Document No.:
Receiving Date:
(ForAPFNetSecretariat)

Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

Completion Report

Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia

(August 2013 – May 2014)

Department of Forestry and Community Forestry

Forestry Administration, MAFF, CAMBODIA.

(DFC/FA/MAFF)

Submission Date: 18 June 2014

Basic Project Information

Project Title(ID)		
	Approved	Actual
Date of commence	06 June 2013	
Date of completion	20 Apr 2014	
Extension period	06 June 2014	18 June 2014
Project Budget (in USD) 96886		
APFNet's Grant (in USD)	95,600.00	95,600.00
Counterpart Contribution (in USD)		
Supervisory Agency	Ministry of Agriculture Forestry and Fisheries	
Project Executing Agency	Department of Forestry and Community Forestry, Forestry Administration, MAFF, CAMBODIA.	
Project Director	H.E Dr.CHHENG KIMSUN	

Project description:

To assess different of forest types in term of monitoring changes condition which give us more accurately estimate the carbon sequestration in forest landscapes. Forest's mapping is very significant for the estimation and evaluation of the forest resources, carbon sequestration, and to support sustainable forest management. It plays a key part in the concentrated effort on illegal logging, forest fire monitoring and early warning for forest degradation, the reduction of deforestation, and the improvement of forest quality. This will be achieved by making intensive use of the most recent satellite remote sensing technology. The primary approach of the project will integrate multi-sources remote sensing data, ground measurements and other thematic geographic data. The generate project outcome will help to clarify where the forests cover and can be estimate carbon stock on forest area in Cambodia.

Prepared and Submitted by	**Reviewed and Endorsed by**
_____	_____
Project Director signatureDate	Project Steering Committee Chair signature Date
FOR APFNET USE	
Reviewed and comments by	**Reviewed and comments by**
_____	_____
ED signature Date	PO signature Date

Executive Summary

The maintenance and enhancement of natural carbon stocks is now considered a key climate change mitigation measure. Land-use changes, is primarily through tropical forest loss and degradation. Significantly conversion of forest land, the history of Cambodia's forest is one of the highest levels in forest cover in Southeast Asia, with approximately 10.7 million hectares of forest in 2006 or 59.09% of total Cambodia's land area. The national assessment show that rate of land-use change with Forestry Administration statistics showing that 379,485 hectares of forest were lost between 2002 and 2005/06, deforestation rate of 0.5% per year. As a consequence Cambodia has been classified as a 'high forest cover, high deforestation' economy for the purposes of REDD+ perspective.

Forest cover monitoring methodology is based on multispectral satellite-acquired data have demonstrated potential as a means to detect, identify, and map changes in forest cover. This project was focuses on the role of remote sensing and geographic information system (GIS) in assessment of changes in forest cover and carbon stock, between 2005/06 -2010 in Cambodia. Landsat ETM+/TM5 of remote sensing data were used in this project which total number of 17 scenes of LandsatETM+/TM5 medium resolution satellite imageries were use to map the land cover for the years 2010 and 2005. After performing classification on these images, a total of seven land use classes were identified and mapped.

Field assessment is 100 forest inventory plots have been established at the center of GLAS data for estimating biomass through the combination of field inventory and GLAS signal. All these plots were located at three different forest types namely the dipterocarp forest (Decidiuose broad leaf), and mangrove forest which were located at eight different forest in Cambodia. In term of project monitoring and evaluation the project was monitored both at national level. These two levels of monitoring helped to ensure that all activities planned be undertaken according to the schedule and objectives targeted earlier achieved at the end of the project.

Within the public available of Landsat 8 and full involvement of stakeholders is wise use of resources to produce the outcomes. It is recommended that similar activities be updated continuously close cooperation should be done.

