pines 3) UN-REDD: Vietnam South Central Coast	6) IPCC: Temperate/tropical pines 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]	$AGB\ (kg/tree) = 0.153*DBH^{2.382}$

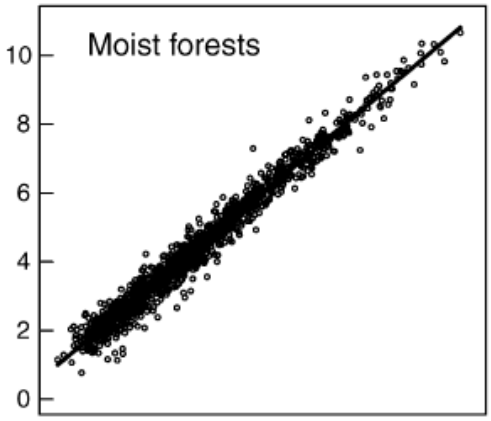
Figure 3-59 Option (1) Existing Region-based (or IPCC-registered) Allometric Equations

	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

Figure 3-60 Option (2): Desk-based Allometric Equations Based on the First NFI Data (for Each Province)



Chave et al. 2005

Moist forest stands:

$$\langle AGB \rangle_{est} = \exp\left(-2.977 + \ln\left(\rho D^2 H\right)\right) \equiv 0.0509 \times \rho D^2 H$$

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

Chave et al. 2014

$$AGB_{est} = \exp[-1.803 - 0.976E + 0.976\ln(\rho) + 2.673\ln(D) - 0.0299[\ln(D)]^2]$$

$$E = (0.178 \times TS - 0.938 \times CWD - 6.61 \times PS) \times 10^{-3}$$

Figure 3-61 Option (3): Generic Allometric Equations (Regardless of Distinction of Regions and Forest Types)

Table 3-49 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

(c) 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.

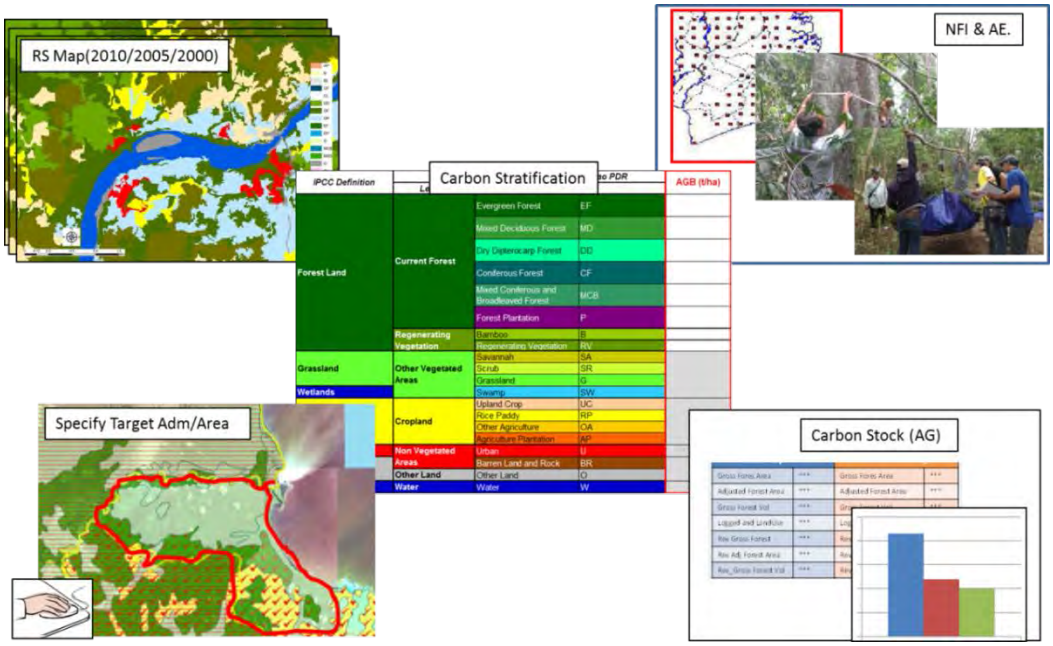


Figure 3-62 Image of Target Range (Area) for Each Carbon Stratification and Estimation of Biomass and Carbon Stocks

Development of Demo Version of Inventory Survey Data Prompt Analysis System

The scope of this project is up to the design of NFIDB. However, a function of promptly analyzing inventory survey data was developed as a demo version, which is a script that runs on free statistical analysis software called "R" (see Output 3). It is expected to improve this system to enable its use in actual operation in the next project.

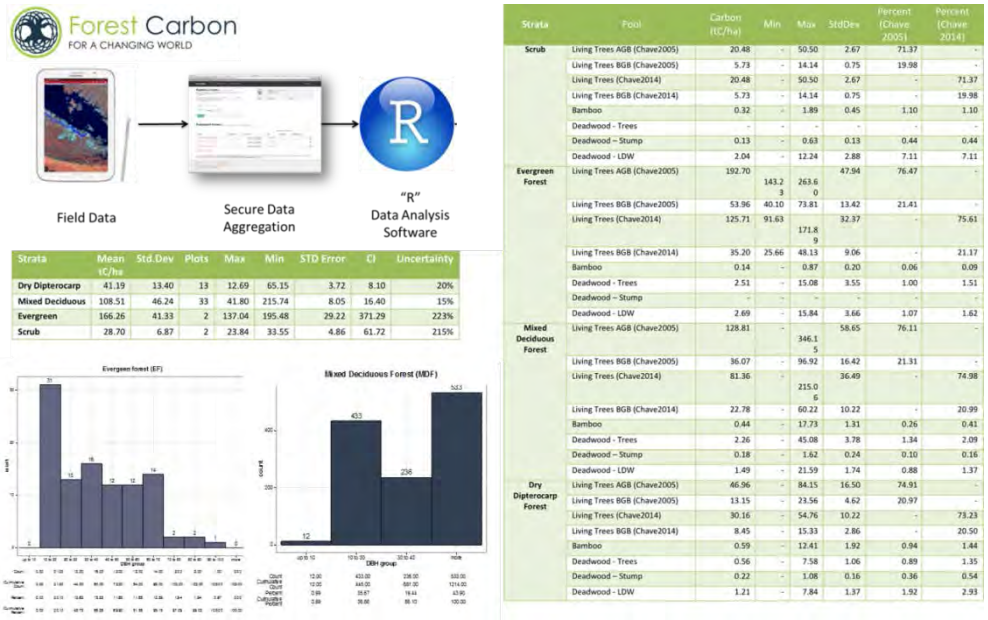


Figure 3-63 Development of Demo Version of Inventory Survey Data Prompt Analysis System Using "R"

Review of Integration with GHG Inventory Software

In comparison of GHG inventory software (IPCC Inventory Software and ALU Software), ALU Software with a relatively higher function of integration with GIS data was studied to identify steps for integration. Although the use of IPCC default values for EF is assumed in the following steps, attention must be paid to the fundamental necessity of integration of the climate types, soil types, and land use data.

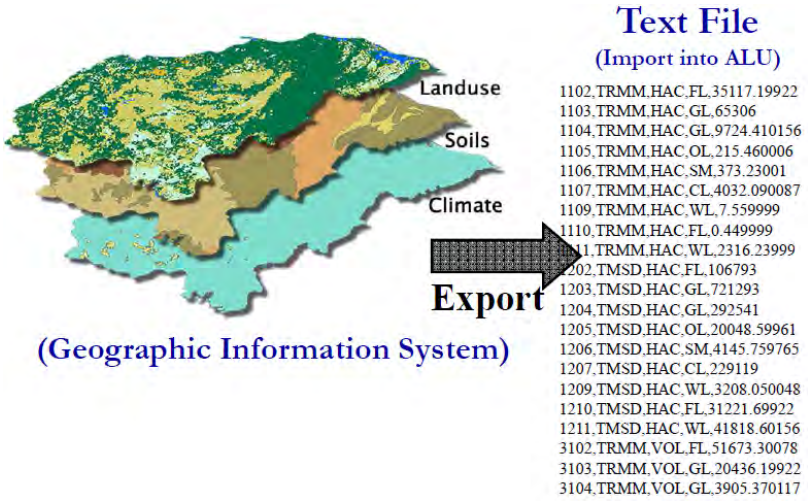


Figure 3-64 Importing of GIS Data to ALU Software (Source: Data from Colorado State University)

Step 1:

Regarding land use spatial data to be used, create an acronym field in the attribute table of GIS data which includes climate, soil, land use, and land use subcategories. The acronyms of climate, soil, land use, and land use subcategories must be consistent with the IPCC category defaults (see below) or country-specific definition file (created by the compiler). (Note: There is no default for land use subcategories because they are always country-specific). Furthermore, acronyms must be unique in a country-specific definition file.

When using IPCC-default climate types, use the following acronyms so that ALU can associate them with the input to the emission factors and stock change factors.

Climate type	Acronym
Tropical Moist Montane	TRMM
Tropical Dry Montane	TRMD
Tropical Wet	TRW
Tropical Moist – Short Dry Season	TMSD
Tropical Moist – Long Dry Season	TMLD
Tropical Dry	TRD
Warm Temperate Moist	WTM
Warm Temperate Dry	WTD

Cool Temperate Moist	CTM
Cool Temperate Dry	CTD
Boreal Moist	BOM
Boreal Dry	BOD
Polar Moist	POM
Polar Dry	POD

When using IPCC-default soil types, use the following acronyms so that ALU can associate them with the input to the emission factors and stock change factors.

Soil type	Acronym
High Activity Clay Mineral Soils	HAC
Low Activity Clay Mineral Soils	LAC
Sandy Soils	SAN
Wetland Soils	WET
Sporadic Soils	SPO
Volcanic Soils	VOL
Organic Soils	ORG

The acronyms for land use categories and activity data in Approach 1 are as shown below.

Land use category	Acronym
Forest Land	FL
Cropland	CL
Grassland	GL
Settlements	SM
Wetlands	WL
Other Lands	OL

The acronyms for land use categories and activity data in Approach 2 or 3 are as shown below.

Land use change category	Acronym
Forest Land remaining Forest Land	FF
Cropland converted to Forest Land	CF
Grassland converted to Forest Land	GF
Forest Land converted to Cropland	FC
Forest Land converted to Grassland	FG
Other categories	see IPCC 2006 Guidelines Volume 4 Annex 1

Approach 1: Data that is not spatially explicit and does not track land use through time
Approach 2: Data that provides land use change through time but is not spatially explicit
Approach 3: Data that provides land use change through time and is spatially explicit

Step 2:

Using GIS software, overlay the climate, soil, land use, and land use subcategory data. Then, using the Union processes, create polygons from their intersections. If the land use subcategories cannot be used in GIS data, use the climate, soil, and land use data to create polygons from their intersections.

Step 3:

Export six fields from the database in this order: Polygon ID code (or other ID code that can be used to link the data to the ALU of GIS data), climate type acronym, soil type acronym, land use category acronym, land use subcategory acronym (if included in the overlay) and areas of polygons (ha). An export file must be a text file that contains field delimiters (*e.g.* tabs are delimiters). Be careful that the land use subcategory fields become blank when they are Settlement, Other land, and Wetland.

Future integration patterns

NFIS is designing the next NFI and studying implementation of the designed NFI in the technical cooperation in preparation. At the same time, the biomass survey is currently being reviewed and prepared for. Therefore, the NFIDB design must be conducted while assuming an integration method after the development of estimated values for carbon stocks, etc. using allometric equations. Until these values are developed and publicized, however, it is necessary to keep the climate and soil layers integrated with the land use categories and use a function to output them in CSV format to facilitate the importing of them using GHG inventory software.

Survey about Report Types of Concerned Departments

Report types to be needed by the concerned C/P departments, which were organized through FPP/TA2 activities, were reviewed.

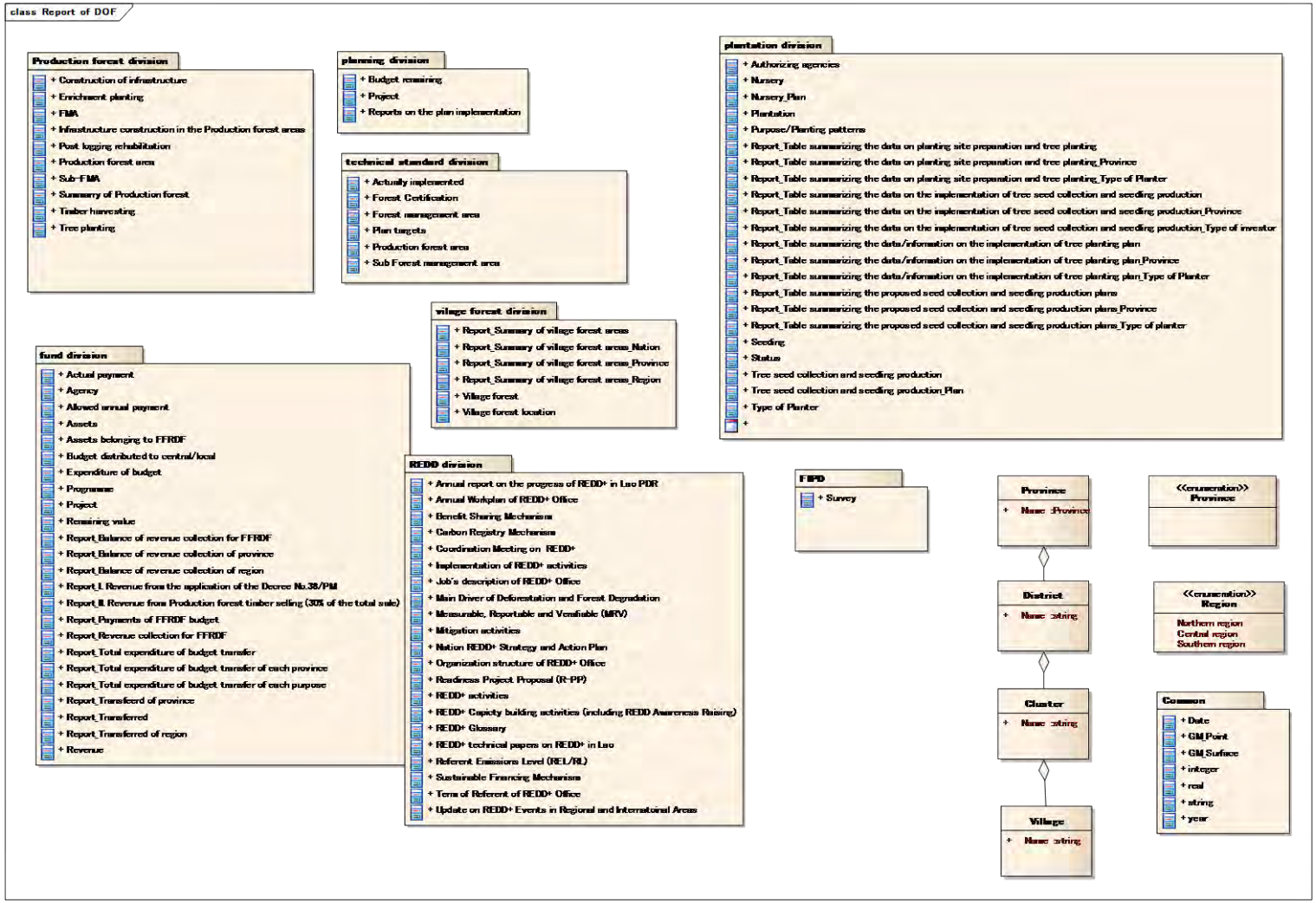


Figure 3-65 Report types to be needed by the concerned C/P departments

3.3.3 Identification of Types/Specifications of Forest Information Data

A technical workshop was held in FIPD in order to discuss the framework of geo-spatial database and identify the necessary data to build the database. The identified data were summarized in table * by the criteria as follows:

- Application of data;
- Category and sub-category of data;
- Availability of data in FIPD;
- Location of data (if not available in FIPD);
- Necessity of creating unavailable data for NFIDB; and
- Where, who and how to create unavailable data.

As a result of discussion and review with the FIPD staff, the types and specifications of forest information data to be surveyed and identified will be organized by the following application fields and data types.

Table 3-50 Organization of Types/Specifications of Forest Information Data

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, Ground truth.

The survey in the second year also concerned the acquisition of data owned by other ministries and departments and found to be needed in the first-year survey. Table 3-51 shows a visiting list for collecting GIS data and a list of data that has been organized, collected, and created.

Table 3-51 GIS Data Collection: Visiting List

	Ministry/department name	Data
1	Natural Resources and Environmental Information Center	GIS Data on land leases and concession
2	Department of Investment Promotion, MPI	GIS Data on land leases and concession
3	Department of Geology and Minerals, MONRE	GIS Data on mining concession
4	Department of Electricity, Ministry of Energy and Mines	GIS Data on hydropower concession
5	Department of Meteorology and Hydrology, MONRE	Meteorological and hydrological data from weather stations
6	Department of Irrigation, MAF	GIS Data on Irrigation Network
7	Mekong River Commission	GIS Data on Watershed
8	Department of Road, MPWT	
9	National Geographic Department, MONRE	
10	Agriculture Land Management and Development Department, MAF	

Table 3-52 List of data to be collected or developed for building geo-spatial database of NFIDB

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 accessd through internet with User ID and password provided by NREIC	MONRE, Natural Resource and Environment Information Canter (NREIC)	Yes	Check MONRE.	Ekvinay (NREIC)	(Amphayban g), Phoukhong, Japanese Consultant	The center will provide User ID and password to access database.	free
	Statistics / Census	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		
		Forestry (Timber and/or NTFP)	Unsure	Yes	Ministry of Trade (Timber trade)	Yes, but possible to collect only national	Check Ministry of Trade.		Khamsouk		

						data in this project.					
		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		
	Developme nt 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	Availabl e 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.		Amphayban g		
	Electric power line network	Electric power line network	Unsure	No	Department of Energy, Trade and Business	Yes	Check Department of Energy, Trade and Business.		Amphayban g		

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							

Addition of Forest Information Data to Forest Information Platform

Forest information collected through activities so far was added to the forest information platform developed in FPP/TA2 as a demo capacity building activity of C/P.

At present, the forest information platform has not been disclosed to the public on the Internet but is in service on the LAN/intranet of DOF. The GIS information and documents of 51 production forest projects were added to this platform. Users can browse the names, periods, outlines, and circumstances of projects.

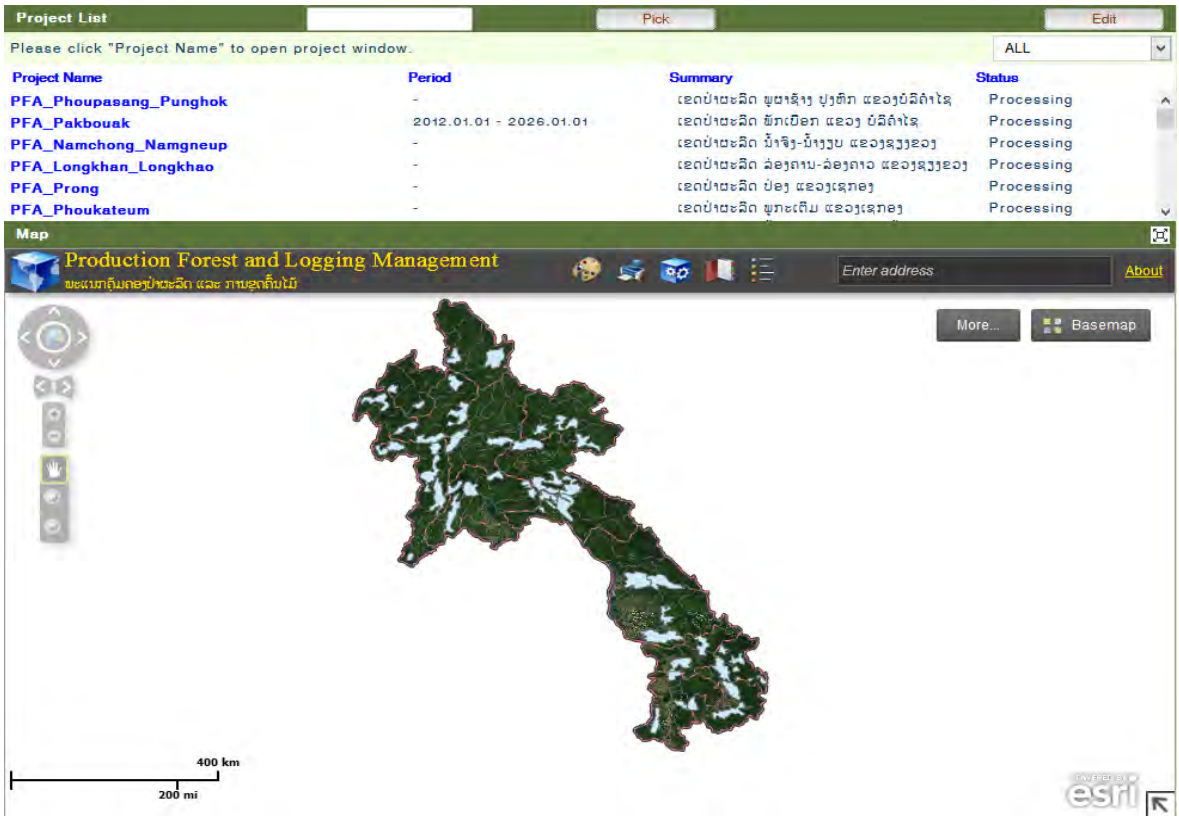


Figure 3-66 Production Forest Project Information Added to Forest Information Platform

Click one of the projects in the list displayed on the upper part of the screen on the platform. A project area is automatically zoomed in. On the platform screen, click the polygon of a desired project to browse the attribute information of the project (Figure 3-67). On the platform, other GIS information than vector layers such as image information (raster layers such as LANDSAT, RapidEye, and aerial photographs) can be added and browsed (Figure 3-68). The platform also has a function that allows users to download additional related documents. Several documents have been added as a demo (Figure 3-69).

The addition of this data was conducted by the C/P in charge of DBs for the operation of the forest information platform, who will play an important role also in NFIDB.