TABLE OF CONTENTS

1. INTRODUCTION

Concern over global problems induced by rising CO2 has prompted attention on the role of forest as carbon 'storage' because forests store a large amount of carbon in vegetation biomass and soil. As climate change becomes more critical in the future, having access to accurate forest types maps and conditions will give us more accurately predict the carbon sequestration capacity in the forested landscapes. Forest's mapping is very significant for the estimation and evaluation of the forest resources, carbon sequestration, and to support sustainable forest management.

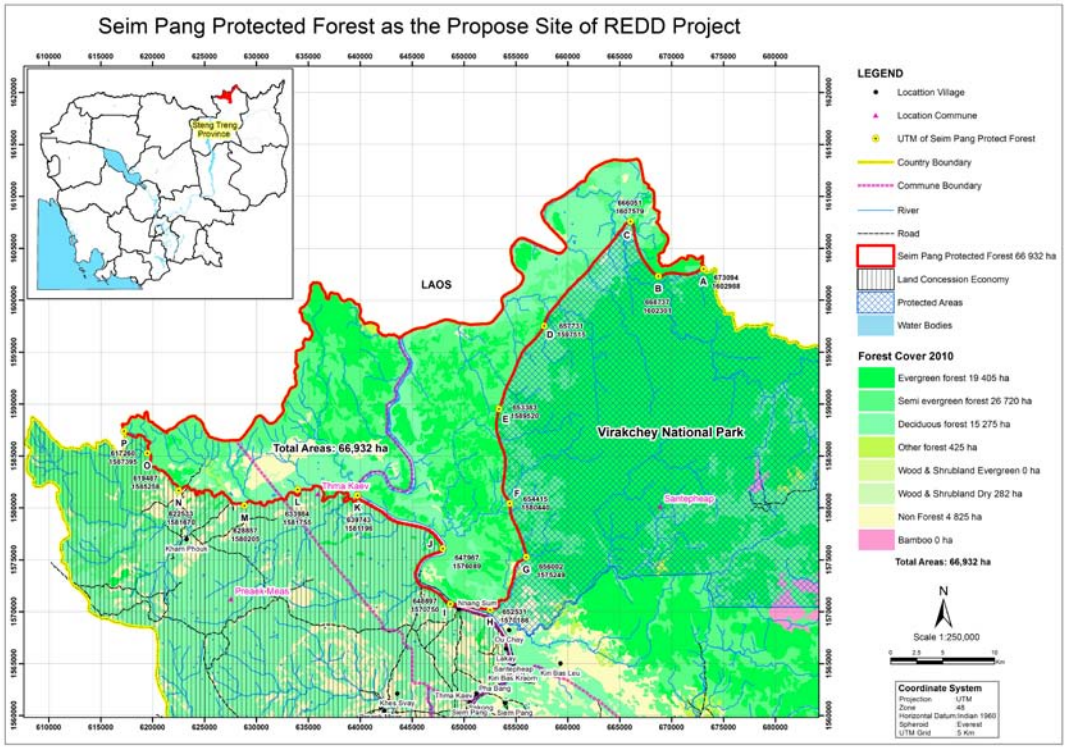
This report describes the completion and results of our forest cover change analysis activities using satellite data from years 2005/06 and 2010. Within these two different years(2005/06-2010) of Cambodia forests were mapped using satellite data. The result showed that the rate of deforestation rate of 0.5% per year. As a consequence Cambodia has been classified as a 'high forest cover, high deforestation' economy for the purposes of REDD+.One point must be kept in mind that in the beginning of 2002's there were considerable developmental activities such as urban development (road construction, new settlement programmes, urban expansion...), Economic land concession (agro-plantation, rice production) etc., which directly affected the forest cover particularly in forest landscape regions.

1.1 Test Site Descriptions

Western Siem Pang is located in the far north-eastern Cambodia, in Stung Treng Province, adjacent to the international border with the Lao PDR (Laos) (Map 1). One of the Mekong's largest tributaries, the Sekong, flows through Western Siem Pang. This river is central to the local communities of Western Siem Pang and the culture and economy of the province as a whole. Western Siem Pang comprises a still largely forested lowland landscape that adjoins several existing protected areas both in Cambodia and Laos. To the north and west across theborder in Laos lies the ecologically very similar XePian National Protected Area (NPA), whileacross the Sekongriverto the east in Cambodia lies Virachey National Park (NP). Togetherthese three areas fit within an even larger contiguous area of protected areas including theNam Gong Provincial Protected Area and Dong Amphan NPA areas in Laos, and Chu MomRay National Park in Vietnam. At well over 66,932 ha this landscape is one of the larger'wilderness' protected landscapes in the region. The proposed Western Siem Pang ProtectedForest covers a somewhat different area from the Western Siem Pang Important Bird Area.

The land cover of project test site containing certain of forest typesevergreen forest and semi-evergreen (evergreen broadleaf), decidiuose forest, woodshrub evergreen, woodshrub dry and non forest.

Figure1: Showing location of project test site



2.PROJECT GOAL, OBJECTIVES AND FORMULATION

2.1Project Goal

The primary development goal of the project aim is to estimate forest coverage and carbon storage mapping in Cambodia by applying simple and acceptable methodologystandard in order to support and participate in the APFNet project of "**Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia** (GMS)".

2.2 Project Objectives

This project is reflected to global concerning on the climate change issue. It is conduct by FA's officer and the objectives are as follow:

1. To produce forest distribution maps of 2005 and 2010 for Cambodia
2. To establish the Remote Sensing data base and generate forest distribution map in test sites of Seim Pang Protected Forest
3. To measure 100 field plots centered by ICES at GLAS footprint from typical forests for biomass estimation.
4. To estimate classification validation plots (50 plots for each class) for forest distribution maps evaluation
5. To establish the database of existing data and reference forest maps.

2.3 Project Designing

To ensure the smooth implementation of this project, a working committee had been established consisting of experts in Forestry Administration, forest researcher and development of remote sensing and forest biomass in this institution. This working committee is involving specialist in forest management, forest inventory, remote sensing and GIS expert. All committee members have worked together with the responsibility to ensure the project progress as planned base on the following work packages:

WP1: Project design and management includecapacity on forest distribution maps
WP2: Generate Remote Sensing Map Base on Forest Distribution in Testing Site(Methods development)
WP3: Remote sensing data acquisition and pre-processing (Mid-resolution forest mapping product)
WP4: Forest above ground biomass mapping product
WP5: Classification validation
WP6: Prepare database of Existing data
WP7: Reporting and dissemination

The proposed demonstration sites in Cambodia were chosen primarily to represent the different forest types. Table 3 shows the summary of information of the different sites.

Name	Organization	Expert	Position	Responsibility
Mr. Makara MEAS	FA/DFC	GIS/Forest Management	Proj. Adviser	WP1, WP5, WP7,
Dr. SokhHeng	FA/IRD	Forest Research Management	Proj. Adviser	WP1, WP7
Mr. Chivin LENG	FA/DFC	RS and Forest Management	National Focal Point and Proj. Leader	WP1, WP2, WP5, WP7
Mr. Pak Chealy	FA/DFC	RS/GIS	RS/GIS, Expert	WP2, WP3, WP4
Mis. SophyraSar	FA/DFC	RS/GIS	RS/GIS, Expert	WP2, WP3, WP4, WP7
Mr. Preap Sam	FA/DPlantation	RS/GIS	RS/GIS, Expert	WP3
Mr. VathanaKhun	FA/DFI	Researcher	Biomass analysis	WP6
Mr. Ing P. rattanak	FA/DFC/WFA	GIS	GIS/Carbon inventory	WP6
Mr. Hem Saravuth	FA/DFC/WFA	GIS	GIS/Carbon inventory	WP6