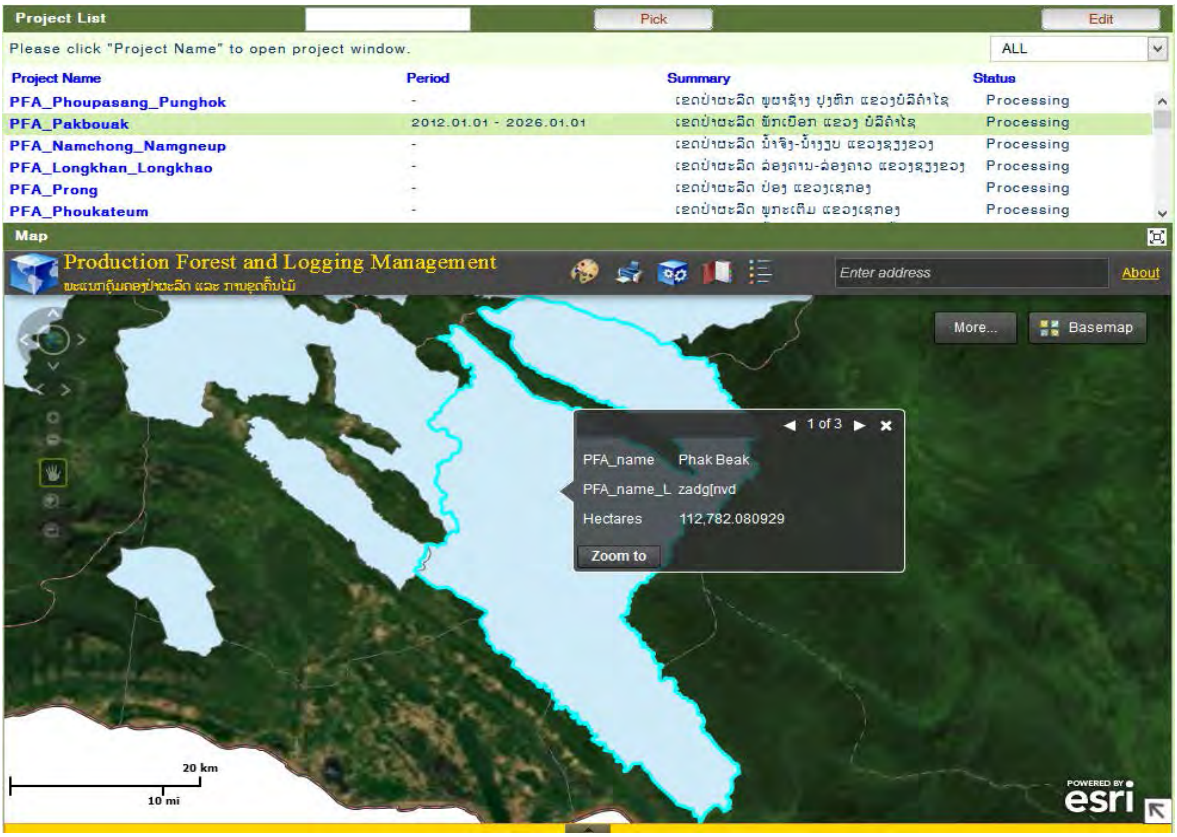


Figure 3-67 Check of Production Forest Project Attribute Information on Forest Information Platform

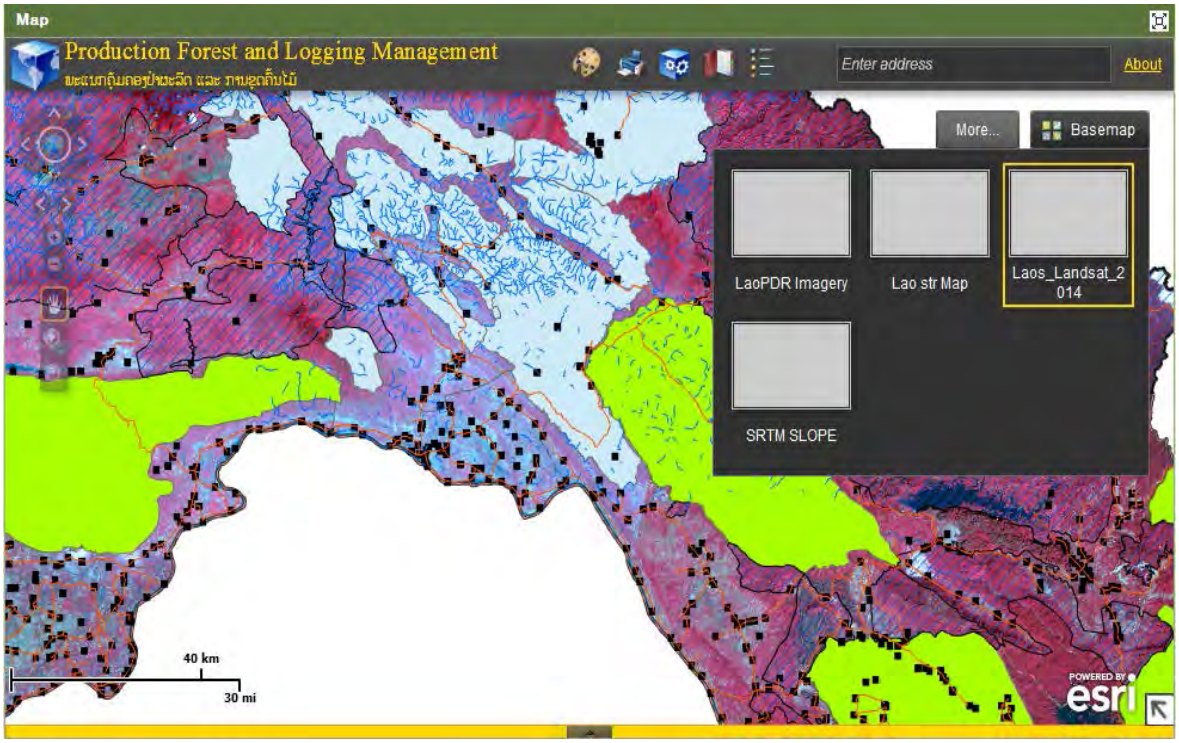


Figure 3-68 Other GIS Information and Image Information on Forest Information Platform

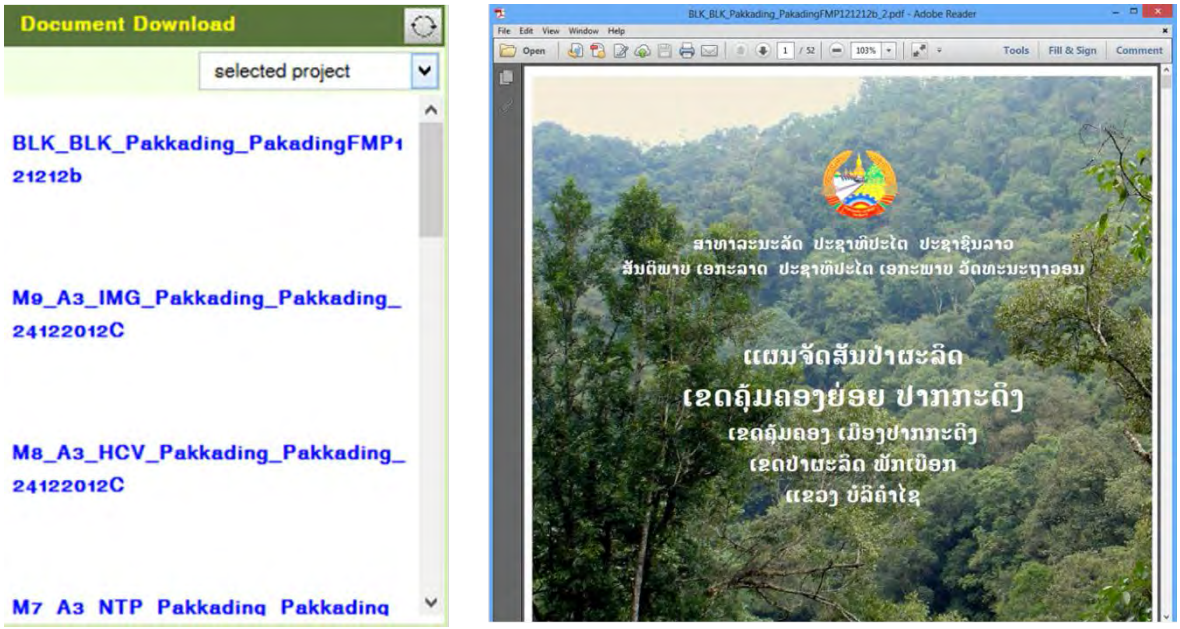


Figure 3-69 Documents Added to Forest Information Platform

Review of Data Sources in Preparation for Future International Reports

UNFCCC Report

Table 3-53shows a list of data sources of UNFCCC reports (AFOLU sector) used in the second National Communication and the next National GHG Inventory report (National Communication or Biannual Update Report). The construction of NFIDB will improve the Tier levels of activity data and emission factors and consequently the accuracy of the next National GHG Inventory report.

Table 3-53 List of Data Sources of UNFCCC Reports Updated by Construction of NFIDB

	Second National Communication (2013)	Next National GHG Inventory report	
Activity data [Tier level]	NFI database (2002) [Tier 2] Five-Year Sustainable Forest Protection Action Plan (2006 – 2010) [Tier 1]	NFIS DB (2000, 2005, 2010) [Tier 2]	
Emission factor [Tier level]	Default values in the 1996 IPCC Guidelines [Tier 1]	Forest land	Country-specific allometric equation: Average biomass for forest types [Tier 2] Default values in the IPCC Guidelines: Ratio of below-ground to above-ground biomass (R) and carbon fraction (CF) [Tier 1]
		Other land use	Default values in the IPCC Guidelines [Tier 1]

Table 3-54shows a list of tables and variables in the Country Report of FRA 2015 as well as the current and expected data sources for FRA 2015 and 2020 respectively taking into consideration the expected outputs of NFIS project. In FRA 2015, past inventory data (1982, 1992 and 2002) and Forest Cover Assessment data (2010) were used as data sources for estimating or forecasting values of FRA reporting years such as forest area (1a), forest expansion and deforestation (1b), forest growing stock (3a), above and below ground biomass (3d), and carbon in above and below ground biomass (3e). However, the methodology to create past inventory data (1982, 1992 and 2002) and Forest Cover Assessment data (2010) is different. That causes lower data consistency. While NFI database (1982, 1992 and 2002) was created by wall to wall mapping using satellite imagery and forest inventory survey data, forest cover assessment data (2010) was created by statistical analysis using the result of forest/non-forest interpretation for 4km grid sampling points.

In NFIS project, NFCMs for three time periods (2000, 2005 and 2010) with adequate thematic accuracy (more than 80% accuracy in forest or non-forest classification) and higher data quality (Tier level 2 depending on the adoption of county or region specific parameters/functions) will be produced. These dataset will be incorporated and/or substituted to the current data sources in the next FRA reporting (FRA 2020) in order to enhance data consistency and data quality. It is estimated that NFI database (1982 and 1992) and NFIS dataset (2000, 2005 and 2010) will be used as data sources for FRA 2020.

Table 3-54 List of data sources for FRA reporting

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					
	… of which artificial	1000 ha/yr	x	x	x	x			n.a		
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
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

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 weathe	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											
1. 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	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

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

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	DFRM: Department of Forest Resource Management	FRDF: Forestry and Forest Resource Development Fund	NBCA: National Biodiversity Conservation Area

OWL: Other wooded land

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OWL: Other wooded land

BCEF: Biomass conversion and expansion factors

3.3.4 Design of National Forest Information Database (Outline Proposal)

Organization of National Forest Monitoring System (NFMS) and Relations

The framework of REDD+ (or REDD) program has been discussed in Conference of the Parties (COP) in the United Nations Framework Convention on Climate Change (UNFCCC) since COP 11, Montreal (2005). The first methodological guidance on REDD+ activities was provided at COP 15, Copenhagen (2009). That requests developing countries to establish robust and transparent National Forest Monitoring System (NFMS) that:

1) Use a combination of remote sensing and ground-based forest carbon inventory approaches for estimating, as appropriate, anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes (Monitoring and Measurement);
2) Provide estimates that are transparent, consistent, as far as possible accurate, and that reduce uncertainties, taking into account national capabilities and capacities (Reporting); and
3) Are transparent and their results are available and suitable for review as agreed by the Conference of the Parties (Verification).

According to UN-REDD NFMS strategy (UN-REDD programme, 2013), NFMS (Figure 3-70) has two main components: Monitoring and MRV (measurement, reporting and verification) functions. MRV function consists of satellite land monitoring system, national forest inventory and GHG inventory. It is considered that NFIDB (Figure 3-70) to be designed in this project shall be a core part of NFMS of Laos. NFIDB has four main functions: (1) geo-spatial database, (2) forest inventory database, (3) forest carbon database and (4) production, protection and conservation forest management database. Geo-spatial database function will be a core part of satellite land monitoring system of NFMS that offers basic geo-spatial dataset including satellite image archives and NFMS for three periods (2000, 2005 and 2010) as well as information necessary for creating historical forest cover changes and Reference Emission Levels (RELs) / Reference Levels (RLs). In addition, forest inventory database and forest carbon database functions of NFIDB database will be a core part of national forest inventory and GHG inventory components of NFMS. However, integration of information/data from other forest inventory and GHG inventory related projects/activities in Laos is required to build up these components.

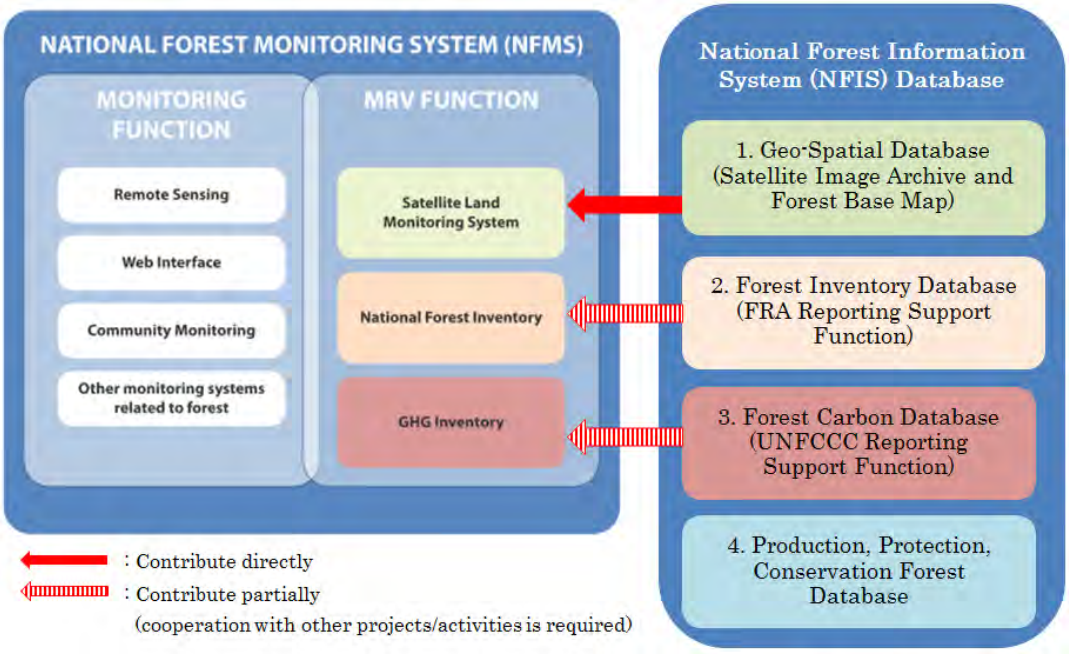


Figure 3-70　NFIDB which will be a core part of NFMS

Role of NFIDB for UNFCCC Report

GHG inventory software will be introduced in the capacity building program of GIZ-CliPAD project. Now, two software (IPCC inventory software (figure 3-62) and ALU software (figure 3-63)) are available for compiling GHG inventory in AFOLU sector.

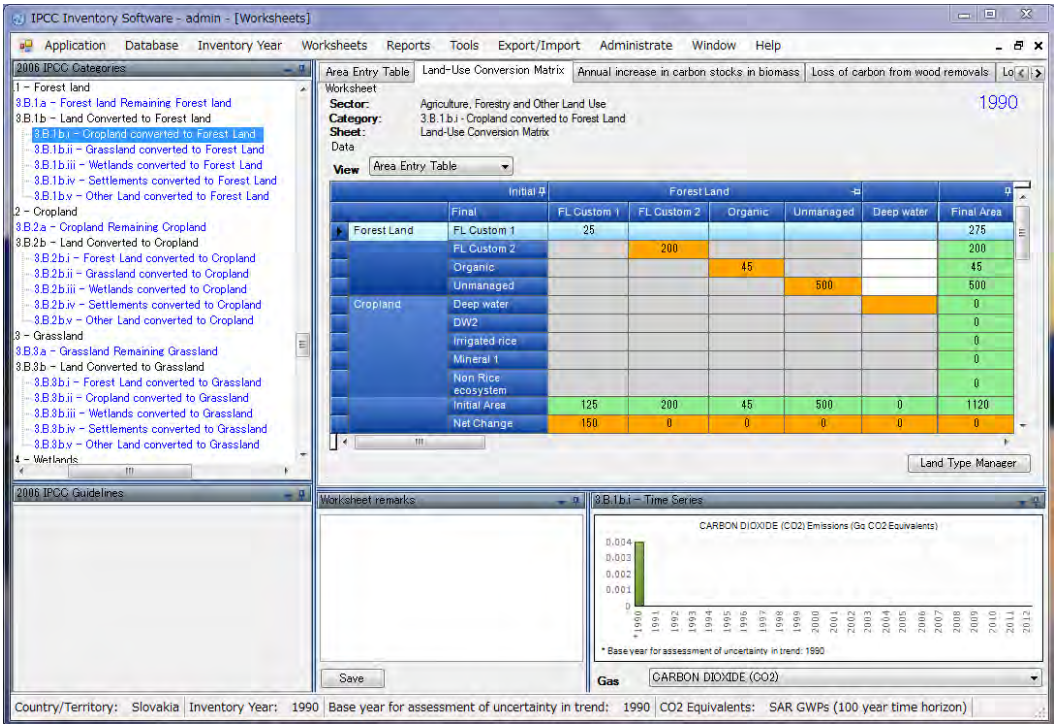


Figure 3-71 IPCC inventory software

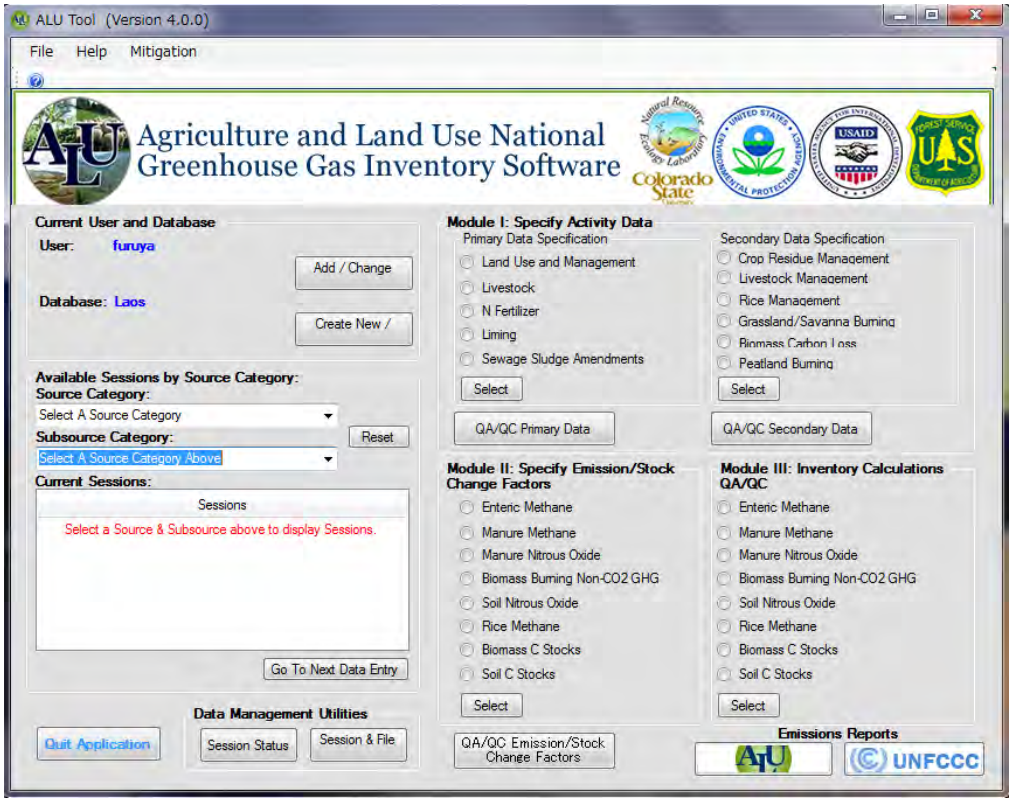


Figure 3-72 ALU software

It is considered that GHG inventory software and NFIDB can be operated together (Figure 3-73). NFIDB can be used to retrieve and summarize AD and EFs (in form of tables and/or GIS data) that are used to develop national forest type and carbon maps. In addition, NFIDB can be used to make forest cover change matrix, reference level (RL) / reference emission level (REL) and maps for the specified area. The summary (in form of tables and/or GIS data) will be used to input AD and EFs to GHG inventory software. GHG inventory software can be used for quality assurance (QA) / quality control (QC), uncertainty analysis and export data tables. The exported data tables will be transmitted to the national focal point to UNFCCC (MONRE) for integration of GHG inventory data from all sectors and compilation of reports following the standard format of IPCC guidelines.

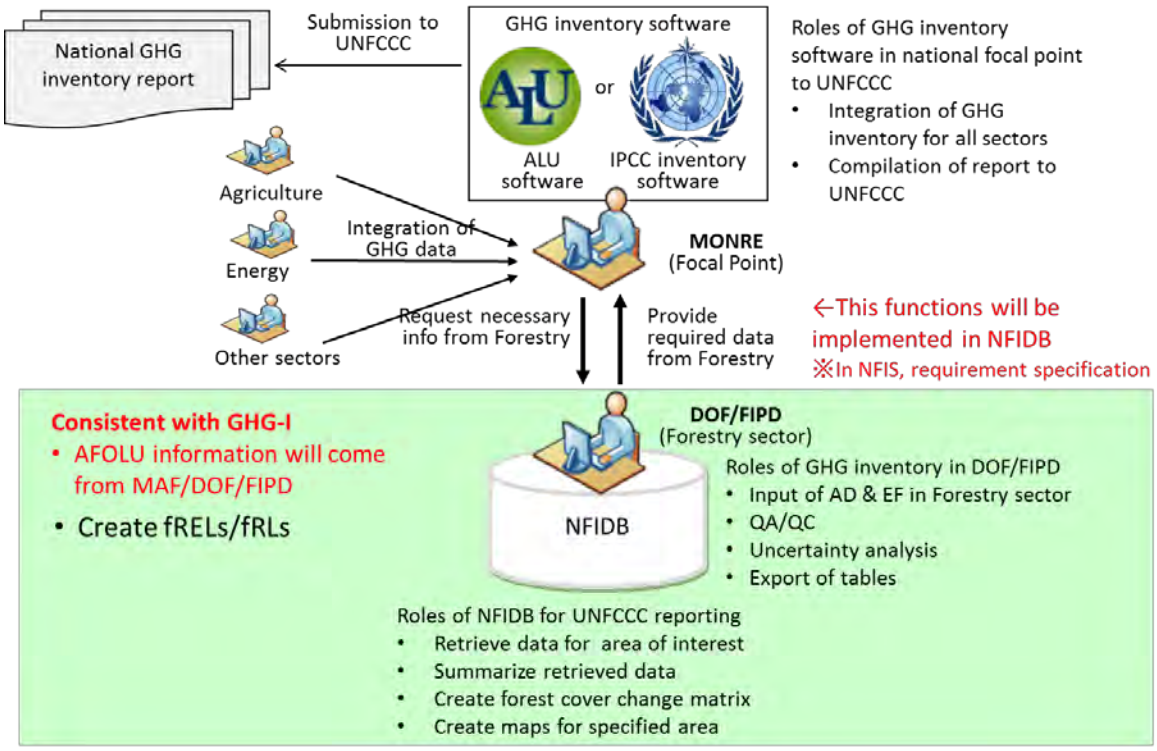


Figure 3-73 Role of NFIDB and GHG inventory software for preparing national GHG inventory report to UNFCCC (This diagram focuses on Forestry sector.)

Role of NFIDB for FRA Country Report

The necessary information/data for FRA reporting are currently dispersed in different ministries/departments and are not well organized. That makes difficult to understand the availability and condition of information/data as well as to create strategy to collect and/or create unavailable information/data. Therefore, it is necessary to create official framework to collect and integrate the information/data periodically from different ministries/departments and store the integrated information/data in a database. As its foundation, this project reviewed and designed data storage and data summary functions in NFIDB to prepare for the next FRA reporting

In FRA 2015, FAO provides online data entry system (Forest Resources Information Management System, FRIMS) to National Correspondents in order to compile the Country Report in a standard format (Figure 3-74 and Figure 3-75). It is considered that FRIMS and NFIDB can be operated together (Figure 3-76). The necessary information/data for FRA reporting will be periodically collected from different departments of DOF and MONRE. The collected information/data will be stored in NFIDB. NFIDB will be used to retrieve necessary data, forecast values for FRA reporting years using the available data, create forest cover change matrix, and make a summary of data for a reference of data entry to FRIMS. The summary of data will be feedback to the related ministries/departments. On the other hand, FRIMS will be used to make Country Report following the standard format of FRA as well as to transmit the finalized report to FAO.

Figure 3-74 Forest Resources Information Management System (FRIMS)

Table 1a

Categories		Area (000 hectares)				
		1990	2000	2005	2010	2015
CRQ	Forest	310134				
CRQ	Other wooded land	919591				
CRQ	Other land	507266				
CRQ	... of which with tree cover					
CRQ	Inland water bodies					
CRQ	Total					
	TOTAL					

Figure 3-75 Data entry form in FRIMS

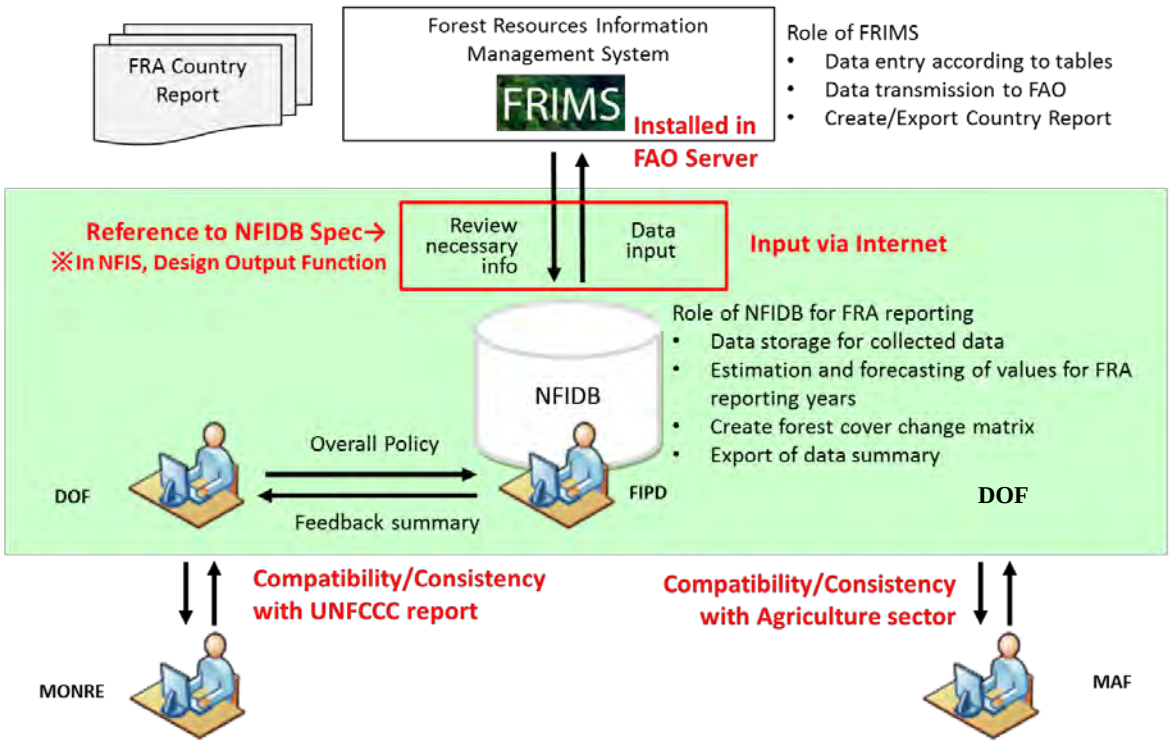


Figure 3-76 Role of NFIDB for FRA Country Report

Considering User Interface (Draft)

The draft User-Integration of Geo-Spatial Database and Forest Inventory Database, which had been developed in FIM, was considered. The image of the interface was presented d in the Technical Workshop.