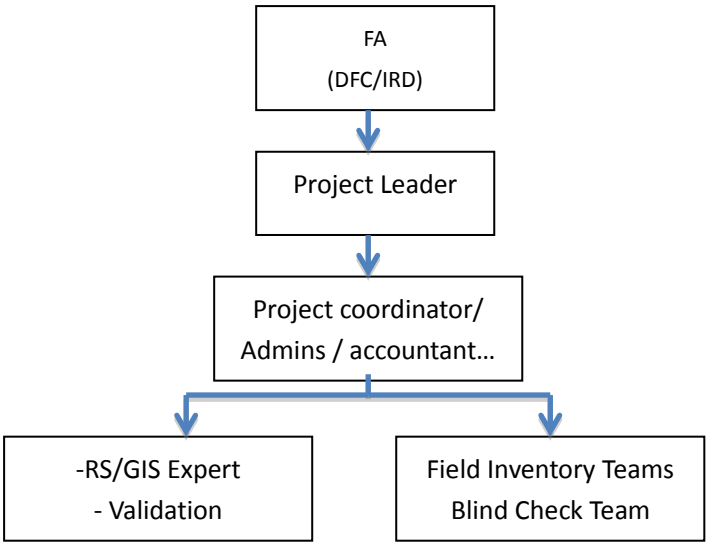
Mr.EarBunareth	FA/DFC/WFA	GIS	GIS/Carbon inventory	WP6
Mr.DorongKhi	FA/DFC/WFA	Forest Inventory	Field Assistant	WP6
Mr.NarinNeth	FA/DFC/WFA	Forest Inventory	Field Assistant	WP6
Mr. Ann Prak	FA/DFC/WFA	Forest Inventory	Field Assistant	WP6
Mrs. NaboreyHout	FA/DFC/WFA	Forest Management	Financial/Admin	Financial /Admin
Mrs. Ben Kea	FA/DFC/WFA	Forest Management	Admin	Administration

3. PROJECT EXECUTION

3.1 Start-up

The project team comprises two main experts from the remote sensing group (to focus on satellite and classification processing); inventory group (to focus on forest inventory activity) and following coordination/admin process . Upon formation of the team, the first task undertaken by the team was to review the project elements, get updates of the project site, conduct relevant literature reviews, the propose project operational framework and detail work plan. Initial consultation with the relevant stakeholders in particular the Forestry Department of Peninsular Malaysia (FDPM) was also undertaken to ensure their continuous support during implementation of the project. The initial stages of the implementation focused on the collection of secondary data, and the compilation and preparation of base map of the project area. Subsequently, a collection of new forest field inventory at the center of GLAS footprint and ground truth mapping activities were gathered.

Figure2: Project organization structure



3.2 Implementation schedule

Activities	Executed	Planed Completion	Extended Completion	Status
Outcome 1: Capacity on forest distribution maps of 2005 and 2010 for Cambodia	100%	Dec. 2013	Dec 2013	Completion
Outcome 2: Generate Remote Sensing Map Base on Forest Distribution in Testing Site	100%	Aug 2103	Oct 2013	Completion
Outcome 3: Field Measurement for Biomass Estimation	100%	Dec 2013	Feb 2014	Completion
Outcome 4: Classification validation	100%	Oct 2013	Apr 2014	Completion
Outcome 5: Prepare database of Existing data	100%	Feb 2014	June 2014	Completion

3.3Revision

No revision of the project out come has been done. But the classification procedure result of 2005 and 2010 is re classed due to confusion of GMS's project strategy. That is why segmentation of forest classes had been done again and cause time delay.

3.4Procurement and consultancy

In general, the flow and the use of the project fund have been appropriated to enable the implementation of the planned activities. There were several PC computer desktop and laptop and printers need for data processing classification of forest as well as forest inventories equipment purchased during the execution of this project including the purchased of Global Positioning System (GPS), camera and other forest equipment and tool to ensure smooth execution of the forest inventory activity.