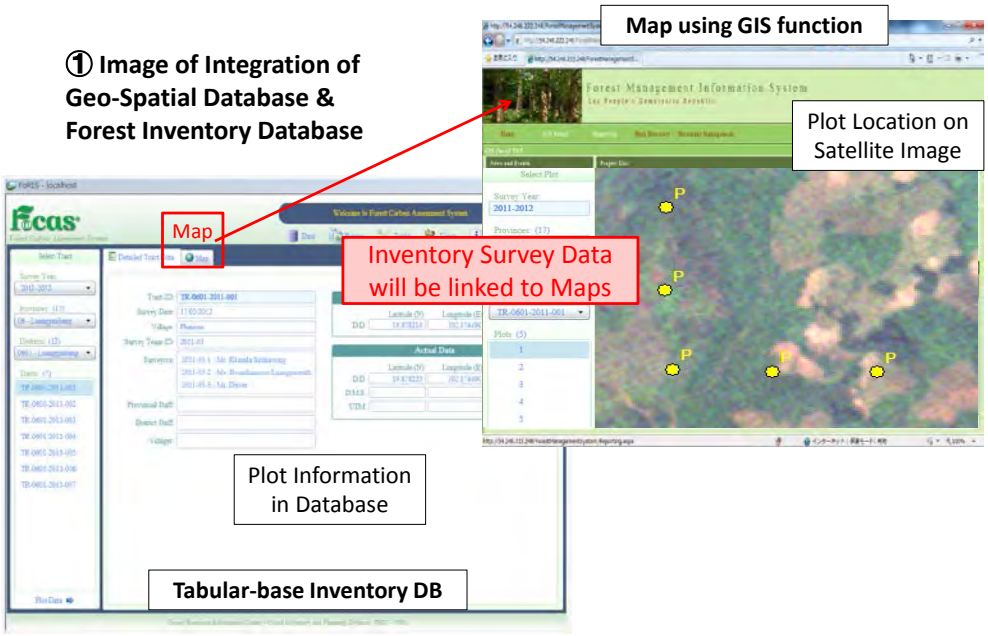


Figure 3-77 Image of Integration of Geo-Spatial Database and Forest Inventory Database

In addition, the plan and image of the reporting user-interface based on browser based interface of Forest Management Information System, which have been developed in FPP, was presented in the Technical Workshop.

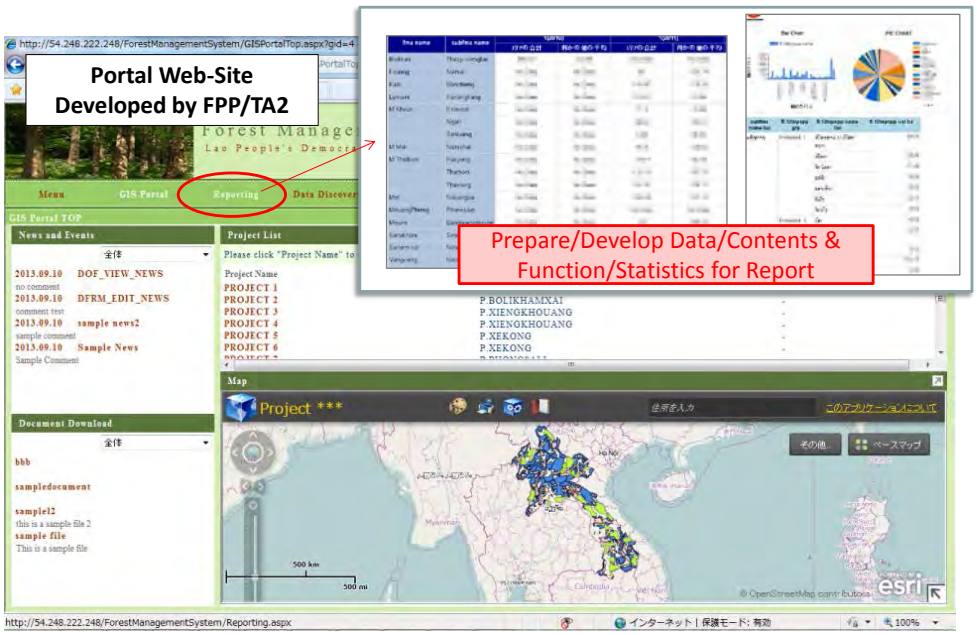


Figure 3-78 Image of Reporting User-Interface based on Web-browser System

Review of "Report Concerning National Forest Information Database Prototype"

The data product specification (proposal) shall be prepared in the following format including the data list to be organized and prepared.

Data Product Specification (Proposal)

Regarding the function requirement definition (proposal), the function list format (proposal), screen design format (proposal), and report design format (proposal) were reviewed.

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】

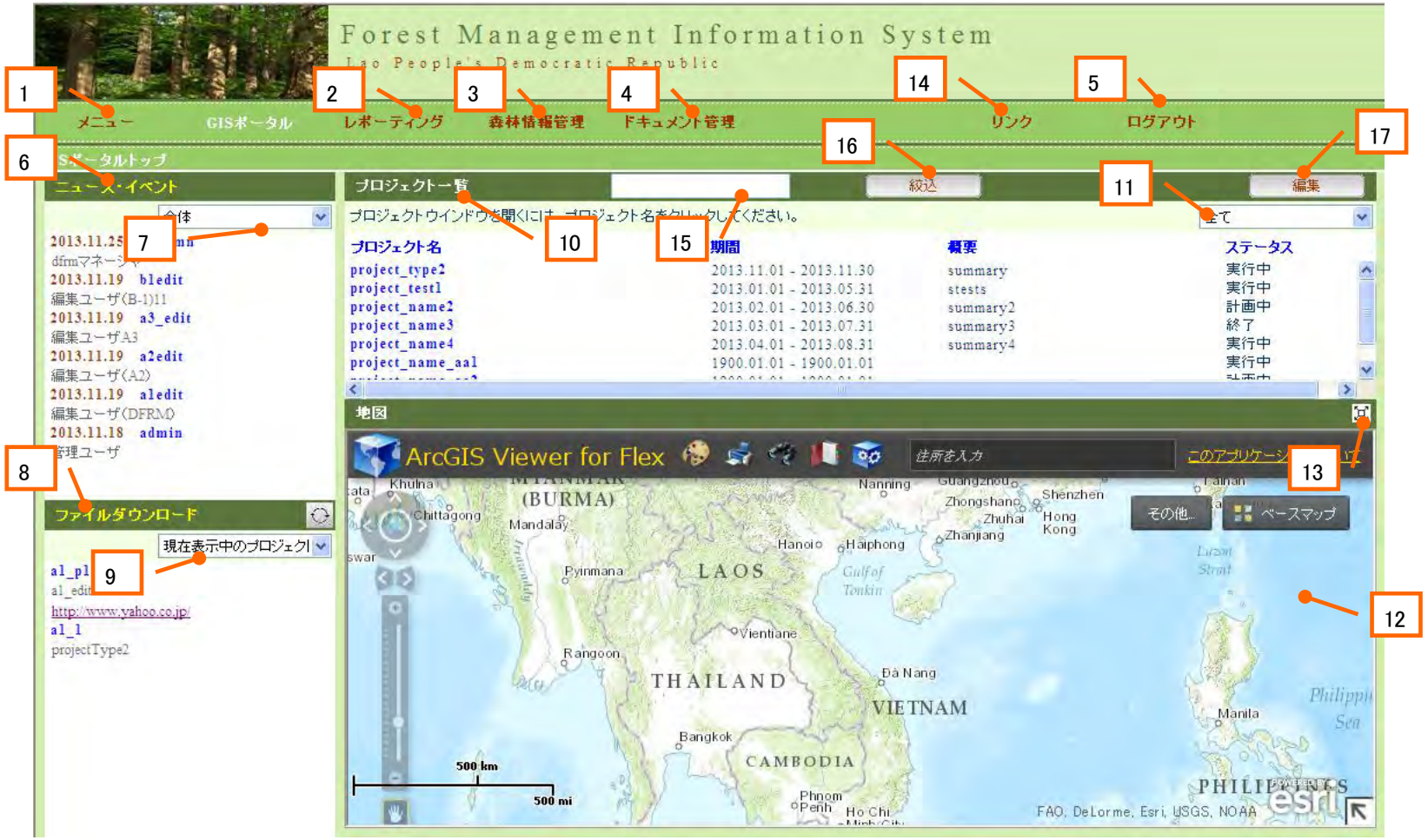
Shape	Scale	Related File	Weight	Color	R	G	B
	※	N/A	※	※	※	※	※

Function List Format (Proposal)

No	Function			Description	Authority	
					Administrator	General user
3	LargeMap					
		(1) Function Selection		Enable selection of a function to be used/Display a list of provinces initially. Have the same layout as the FIMS-Admin screen/Display a province when it is selected.	○	○
			a. Province	Display a list of FMUs of a selected province.	○	○
			b. Concession	Display a list of Concessions of a selected province.	○	○
			c. Proposed Concession	Display a list of proposed Concessions of a selected province.	○	○
			d. Map display function	Indicate that this function is being selected.	○	○
			e. Management function	Open the management function screen.	○	—
		(2) Map display				
			a. Map display function			
			Map display function	Display the map of the FMU of a PNG./Specify a layer to be displayed/Add or delete a layer that can be displayed/Zoom in or out and move the display position/Specify a layer and change the display method (colors, patterns, etc.).	○	○
			b. Legend display			
			Layer display	Display the names of layers being displayed on a map and the legends for them.	○	○
			c. Draw/Edit			
			Draw function	Specify a layer and draw planimetric features. Differentiate between layers that can and cannot be drawn.	○	—
			Attribute edit function	Edit the attributes of a planimetric feature after drawing it. Edit the attributes of a planimetric feature after selecting it on a map. Automatically acquire the values of "Area" attribute.	○	—
			Graphic edit function	Edit the graphic of a planimetric feature after selecting it on a map.	○	—
			d. Import function	Import to replace a layer that can be drawn.	○	—
			e. Print function			
			Copy function	Copy a map being displayed to the clipboard.	○	○
			Preview function	Display the print preview of a map being displayed. The preview shall also display legends.	○	○

No	Function				Description	Authority	
						Administrator	General user
				Print function	Print a map being displayed. The print result shall also include legends.	○	○
			f.	Calculation function	After editing a planimetric feature, recalculate the area and reflect the result on the Province, Concession, and Proposed Concession.	○	—

Screen Design Format (Proposal)


Forest Management Information System
Lao People's Democratic Republic
メニュー
GISポータル
レポーティング
森林情報管理
ドキュメント管理
リンク
ログアウト
GISポータルトップ
ニュース・イベント
プロジェクト一覧
絞込
編集
プロジェクトウインドウを開くには、プロジェクト名をクリックしてください。
プロジェクト名
期間
概要
ステータス
project_type2 2013.11.01 - 2013.11.30 summary 実行中
project_testl 2013.01.01 - 2013.05.31 stests 実行中
project_name2 2013.02.01 - 2013.06.30 summary2 計画中
project_name3 2013.03.01 - 2013.07.31 summary3 終了
project_name4 2013.04.01 - 2013.08.31 summary4 実行中
project_name_aal 1900.01.01 - 1900.01.01 実行中
地図
ArcGIS Viewer for Flex
住所を入力
その他...
ベースマップ
ファイルダウンロード
現在表示中のプロジェクト
http://www.yahoo.co.jp/
a1_1
projectType2
MYANMAR (BURMA)
LAOS
THAILAND
VIETNAM
CAMBODIA
Khulna
Chittagong
Mandalay
Pyinmana
Hanoi
Haiphong
Nanning
Guangzhou
Shenzhen
Zhongshang
Zhuhai
Hong Kong
Zhanjiang
Rangoon
Vientiane
Bà Nang
Bangkok
Manila
Gulf of Tonkin
Luzon Strait
Philippine Sea
500 km
500 mi
FAO, DeLorme, Esri, USGS, NOAA
esri
1
2
3
4
5
6
7
8
9
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17

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	-	-

Report Design Format (Proposal)

FIM - Forest Inventory and Mapping

2

National Change Summary - by Forest Type and Province

1

16

Print out: 24-Apr-2013

Last update: 23-Apr-2013

North Solomons

Forest Type			Resource As at 1975			Change 1975 - Current			Current Resource		
Code	F	Description	Forest Area (ha)		Gross Vol (cu m)	Logged Over Area (ha) (b)	Converted to Land Use		Forest Area (ha)		Gross Vol (cu m)
			Gross (a)	Adjusted			Logged (ha) (c)	Cleared (ha) (d)	Gross (e)	Adjusted	
3	4	5									
Po/Wsw/Gs	☐	Open forest/Swamp woodland/Swamp grassland	6 3,239	7 2,105	8 52,625	9 0	10 0	11 0	12 3,239	13 2,105	14 52,625
ScBc/L	☐	Scrub with Bambusa and Cyathea/Small crowned forest	22,855	6,623	165,575	0	0	0	22,855	6,623	165,575
Province Totals			**26,094**	**8,728**	**218,200**	**0**	**0**	**0**	**26,094**	**8,728**	**218,200**

Western

Forest Type			Resource As at 1975			Change 1975 - Current			Current Resource		
Code	F	Description	Forest Area (ha)		Gross Vol (cu m)	Logged Over Area (ha) (b)	Converted to Land Use		Forest Area (ha)		Gross Vol (cu m)
			Gross (a)	Adjusted			Logged (ha) (c)	Cleared (ha) (d)	Gross (e)	Adjusted	
D	☑	Dry evergreen forest	269,160	267,824	6,695,600	18	0	0	269,142	267,815	6,695,375
D/Fsw	☑	Dry evergreen forest/Mixed swamp forest	142,297	141,885	3,547,125	48,293	0	3,295	90,709	90,446	2,261,150
Province Totals			**411,457**	**409,709**	**10,242,725**	**48,311**	**0**	**3,295**	**359,851**	**358,261**	**8,956,525**
National Totals			**437,551**	**418,437**	**10,460,925**	**48,311**	**0**	**3,295**	**385,945**	**366,989**	**9,174,725**

Adjusted Forest Area = Gross Forest Area, less area of disturbance and the non-forest proportion of FMU's mapped as complexes

Current Gross Forest Area = Gross Forest Area in 1975, less areas of Logged Over or Converted to Land Use between 1975 and current date

(e) = (a) - (b) - (c) - (d)

15 Page 1 of 1

No	Part	Data	Digit number	memo
1	Page Header	sysdate	10	Print Date
2	Page Header	qry_rpt_National_Change_ForestType_ByProv.ProvinceName	15	
16	Page Header	ctrl_LastCalclationDate. CalcDate	10	Calculation Date
3	Detail	qry_rpt_National_Change_ForestType_ByProv.Forest_Type_No_Dist	15	
4	Detail	qry_rpt_National_Change_ForestType_ByProv.FirstOfFragile_Forest_Type	1	
5	Detail	qry_rpt_National_Change_ForestType_ByProv.Dscription	250	
6	Detail	IIf(Not IsNull([SumOfGross_Forest_Area_75]),CLng([SumOfGross_Forest_Area_75]),0)	18	Summary to Report Footer
7	Detail	IIf(NotIsNull([SumOfAdjusted_Forest_Area_75]), CLng([SumOfAdjusted_Forest_Area_75]),0)	18	Summary to Report Footer
8	Detail	IIf(Not IsNull([SumOfGross_Forest_Vol_75]),CLng([SumOfGross_Forest_Vol_75]),0)	18	Summary to Report Footer
9	Detail	IIf(NotIsNull([SumOfLogged_NotLandUse_Current]), CLng([SumOfLogged_NotLandUse_Current]),0)	18	Summary to Report Footer
10	Detail	IIf(NotIsNull([SumOfLogged_LandUse_Current]), CLng([SumOfLogged_LandUse_Current]),0)	18	Summary to Report Footer
11	Detail	IIf(NotIsNull([SumOfLandUse_NotLogged_Current]), CLng([SumOfLandUse_NotLogged_Current]),0)	18	Summary to Report Footer
12	Detail	IIf(NotIsNull([SumOfRev_Gross_Forest_Area]),CLng([SumOfRev_Gross_Forest_Area]),0)	18	Summary to Report Footer
13	Detail	IIf(NotIsNull([SumOfRev_Adjusted_Forest_Area]), CLng([SumOfRev_Adjusted_Forest_Area]),0)	18	Summary to Report Footer
14	Detail	IIf(Not IsNull([SumOfRev_Gross_Forest_Vol]),CLng([SumOfRev_Gross_Forest_Vol]),0)	18	Summary to Report Footer
15	Page Footer			Current Page No / Total Page No

3.4 Output 3

3.4.1 Result of 1st NFi reviwing

During the 1st Phase, collection and analysis of data/information,action of the 1st NFI (1991-99), Design of Forest Resource Assessment (FRA) by SUFORD (2010), Nation-wide inventory of FIM and Forest Biomass Survey in Houaphane Province by CliPAD was conducted. Among these, SUFORD FRA proposes a tract and plot design, which is slightly modified version of NFI's, but doesn't propose concrete methods including number of tracts/plots and survey items, therefore it is not analyzed further.

The objectives, target area, survey items are compiled in Table 3-55 below.

Table 3-55 Objectives, Target areas and Survey Items of 1st NFI, FIM and CliPAD

	1st NFI	FIM	CliPAD
Objectives	- Estimate of growing stock - Development of volume functions - Revision of forest definitions if found necessary	- Estimate of forest carbon stock - Reference for forest type map	Forest biomass survey for VCS JNR certification
Target area	Nation wide (Only accessible areas)	Nation wide (Only easily accessible areas)	2 Districts in Houaphane Province
Implementation Year	1991-1999	2011-2012	2014
Number of plots	Forest : 2368 Non-forest : 1696	Forest : 1680 Non-forest : 720	
Plot design and shape			
Single plots			
Cluster plots	**X**	**X**	**X**
Nested plots		X	X
Circular plots		X	
Rectangular plots	X		X
Forest classification	X	X	X
Photographs		X	X
Living trees	**X**	**X**	**X**

DBH	X	X	X
Diameters at middle and top of bole	X		
Tree height	X	X	
Tree quality	X	X	
Population of saplings	X	X	
Canopy density	X	X	X
Non-forest class	X	X	X
Forest structure	X	X	
Speices (local name)	X	X	X
Species (Scientific name)			
Slope	X	X	X
Deciduousness			X
Leaf fall index			X
Stumps	**X**		**X**
Diameter	X		X
Height	X		X
Non-tree vegetation			
Fresh mass			
Dry mass			
Standing dead trees			**X**
DBH			X
Height			X
Lying Dead Wood			**X**
Diameter			X
Density			
Decomposition class			X
Litter			
Fresh mass			
Dry mass			
Soil	**X**		
Soil type	X		
Bulk density			
Organic carbon content			

NTFP	**X**		
Rattan	X		
Bamboo	X		
Hauling	**X**		
Hauling distance to road	X		
Slope of hauling route	X		

Source

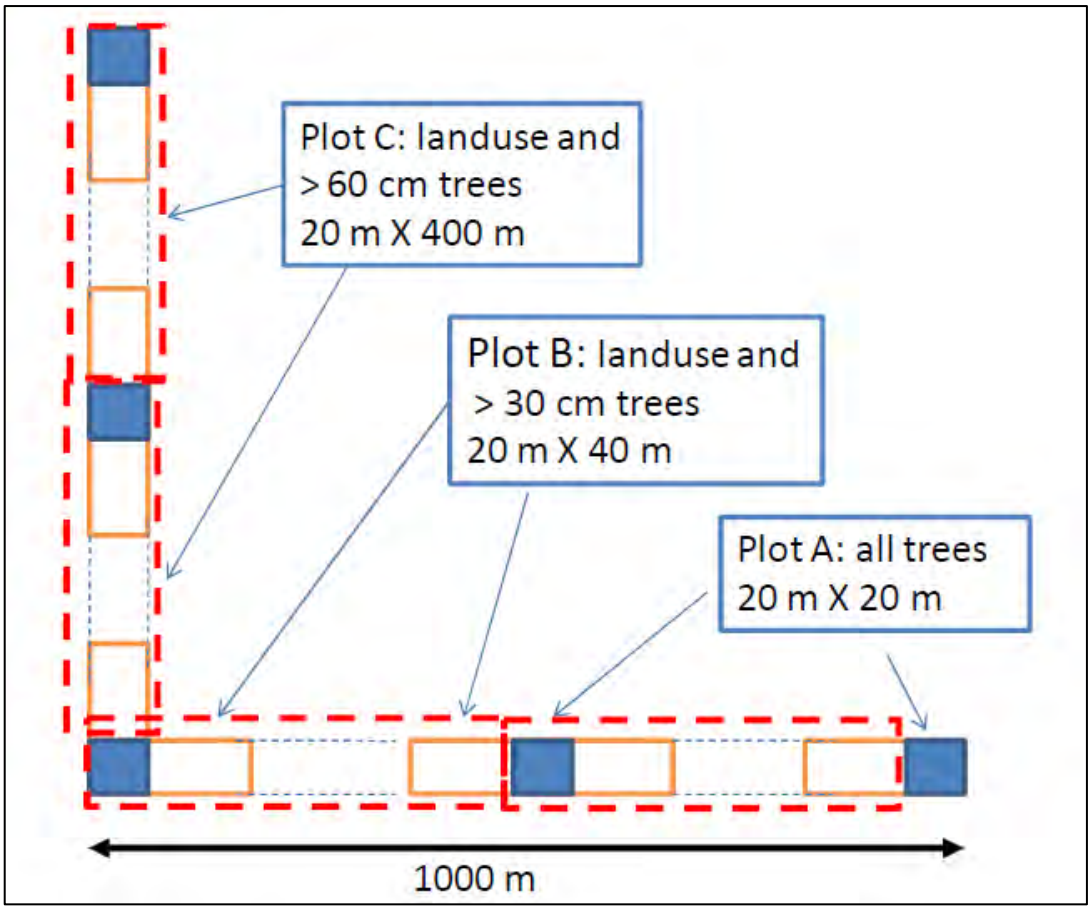
1st NFI: Lao National Forest Inventory Field Manual 1993/94, DOF

FIM: Guideline on National Forest Inventory Survey for Satellite Image Classification Analysis, Jul 2012, JICS/FIPD/Kokusai Kogyo

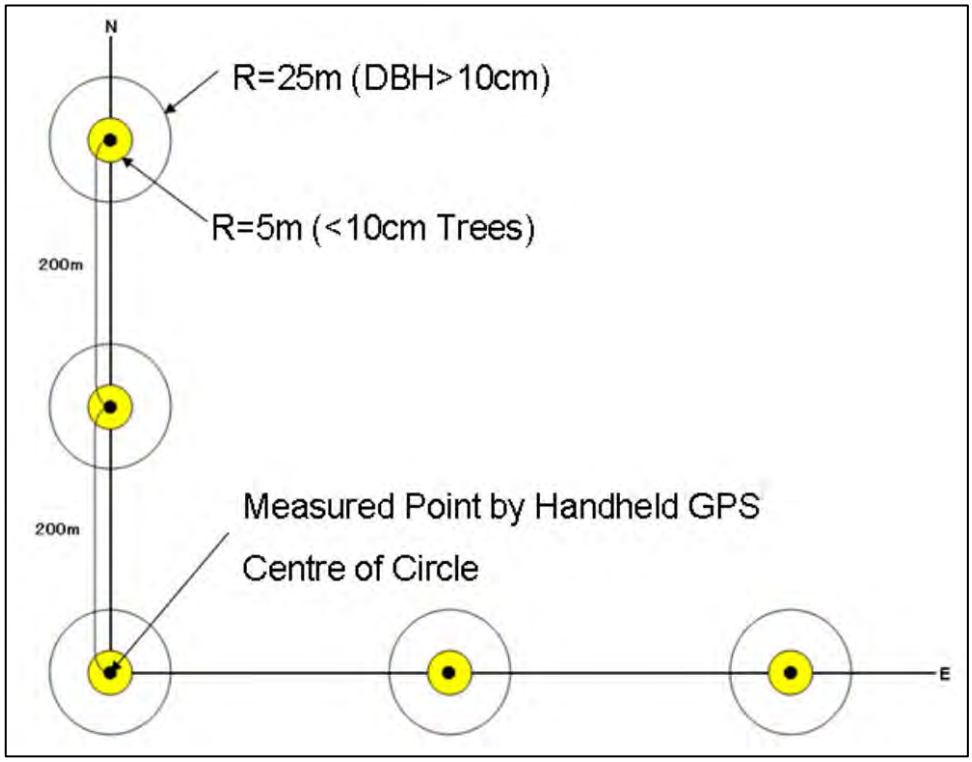
CliPAD; Proposed National Carbon Assessment Standard Operating Procedures submitted by Felipe Casarim, Gabriel Eickhoff, Timothy Pearson and Sandra Brown, Sep 2013

Design of tract (cluster plots) of each survey is as follows.