3.5Monitoring, evaluation and reporting

In terms of methodology, semi-automatic segmentation classification and manual editing was used. After classification, the preliminary spectral classes were visually interpreted and compare with reference information and field survey knowledge. Then, the preliminary classes were merged subjectively to obtain meaningful classes of vegetation and land covers. During classification process, expert committee form Forestry Administration, JICA-CAMREDD and FAO-UNREDDprovided guidance on matters pertaining to the implementation of the project and ensures that the project is directed towards achieving its intended goals.

3.6Efficiency and effectiveness

The sustainable forest management requires the current information; fresh and consistent data are needed. It will provide a decision tool for understanding ongoing forestry activities and the development of future policies to help sustainably manage forests in the country. That is why this kind of information system development project is very useful in implementing Sustainable Forest Management practices within the region.

The project was designed efficiently such that all the objectives were achieved according to the plan. The execution of the project was in accordance with the milestones and expectation outlined during preparation of the proposal. The participation and support given by the targeted stakeholders; which is the forestry departments were very encouraging throughout the project implementation. Their active participation among others was reflected during the field data collection. In general, it can be said that the project was implemented on schedule except a short extension given to carry out the field survey and updating the landuse classification activity that was given by bad weather condition (raining season) and time delay of budget allocation.

3.7Project Costs and Sources

A total of USD 39400.00 (first allocation) and USD 38090.00 (second allocation) of project fund had been received respectively from APFNet. However, until 31 May2014, about USD 82547.80 has been spent. There is an excess use of project budget of USD 5057.8; this is due to the additional time in implementing the field survey activities because of unpredictable weather condition during the implementation of this project.

As following we had receive in both time allocation budget from APFNet until project time end in April 2014 of USD 77490.00 (USD 39400+38090) which is still amount of USD 19388.02 left that not been yet requested from APFNet due to final map product not been yet produced and significantly the auditor also not been yet audited.

3.8Dissemination

The project outputs and findings from this project will be disseminated to the various interested stakeholders. Among others, the project materials and outputs will be published in the form of a technical book. At the end of the project, relevant government agencies in Cambodia, particularly the forestry and community department of Forest Administration will have better understanding on the forest cover and forest changes in Cambodia and can contribute to better management of this ecosystem in the future.

4. PROJECT STAKEHOLDERS'PERFORMANCE

4.1Supervisory Agency

Forestry Administration(FA) of Ministry of Agriculture Forestry and Fisheries (MAFF) is government body and the leading agency to implementAPFNet project in Cambodia. FA is responsible for the managing of natural resources (Forest management including monitoring of forest, Wildlife and biodiversity conservation and other environmental protection). The main responsibility of FA is monitor the project progress and to ensure the successful implementation of all activities specified in the project document.

The monitoring committee comprising leader of FA department, FA research institute plus REDD+ technical expert JICA-CAMREDD and FAO-UNREDD which carry out meeting at least one time per month, to govern the implementation of the project.

4.2 Executing Agency

The Forest Administration (FA) is the key government agency in the forestry sector in Cambodia. There are also a large number of other actors including forest-dependent ruralcommunities, Development Partners (DPs), investors and international and national NonGovernmental Organizations. In 1998 the Royal Government of Cambodia (RGC) initiatedthe forestry reform process by establishing a national committee on forest policy reform withsupport from DPs. In 2002, the secretariat of the committee formulated a national forestpolicy statement. Subsequently, a new Forest Law was promulgated in 2002, and a newForestry Administration was established in 2003 (replacing the former Department ofForestry & Wildlife).

During the starting period of the project, a project team member were identified and recruited within the scientists in FA based on their expertise and knowledge on the subject of interest. The team comprises of one project leader and another experts with the remote sensing expertise by adequate monitoring from project adviser in order to ensure the smooth implementation of this project, a working committee was established consisting of experts and development of remote sensing and forest biomass.