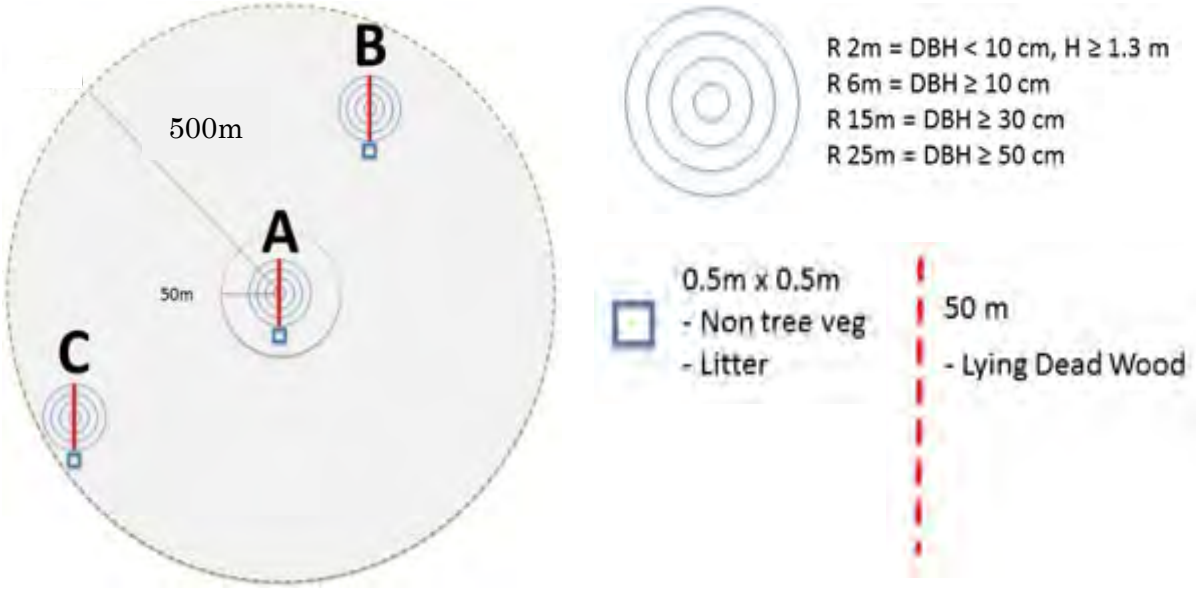
1st NFI



FIM



CliPAD



The 1st NFI's objective was mainly to assess the resource situation of wood and major NTFP for commercial harvest planning, and the survey items clearly reflect this objective. On the other hand, CliPAD survey focuses on estimate of biomass/carbon of 3 pools i.e AGB, dead tree and litter out of the 5 pools defined in IPCC guidelines. Its plot design is the one proposed by SUFORD FRA design and it is said that by using laser distance measurement equipments plot boundary setting by

rope is not necessary and much more efficient than the conventional method. FIM is the only survey among these which uses circulr cluster plots and plot setting is easier than rectangular ones by use of sound distance measurement equipments. These modern distance measurement equipment can easily judge whether trees on plot borders are in for measurement or out for no-measurement.

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 1st NFI. FIM measured one tract per day on average.

The list of data and reports

At the same time as the review above, the data and report of the past and current projects were listed up (Annex 11). The information of the list was shared with C/P and additional materials were collected and updated.

Provision of Data from Inventory Survey Projects

A request was made for the provision of similar survey data from the SN-REDD and PAREDD+ projects. SN-REDD outputs including reports and raw survey data were to be shared initially at the end of January and then after the modified agreement at the end of April, but as of July 2015 no outputs have been provided. If the outputs are shared before implementation of the next NFI, they will be used in the design of the manuals and other survey tools. The final outputs of PAREDD+ were shared through JICA.

3.4.2 Study of Next National Forest Inventory Survey Methods (Sampling method, plot design, survey items, etc.)

The next NFI survey methods were compiled based on a review of past and ongoing projects and a certain level of agreement was obtained following discussions with the C/P. The outputs were compiled for each of the following items.

Creation of Survey Item Options

In order to discuss and decide the NFI survey purposes with the C/P, the following list of survey item options was created (Table 3-56). The various purposes of the NFI include grasping the carbon stock and growing stock and investigating non-timber forest products. The survey items will change according to the purpose. Which survey items are used for which purpose can be grasped from the Table 3-56 below. The survey items used in the first NFI, FIM, CliPAD and PFA

(Production Forest Area) are shown as reference information.

Table 3-56 Survey Item Option

Priority Parameter? (H,M,L,U)	Parameter	Purpose						Other Studies			
		Carbon	Timber Volume	NTFP resources	Land Degradation / Forest health	Forest Composition	Tree Growth Rate	1st NFI	FIM	CLIPAD	Production Forest Area Inventory
	Sample point distribution										
	Systematic							X			
	Random								X		X
☆	Two-stage systematic random									X	
	Post-stratification							X			X
☆	Pre-stratification								X	X	
☆	Permanent plots										
☆	Temporary plots							X	X	X	
	Sample point type										
	Single plots										
☆	Cluster plots, nested							X	X	X	
	Transect of plots, nested										X
☆	Circular plots								X	X	
	Rectangular plots							X			X
	Sampling Information										
	# Team members							8	6	3	X
	Time to walk to plot							40 hrs	1 day	1 day	
	Time to complete each carbon pool										

Priority Parameter? (H,M,L,U)	Parameter	Purpose						Other Studies			
		Carbon	Timber Volume	NTFP resources	Land Degradation / Forest health	Forest Composition	Tree Growth Rate	1st NFI	FIM	CLIPAD	Forest Area Production Inventory
	Costs of transport										
	Costs of fieldwork										
	Equipment used										
	Sample point information										
	Land Cover	X	X		X	X	X			X	X
	Land Use	X			X	X	X			X	X
	Photographs							X	X	X	
	Slope	X	X		X						X
	Slope Aspect				X						X
	Topographic position of plot							X			
	Surface topography class							X			
	LU evidence				X						
	Grazing				X						
	Fire				X						
	Logging				X						
	Logging evidence class							X			
	NTFP collection				X						X
	Stand Damage evidence class		X		X	X		X			
	Erosion, soil conditions				X						
	Canopy density				X	X		X	X	X	X
	Deciduousness				X	X				X	
	Leaf fall index				X	X				X	

Priority Parameter? (H,M,L,U)	Parameter	Purpose						Other Studies			
		Carbon	Timber Volume	NTFP resources	Land Degradation / Forest health	Forest Composition	Tree Growth Rate	1st NFI	FIM	CLIPAD	Forest Area Production Inventory
	Forest Structure							X	X	X	
	Hauling distance from road		X					X			
	Hauling route		X					X			
	Epiphytes										
	main species				X	X					X
	Prevalence				X	X					X
	Evidence of wildlife class				X	X					X
	Evidence of 'Indicator' Species				X	X					
	Trees										
	Species	X	X			X		X	X	X	X
	DBH	X	X				X	X	X	X	X
	H		X					X	X		X
	Buttress H	X	X					X			
	Bole H		X								X
	Bole length		X								
	Bole condition		X		X	X					
	Crown condition				X	X					
	Disease				X	X	X				
	Tree quality class		X					X	X		X
	Palms										

Priority Parameter? (H,M,L,U)	Parameter	Purpose						Other Studies			
		Carbon	Timber Volume	NTFP resources	Land Degradation / Forest health	Forest Composition	Tree Growth Rate	1st NFI	FIM	CLIPAD	Forest Area Production Inventory
	Species	X		X	X			X	X	X	
	Height	X		X	X	X		X	X	X	
	Saplings										
	Number	X	X				X	X	X	X	X
	Species					X					
	Seedlings										
	Number	X	X				X				X
	Species					X					
	Bamboo										
	# culms, by age			X	X	X		X		X	X
	Species			X	X	X		X		X	X
	Rattan										
	# clumps			X	X	X		X			X
	# solitary			X	X	X		X			X
	estimate of natural regeneration potential			X							X
	Berberine, Kheua Haem										
	# plants			X							X
	estimate of kg			X							X
	Cardamom, Mak Naeng										X
	# young plants			X							
	# mature plants			X							
	Malva Nut, Mak Chong										
	# trees			X							X
	fruit production category			X							X

Priority Parameter? (H,M,L,U)	Parameter	Purpose							Other Studies			
		Carbon	Timber Volume	NTFP resources	Land Degradation / Forest health	Forest Composition	Tree Growth Rate		1st NFI	FIM	CLIPAD	Production Forest Area Inventory
	Lianas											
	species composition				X	X						X
	DBH	X										X
	Shrubs											
	prevalence class				X	X			X			
	species comp?				X	X						
	wet mass	X										
	sub-sample for dry mass											
	Non-woody veg											
	species comp?				X	X					X	
	wet mass										X	
	sub-sample for dry mass										X	
	Standing deadwood (including stumps)	X			X							
	DBH										X	
	Top diameter								X		X	
	Height								X		X	
	Lying Deadwood	X			X						X	
	Litter	X			X							
	wet mass										X	
	sub-sample for dry mass										X	
	Soil											
	bulk density	X			X							
	Carbon	X			X							
	Type				X				X			X

Agreement of National Forest Inventory Purposes and Survey Items

Two technical workshops were held with the C/P based on the above-mentioned created materials as well as the results of past and present inventory surveys analyzed so far. As the C/P participated from the process of designing the NFI survey method, they were encouraged to consider anew the purposes and meaning of the survey items, and at the same time strong emphasis was placed on getting them to understand the process of deciding the detailed content. A summary of the technical workshops is given below.

	Date	Place	Participants	Content
First Workshop	9/25/2014	FIPD Training Room	Mr. Linthong KHAMDY, Director, FIPD Mr. Soukanh Sanontry, DDG,FIPD Mr. Bounpheng VICHITH, DDG, FIPD Approx. 8 members of FIPD Forest Inventory and Planning Division Group members and subcontractors' engineers	Mainly lectures on NFI purposes, cases in other countries, cases in Lao PDR, candidate survey items, demands of international society, stratification and sampling design.
Second Workshop	10/10/2014	FIPD Training Room	Mr. Khamphay MANIVONG, Deputy DG, DOF Mr. Somchay SANONTRY, Deputy DG, DOF Mr. Linthong KHAMDY, Director, FIPD Mr. Soukanh Sanontry, DDG,FIPD Mr. Bounpheng VICHITH, DDG, FIPD Group members and subcontractors' engineers	Lectures on survey purposes, survey items, survey frequency, implementation system and plot design based on the first technical workshop.

The decisions reached during the second workshop were recorded in the minutes signed by Mr. Khamphay, Deputy Director General of DOF. The next NFI survey items (draft) and implementation system (draft) will be designed based on the decisions contained therein. A summary of the decisions is given below. For details, refer to Annex 2-3.

Table 3-57 Decisions on Next NFI

Item	Main Decisions
Purposes of NFI	• The focus of the next NFI will be on grasping carbon and biomass volume • The number of plots should differ for the three forest types (protected forest, conservation forest and forest reserve) • It is enough just to investigate whether NTFP exists or not • As no expansion factors were developed for calculating the trunk volume of some of the main tree species in the first NFI, they will be developed in the biomass survey (allometric equation development survey) planned in the current fiscal year
Land coverage targeted in NFI	• Forest types and forest definitions should be formally established at the earliest possible stage
Plot design	• Basically, systematic random, pre-stratification plot design is adopted
Plot type	• Mainly temporary plots are established • A few permanent plots are also established to grasp the amount of growth
Survey frequency (period)	• Leaving aside financial feasibility, the NFI survey should be implemented for one year (as the land cover changes quickly in Lao PDR). However, depending on the survey items, the permissible range of implementation is 2-3 years. The shorter the period, the better.

Creation of Draft Manual

The next NFI manual (draft) and forest carbon sampling guidance document were created prior to the inventory pilot survey, based on past surveys and items agreed with the C/P. For the details, see Annex 10 and 11. The annex versions, however, reflect the results of the pilot survey mentioned in Section 3.4.4. Only the list of contents (draft) is shown on the next page.

No mention is made in Table 3-57 above, but it was agreed with the C/P that in the next NFI, the survey will use tablets instead of recording on paper in the survey field log. The manual is created on the premise that tablets will be used.

—Lao PDR National Forest Inventory Standard Operating Procedures (SOP) Manual for Terrestrial Carbon Measurement_July 2015 Version

CONTENTS

—National Forest Inventory for Forest Carbon Sampling – Guidance Document

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3.4.3 Study of Next National Forest Inventory Implementation System

The implementation system for the next national inventory was discussed in the second technical workshop (held on 10 October 2014) described in Section 3.4.2. The allocation of roles shown in the table below was confirmed with the C/P.

Table 3-58: **Summary of Next National Forest Inventory Implementation System (Allocation of roles)**

	National	Provincial	District	Local
Key Task				
Sampling desing	×			
SOP mannual creation	×			
Preparing training material	×			
Implementation of training	×			
Implementation of field survey		×	×	×
Reporting of field survey result		×	×	
Input of survey sata to data base		×	×	
Data analysis	×			
Creation of Report	×			

The above is a general framework for the sharing of roles. In subsequent discussions it was decided that PAFO, DAFO, PONRE and DONRE staff will also be included in the survey structure, centered on FIPD. It was also confirmed in the final briefing session that the Forest Inventory Division of DFRM will also be involved in the survey for the next NFI.

The NFI Steering Committee will be established before the next NFI is conducted, and the purposes, methods and structure of the survey will be approved. Furthermore, the permits required for implementing the survey will be made widely known to the related ministries and agencies to ensure smooth implementation of the survey.

3.4.4 Summary of Inventory Pilot Survey

An overview of the pilot survey and the results are shown in the table below. For details, see Annex 12.

Overview

Items	Detail
Purpose	- To examine efficiency and accuracy of the survey method specified in the next NFI manualdraft - To grasp average carbon biomass and Standard deviation for the each targeted three forest type - To grasp the average time required for a plot - To verify the plot designing (L type or Floating tye)

	- To suggest the improvement for the next NFI
Survey area	Khammuane Province, whole area
Forest type of survey area	- Dry Dipterocarp - Mixed Deciduous Forest - Evergreen Forest
Time schedule	- 2015. Jan – Mar: discussion and dicision of the survey method and plot design - Mar 9 – 13: training of FIPD staff - Mar 19 – Apr 7: Field survey - May 1 – 10: analysis of the survey results
Implementation system	- Training and field survey supervision : Forest Carbon (subcontractor) Mr. Morikawa expert - Field survey teams: 3 tems - Member of the tems: FIPD inventory 2 or 3, PAFO 1 or 2, DAFO 1 or 2
Number of targeted survey plots	- 85 Clusters

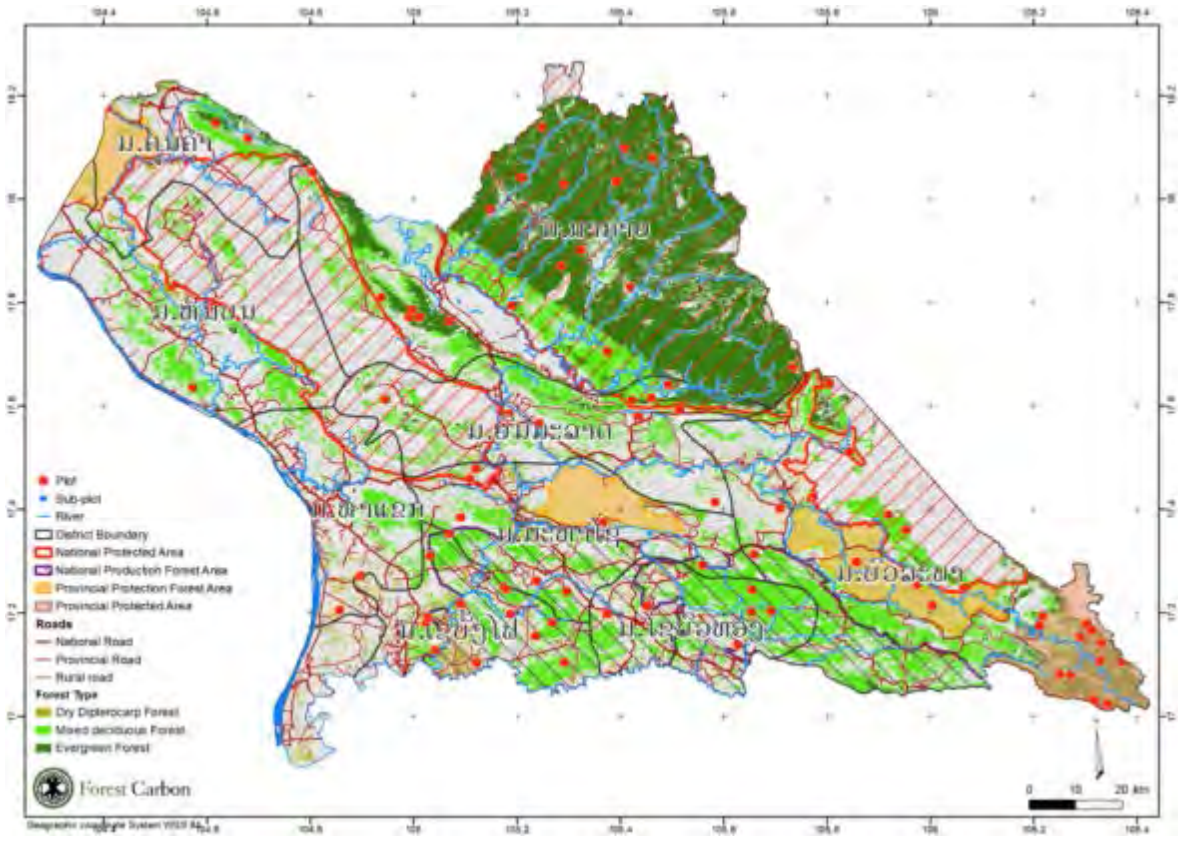


Figure 3-79 Plot position map of the Pilot Survey

Cheking the rout with a tablet

Plot design

Collecting Sample(litter)

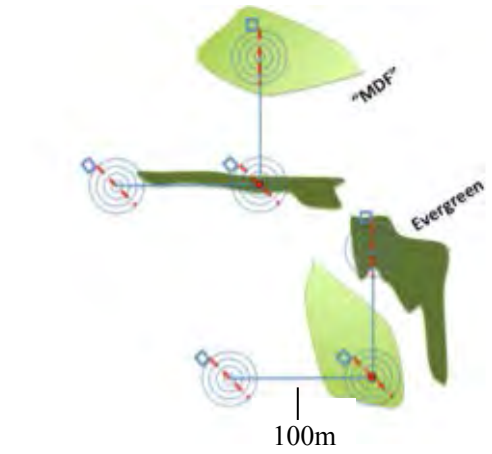
Measurement of the dead wood

Results

(1) Results of Cluster Plot Design Validation (L-shape or Floating)

Before starting the pilot survey, a review was carried out to establish which type of cluster plot design (L-shape (left) or floating (right)) was appropriate for the forest distribution in the target area. The results showed that in Khammuane Province where forest types are found in small patches, with the L-shaped plot design, there were few plots on the same forest type, while many clusters fell outside the survey when arranged at random. Hence, the floating type plot design was adopted for the pilot survey.

For details of the floating type, see Figure 3-80. The plots are arranged randomly on GIS so that Plots B and C fall within the polygon of the same forest type within a range of 50m-300m of Plot A which forms the center point of the cluster.



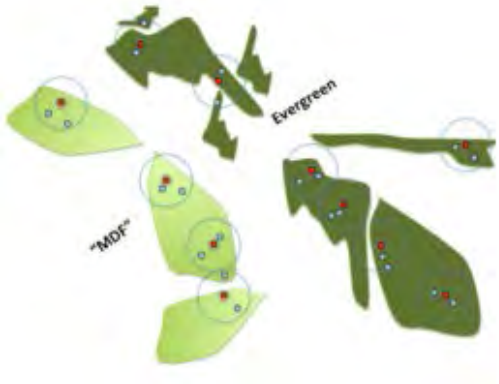


Figure 3-80 Floating Type Cluster Design

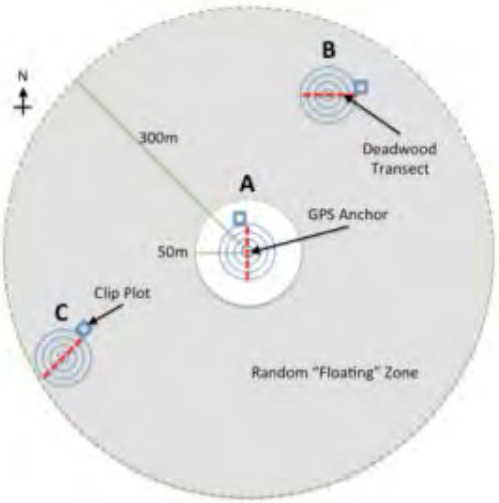


Figure 3-81 Plot design

(2) Results of Survey of Each Forest Type

Figure 3-55: Results of Survey of Each Forest Type shows the carbon stock (tC/ha) for each forest type, standard deviation, number of survey plots, etc. As Lao PDRs' own allometric equation will be completed in June 2016, Chave et al 2005, which is widely used in tropical regions, was used to calculate the carbon stock. Details of the equation are shown below.

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

Where:

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

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

Table 3-59 Results of Survey of Each Forest Type

Strata	Mean tC/ha	Std. Dev	Plots	Max	Min	CI	Uncertainty
Dry Dipterocarp	62.69	21.42	13	18.40	103.31	12.94	21%
Mixed Deciduous	169.24	74.54	33	65.13	344.50	26.43	16%
Evergreen	252.01	61.26	2	208.69	295.33	550.41	218%

※CI:Confidence Interval

As only two plots were surveyed for evergreen forests due to access and time restrictions, few data were obtained. With regard to mixed deciduous forests on the other hand, over 30 plots were surveyed and such forests are thought to be adequate. The average carbon accumulation value (tC/ha) showed no major deviation from the existing results and was deemed appropriate. Based on the fact that the survey was conducted in the province, there is little uncertainty surrounding mixed deciduous forests. The suitability of the plot design to the forests in Lao PDR and the fairly high survey accuracy are considered to be the primary factors.

The carbon stock in each carbon pool of mixed deciduous forests and dry dipterocarp forests is shown in Table 3-60. As living trees account for over 90% of the carbon stock in both forest types and deadwood and bamboo together account for less than 5%, according to the IPCC guidelines these can be ignored. Similar results were obtained in the survey carried out in the CliPAD project in Houaphane Province.

Table 3-60 Biomass of each Carbon Pool

Strata	Plots	Pool	C (tC/ha)	Min	Max	Std Dev	Percent (Chave 2005)
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
		Bamboo	0.44	0	5.91	1.31	0.26
		Deadwood - Trees	1.8	0.99	9.4	2.8	1.07
		Deadwood – Stump	0.18	0.13	0.93	0.24	0.11
		Deadwood - LDW	1.49	0.06	8.32	1.74	0.88
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
		Bamboo	0.59	0.23	6.97	1.92	0.94
		Deadwood - Trees	0.56	2.21	2.53	1.06	0.89
		Deadwood – Stump	0.22	0.1	0.53	0.16	0.36
		Deadwood - LDW	1.21	0.13	4.6	1.37	1.92

Table 3-61 shows the average survey time per cluster plot for each forest type. The survey times vary due to slopes and vegetation density, but on average one cluster survey (three plots) is completed per day for all forest types even when access is included. The precise time required is not recorded, but even when survey permission has been obtained from DOF or DFRM which manage the survey plots, under Lao PDR culture it is still necessary to obtain the permission of the village where the plot is located, and sometimes this process took at least half a day.

Table 3-61 Average survey time of cluster plots for each forest type

Forest Types	Sub Plot Sample Size	Mean time per subplot (minutes)	StdDev
Dry Dipterocarp	35	**16.04**	9.92
Mixed Deciduous Forest	98	**23.23**	11.37

Evergreen Forest	3	**17.78**	2.76

Development of Analysis Tool (R-Script)

The tablets used in the pilot survey are designed so that the entered survey data is automatically uploaded to the server when the tablet is connected to the internet, making it possible to check the survey plots and survey data daily from the capital.

Figure 3-82 Data of the survey plots and the plot information

On the other hand, the survey data were analyzed using Excel as in the past, resulting in human errors in manual operation and a time lag until the analysis results was obtained. So a script was developed in the free statistical analysis software called “R” that enables output of the analysis results (carbon stock per stratum, standard deviation, DBH dissemination, etc.) in 10-15 seconds. See Figure 3-83.

Whenever the NFI manual is revised, the script also needs to be revised, but script-based analysis is expected to be used in the next NFI. As this will not only reduce human error and analysis time but also enable confirmation of daily progress during the survey period, the ability to determine termination of the survey at the point when the required number of survey plots has been obtained will be a major advantage.

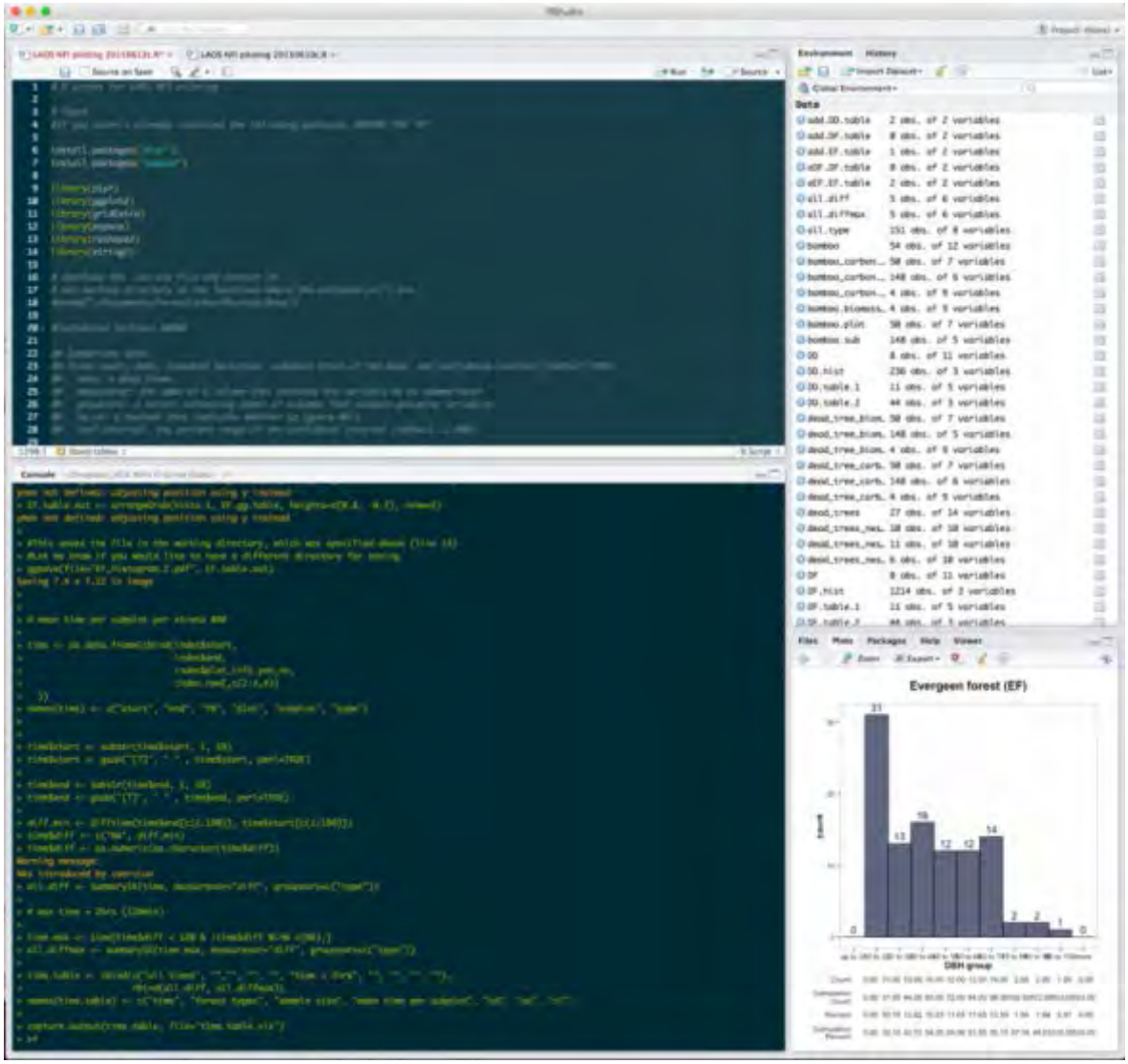


Figure 3-83 Developed R-Script Screen Captures (Analysis results are shown at bottom right)

3.4.4 Final Draft of Next National Forest Inventory Manual

The changes from the manual (draft) created in 3.4.2, based on the above-mentioned pilot survey, are described below.

Plot Design

As the effectiveness of the floating type plot design was verified in Khammuane Province where the pilot survey was conducted and in Houaphane Province where the CliPAD project was implemented, it was decided to use the floating type plot design instead of the L-shape in the next NFI.

Carbon Pools

As described in 3.4.3, the results of the pilot survey and the survey in Houaphane Province led to the conclusion that only a negligible amount of carbon was stocked in deadwood. On the other hand, since the results were only from two provinces, the survey time was very short and carrying out a deadwood survey may be used in future analysis of forest degradation, illegal logging, etc., they will be included in the survey items in the next NFI.

Survey Structure

Following discussions with the C/P, based on the results of the pilot survey, it is expected that the next NFI will be conducted using the following survey structure.

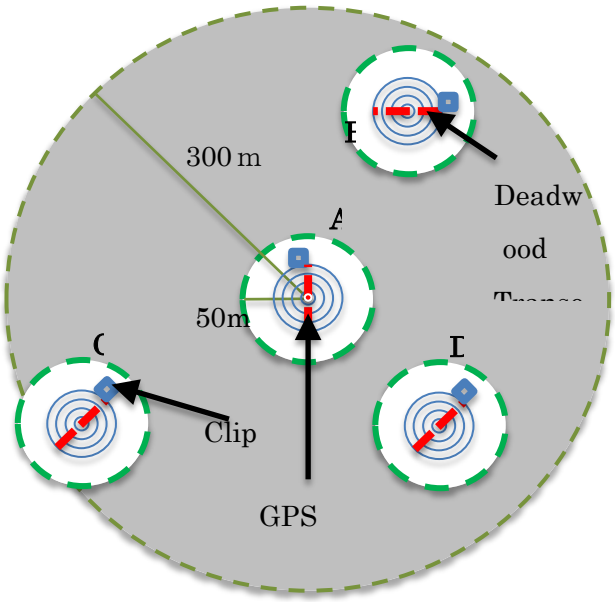
- Team leader/data input (FIPD)
- DBH measurement 1 (FIPD)
- DBH measurement 2 (PONRE or PAFO)
- Deadwood and clip plots (PONRE, PAFO, DONRE or DAFO)
- Others (DONRE, DAFO or local residents)

Collaboration with the DFRM Forest Inventory Division was confirmed with the C/P, but the precise responsibilities need to be reviewed in future.

As described above, paying courtesy visito to local residents prior to entering the survey plot and searching for an access route to the survey plot take a very long time, so moving as an entire team is not efficient. For this reason, the C/P suggested that in the next NFI one or two persons go to the site three days to one week in advance as the advance party and complete the courtesy visit and route development, and this was incorporated into the next NFI manual.

Plot Design

In the pilot survey, in order to handle data per cluster, a rule was established that surveys would be conducted of at least two plots. In the event that both plots happened to be non-forested areas, the team would move on to the next cluster without surveying a third plot. It was also confirmed that, even if a three-plot survey is conducted, some clusters show big variation in data. Therefore, with the aim of increasing the probability of surveys of two or more plots and minimizing variation in data, it was decided to increase the number of plots to four instead of three. It was also confirmed that the plots are located within 300m of the center point and that even when one cluster is surveyed per day, there is 20 or 30 minutes' grace, so increasing the number of plots has little impact on the efficiency of the survey.



Next, the targeted DBH and nest radius in the plots were changed as shown below. It was found that a maximum radius of 20m was adequate for the equipment and DME used in Lao PDR' forests, so the radius was changed from 25m to 20m. The DBH was also changed from the original 15m to ≥ 30cm and from 20m to ≥ 40cm. The data obtained from the pilot survey and the results of the Houaphane survey in the CliPAD project were analyzed and the following changes were made to achieve the most efficient, omission-free plot design as shown below. However, due to the shortage of analysis data, future data to be provided by SUFORD should also be taken into account and the plot design finalized before the next NFI survey is begun.

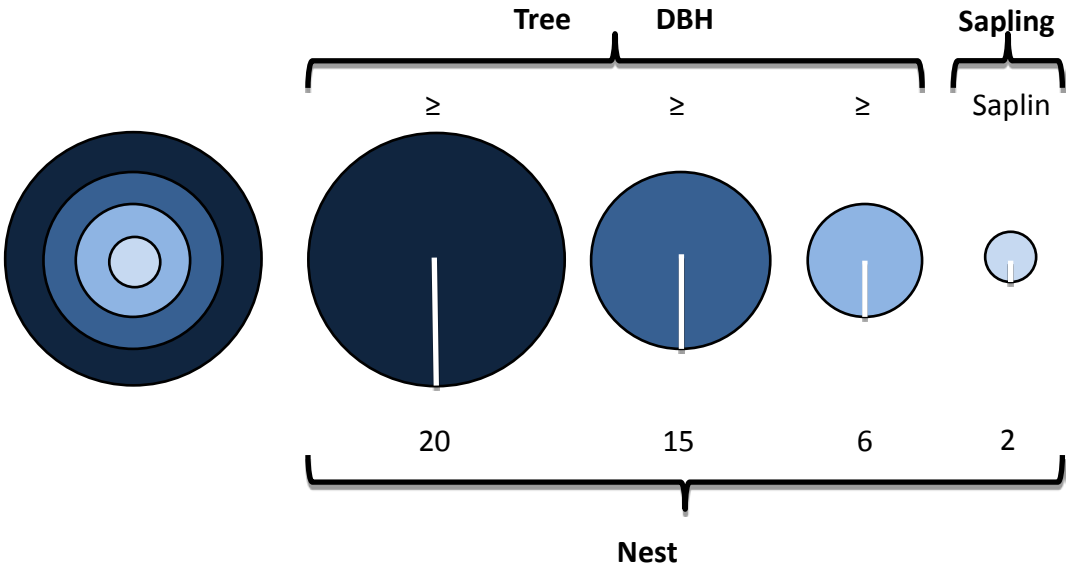


Figure 3-84 Targeted DBH and Nest size

Survey Equipment

The necessary equipment is assumed as listed below. The number of DME was changed from one to two based on the results of the pilot survey. There are two types of clinometer, one for measuring slopes and one for measuring direct height. FIPD owns mostly the latter type and is unable to measure slopes. An adequate number of clinometers should be purchased before the start of the next NFI.

Table 3-62 List of the survey equipment

Equipment	Quantity	Equipment	Quantity
NFI Sampling Coordinator		AA batteries for transponder	many
Tablet w Code	1	9V batter for DME grey box	many
GPS w memory card	1	Clinometer	1/team
AA batteries for GPS	Many	Measuring Tape - 50 m	2/team
Field Sampling Crew		(Biodegradable) Flagging tape	2/team
Machete	2/team	Diameter tape measure	2/team
Whistles	1/person	Work gloves	1/person
First Aid Kit	1/team	Equipment backpacks	3+/team
1.3 m poles	2/team	Small backpack or hipsack	1/person
Durable plastic tarp ~2 m x 2 m	1/team	Sturdy backpacks, bags	2/team
Two-way radios	1/team	Permanent Marker	5/team

Tablet w Code	1	Pens	many
Camera (or use Tablet)	1/team	Pencils	many
GPS w memory	1/team	Erasers	many
GPS Waterproof case	1/GPS	Stapler	1/team
AA batteries for GPS	many	small notebooks	1/person
Bright colored spray paint	many	small notebooks	1/person
DME pole	1/team	Clip board	1/team
DME transponder (yellow piece)	1/team	Compass	1/team
DME distance measuring unit (grey box)	2/team		

Number of Survey Plots in the Next National Forest Inventory

The required number of survey plots was calculated based on the data obtained from the first NFI, Houaphane data from the CliPAD project and Khammuane data from the pilot project. The average carbon stock per stratum, standard deviation and obtained uncertainty were used in the calculation. The precise equation is shown below.

$$number\ of\ plots\ for\ strata\ = (t * \frac{standard\ deviation}{0.10 * x})\text{^}2$$

t = Critical value from a two tail-test with n-1 degrees of freedom, based on target confidence level (e.g. 90%)

A list of the collected data is shown below.

Table 3-63 List of the data for calculation of survey plots

Survey	Stratum Name	Number of Plots Surveyed	Mean AG Tree Carbon (t C ha^{-1})	StandardDeviation (t C ha^{-1})
1st NFI	EF	56	110	50
Khammouane	EF	2	185	31
1st NFI	MD	805	60	41
Houaphan	MD	82	92	63
Khammouane	MD	33	114	51
1st NFI	DD	636	43	26
Khammouane	DD	13	48	16
1st NFI	CF	27	32	26

1st NFI	MCB	74	80	48
1st NFI	RV	102	7	10

Table 3-64 shows the results of calculation of the minimum number of survey plots. The results take into account the fact that as provincial data are used, the standard deviation is lower than at national level and the percentage of conifers in the forest area is low, as noted in Output 1. However, the results are provisional and the number of survey plots is not necessarily deemed to be the optimal number. As described in Chapter 4, it is necessary to collect data from similar projects before starting the survey and to review the required number of survey plots in the next integrated project.

Table 3-64 Required Number of Survey Plots in the Next National Forest Inventory (Provisional)

Strata Level 2	Minimum number of Plots	Error Target
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
MCB	120	<10% Error at 90% CI

3.4.5 Supplementa document

In addition to the Next National Forest Inventory Manual refered in Section 3.4.4, the subsidiary documents and data below were provided to C/P.

- NFI Sampling Guidance document
- Pilot Survey Results Report
- Sample Plot Calculator Excel Tool (to estimate number plots)
- Calculations for Estimating Carbon Stocks Manual
- Statistical software 'R' script to transform field data collected on tablets into analyzed data

Also when finalizing the manual, it is expected that the following document will be provided from the "Sustainable Forest Management and REDD+ Support Project in The LAO PDR".

- Allometric Equation Evaluation Guidance Document

Environmental Program Grant Aid Lao PDR National Forest Conservation Allometric Equation Development Project Report

3.5 Output 4

3.5.1 Investigation of Method of Preparation of REL/RL

Items determined by UNFCCC

Decisions regarding FREL / FRL in UNFCCC are taken at COP 15, 16, 17, and 19, and the following is a summary of these decisions.

Decision 4/COP 15, paragraph 7; Adjustment by taking past data into consideration and the national circumstances

Decision 1/CP 16, paragraph 71(b); Preparation of national FREL/FRL as one of the 4 factors that are necessary for REDD+

Decision 12/CP 17; Forms of FREL/FRL

Paragraph 7: Announcement of annual carbon dioxide stock as the number of tons, as a benchmark for evaluation of the results of implementation of REDD+ activities

Paragraph 8; Ensuring consistency between the quantity of GHG emissions for each source of emissions related to man-made forests in the GHG inventory of each country and the quantity of GHG absorbed for each source of absorption

Paragraph 9; Submission of information and its basis including the national circumstances regarding development of FREL/FRL in accordance with the attached guidelines and its application

Paragraph 10: Higher accuracy data, and improvement in FREL/FRL in stages by adoption of multiple pools, etc.

Paragraph 11; Sub-national FREL/FRL recognized as means for transferring to the national level

Paragraph 12; FREL/FRL should be amended as appropriate taking into consideration new knowledge, trends, review of the scope and methods of FREL/FRL, etc.

Paragraph 13; Request developing countries to submit optionally FREL/FRL (proposed) together with the Article 9 information.

Paragraph 14; Request secretariat requested to publish on the REDD web platform of the UNFCCC the information regarding FREL/FRL including submitted FREL/FRL.

Paragraph 15; Agreement regarding establishing the process of implementation of technical assessment of the submitted FREL/FRL based on guidance prepared by SBSTA

The following is a summary of the guidelines defined in paragraph 9.

The submitted FREL/FRL should be prepared based on the latest IPCC guidelines approved or recommended by COP, and include the following information.

(a) Complete and transparent information including past data used in preparation of FREL/FRL

(b) Transparent, complete, consistent, and correct information including data sets, approaches, methods and methodology, models, assumptions, related measures and plans, etc., used in FREL/FRL development

(c) Pools and greenhouse gases, and REDD+ activities included in the preparation of FREL/FRL. Based on the assumption that important pools and gases should be included, the reasons for excluding pools and gases that are not included.

(d) Definition of forests used in preparation of FREL/FRL. When definitions differ from the definitions used in national GHG inventories or reports to international organizations, an explanation of the reasons and methods of use of these different definitions.

In COP19, the technical assessment guidelines and procedures (including exchange of opinions with the submitting country) is explained (Decision 13/CP.19), but the content of the guidelines is virtually the same as the content decided on at COP17. Specific methods, standards, etc., for preparation of FREL/FRL were not determined, only that the submitting country can modify them in the technical evaluation process, and it is considered that basically the submitted FREL/FRL is the MRV benchmark for results-based payment. However, as can be seen from the following examples, it is considered that there are large differences in the technical accuracy of the submitted FREL/FRL, the national circumstance considerations, etc., and that it is necessary that there be further discussions in the future based on the initiatives at the FCPF fund, etc.

Arrangement and Analysis of Submitted REL/RL

1. Brazil

Region (sub-national): Amazon Biome

The Amazon Biome is the largest of the 6 biomes in Brazil and covers the region of the Amazon River basin. It has an area of about 4.2 million km^2, or about 49.3% of the area of the country. As stated in the following REDD+ activities, the REDD+ activities target only reducing emissions by

minimizing the reduction in forests, so the reduction of forests in the whole area is accounted for (not classified into managed and unmanaged areas in accordance with IPCC Guidelines).

In the second national report of the year 2000, emissions in the LULUCF field accounted for 78% of the total, of which more than half was from the Amazon Biome. Also, the data and classifications used in the preparation of the FREL/FRL were consistent with the GHG inventory of the LULUCF field of the second national report.

REDD+ Activities

"Reduction of emissions by minimizing forest reduction" only

Carbon Pools

AGB, BGB, and Litter

Measurement of AD and EF

(1) Activity Data

Since 1996 the newly cleared area of the whole region has been measured every year mainly by Landsat (minimum polygon area 6.25 ha).

(2) Emission Factor

There are 22 forest types in the area, and the region has been classified into 22 regions as a result of forest surveys carried out between 1970 to 1985. For 9 of the forest types and regions that were the subject of the forest surveys, the average AGB biomass stock was estimated from allometric equations with the diameter at breast height (5 cm or more) as an independent variable. The BGB and litter as a percentage of the AGB calculated based on other surveys were added, from which the tree AGB+BGB + litter B, as well as the carbon stock and carbon dioxide stock were estimated.

The biomass stock of palm tree vegetation and climbing plants was added along with that of timbers based on survey results. For the biomass stock for surveyed forest types in regions that were not surveyed, the average carbon stock for each forest type was calculated by interpolation or extrapolation for surveyed vegetation regions, and from existing documentation for forest types that were not surveyed (the surveyed forest types have the greater biomass stock).

(3) Use of Carbon Maps

Based on the results of (2), carbon maps were prepared classified according to the average carbon stock per unit area for the Amazon region, and the amount of carbon emissions for that year were automatically calculated using GIS from the location and area of newly cleared areas in section 4.1.

FREL

(1) Reference period and method

The method used was that the reference period was taken from 1996 when area data started to be taken, and the average of the past data was taken to be the FREL/FRL for the following 5 year period.

(2) FREL/FRL (annual average)

The first FREL/FRL (2006－2010) was the average of the past data for 1996 to 2005 or about 1,106 million tCO_2

The second FREL/FRL (2011－2015) was the average of the past data for 1996－2010 or about 908 million tCO_2

(3) Policy incentive target stock (credit stock; 2006-2010)

The annual average amount of emissions from 2006 to 2010 was already measured as about 512 million tCO_2, so the amount of credits obtained as the difference from the FREL/FRL was an annual average of 594 million tCO_2. Assuming a price of \$1/tCO_2, this amounts to \$594 million or about \$3 billion over 5 years, or about 1/3 of the about \$9 billion declared as contributed to the GCF.

Note: The GCF fund is not only used for REDD+ payment. Also the contribution target is \$100 billion annually.

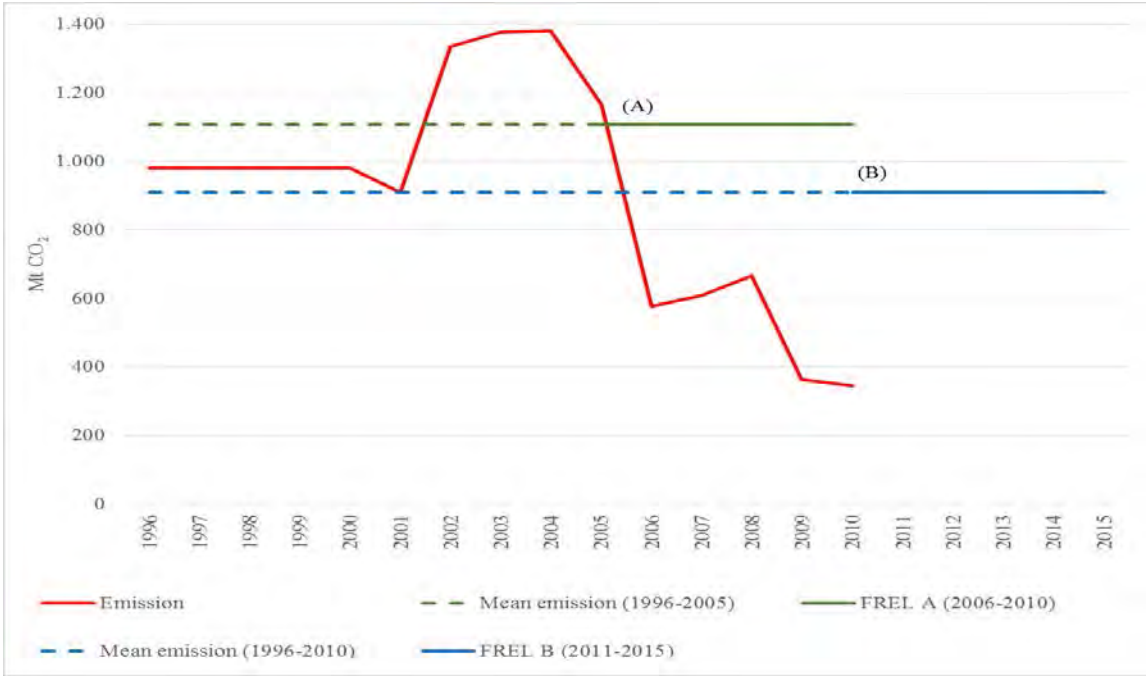


Figure 3-85 The past CO_2 emmision amount and the REL of Brazil

Source; Brazil's submission of a forest reference emission level for deforestation in the Amazon biome for results-based payments for REDD+ under the UNFCCC

Comments

Points in common with the Amazon Fund

The measured area of forest reduction, the FREL/FRL setting method, and the calculation of amount of credits, etc., are virtually the same as the Amazon Fund, apart from the carbon stock per unit area, and it can be said that the existing data has been converted for submission to UNFCCC. Payment of large amounts to the Amazon Fund based on the same FREL has been carried out by Norway and others. These payments are not associated with a transfer of emission rights, so results-based payment can be received institutionally from UNFCCC for a similar reduction in emissions. However it is considered that there is a possibility that duplicating a large amount of results-based payment would be viewed as a problem by countries without a system such as the Amazon Fund.

Carbon Stock per Unit Area

The carbon stock per ha (EF) is used consistently based on surveys from more than 30 years ago, but during this period degradation (reduction of EF) due to clearing, etc., has not been taken into consideration, so there is a possibility that in recent years the amount of emissions and resulting amount of credits have been over calculated. Note that because only forest reduction is included, it is considered that this can also be understood to include the amount of emissions associated with degradation by clearing, etc. Also, it is considered that in MRV it is necessary to investigate the displacement of emissions due to expansion of clearing, etc., in other regions by minimization of forest reduction.

Carbon Stock of Diverted Areas

The carbon stock in the diverted areas after clearing (soya plantations, pasture land, etc.) is not accounted for, and the total amount of emissions = net amount of emissions, so it is said that the amount of emissions is over calculated. Also, the reason that it is not accounted for is not stated.

Reference Period and FREL/FRL Preparation Method

The average amount of emissions from 1996 is taken to be the FREL/FRL, but it is not explained whether or not the drivers for reduction 20 years ago are the same as today, and it is possible that this can be interpreted as a method of producing an excessive amount of credits.

Comparison and points of reference with Brazil's FREL/FRL

Table 3-65 FREL/REL Comparison between Brazil and Lao

Item	Brazil	Lao PDR
Target region	Amazon Biome in this case (to be expanded to national level in the future)	The whole country (it is possible to classify FREL/FRL regions according to differences in forest carbon change trends and their drivers)
Reference period	From 1996 to 2005	From 2000 to 2015
Reference data frequency	Annually	Every 5 years
AD	Newly cleared areas determined yearly mainly by Landsat.	Amount of change determined every 5 years by Landsat in 2000, by SPOT4 in 2005, and by Rapideye in 2010 and 2015, each with different resolution (the 2010 forest maps are the base maps)
EF	EF obtained by converting 1970s to 1980s survey data using an allometric equation used for the reference period and for preparation of FREL/FRL.	Converted into carbon stock using an allometric equation in accordance with stratification of forest survey data for the 2 points of the 1990s and 2018-2018.
Target REDD+ activities	Reduction in emissions due to reduction in forest reduction from the AD estimation method only (methods of including degradation, etc., in the future are being investigated)	From the AD and EF estimation method it is possible to estimate any of the reduction, degradation, increase, and net change. Determined based on the FREL/FRL estimation method, likely amount of credits, etc.
Monitoring frequency	AD is monitored annually	AD is monitored every 5 years (First monitoring to be carried out in 2020)
FREL/FRL preparation method and period	(1) Average amount of emissions due to the reduction from 1996 (2) 2006-2010 is the first FREL/FRL preparation period,	(1) Determined after trials (Average and trends, etc.) (2) Likely to be in the 5 year period from 2016 to 2020.

	2011-2015 is the second period.	
Consistency with GHG inventory	Consistent with the GHG inventory in the second national report (as of year 2000)	The GHG inventory in the second national report is in accordance with the 1996 IPCC guidelines, so it does not have area data, etc.

Table 3-66 Consistency with the main evaluation items of the Technical Evaluation Guidelines for FREL/FRL by UNFCCC

Evaluation item	Brazil	Lao PDR
Consistency with GHG inventory	Said to be consistent (not confirmed in this Project)	The second national report does not contain area data, etc., so it is necessary to prepare the GHG inventory for the next national report or the biannual report in accordance with the 2003 IPCC guidelines. The data enables a matrix of the 2005-2010 forest area / change in carbon stock per unit area / change in forest carbon to be used.
Use of past data	Based on the past data as the average of the past data.	The method is not clear, but it is likely that it is based on past data.
Transparency, completeness, consistency, and correctness of information provided (including information regarding methods)	Transparency All disclosed on the web Completeness All the information is provided Consistency AD is estimated from satellites of the same resolution and by the same organization, so it is consistent. Correctness Calculation of uncertainty for AD, EF, and change in carbon stock has not been carried out, but uncertainties clearly exist, and this is to be dealt with in the future.	Transparency For investigation in the future Completeness All the data can be provided Consistency The image resolution is not consistent, but the 2 most recent years have the same resolution, and the change in AD quantity has been determined by the same organization by comparison with the 2010 base maps, so it can be said to be consistent. However, the forest definitions are scheduled to be changed, and the forest maps for each year must be interpreted in accordance with the new definitions. Correctness The uncertainty in the A/D and EF, etc., can be estimated and stated.