Dissemination of project outputs was done at various levels including by presenting the results and finding at seminar and workshop, publishing articles related to the study in various publications. Throughout the implementation of the project, a series of technology transfer was undertaken through training on various aspects related to the project including training on the use of remote sensing for forest biomass estimation.

4.3Other project partners

The monitoring committee (FA research institute, JICA-CAMREDD and FAO-UNREDD) also known as project partner, the main responsibilities among others are to provide assistance and approval for the project team to undertake field survey in their respective forest areas. In addition they also provide other forest related information such as forest types, management history, and forest status to be used by the project in undertaking data analysis.

Overall, project partners had contributed substantially in various aspects in line with their roles and responsibilities for the project. The information provided and assistance rendered by them had made major contribution in ensuring the success of the project. Without their full commitment no doubt it will be very difficult for the project to achieve its goals and outcome.

4.4 APFNet

The project strategy, technical guidance and other arrangement is guided by APFNet for the project implementation. But for Cambodia, signing agreement will take time due to administration process and other government procedured which cause some delay in budget disbursement which is distracted some of implementing project activities. That mean we receive 1st disbursement was received on end of July 2013 is about more then a month after official date of project signing, while second disbursement received on February 2014. All this had in one way or another effect the overall implementation of the project activities in particular the field survey works. Therefore for the next second phase project, please send us the project contract at least 3 month ahead.

Besides that there is no clear problem in term of communication since most of the time it had been well communicated mainly through email and other internet services.

5.RESULTS

5.1Achievements

This project was focuses on the role of remote sensing and geographic information system (GIS) in assessment of changes in forest cover and carbon stock, between 2005/06 and 2010 in Cambodia.The project provide more convenient on the technical support procedures required for the sound management through establishment of robust National Forest Monitoring system (NFM). RS/GIS Unite of Forestry Administration (FA) which is using satellite imagery for evaluating changes in forest cover in several different components of the current forest estate, including active forest concessions, cancelled forest concession, protected forests. The cover assessment will discriminate between evergreen/mixed forests, deciduous forests and other forest types.

Biomass governs the potential carbon emission that could be released to the atmosphere due to deforestation, and regional biomass changes have been associated with important outcomes in ecosystem functional characteristics and climate change. Accurate delineation of biomass distribution at scales from local and regional to global becomes significant in reducing the uncertainty of carbon emission and sequestration, understanding their roles in influencing soil fertility and land degradation or restoration, and understanding the roles in environmental processes and sustainability (Foody et al., 2003).

The classification maps contained details spatial distribution of land use information. This information is useful particularly to discover the driving forces of the forest changes and could provide supporting information for the policy maker of Cambodia government agency (Forestry Administration). A total of 100 plots have been established at the center of GLAS data for estimating biomass through the combination of field inventory and GLAS signal. All these plots were located at three main different forest types namely the evergreen broadleaf and dipterocarp forest (decidouse broadleaf) and mangrove forest which were located at differences of forest landscape. It was found that the distribution of biomass within the plot is average 111.72t/ha of above ground carbon stock while below ground biomass is about 18.3t/ha.

Through this project, FA able to produced map of forest area (2005/06 and 2010) as the output of this project provides information on the status of forest areas. Two series of forest cover maps (2005/06 and 2010) gave valuable information on the changes of forest areas within that period. This would help us in determining the status of their forest areas whether if there a still forest in that particular area or the forest is degraded.

It was noticed that forest cover has dramatically decreased between 2005/06 and 2010, due to the development of agro-plantation, expended of rice paddy field, horticulture and urban development etc. It is envisage that this project would prove the usefulness of remote sensing and geographic information system in forest resource management. The maps produced could serve as a platform for assessing and monitoring forest resources in Cambodia.