Description of appropriate REDD+ measures, etc.	An action plan to prevent and regulate the reduction of forests in the Amazon has been published.	In the future it is necessary to proceed smoothly with the preparation of an REDD+ strategy.
Target pools, gases, REDD+ activities clearly stated, and statement of the unimportance of excluded pools, etc.	Each clearly stated. Reasons for not including excluded pools (soil carbon), and activities other than reduction are not clearly stated	Can be clearly stated. Target pools and gases are not identified, but it is likely that soil is not included, and data to explain its unimportance is required.
The description of forest definitions and the definitions used in the GHG inventory, etc., are the same	Definitions are clearly stated, and are the same as the definitions in the data submitted to the FRA of the FAO.	The forest definitions are scheduled to be changed, but can be stated. The preparation and submission of future GHG inventories is likely to be carried out based on the new definitions. The same response can be made for FAO FRA.

Reference Points for FREL/FRL Preparation in Lao PDR

(1) Data, etc.

Data for AD and EF applicable to Lao PDR is scheduled to be collected and summarized, and there is no particular reference data.

(2) Preparation methods and periods

The target period for FREL/FRL is from 2006 when reduction of the forest reduction started, for FREL the average of the past amount of emissions as far back as there was data is used. This is considered to be the method to maximize the amount of credits, and Lao PDR can also investigate methods from this point of view.

2. Mexico

Submission Periods and Organizations

Period: The submitted FREL document does not clearly state the period, but it was during the period of the November 2014 COP21.

Organization: Secretariat of Environment and Natural Resources

Technical assessment by UNFCCC

Technical assessment of FREL is carried out once per year, and it is believed that assessment will be carried out in 2015 together with 5 other countries that have submitted.

Target Regions and REDD+ Activities

The target region is the whole country, and the REDD+ activities target only to emissions due to reduction in forests and forest fires.

Carbon Pools and GHG

Carbon Pools

Forest reduction includes AGB and BGB, forest fires include deadwood, litter, understory vegetation, and the humus layer (it is assumed the living tree trunks do not burn).

GHG

For forest reduction only CO_2 is calculated, but for forest fires in addition to CO_2, CH_4, CO, N_2O, and NO_3 are calculated.

Measurement and application of AD

Area of forest reduction

Area of forest reduction was measured and applied for each forest type (total 19 types) for each period from forest maps based on terrestrial surveys carried out in the 90s, and forest maps based on interpretation of Landsat from 2002 to 2005 (resolution 30 m) and SPOT5 from 2007 to 2010 (resolution 10 m).

Area of forest fires

The area of forest fires was taken to be the area reported in forest fires every year from 1995 onwards, and applied to calculation of the amount of emissions.

Measurement and application of EF

Reduction of forests

The Nationwide forest survey carried out from 2004 to 2007 (systematic sampling based on a grid. Total number of plots 26,220, and for each plot 4 subplots were set) and an allometric equation appropriate to each tree type were applied, from which AGB and BGB were measured for each forest type on the forest maps at the location of the plots. In the case of forest reduction diverted to land-use having vegetation such as agricultural land, etc., the default values of IPCC (2003) were

used for the biomass stock of the vegetation after diversion, and the difference from the carbon stock of the forest was taken to be the amount of emissions. For diversion to use not having vegetation, the total carbon stock of the forest is taken to be emitted.

Forest fires

The carbon stock in deadwood, litter, and the humus layer, and the amount of CO_2, CH_4, CO, N_2O, and NO_3 emissions are estimated from documents, and this is multiplied by a certain combustion percentage (because combustion is not complete), to obtain the emission coefficient.

Forest Definitions

The forest definition is an area of 50 ha or more, a height of 4 m or more, and a canopy cover ratio of 10%, the same as used in the FAO report and GHG inventory. The same definition is also used for woodland, which is one of the land categories in the GHG inventory.

Reference Period and FREL/FRL

The 11 year period from 2000 to 2010 is taken to be the reference based on the establishment of the National Forestry Commission in 2001, the enactment of the Sustainable Forestry Management Act in 2003, and the implementation of various measures.

The annual average of the amount of emissions during this 11 year period was set as the FREL/FRL from 2011 to 2015 (about 45 million tons), and results-based payment is sought based on the monitoring results from 2011 to 2015.

Table 13. Total annual emissions due to deforestation and forest fires and the average representing the forest reference emission level

Year	Emissions $GgCO_2e$
2000	46,792.70
2001	43,881.55
2002	57,101.37
2003	60,012.41
2004	54,127.95
2005	58,115.62
2006	58,146.21
2007	28,563.15
2008	30,202.90
2009	31,486.21
2010	27,367.61
Average	**45,072.52**

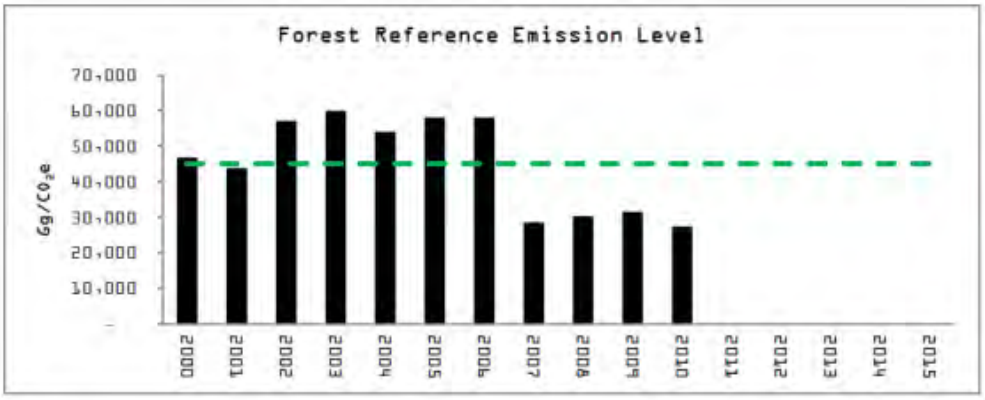


Figure 3-86 **Amount of emissions and FREL**

Comments

Derivation of Emissions from Forest Fires

Forest fires (due to the action of humans only) emit GHG with an extremely high greenhouse effect apart from CO_2, the same as for slash and burn land, so it is considered necessary to calculate when the percentage is greater than a certain percentage of the total emissions. However in the Mexican FREL there is no classification into man-made or natural fires, and, only the reported fires are dealt with in an incomplete manner, so improvement is necessary.

Reference Period and Results-based Payment

With the period from 2000 to 2011 as the reference period based mainly on the implementation of sustainable forestry measures based on the development of systems regarding forestry, payment is sought based on the results for 2011 to 2015, but implementation of REDD+ related measures after

the reference period are important, and these have not been mentioned. Also, this is a period in which the same drivers of forest reduction are acting as in the reference period, but this point is not explained (it is considered that this is not clearly required in terms of the UNFCCC decisions, but it is considered to be necessary as the basis of the method of the average over the 11 year period).

Forest Definitions and Carbon Stock for Each Forest Type

The minimal area of a forest map is 50 ha, so it is considered that the first definition is also the same, but it is considered that within this 50 ha there are many types of forest (in particular in the case of Mexico 19 types), so it is considered that accuracy verification (not carried out) maybe rough and difficult. Also, the forest type of the forest survey plot is the forest type on the forest map at the location of the plot, but it is considered that the forest type should be judged based on the vegetation of the survey plot.

Reference Points for FREL/FRL Preparation in Lao PDR

In Lao PDR there is slash and burn land over a wide range. For Mexico's forest fires, the amount of emissions of GH gases other than CO_2 is calculated, but in the case of Lao PDR it is essential to estimate the GH gases emitted associated with the area of slash and burn land, formation of agricultural land such as plantations, etc., and clearing, plowing, and burning of existing vegetation.

Methodological Framework of the FCPF Carbon Fund

The FCPF provides the Carbon Fund to implement a pilot scheme for results-based payments in various countries. Countries wishing to participate prepare an Emission Reduction Program (ERP), and conclude an Emission Reduction Purchase Agreement (ERPA) with Carbon Fund contributors (countries, private sector, NGOs, etc.) via the World Bank, and receive payments via MRV results. The methodological framework differs from the specific standards for FREL/FRL preparation or MRV in that criteria and indicators are set for preparation of the ERP by countries wanting to participate, and apart from FREL/FRL and MRV rules and indices are indicated for uncertainties, dealing with displacement of emissions, dealing with impermanence, SG, allocation of benefits, non-carbon benefits, etc.

For FREL/FRL 3 standards and 10 indices are provided, which are summarized below.

Present Status of Data for Preparation of FREL/FRL in Lao PDR and Prospects for Preparation

For details refer to the annex 13 "Report on Analysis of the Methodology for Development of

Reference Levels REL/RL for REDD+" and Lao PDR FREL/FRL Provisional Proposal to UNFCCC and the Carbon Fund

(1) Change in forest area

As a result of the support of this Project, forest distribution maps for 2000, 2005, and 2010 are scheduled to be prepared by the end of August 2015. In the Environment Program Grant Aid Forest Conservation Program satellite images covering the whole country from the end of 2014 to the beginning of 2015 are scheduled to be procured for the 2015 forest coverage survey, and the 2015 forest category maps can be created in 2016 with support from the Integrated Technical Program full-scale phase, etc.

(2) Carbon stock per unit area

The data of the first nationwide forest survey conducted in the 1990s has been converted into the carbon stock using some default equations and values through support from SUFORD. However the year of the survey varies (from 1991 to 2000) depending on the province.

This Project is investigating stratification due to other factors, and not just forest type, based on this data. Based on the above stratification results, an allometric equation applicable to Lao PDR is scheduled to be developed by the middle of 2016 in the Environment Program Grant Aid Forest Conservation Program.

Also, the next period nationwide forest survey has been designed with support from this Project, and if this is implemented and summarized with support in the integrated full-scale phase then in 2017 or 2018 it will be possible to calculate the forest carbon stock using the allometric equation. Also, the first forest survey data is also likely to be converted into the carbon stock in the same way.

(3) Target pools and GHG types

In Houaphanh and Khammouane Provinces basically the only target pool is living trees with roots, based on the results of biomass surveys.

Slash and burn is widely practiced in Lao PDR, and on plantation land also remaining vegetation is burned, so it is necessary to estimate the amount of NH_4, etc., generated as a result, and convert it into CO_2. In this case it is necessary to estimate the burn area and the burn percentage (the biomass burned as a percentage of the biomass stock on the land/forest).

(4) Prospects for preparation of FREL/FRL

As described above, during 2016 the change in area over 3 periods will be determined.

The carbon stock per unit area is also likely to be capable of estimation by some method for the periods 2000, 05, 10, and 15, although this depends on the stratification and the status of the change in carbon stock in the 90s and 2017-18. From the above, it is likely that the forest carbon stock can be estimated for the 4 points in time of the 3 time periods in each stratum for the reduction, degradation, and increase.

By analyzing the factors for the change in the 3 periods, REDD+ activities will be identified, and if necessary local classification, etc., will be carried out for preparation of FREL/FRL, trials will be carried out by preparing averages, trends, and models, and the Lao PDR national REDD+ forest FREL/FRL will be prepared for submission to UNFCCC.

(5) Prospects for MRV

Construction of the national forest monitoring system in Lao PDR as agreed with UNFCCC and establishing the systems for MR of the MRV are tasks for the future. However taking into consideration the national development plan period (5 years) and the capabilities of Lao PDR, it is considered that the change in forest area can be determined every 5 years. However, it is not clear that a nationwide forest survey to determine the carbon stock per unit area of Lao PDR can be carried out every 5 years.

3.5.2 Investigation of MRV Adjustments

The NFI from the 1990s was a resource survey for the purpose of commercial logging, etc., so the emphasis was mainly placed on estimation of the volume of tree trunks. In SUFORD this was converted into AGB. Also, FIM measured living trees, and the FREL/FRL prepared based on this data was for 2 pools only, not only the AGB, but also the BGB obtained by multiplying by a constant, so the remaining 3 pools (deadwood, litter, and soil) were excluded. Therefore until a survey is done nationwide for these 3 pools, future national level MRV is sufficient for AGB only.

On the other hand, CliPAD have measured 4 pools excluding soil in a biomass survey in Houaphanh Province, in which deadwood and litter accounted for several % of the total carbon stock. Also, the same result was obtained in a pilot survey in Khammouane Province by NFIS.

Regarding the method of adjusting MRV between national level and sub-national/ project level, the following are the interim results of an investigation into a uniform concept of verification and registration with the UNFCCC of the current sub-national/project level REDD+ and national level REDD+. In Lao PDR the sub-national/ project level REDD for which there is a possibility of verification by a system other than UNFCCC include the following 3 cases. Note that the verification periods are postulated.

(1) VCS verification, monitoring, issuing of credits, and sale for SN-REDD in Savannakhet Province at a similar time period and time (VCS rules state that the baseline period for REDD projects is 10 years).

(2) A JCM/REDD development survey is being carried out in Phonxay District, Luang Prabang Province, that will be verified and registered in 2016 with 2016-2020 as the 5 year baseline period (at present JCM is until 2020, and can be extended by bilateral agreement). Monitoring, issue of credits, and sale is envisaged in 2020.

(3) FCPF Carbon Fund Emission Reduction Program (6 provinces in the north including LPB Province; sub-national): It is not clear at present whether or not it is possible to participate, but if participation is possible, national level data is used, REL/RL is submitted at the same periods as for UNFCCC (2017-18 with final standard year 2015), MRV will be carried out in about 2018-19, but there is an obligation to measure AD twice during the credit period, and the second independent MRV will be carried out in 2021-22.

The locations of (1) and (2) above are different, so it is not necessary that the target REDD+ activities or carbon pools, etc., are consistent between the two, verification and monitoring, etc., will be carried out under their respective systems, and credits can be issued and sold. However, the regulations and requirements of each system specify that the forest definitions be in accordance with host country's national regulations.

Therefore, it is considered that consistency will be necessary in the case of REDD+ of (1) and (2) and receiving incentives for monitoring results for the registration of FREL/FRL in the two cases of national level (UNFCCC) and Carbon Fund and national level (UNFCCC) (in UNFCCC there are no regulations for "verification" of FREL/FRL, "registration", and "issuing credits", but this terminology is used for ease of comparison). Number ② is located within a Carbon Fund region, so consistency is necessary, but a method of achieving consistency between project and national level can be used.

The following is a summary of each envisaged case.

Case 1: When UNFCCC verification and registration of national level FREL/FRL is delayed relative to project level

As stated in the section on the REL/RL investigation method, from the status of preparation of REDD+, submission of REL/RL to UNFCCC at the earliest is likely to be 2017-18, and this case is practical. In order to simplify the investigation of the specific method of adjustment, it is assumed that FREL/FRL submission, verification, and registration with UNFCCC is in 2018, the FREL/FRL

period is the 10 years between 2016 and 2025 (2015 is the final year of the past data and the REDD+ strategy is being investigated, but assuming promotion of REDD+ in the five-year plan from 2016 and that the measures therefor are stated, it is assumed that monitoring is from 2016 onwards), and it is assumed that submission of monitoring results will be in 2020 and 2025.

Project REDD+ will be verified in 2015, 3 years earlier than national level, but the FREL/FRL period will be the 10 years from 2016 to 2025 (in the case of Phonxay District, the 5 years from 2016 to 2020), and monitoring will also be the same in 2020 and 2025 (in the case of Phonxay District once only in 2020). For project REDD an agreement such as an MOU regarding implementation is exchanged with the national government, and at least for the initial FREL/FRL period (10 years) the project, monitoring, credit sales, and so on are to be carried out in accordance with the MOU.

National level FREL/FRL includes the target area of project REDD, and there is a high possibility of double counting when credits are generated for each monitoring result (because national level FREL/FRL cannot be divided to provincial or other levels, also the AD, EF and other data used is different so the amount of double counting is not certain).

In order to avoid this double counting and issuing, the following two methods can be considered. (VCS does not recognize double counting with other verification programs. The current decisions of UNFCCC do not provide rules regarding double counting between sub-national and project levels, but basically it is envisaged that it is not recognized. However, the results-based payments by Norway to Vietnam and others do not assume transfer of credits to Norway, so it is considered that the host country can also include this amount in the national level FREL/FRL to the UNFCCC.)

a. The national level FREL/FRL submitted to the UNFCCC is the FREL/FRL calculated for the whole country from which the sub-national, etc., FREL/FRL is subtracted.

b. Calculate FREL/FRL by excluding the sub-national / project regions from the national level AD data.

Of this, regarding a., the data used in preparation of FREL/FRL (mainly regarding the EF, such as target carbon pools, carbon estimation method, etc.) and preparation method have a high possibility of differing between national, sub-national, and project levels. Therefore it is not appropriate to simply subtract them, but it is necessary to re-calculate the individual FREL/FRL that were used at other than the national level data. Also, the amount of credits of the monitoring results are to be re-calculated in the same way, and the amount of credits for other than national level are deducted

from the amount of credits for national level.

On the other hand, b. above is excluded from the preparation of the national level FREL/FRL so this re-calculation is not necessary, and each of the credits can be treated as independent, so it is considered that this method is convenient and appropriate. Note that cases in which none of the above methods are taken can be considered, for sales procedures, pricing of credits, etc., (for example if purchase by UNFCCC is simple and the price is high and sub-national / project independent credits are not sold and the nation as a whole receives the sales profit, and these are allocated by some method, etc.), but here only the technical aspects are being investigated.

For dealing with monitoring from 2025, from an extension of the simple subtraction method described above various cases of allocation from nation → project organizers, depending on the national REDD+ regulations, the intentions of the country and project organizations to continue sub-national / project REDD+ projects, the trend in REDD+ credit market and prices, etc.

Case 2: When UNFCCC verification and registration of national level FREL/FRL is earlier than that of project level

At the present time this is a low probability case, at least for initial verification and registration, but cases in which after UNFCCC verification and registration of national level FREL/FRL, new sub-national / project level REDD+ other than the above 2 cases could be verified and registered by a third party organization such as VCS, etc., can be considered.

Even when a country has submitted the national level FREL/FRL and it has been verified and registered by UNFCCC, and intends to increase the number of credits received by the country by promoting policies and measures for REDD+, they may also have a policy of promoting private sector investment at sub-national and project level. In this event the method of third party verification can be adopted, or a case in which this is recognized by the country and a case where the third party verification is not recognized can be considered.

In the first case in order to avoid double counting it is necessary that at the time of verification and registration by the third party the national level FREL/FRL is re-calculated and re-submitted by the method of b. above. Also, the same applies to the monitoring results.

In the second case, for investment by a private sector organization, it is conceivable that the details could include when the country has agreed, a certain amount of the credits arising at national level in the future are allocated (the private sector organization sells these), or a certain portion of results-based payments received at national level are paid. Objective data, etc., is indispensable for these results when the amount of credits or an amount of results-based payment is allocated for sub-national / project level. Therefore methods that can be considered for this purpose

include the applicant country assessing the submitted documents such as planning documents, etc., the same as for third party verification, and the country calculating the FREL/FRL of the sub-national / project level using the national level data and method, with the agreement of the investors.

Case 3; Carbon Fund regions and the national level

In this case REL/RL is submitted using the same data set and in the same period. Also, there is a high possibility that for the Carbon Fund there will be a condition that an REDD+ strategy, and NFMS and SG information system be established as a condition of the payment contract, and that the first MRV based on the NFMS will use the same data set and the same periods.

On the other hand, the Carbon Fund has payment funds, and its systems such as payment contracts, etc., are developed, so compared with UNFCCC for which these are not developed, there is a high possibility that payment will be made earlier. Therefore, it is considered that there should be 2 types of submission, for payment from the Carbon Fund with REL/RL and MRV submitted to UNFCCC (with the Carbon Fund regions excluded), and for the whole country, and the UNFCCC should be notified which is being adopted in accordance with whether or not there is payment from the Carbon Fund.

In COP19 MRV for verification and analysis of results-based payments, biannual reports are to be provided, but an outline of the SG information, etc., included in the national report once every 4 years is also to be periodically submitted, and, in addition it can be optionally submitted via the REDD+ site of the UNFCCC.

At SBSTA42 held in June 2015 all the remaining issues in the REDD+ system were agreed, and these are scheduled to be formally adopted at COP21 in December. One of these is guidelines for transparency, consistency, and comprehensiveness of SG information and for ensuring the effect, and the main agreement items are as follows.

3.5.3 Study on information developed approaches to safe guard

Decisions made at UNFCCC

COP 16 adopted so called “Cancun Agreement”, which contains the landmark decisions on REDD+ including Safeguards, which developing countries should promote and support when implementing the 5 REDD+ activities. Safeguards shown in Table 3-25 are annexed to the main

text, but the other items i.e. land tenure and genderconsideration are often dealt together with the 7 SG items.

Table 3-25:Safguards items agreed in Cancun

	Safeguards	Category*
(a)	Actions should complement or be consistent with the objectives of national forest programs and relevant international conventions and agreements	Forest Governance
(b)	National forest governance structures should be transparent and effective, taking into account national legislation and sovereignty	
(c)	Actions should respect for the knowledge and rights of indigenous peoples and members of local communities, by taking into account relevant international obligations, national circumstances and laws, and noting that the United Nations General Assembly has adopted the United Nations Declaration on the Rights of Indigenous Peoples	Social
(d)	The relevant stakeholders, in particular indigenous peoples and local communities, should fully and effectively participate in the actions referred to in paragraphs 70 and 72 of this decision	
(e)	Actions should be consistent with the conservation of natural forests and biological diversity, ensuring that the actions referred to in paragraph 70 of this decision are not used for the conversion of natural forests, but are instead used to incentivize the protection and conservation of natural forests and their ecosystem services, and to enhance other social and environmental benefits	Environmental/ Social
(f)	Actions should be taken to address the risks of reversals	Climate
(g)	Actions should be taken to reduce displacement of emissions	

Note: *) “Category” is the FFPRI's grouping, not UNFCCC's.

At COP17 (Decision 2/CP.17) it was agreed that developing countries should have a system for providing information on how REDD+ SG are being addressed and respected to obtain and receive result-based finance. Furthermore, a summary of SG information should be provided in

national communications , or , through communication channels agreed by COP after the start of implementation of the 5 REDD+ activities. At COP19, it is agreed that the summary of SG information could be submitted on a voluntary basis via the web platform on the UNFCCC site (Decision 12/CP.19).

This means that developing countries should have a REDD+ strategy, National Forest Monitoring System and SG information System in place and submit REL/RL and provide a summary of SG information after starting REDD+ activities.

Decision 2/CP. 17 *paragraph* 2:

"Agrees that systems for providing information on how the safeguards referred to in appendix I to decision 1/CP.16 are addressed and respected should, taking into account national circumstances and respective capabilities, and recognizing national sovereignty and legislation, and relevant international obligations and agreements, and respecting gender considerations:

(a) Be consistent with the guidance identified in decision 1/CP.16, appendix I, paragraph 1;

(b) Provide transparent and consistent information that is accessible by all relevant stakeholders and updated on a regular basis;

(c) Be transparent and flexible to allow for improvements over time;

(d) Provide information on how all of the safeguards referred to in appendix I to decision 1/CP.16 are being addressed and respected;

(e) Be country-driven and implemented at the national level;

(f) Build upon existing systems, as appropriate;

In COP19 MRV for verification and analysis of results-based payments, biannual reports are to be provided, but an outline of the SG information, etc., included in the national report once every 4 years is also to be periodically submitted, and, in addition it can be optionally submitted via the REDD+ site of the UNFCCC.

At SBSTA42 held in June 2015 all the remaining issues in the REDD+ system were agreed, and these are scheduled to be formally adopted at COP21 in December. One of these is guidelines for transparency, consistency, and comprehensiveness of SG information and for ensuring the effect, and the main agreement items are as follows.

5. *Strongly encourages* developing country Parties, when providing the summary of information

referred to in paragraph 1 above, to include the following elements, where appropriate:

(a) Information on national circumstances relevant to addressing and respecting the safeguards;

(b) A description of each safeguard in accordance with national circumstances;

(c) A description of existing systems and processes relevant to addressing and respecting safeguards, including the information systems referred to in decision 12/CP.17, in accordance with national circumstances;

(d) Information on how each of the safeguards has been addressed and respected, in accordance with national circumstances;

6. *Encourages* developing country Parties to provide any other relevant information on the safeguards in the summary of information referred to in paragraph 1 above;

7. *Also encourages* developing country Parties to improve the information provided in the summary of information referred to in paragraph 1 above taking into account the stepwise approach;

As can be seen from the agreement, there are no specific standards for how much information to submit, and the items stated are simply summarized as follows.

1. Information on national circumstances relevant to addressing and respecting the SG
2. A description of each SG in accordance with national circumstances
3. A description of existing systems and processes relevant to addressing and respecting SG, including the SG information systems, in accordance with national circumstances
4. Information on how each of the SG has been addressed and respected, in accordance with national circumstances
5. Other relevant information on the SG in the summary of information
6. Improving the information provided in the summary of information on SG taking into account the stepwise approach

Note that finally further guidance regarding addressing and respecting the SG is not necessary, so it is foreseen that there will be major differences between countries in the

content and volume of the SG summary of information submitted. Also, for submitted summaries of information in which the reference levels and the MRV differ there is no assessment by specialists, so it is expected that there will be cases that are very simply summarized.

Organization and Analysis of SG Information Outline in Brazil Submitted to UNFCCC

Outline of application and observance of safeguards in Brazil submitted to UNFCCC (SG outline)

(1) Major items of the submitted document

1) Introduction: Description of SG, submission of the outline thereof, relationship with the UNFCCC resolution relevant to the SG information system (SIS) (conditions for result-based payment, etc.) and observance
2) Method: Description of the fact that the submitted SG outline is based on the “Survey to identify information and sources to feed the Safeguards Information System (April 2013)” compiled by a technical panel comprised of members chosen from the private sector, the draft SG outline was publicized on the REDD+ website of Brazil for two weeks to collect opinions from the public, after thorough examination by the technical panel for revision and other experts, final version was prepared and sent to the Ministry of Science, Technology and Innovation, which is in charge of national report, by the Ministry of the Environment and that this outline was submitted to UNFCCC for publication on the REDD+ website of UNFCCC in accordance with the resolution of COP19.
3) REDD+ of Brazil: Introduction of action program to combat forest decline concerning the Amazon biosphere, which is the target area of FREL, and national and state programs under the action program, after describing the fact that Brazil has already submitted FREL to receive the result-based payment, Brazil has a national REDD+ strategy and that data and information for the MRV are attached to the BUR submitted at the end of 2014. Also, introduction of the types, outline, etc. of projects implemented by the Amazon Fund.
4) Explanation of the interpretation of each SG item, application and observance of SG in the activities in the Amazon biosphere.
5) Introduction of existing information systems relating to the development of SIS and description of the intent of the development of SIS.

(2) Features

1) Submission of SG information outline prior to the establishment of SIS

Since SIS is specified as one of the REDD+ elements to be developed by developing countries in the Cancun Agreements and submission of the SG outline is a condition for receiving the result-based payment according to the Warsaw Framework for REDD+, it is generally understood that after the establishment of SIS, SG outline generated by the SIS should be reported to the UNFCCC. However, Brazil defines in its SG outline that the SIS and the SG outline are different. It is considered that this is basically due to the fact that Brazil has already submitted FREL (at the subnational level; Amazon biosphere) and the BUR including the MRV of the area in question and that the submission of the SG outline will suffice as a condition to receive the result-based payment since SIS will require long time for establishment. However, it remains to be seen whether or not the UNFCCC will determine that Brazil satisfies the condition for the result-based payment even though the SIS has not been developed yet.

2) Relationship with the submitted FREL

Since the FREL submitted after the technical assessment by the UNFCCC covers the Amazon biosphere, this document mainly describes national policies and plans, national and state programs that mainly cover the Amazon biosphere as well as the application and observance of SG in the REDD+ programs implemented with the support of the Amazon Fund. It is considered natural as the initial result-based payment targets the Amazon biosphere.

3) Outline of the description concerning each SG item

(a) The national forest program and relevant international conventions and agreements shall be complemented and consistent activities shall be facilitated and supported.

After the description of the fact that Brazil has many programs and activities relating to the promotion of REDD+, the Constitution, the New Forest Act, national policies concerning regional and environmental management of the indigenous people’s areas, Public Forest Management Act, national environmental policies, etc. are listed.

With respect to the Amazon biosphere, which is the target area for the REDD+ payment, it is described that the complementarity and integrity of these policies and

programs are ensured in the action programs to combat forest decline concerning the Amazon biosphere.

(b) Transparent and effective national forest governance in consideration of the laws and regulations as well as the sovereignty of the host country shall be facilitated and supported.

Criteria to evaluate the “transparent and effective national forest governance” in this SG item were established by the technical panel. The criteria consist of 1) structure and system and 2) transparency, and with regard to 1), information concerning composition (fairness of the government and civil society), periodicity (frequency of meeting) and jurisdiction was collected and as for 2), information on the existence and publication of data was collected.

Structure for the implementation of the action programs to combat forest decline concerning the Amazon biosphere is composed of three fields, namely, project implementation, transparency and discussion, and discussion with civil society is a prerequisite for the formulation of action programs. Also, groups are formed for each project field to serve as a forum for discussion, project monitoring and resolution of issues.

With respect to project implementation by the Amazon Fund, the Amazon Fund Guidance Committee (COFA) has been organized for the preparation of project implementation guidelines and monitoring. The Committee is participated by NGOs, organizations of indigenous peoples, industrial circle, organizations of scientists, etc. in addition to relevant ministries and agencies and state government agencies. Records of the COFA meetings and implemented projects are publicized on the Amazon Fund website.

(c) The knowledge and rights of indigenous peoples and community residents shall be respected while taking into consideration relevant international obligations as well as the conditions and legal system of each country and taking note of the UNDRIP (United Nations Declaration on the Rights of Indigenous Peoples)

The technical panel has identified regulations concerning the rights of indigenous peoples and enumerates 14 regulations including the International Labor Organization Convention 169, the Constitution, national policies concerning regional and environmental management in the indigenous people’s areas and laws and regulations

concerning indigenous peoples. Of the rights relating to these regulations, the panel has specified the FPIC, the rights in the indigenous people's areas and the rights concerning the utilization of resources and distribution of benefits as the most important rights.

It is considered necessary to evaluate the status concerning the execution of such rights, environmental crimes and violation of rights, formulation of the confirmation and management plan of indigenous people's areas in implementing the action programs to combat forest decline concerning the Amazon biosphere. With respect to the indigenous people's areas, although 10 million ha has been confirmed for reservation, the panel members pointed out that data from the national indigenous peoples organization concerning disputes and violence occurred during the confirmation process has not been used, and as such, it is considered necessary to evaluate the implementation of this SG item in more detail.

With respect to the selection and implementation of the Amazon Fund projects in the indigenous people's areas, as the national indigenous peoples organization is also involved in the selection and implementation process, guidelines for the preparation of the land and environmental management plan established by said organization are taken into consideration. The national indigenous people's organization is also actively engaged in the activities of the WG consisting of members from relevant ministries and agencies, which was established for the purpose of formulating the national REDD+ strategy.

It is pointed out that the lack of national regulations in regards to implementing International Labor Organization Convention 169 and organization to control the violation of rights is an area that requires improvement with regards to the implementation of this SG item.

(d) Adequate and efficient participation of stakeholders (particularly, indigenous peoples and community residents) shall be supported

Process at the federal level

According to the interpretation of the technical panel, "adequate and efficient participation" means participation of the representatives of indigenous peoples, etc. in the decision-making process concerning the formation and implementation of REDD+ policies and activities. As such, it is considered important that such representatives play a leading role with respect to REDD+ in the indigenous people's areas.

Various stakeholders have participated in the formulation of the action programs to combat forest decline concerning the Amazon biosphere. However, the panel members pointed out that discussions involving such stakeholders mostly end up as technical discussions and do not sufficiently reflect grass root opinions. Nevertheless, in recent years, theme-wise workshops have been regularly organized with the initiative of the national indigenous people's organization to ensure hearing of opinions and participation at the grass root level.

The document describes that the Guidance Committee concerning the implementation of the Amazon Fund projects (COFA) has members from indigenous peoples organizations and that the guidelines of the Fund approved by COFA includes 1) Projects shall require acceptance by all partners and 2) Projects relevant to indigenous peoples shall require submission of documents concerning the acceptance of FPIC by indigenous peoples.

In addition, the document also describes in detail that various stakeholders, including civil society, indigenous peoples organizations and scientists, participated in the formulation of the national REDD+ strategy, dialogues with the indigenous peoples organizations took place with respect to the SG and that information on the matters above is publicized on the REDD+ website of the Ministry of the Environment.

Furthermore, it was noted that there was an opinion that emphasizes the necessity of the federal government's effort to facilitate the participation of a greater number of NGOs and governmental organizations with regard to the publication of the draft SG outline and hearing of opinions.

Carbon projects and harmful contracts

In formulating the national REDD+ strategy, the Brazilian government has decided that, in accordance with the UNFCCC agreement, REDD+ will be implemented at the ecosystem (subnational) level for the time being and it will be gradually expanded to the national level and that REDD+ will not be implemented in the form of carbon projects or by administrative units.

Meanwhile, many carbon projects targeting voluntary market were started also in Brazil, but some of the contracts between indigenous peoples and overseas corporations violated the Cancun SG, particularly laws and regulations and international agreements as follows:

- Project activities violating the Constitution, etc. providing for exclusive use of indigenous peoples in the indigenous people's areas

- Contract negotiations without adequate and effective participation of indigenous peoples and other parties concerned or ignoring the FPIC

In relation to these issues, in 2011, the national indigenous people's organization publicized a list of about 20 foreign companies that are negotiating a contract that does not satisfy the minimum necessary legal standards with indigenous peoples. The Ministry of the Environment has been examining these contracts and monitoring the trends of other companies in collaboration with the Federal Bureau of Investigation. As a result, the number of such cases decreased in 2013 and 2014.

(e) Actions that will maintain consistency with the conservation of natural forests and biodiversity, will not convert natural forests, will grant incentives concerning the protection and preservation of natural forests and ecosystem services and will enhance the benefits to society and the environment shall be facilitated and supported.

After stating that Brazil has several legal measures concerning the conservation of biodiversity, the document refers to national biodiversity policies and national programs relating to biodiversity and the national biodiversity committee as examples and specifies that effective implementation of these legal measures is the condition for facilitating this SG item.

In accordance with the action programs to combat forest decline concerning the Amazon biosphere, 50 million ha of protected forests have been designated in the Amazon biosphere by the federal and state governments. This has resulted in a significant reduction of the forest decline area within the protected forests and the percentage of the decline area of the whole biosphere has been maintained at 4% or less for the federal protected forests and 6% or less for the state protected forests.

However, the technical panel members have pointed out that thorough management of these protected forests and integration of the areas between and surrounding the protected forests are needed to respect this SG item. Activities by the Amazon Fund should particularly aim at supporting the management of public and protected forests, restoration of forest decline areas and conservation and sustainable utilization of biodiversity and accordingly, they should be relevant to the respect of this SG item.

(f) Activities that do not cause rebound (eventually contributing only to temporary emission reduction and absorption) shall be facilitated and supported.

The document cites the New Forest Act, which obligates that the percentage of natural vegetation in owned land be maintained at 80%, as an example of existing measures and means to maintain the REDD+ performance and states that forest and vegetation monitoring program and illegal logging monitoring system are useful for the implementation of these regulations.

Also, according to the document, the REDD+ result-based payment is the key to suppressing rebound. While suppression of forest decline has been made possible mainly by monitoring funded by the federal budget and enforcement of laws and regulations, as the unit of decline in recent years is as small as 25ha or less, it is difficult to deal with this issue with the conventional system. Therefore, implementation of land management and sustainable production activities in the Amazon biosphere would be effective and essential. The document says that the REDD+ result-based payment may be an important investment to facilitate the conversion to such format of resource utilization.

(g) Activities to suppress emission displacement shall be facilitated and supported.

According to the document, activities to suppress emission displacement include sound, comprehensive and constant forest monitoring to ensure the environmental integrity of REDD+. As with the measures to avoid rebound in relation to the SG, forest and vegetation monitoring program and illegal logging monitoring system would be useful for this purpose.

Brazil also has a monitoring system for forest deterioration in addition to forest decline. Monitoring of forest deterioration has been carried out every year since 2007 and information on deteriorated land is publicized. The document says that no correlation has been confirmed between the suppression of forest decline in one area and the expansion of deterioration in other areas.

In addition, as a measure to maintain the suppression of forest decline, specific municipalities are designated based on the forest decline area and other standards to improve forest monitoring and suppression activities, confirm land ownership and utilization plan and support environmentally sustainable economic activities.

Also, it is essential to expand the monitoring system of the Amazon biosphere to other ecosystems and to areas around the country to suppress the emission displacement from the Amazon biosphere and monitoring has already started in the Cerrado ecosystem. The national REDD+ strategy declares that the REDD+ activities should be expanded to other ecosystems for the purpose of suppressing emission displacement and accordingly,

efforts have already been made to expand the forest monitoring system across the country.

(3) Existing information systems in Brazil

The technical panel has confirmed the existence of existing information systems and databases. They are all independent and none of them are connected to each other, but they can be the foundation for the SIS to be constructed in the future. Nine information systems, including forest information system, Amazon forest monitoring system information system, biodiversity and ecosystem information system, are listed.

(4) Comments and applicability to the development of SG information in Lao PDR

1) First submission of SG information outline

As Brazil is the first country to submit the SG outline, this case of Brazil may serve as an important reference for other countries, especially those that have already submitted FREL/REL, to prepare the SG outline to submit. It has been considered that development of the SG information and submission of the SG outline are complicated work requiring a lot of labor, but the case of Brazil will serve as a precedent for other countries as it suggests the information to be collected and the way to prepare the outline, thereby helping them to develop the SG information.

2) Amazon biosphere and national level SG information outline

The SG information outline of Brazil briefly introduces the national level initiatives in the information outline of each SG item first. Then, it provides detailed information about the Amazon biosphere, which is the target area of the FREL and the result-based payment.

3) List of issues

With respect to socio-environmental SG items, in addition to the introduction of legal systems and guidelines, issues in implementation are presented in the form of comments by the technical panel members. It must be possible for Lao PDR, which has serious problems particularly in the enforcement of laws and regulations, to organize and present ongoing and future issues in preparing the SG information outline.

4) Applicability to the development of SG information in Lao PDR

Items 1) and 3) above must be applicable also to Lao PDR. With respect to 3), however, political and social conditions of Lao PDR are greatly different from those of Brazil, which is

a democratic country with a long history of tackling and solving the issues of forest decline and indigenous peoples in the aspects of systems and implementation. Therefore, it is considered that Lao PDR needs to make efforts to ensure proactive and effective participation of residents in forest management (from planning to implementation and monitoring) in both the aspects of systems and implementation in the future.

Multi-process initiatives relating to SG

Most of the developing countries tackling REDD+ are supported by the FCPF or UN-REDD. Initiatives relating to SG have been carried out also in these processes. With respect to the FCPF, World Bank has set up guidelines concerning environmental and social impacts in implementing projects and other support programs. Based on these guidelines, Strategic Environment and Social Assessment (SESA) is carried out in the R-PP to check the REDD+ strategy and activities in advance and it is mandatory to formulate the Environment and Social Management Framework (ESMF) to address the socio-environmental risks identified in the SESA. The SESA and the ESMF do not have specific check items like the seven SG items, but they attach more importance to establishing thorough examination procedures involving a wide range of parties concerned.

The UN-REDD has taken a more specific approach and determined the Social and Environmental Principles and Indicators (SEPC) to be applied in formulating the REDD+ programs in each country. The SEPC indicates study items in more detail than SESA which consist of seven principles and 25 standards and relevance to the seven SG items is also clearly indicated. Also, guidelines concerning specific application of the SEPC have been prepared.

Initiative in Lao PDR

Lao PDR is one of the 14 countries that initially participated in the FCPF. Its R-PP was submitted in August 2010 and approved by the FCPF committee in December 2010 after modification. However, as the SESA was fully incorporated into the September 2010 version of the R-PP template for the first time and since Lao PDR uses a template prior to that, its R-PP does not include the SESA or the resultant development of ESMF. It was decided that the SESA and the development of ESMF with regard to the R-PP or the REDD+ national strategy, which is expected to be newly formulated, will be implemented in the FCPF preparation project (USD 3.6 million). The preparation project was delayed due

to the impact of the split of the function of forest management organization into two ministries and started at the end of 2014. However, selection of consultants who will be mainly in charge of establishing the four REDD+ elements has just begun and as such, it is expected that the project will actually be put to operation in the beginning of 2016.

Workshop on assessment of “transparent and effective forest governance system”

On October 27 and 28 in 2014, a workshop on the assessment of “transparent and effective forest governance system”, which is one of the SG items, was held in Vientiane with the support of World Bank, CliPAD and other sponsors. The objective of the workshop was that the participants score the matters relating to forest governance and make recommendations for the improvement of the matters that earned low scores.

The participants were divided into groups of 10 to 20 and each group assessed matters prepared in advance for one of the three areas of forest governance that is relevant to them based on consensus on the sale of high, medium, and low. The three areas are 1) policy and legal system, 2) planning and decision-making process and 3) implementation, execution and observance. The Chief Advisor of this Project participated in the group discussion on policy and legal system. Other participants included officials from the Ministry of Development Planning, the Ministry of Agriculture and Forestry, the Ministry of Natural Resources and the Environment and the CSO as well as foreign advisors. For some of the assessment matters, such as “Project for diversion within forests shall require discussions among relevant organizations”, opinions were split among the participants, but there were some cases in which the participants from the government acknowledged the deficiency of the legal system. The assessment results will be summarized by the consultants of World Bank and publicized.

Ensuring safeguards and direction of response under the current legal system of Lao PDR

The status of SG application, observance and response measures under the current legal system of Lao PDR is summarized as follows.

The SG information outline to be submitted to the UNFCCC will be prepared in accordance with the guidance agreed in the SBSTA42, but it is considered necessary to explain centralized management of natural resources including forests by the national government and on-going efforts and issues involved in the improvement of forest governance to

describe the status of the country and indicate the interpretation of each SG item in accordance with the status as shown below.

SG items	Specific items in Lao PDR	Relevance to REDD+activities and response measures
(a) The national forest program and relevant international conventions and agreements shall be complemented and consistent activities shall be facilitated and supported.	1.National forest program: Forest-related target in the Forest Strategy 2020 and the 8th National Economic and Social Development Plan (2016-2020) : More specifically, forest coverage of 70% 2.Relevant international conventions and agreements Lao PDR is a contracting party to the CBD and the Ramsar Convention in addition to the UNFCCC.	1.Considering the objective, the REDD+ activities may contribute to the achievement of the target 70% (complementing). Also, to ensure consistency with the REDD+ activities, it is necessary to match the content of the REDD+ strategy and action plan to be formulated in the future with that of the national forest program. 2.The CBD requires formulation of national biodiversity strategy and action plan as well as annual reporting, but since the current strategy and action plan are effective only up to 2010, it is necessary to revise them and determine the positioning of the REDD+ activities to ensure complementarity and consistency.
(b) Transparent and effective national forest governance in consideration of the laws and regulations as well as the sovereignty of the host country shall be facilitated and supported.	1. Administrative organization including the national and provincial governments with clear and integrated definition of authorities and responsibilities concerning forests (transparency)	1. Since authorizes and responsibilities of the central forest administration, which are divided according to forest type between the Ministry of Agriculture and the Ministry of Natural Resources and the Environment, agencies relating to sale of lumber (Ministry of Agriculture and Forestry, Ministry of Commerce and Industry and Ministry of Finance), agencies relating to illegal logging and logged material (MONRE, MAF, Police, etc.) and their provincial branches are

SG items	Specific items in Lao PDR	Relevance to REDD+activities and response measures
	2.System with the capacity, budget, etc. capable of developing the policies and activities to achieve the target in the national forest program (effective).	unclear and overlapped, it is essential to reorganize, disseminate and publicize them to implement the REDD+ activities. 2.Specific forest management activities are not implemented efficiently, because they are carried out by each of the relevant organizations described in 1 with no uniformity. Moreover, as they are dependent on activities and supports by donor projects, the implementation system is not effective. It is necessary to strengthen the system in terms of capacity and budget as well as in other aspects through the implementation of the REDD+ activities and the result-based payment.
(c) The knowledge and rights of indigenous peoples and community residents shall be respected while taking into consideration relevant international obligations as well as the conditions and legal system of each country and taking note of the UNDRIP (United Nations Declaration on the Rights of Indigenous Peoples) (The act of respecting the knowledge and rights of	1. Consideration of the conditions and legal system (concerning the knowledge and rights of community residents) of Lao PDR The Constitution, the Land Act and the Forest Act of Lao PDR stipulate that forests and other natural resources belong to all people and the national government distributes the rights to use them to individuals, households and organizations.	1. It is impossible to change the basic provisions about the ownership and distribution of natural resources in the current Constitution and other acts. 2. It is highly likely that the village land use plans, which are formulated, approved and implemented based on the PLUP in each project, will become a major element of the REDD+ activities. However, it is necessary to resolve the following issues: 1) It is not clear if such plans have legal force against third party (For example, they may not be subject to concession by the national government or discussions with the villages concerned may be essential for the government to grant concession.), 2)

SG items	Specific items in Lao PDR	Relevance to REDD+activities and response measures
indigenous peoples and community residents shall be facilitated and supported, while considering relevant international obligations, and conditions and legal system of each country and giving due consideration to the UNDRIP (United Nations Declaration on the Rights of Indigenous Peoples))	With respect to forests, forests for village use are those that villages are allowed to use, but it is not clear if such villages can have externally effective rights of use. (In a small portion of villages, village rights of use were established on a trial basis, but it is unclear if these rights are publicly recognized or still effective.) With regards to production forests, a system allowing relevant villages to participate in the formulation and implementation of management plan and receive part of the revenue from the sale of lumber has been established and it seems that the knowledge and rights of community residents are respected in this process.	Relationship between the PLUP within protection forests and regulations on protection forests is not clear. 3. Currently, type 3 forests including protection forests are being reexamined (the method of reexamination is being developed). The result of this reexamination will make a great impact on the REDD+. As such, from the viewpoint of respecting the knowledge and rights of community residents, the reexamination method and implementation of the method should respect the knowledge and the rights of conventional use of community residents. 4. It is expected that laws relating to land, such as the Land Act and the Forest Act, will be amended in accordance with the decision of the national land policies. It is necessary to pay attention to the amendment direction from the viewpoint of respecting the knowledge and rights of community residents. 5. In order to support and facilitate effective national governance as in item (b) above, it is important to respect the knowledge and rights of community residents who actually utilize the forests in

SG items	Specific items in Lao PDR	Relevance to REDD+activities and response measures
	In other forests, collection and use of forest products are allowed only to a limited extent. According to new national land policies under examination, setting of shared land will be allowed. On the other hand, it seems that the possibility of land expropriation by the national government for the purpose of private development (currently for public development only) is also studied. 2. Respect of the knowledge of community residents 2.1 Knowledge of residents concerning forest and water resources shall be respected in designating forests for village use and formulating and approving the rules of use (authority of the district headman). 2.2 Knowledge of	implementing the REDD+ activities.

SG items	Specific items in Lao PDR	Relevance to REDD+activities and response measures
	community residents concerning the status of forests, water resources, the NTFP etc., shall be utilized and respected in the formulation and implementation of other forest management plans. 3. Respecting the rights of community residents 3.1 Conventional status of use shall be reflected in the designation of forests for village use and formulation of the rules of use. 3.2 Conventional use of forests, water resources, the NTFP, etc. by community residents shall be respected in the formulation and implementation of other forest management plans.	

SG items	Specific items in Lao PDR	Relevance to REDD+activities and response measures
(d) (Adequate and) efficient participation of stakeholders (particularly, indigenous peoples and community residents) shall be facilitated and supported.	1. Community residents shall participate in the process of formulation including decision-making and implementation of various forest management plans and action plans relating to forests. (This is also an important element of (b) effective forest governance.) As described in item (c) above, under the current legal system, community residents do not (adequately and) efficiently participate in the formulation of various forest management plans except for those of production forests. Hearing of opinions from stakeholders is not in practice, either.	1. It is necessary to study the development of schemes and systems for phase disclosure of the process to determine the draft of REDD+ strategy and activities at the national and provincial levels. (This should be carried out before the development of the SG information system.) 2. It is necessary to study how and in what level of the formulation of management plans of protected forests, which spreads widely and include many villages, should community residents (or their representatives) participate to achieve maximum effectiveness and efficiency.
(e) Actions that will maintain consistency with the conservation of natural forests and biodiversity, will not convert natural forests, will grant incentives concerning the protection	1. Consistency with conservation of natural forests and conservation of biodiversity With respect to conservation of natural forests, it is necessary to	1. As the REDD+ activities generally facilitate conservation of natural forests and conservation of biodiversity, it is considered that consistency exists. However, to ensure in detail, it is necessary to revise the biodiversity strategy and make sure that the revised strategy is consistent with the REDD+

SG items	Specific items in Lao PDR	Relevance to REDD+activities and response measures
and preservation of natural forests and ecosystem services and will enhance the benefits to society and the environment shall be facilitated and supported.	grasp the position, area, etc. of existing natural forests (certain definition would be needed) and take measures for conservation, such as incorporation into conservation forests. With respect to biodiversity, as described in item (a) above, Lao PDR is a contracting party to the CBD, but has not been able to perform the obligations. 2. Grant of incentives for the protection and conservation of natural forests and ecosystem services This is one of the objectives of the REDD+ but domestically, fair and transparent distribution system of the REDD+ benefits and definite forest management rights, which are a prerequisite of such system will be needed. 3.Facilitation and support of	strategy. In addition, it is necessary to grasp the position, area, etc. of existing natural forests (certain definition would be needed) and take measures for conservation, such as incorporation into conservation forests. 2. It is essential to clearly define “fair and transparent distribution system of the REDD+ benefits” and definite forest management rights as a prerequisite of such system. 3. It seems that this refers to the enhancement of non-carbon benefits in the REDD+, but it is considered to be ensured by securely implementing 1 and 2 above. There has been a move to institutionalize payment for the forest

SG items	Specific items in Lao PDR	Relevance to REDD+activities and response measures
	actions that will enhance other social and environmental benefits It is also necessary to examine payment system to other forest environment services through the REDD+ and implement such system.	conservation activity in the water source area by hydro power generators. Since forest conservation in water source area is also effective to the REDD+, it is necessary to consider provision of support.
(f) Activities that do not cause rebound (eventually contributing only to temporary emission reduction and absorption) shall be facilitated and supported.	1. Continuation of necessary support to forest managers 2. Decision and communication of countermeasures against rebound 3. Forest monitoring	1. Methods contributing to long-term forest conservation, such as spending allocated REDD+ benefits on infrastructure investment for forest management, should be studied. 2. With respect to addressing national level rebound, establishment of an international system is likely to be examined. For regional rebound in the country, examination, decision and communication of countermeasures are needed in accordance with the causes. 3. Accurate and periodic forest monitoring is essential for suppressing and checking rebounds at the national and regional levels.
(g) Activities to suppress emission displacement shall be facilitated and supported.	1. Depending on the causes of forest decline and deterioration, it is necessary to carry out	1. Same as left

SG items	Specific items in Lao PDR	Relevance to REDD+activities and response measures
	REDD+ activities with a high displacement potential, such as strengthening of illegal logging control, in the whole area where the activity may cause displacement.	

Survey of existing websites and databases relating to SG and examination of the method to construct the SG information system

Described in Annex 14: Report of organization and analysis of information concerning safeguards of REDD+.

3.5 Deliverables

(1) Report

Reports and other documents to be prepared / submitted at each stage of work are described in this section.

Report Title	Deadline for Submittal	Copies
Final Report (draft)	July 31, 2015	40 Copies in English Report CD-ROM（English）
Final Report	Upon completion of contract in final year	50 Copies in English Report CD-ROM（English）
Final Report Summary	Upon completion of contract in final year	50 Copies in English Report CD-ROM（English）

(2) Technical cooperation reports

The following technical cooperation reports to be prepared / submitted at each stage of work are described in this section. Report shall be attached to the Work Completion Report for the each year.

Report title	**Copies**
Revised forest base map（2010）,Forest type map（2005, 2000）	One color printout of digital color map
National forest carbon map（2010, 2005, 2000）	One color printout of digital color map
Report concering prototype of national forest information database	5 Copies in English Report CD-ROM（English）
Revised national forest inventory manual	5 Copies in English Report CD-ROM（English）
Report concerning method of preparation of REL/RL in REDD+	5 Copies in English Report CD-ROM（English）
Report concerning safeguard in REDD+	5 Copies in English Report CD-ROM（English）
Action plan on development of national forest monitoring system	5 Copies in English Report CD-ROM（English）
Degital Pictures	2set of CD-R

Chapter4 Issues for Project Implementation and Management

4.1 Issues for All Outputs

4.1.1 Adoption of Project Output as National System and Data

Major output of this Project consists of forest type maps of three points in time, stratified carbon map and designing of the next NFI. Forest definition and forest/land classification, which are the basis of the Project, are described in the report of forest coverage survey that has been conducted every ten years, but the national government has not decided official definition or classification. Discussions were held over this issue with the DOF, which is the C/P, and other project members and an agreement was reached in the form of a minute, which was a step taken forward.

MONRE is the contact for the decision and submission of the next GHG inventory and REDD+ reference level and DOF has conducted discussions with the departments under MONRE (Department of Climate Change and Disaster and Department of Land Management) and the Ministry of Agriculture and Forestry (Department of Farmland Development) for early adoption of the project output as the national definition and classification and minutes have been prepared for confirmation and to facilitate and support the adoption process. Also, staff of the Department of Climate Change and Disaster in charge of GHG inventory and relevant staff of the Ministry of Agriculture and Forestry were invited to the WS (May 2015) on the NFMS of REDD+ organized by the F-PREP and to the final report meeting of NFIS (July 2015) to call for their cooperation in these discussions.

4.1.2 Improvement of the Ownership of C/P

The project director (PD) of this Project is a director of FIPD. As he does not have much knowledge in accuracy verification and other technical issues, during the early period of the Project, he seldom took the initiative in giving an explanation to the DOF executives and it often happened that Japanese experts met with the deputy director in charge of REDD+ for explanation and consultation, and when important issues had to be dealt with, the Japanese experts consulted with and asked for the opinions of the acting director general or the director general.

However, as a result of frequent discussions and consultations with the PD while emphasizing the fact that the output of this Project comprises the most fundamental part of the promotion of REDD+ construction and sustainable forest management in Lao PDR, the PD has come to involve himself in discussions with the executives and make comments in meetings and WS more frequently and proactively, which resulted in reducing the workload of the experts. This shows that ownership has been formed on the Lao PDR side.

4.1.3 Collaboration and Coordination with Other Donors

Projects engaged in activities relating to this Project include FSCAP/F-PREP, PAREDD, SUFORD-SU, CliPAD and SN-REDD, and collaboration and coordination with the teams of these projects were sought in accordance with the details of the technology and skills held by them.

CliPAD is engaged in the REDD+ subnational activities in two districts in Houaphane Province, and they have been on good terms with this Project since the time of FIM, and during the implementation of this Project, WS on forest definition and classification was jointly organized with them, which helped in reaching an agreement with DOF and other organizaions concerned. The Project has also been able to maintain good collaboration with SUFORD-SU, as they cooperated with us in the operations of forest classification and we cooperated in the development of forest landscape management method by SUFORD.

Also, in order to collect data and information necessary for designing the next NFI, DOF will send a document to request for submission of such data and information to PAREDD, WWF and SN-REDD to get response from them. With respect to forest definition and land/forest classification, an agreement has been reached with the DOF/DFRM, although the final decision has not yet been made. It is also necessary to send such national-level information about this Project to the subnational and project level REDD+.

4.1.4 Creation of REDD+ Process Chart

In relation to 4.1.1 above, REDD+ will be included as part of the next framework concerning climate change. Preparation of resolutions and framework by the UNFCCC concerning REDD+ has almost finished, and Brazil and several other countries have already submitted a reference level. Moreover, Brazil submitted BUR with the result of MR(V) for the reference level attached as a technical annex at the end of 2014 and the safeguards information outline in May 2015.

Players are getting ready in Lao PDR as well, exemplified by the fact that a project to support the preparation of the FCPF, which will play a key role in the development of the REDD+ strategy, has started. Also, it has been decided that support will be provided to the creation and submission of reference level, construction of NFMS and implementation of the first MRV in accordance with data development through this Project and Sustainable Forest Management and REDD+ Support Project in The LAO PDR. In light of these international and domestic situations, creation of a process chart that covers the development of REDD strategy, creation and submission of reference level, construction of national forest monitoring system, etc. by the REDD+ taskforce was called for at the third REDD+ Taskforce Conference (July 2015) to obtain a basic agreement since creation of such process chart and gaining an agreement on it are effective and essential for

efficient promotion of the implementation of each operation and identification of supporting organizations as well as identification of incidental operations and coordination of such operations.

4.2 Issues for Forest Type Map

4.2.1 Consensus Building with the Non-Forest Sector regarding Forest Definitions and National-level Classification System

This project revised the forest definitions and national-level classification system, and successfully obtained consensus among the forest-sector government organizations, other donors, and forestry experts at universities. However, consensus building with other sectors is also required because the forest definitions and national-level classification system influence not only the forest sector but also many other sectors such as agricultural and land management sectors. Therefore, a request was made to the C/P to promote consensus building, but further efforts should be made to encourage this consensus building.

4.2.2 Continuous Enhancement of Image Interpretation Capabilities

The interpretation capabilities of the C/P RS/GIS technical experts were not uniform due to the impact of personnel relocation and other such factors. Therefore, taking into consideration of the ground truth survey implemented in the first year, the interpretation keys used for correction of the forest type maps were unified and, using this, OJT was provided to strengthen the interpretation capabilities of the C/P. As a result, the C/P came to have better interpretation capabilities, but there still remains a difference in their capabilities. Since the image interpretation capabilities cannot be acquired in a short period of time, it is important to provide technical assistance continuously in the future.

4.2.3 Enhancement of Ground Truth Survey Capabilities

During the ground truth survey, Mr. Soukanh, Deputy Director of FIPD, said that some of the technical experts had little experience in field surveys and had difficulty in accurately determining a forest type in the field, and that training corresponding to the vegetation of each region was required. During the report meeting of the first year survey also, the same opinion was heard from Mr. Khamphay, who was Acting Director General of DOF at the time. In this project, the Japanese technical experts joined each of the teams for one or two days during the ground truth survey and provided field training to them. In the future, it is necessary to prolong the field training period and/or provide field training to the representatives of all the teams gathered in one place, putting more focus on the cultivation of a common understanding.

4.2.4 Issues in Classification of Forest/Agricultural Plantations

The forest/agricultural plantations classified in forest type maps developed in this project cannot

be classified easily on satellite images and therefore are often classified based on the knowledge of the C/P staff who know the local circumstances well through the GT survey. Furthermore, forest/agricultural plantations in mountainous areas do not have apparent divisions that are characteristic of plantations and therefore cannot be easily distinguished from fallow land after slash and burn agriculture. Concession data converted to GIS format will be effective in improving the classification accuracy. However, little concession data has been converted to GIS format at present. Moreover, actual plantations are located in these concession areas that are widely permitted for use as available areas, but the acquirers seldom report about their land development and planting areas, making data conversion difficult. In the future, it will be necessary to pursue conversion of concession data to improve the classification accuracy of plantations. Meanwhile, the execution of this pursuit is expected to be difficult because various interests are going to be involved.

4.3 Issues for Carbon Stratification

4.3.1 Development of the Data Necessary for Evaluation of Uncertainty

It is desirable that carbon stratification be investigated based on evaluation of the overall uncertainty, but at the present time the available data is only the first NFI data for which the national level EF data is an issue, so it was difficult to obtain a conclusion. The next period NFI data is ideal, but forest surveys are being carried out by Finland/World Bank SUFORD-SU for the nationwide production forests, CliPAD of Germany in the northern provinces, this project in the central provinces with the NFI pilot, and the private sector SN-REDD in the southern provinces. It is considered that the next best thing is to compile this data and study it.

4.3.2 Consensus Formation regarding Carbon Stratification

In Section 4.3.1 it was shown that the carbon stratification scheme can be investigated, but in order to determine the final carbon stratification it is essential that there be consultations for consensus formation among those involved. Those involved in carbon stratification include not only the forestry sector, but it is considered that it is also necessary to consult with the departments associated with climate change, as the contacts for international reporting. It is considered that continued support is necessary for consensus formation.

4.4 Issues for Forest Information DB Design

4.4.1 Integration with Existing Forest Information Databases

Integration with Existing Forest Information Databases

This project analyzed the first NFI's DB (ForestCalc) and FIM inventory DB (FoCAS) to discover

that the characteristics of them do not completely agree with each other and that there are issues to be solved in order to use their data in combination. Therefore, it is necessary to store them in the same DB physically, design tables and relations while using the existing DBs as examples, and inherit the functions that have been implemented but avoid integration of tables and data and implement a system for extracting data as required.

Integration with Production Forest Management and Monitoring DB

The production forest management and monitoring DB promoted by SUFORD SU was still in the internal review and design stage when this project was implemented. Although discussion was held on the roles and future directions of the two DBs, no sufficient consensus was reached on the specific operation and technical details such as which data should be shared (input/output) and how sharing should be realized. The next project needs to recheck the progress statuses of the two projects to allow the engineers of the C/P and both the parties to have discussions as required in order to reach consensus on the operation and technical details.

4.4.2 Implementation of Functions for Statistics/Reporting

Automation of Importing and Conversion of Survey Data to DB

The scope of this project was the design of a prototype DB. However, a demo-version R script for promptly analyzing pilot survey data of NFI was also developed. On the other hand, this project did not realize a function for automatic importing and conversion of survey records into a relational DB although a relational DB structure was adopted for the design in consideration of a use in combination with other existing data. The next project needs to organize the future operation methods again and implement a function for importing and conversion if required.

Organization of Requirement Specifications of Domestic Reports

It was confirmed that the types of reports required in Laos were organized through FPP/TA2 activities. However, no specific consensus was reached on the details because neither the carbon stratification nor the NFI survey details were settled at that time. Since the activities of this project have settled the carbon stratification and the NFI survey details and organized the data owned by the concerned ministries and departments, the next project is expected to conduct review and discussion with the C/P and other stakeholders again while providing specific samples.

Customizable Statistics and Report Functions

This project organized data, calculation formulas, constants and information required for international reports. For actual use, it will be convenient if there are statistics and report functions that can be customized according to user needs. Apart from Report Builder of MS, new browser-based services customizable on an interactive basis are being released. Therefore, specific implementation should be conducted while checking the trends and situations of new technologies as required.

4.4.3 Collection and Disclosure of Forest Information Data

Consultation about Information Data Collection

The activities of this project surveyed and confirmed the existence of forest information data in the Department of Forestry and concerned ministries/departments (and acquired part of it as samples). Next, it is necessary to formally request for supply of the data and actually acquire it. It is also necessary not only to collect data but also to inform advantages and feedback information from NFIDB to data suppliers. For this purpose, individual consultation must be conducted regarding the purposes and conditions of using data.

Information Disclosure via Forest Information Platform

This project conducted a demonstration of information disclosure via the forest information platform using collected sample data. Before information disclosure, however, it is necessary to organize the operation processes and regulations regarding, e.g., which data can or should be disclosed, which data should be limited to internal use or browsing, and how approval should be given. Furthermore, the integration of the platform with the ordinary portal sites of ministries/departments and a phased-in realization method must be organized.

4.4.4 Development and Operation of National Forest Information Database

Capability of C/P Staff and Concentration of Workload on C/P Staff in Charge

The forest-sector organizations of Laos have a limited number of C/P staff with related technical skills or knowledge about IT. Through the technical assistance activities so far, some of the C/P staff have acquired a capability of modifying and operating a system by themselves. However, the number of them is limited so that the workload is concentrated on the C/P staff in charge. Therefore, an increase in the number of such C/P staff is urgently required. Even C/P staff who acquired the required capabilities does not yet have sufficient experience to carry out all the DB design and development of the country. Therefore, the utilization of local human resources is essential.

Development System and Future Maintenance and Operation

In Laos, there are insufficient IT-enabled local human resources who understand the forest-sector operations so that workload is concentrated on part of the staff, which remains as an issue to be solved. Therefore, it is necessary to review the development and operation systems including the resources not only in Laos and the forest sector but also in neighbor countries (particularly Thailand with a similar language). The development of a DB using limited assignment to the Japanese consultant is not realistic. In the next project, therefore, it is necessary to secure a DB development budget using local resources and construct development and operation systems involving C/P.

4.5 Issues Concerning design of Next National Forest Inventory

4.5.1 Ability of C/P

Design of NFI

As confirmed through the inventory piloting, FIPD inventory team, which is required to play a key role at least during the on-site survey, is considered to have acquired necessary skills. On the other hand, it has to be admitted that the team has a low understanding of inventory design, such as the reason for adoption of a particular plot design. Inventory design does not simply mean developing the method for grasping carbon stock efficiently, but it should be carried out based on the understanding of the accuracy required of the international community and the method of use, limitation and advantages of each and every piece of equipment among many other factors. It is considered that the director-level staff of C/P has some understanding as they have experience with the 1st NFI, but the level of understanding of the field staff is far from satisfactory. Although the points described above have been repeatedly explained in the technical workshops and inventory piloting training in this Project, they do not seem to get across. It is not necessary to require all the staff to understand 100%, but with respect to several leading members of the inventory team, additional capacity building is necessary when the next NFI is implemented.

GIS and DB skills

As described earlier, FIFD inventory team is considered to have fully acquired the skills required for surveying in the on-site survey and use of tablet. On the other hand, they still need to be supported for the placement of survey plots and setting and preparation of data for tablets. Also, with respect to statistical software R, which was developed immediately before the end of the Project, they have only seen a demonstration on the way to use it and have not been trained in the method of use. Although a high level of technology is required for the development of R, the method of use is very simple. As such, it is expected that training in the method of use will be implemented for the next NFI. Since a certain level of IT literacy (especially in GIS) is needed for the placement of survey plots and data setting for tablet, it will also be necessary to establish a structure for cooperation with the GIS/RS teams of FIPD.

4.5.2 Survey permit and license

The biggest reason for the failure to obtain sufficient number of survey locations in the inventory piloting was that it took longer time than expected to obtain permit for the conservation forests and protection forests managed by the DRFM. After the statement of the survey outline and the letter are submitted by the FIPD to the DOF, the survey license is granted following the course of DFRM, PONRE and DONRE. To avoid such problem, it was confirmed at the final workshop that for the

next NFI, a steering committee should be set up before the start of survey, and a meeting should be organized to explain the survey outline and permit and license with the attendance of organizations concerned. Also, it is expected that inclusion of the DFRM staff in the surveyors will facilitate the process of acquiring the permit and survey in the protection forests and conservation forests.

4.5.3 Finalization of Next NFI Manual

As described in Chapter 3, it took longer time than expected to collect data from the projects implementing surveys relating to inventory. Some of the data have not yet been obtained as of now even though the project has completed. Moreover, some projects, such as the allometric equation development project, are scheduled to complete between 2016 and the dry season of 2017, when the next NFI will be implemented. It is necessary to continue collecting such data and reports to finalize the NFI manual in the next integration project. At present, the following points are considered to require modification.

− Survey method of regenerating vegetation and bamboo

For example, in the allometric equation development project, it is not yet decided if the parameter of the equation for regenerating vegetation should be DBH or the number of years after burning. It is necessary to finalize the NFI manual in accordance with the report of the allometric equation development project.

− Number of survey locations

It may be possible to reduce the number of survey locations in PFA by analyzing the PFA report to be completed by SUFORD in December 2016. It is necessary to recalculate the number of necessary locations after collecting and analyzing other data as well.

− Plot design

As described in Chapter 3, with respect to DBH measurement for each nest, tentative decision has been made, but it is not based on the result of analyzing sufficient amount of data. It is necessary to continue the analysis with the data to be obtained, particularly raw survey data of the PFA report, to finalize the manual.

4.6. Issues Concerning Development of Relevant information required by REDD+

4.6.1 Necessity for Additional Development of AD

There are various methods for preparing REL/RL, but for each of these methods it is necessary to estimate the change in the overall carbon accumulated stock over three or more periods. In this project AD was obtained between two periods by producing the forest type maps for 2000, 2005,

and 2010. Therefore the change in the overall carbon accumulated stock can be estimated over two periods, but in order to satisfy the above requirement forest type maps are required for one more period. The RapidEye images taken in 2015 have been procured using the remaining budget of the Forest Preservation Program, so it is considered desirable to prepare the 2015 forest type maps based on these in order to preserve consistency with the 2010 forest type maps which were prepared based on RapidEye images.

4.6.2 Definition of Forest Degradation and Investigation of Methods of Monitoring

In this report, it has been stated that it was agreed to treat slash and burn fallow land as forest land for reporting to UNFCCC. However in this case the change from evergreen broad leaf forest (EF) and mixed deciduous forest (MD) to slash and burn fallow land would be treated as forest degradation. In the Lao PDR where mixed deciduous forest (MD) and slash and burn fallow land account for almost 80% of the national land, this forest degradation is a large source of emissions, so it is considered that there was no choice but to deal with this forest degradation.

On the other hand, the main drivers of forest degradation apart from this are selective logging, gathering firewood, forest fires, etc., but in any case it is necessary to clearly define forest degradation in some way. It is necessary to investigate how to carry out monitoring of forest degradation.

4.6.3 Carbon Stock Estimate at Tier2

As described in Chapter 3 with respect to the output of cooperation, the biomass stock of each forest type and nationwide forests calculated as an output of this Project are the results of conversion of NFI data in the 1990's by partly using default equations and values, and they are not Tier 2 values that are required by the FCPF or the JNR of VCS.

After discussing with this Project, DOF proposed a nationwide destructive biomass survey (development of allometric equations) with the remaining deposits of the Forest Preservation Program, which was accepted by the Joint Committee. The survey has already started and allometric equations specific to Lao PDR are scheduled to be developed in the middle of 2016. Multiplication of these equations with the results of the second NFI, which will be supported by the Sustainable Forest Management and REDD+ Support Project in The LAO PDR, will enable conversion to average carbon stock estimate by forest type at Tier 2.

4.6.4 Relationship between SG Information and REDD+ Strategy/PaMs

According to the UNFCCC resolutions, safeguards (SG) are to be supported and respected when

developing countries implement REDD+5 activities. Accordingly, it is considered that information to be collected about SG varies depending to the specific details of the REDD+ activities. For example, at the national level, the activities would mainly consist of policies, compliance and measures (nationwide measures would be very limited due to budgetary constraints), but unless the details of the activities are clarified, many issues would remain unclear, such as how to ensure resident participation, what information should be collected and how such activities affect biodiversity. As such, no specific action can be taken to respect SG or to collect/provide information relating to SG.

As national level REDD+ activities would mainly consist of strengthening existing ones and it would be after the completion of this Project that the REDD+ strategy will be formulated, efforts in this Project were focused on grasping matters relating to SG with respect to current laws, regulations and measures.

4.6.5 Verification of Forest Type Changes

Change matrix that shows changes in the area of each forest type every five years provides activity data for the calculation of changes in carbon stock. As it is difficult to distinguish between EF and MD, and MD and RV, it is anticipated that the matrix includes substantial areas of changes of EF＜－＞MD and MD＜－＞RV. The carbon stock per area decreases in the order of EF, MD and RV, but it is necessary to verify if handling of forests (logging, collection of fuel wood, etc.) causes such continuous changes.

If excessive logging of EF is the cause of the change of forest type to MD, this may be specified as deterioration, but considering that the survey result suggests that the composition of major tree species is the same for both types, if the interpretation is based on the existence and density of large diameter trees instead of the percentage of deciduous trees as specified in the definition, it is necessary to change the definition. Also, it is considered that changes of EF and MD to RV are mostly accompanied by logging and burn off. Therefore, RV is not the result of continuous changes but regeneration after forest decline caused by burn off and as such, it is necessary to conduct further studies to determine if this can be specified as deterioration. Opinions of Lao PDR engineers were requested at the final WS, but it was impossible to obtain a clear conclusion.

Chapter5 Suggestions For Achievement of the Overall Goal

5.1 Suggestions in General

Suggestions for achievement of the overall goal "Construction of national forest information system in Lao PDR" are described below.

Contribution to formulation of REL/RL and implementation of MRV

As the design and development of the national forest information system will be carried out in parallel with the formulation of REL/RL (first version) of Lao PDR, it is expected that the content of REL/RL will be reflected in the design and development of the system and MRW, which is consistent with the REL/RL, will be implemented by utilizing the national forest information system in actuality.

At the Third National REDD Taskforce (NRTF) Conference held in July 2015, it was decided to organize six technical WGs (TWG) including that of REL/MRV. It is expected that the TOR and composition of each TWG will be proposed and agreed at the Fourth Conference scheduled in September. It is desired that the full-scale phase of the integrated technical cooperation project will greatly contribute to the REL/MRV operations and the construction of the NFMS, which is the means of these operations, as the lead donor of REL/RL TWG by leveraging on the outcome of this Project.

Contribution to construction of NFMS and operation of SIS

The national forest information system is the foundation of monitoring by the NFMS and should be the storage of update information obtained by monitoring. With respect to the NFMS, it is necessary to continuously acquire satellite data and ground test data and register the analysis result of these data to the national forest information system with the data of each REDD+ activity. Moreover, it is also necessary to disclose information relating to the REDD+ activities by using the forest information platform, which will be installed as a function of the national forest information system, to help in the operation of SIS specific to Lao PDR.

Ensuring consistency with GHG inventory

The MRV of REDD+ under the UNFCCC is supposed to be submitted as an annex of the national level GHG inventory (GHG-I). As such, it is required that the GHG-I in AFOLU sector be consistent with the REL/RL and MR of REDD+. With respect to GHG-I, it is necessary to capture the carbon stock and the area of land for other uses in order to calculate carbon stock changes

accompanying the conversion of forest land to land for other uses, especially farmland or grassland with certain biomass stock, or conversion of such land to forest land. For this purpose, it is essential that the Department of Climate Change and Disaster and the Department of Land Management of MONRE, which are in charge of GHG-I, collaborate with the Department of Farmland Management of MAF. Accordingly, it is necessary to include the staff of these departments concerned in the members of TWG for REL/MRV organized under the NRTF to facilitate the collaboration through discussions in the TWG.

Collaboration and coordination with relevant projects

The other projects described in Chapter 3 are not engaged in data development at the national level, but they have obtained knowledge on REL/RL, SG and other information relating to REDD+ through field activities. Also, Readiness Support Project of the FCPF, which started at the end of 2014, has an REL/MRV component. As such, it is necessary to endeavor to collaborate with these projects in an adequate manner to construct an efficient and user-friendly national forest monitoring system.

Promoting formulation of REDD+ strategy

REDD+ strategy should be developed by the country implementing REDD+, together with reference level, national forest monitoring system (NFMS) and SG information outline. Also, as described in Chapter 3, content of the strategy and the SG information are closely related to each other. The REDD+ strategy that will be created mainly by the FCPF project is not likely to be greatly different from the strategy option described in R-PP, but it may be changed depending on the trend of carbon stock changes identified by this Project and the result of NFI/forest area survey in 2015. As support to strategy formulation is also scheduled in the integrated full-scale phase, reflecting on the result of this Project, it is necessary to urge the C/P to formulate an appropriate strategy as early as possible with no difference in timing from the development of REL/RL and other elements in order not to cause any delay in submission to the UNFCCC.