5.2 Good stories,best practices,intelligence products to be shared in the region

This project has given valuable knowledge and experience to FA's Cambodia. This project has strengthened FA’s relationship with other related department such as the Forestry Department, forest research institute, Agro-based Industry and other partners. Our activities related improving capacity in term forest monitoring and forest inventory has become faster developed and easy with well cooperation and instructed by them in particular the technical development from this project such as biomass mapping using both field and remote sensing data is useful to the country. The data information can be use by the authority for better plan and manage the remaining forests areas in this country.

5.3Lessons learned and outstanding issues

- Development Lessons:

Similar to point 5.1 above, the project offer and improvingmore technical support procedures required for the sound management through establishment of robust National Forest Monitoring system (NFM)lead to translate to the framework of UNFCCC guidelines for the preparation of REDD+ RLs for consideration by negotiators as part of a SBSTA decision on modalities for REDD+ RLs. Participated economies will be required to

establish a system for monitoring, reporting and verifying emissions reductions.

Among others, one important factor in the project design which should be consider in the future is on the allocating some adequate reserve time for field survey activities in anticipating problem to do field survey due to the bad weather as well as difficult accessibility to the project site in unpredictable tropical weather condition as well as tropical forest environment.

· Operational Lessons:

The project design was enable effective implementation of the entire project. Close collaboration with the supervision of project adviser had enabled all necessary decision to implement the project achieved on time and without delay. Early consultation with the partners including the forestry departments helped in getting support and approval from them to undertake field survey and other project activities. This indirectly support led to an interest by the staff to learn and gain more knowledge related to the work.

5.4Impacts

Result of project outcome has given positive impact to the country in general and in forestry sector in particular. The carbon and biomass distribution maps will be used by the relevant authority in this country to plan for better resource management taking into consideration of local and global climate change related issues. This would provide direct benefits for the country and the region. The information on forest carbon distribution and its important will also protect the forest ecosystem and contributes towards the conservation of biological diversity. This will provide benefits not only to Cambodia but also to the global community. The output project activity which is generated,will have long term effect and it is important to be sustainably managed. It is anticipated that FA will plays an important role to ensure the project sustainability beyond the project life span.

6. SUSTAINBILITY

The information and results from the project will be used in other project activities like ITTO REDD+ project of Forestry Administration in particular Department of Forestry and Community Forestry. The complement of project result provides robust information for sustainable management and utilization of the forest resources in Cambodia. The project outcome provides inputs for the policy makers and forest managers on designing appropriate strategy to manage forest in a sustainable way in order to maximise the social, economic and environmental benefits and cultural values of the Kingdom of Cambodia and Cambodian people harmonize with sustainable forest management principle.

7.RECOMMENDATIONS

The achieving of project activities could be development effective of Cambodia monitoring systems lead to establishment of current MRV information system, fresh and consistent data are needed. That is why this GMS+ project is very useful in practicing Sustainable Forest Management in Developing of Cambodia country.

From the starting of project point, early consultation with identified committee helped in getting support and approval from them to undertake the project in the proposed project site. For the future cooperation, it is recommended that any project should put an emphasis in taking necessary stakeholder consultation process as early as possible to ensure the smooth project implementation.

Additionally, also from the beginning within all country members should be commonly agreed on the project template rather than confusion concept was happen during implementation process.

Within the public available of Landsat 8 and full involvement of stakeholders is wise use of resources to produce the outcomes. It is recommended that similar activities be updated continuously close cooperation should be done.

Annex(es):

Annex A: Implementation schedule
Annex B: Details of project cost by category

Annex A Implementation schedule(scheduledversus actual)

Activities	Executed	Planed Completion	Extended Completion	Status
Outcome 1: Capacity on forest distribution maps of 2005 and 2010 for Cambodia	100%	Dec. 2013	Dec 2013	Completion
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Outcome 5: Prepare database of Existing data	100%	Feb 2014	June 2014	Completion

Annex BDetails of project cost by category (scheduled versus actual)

Expenses (USD)	APFNet Grant			
	Anticipated A_1	Actual B_1	Variance $C_1(A_1-B_1)$	Variance rate $D_1(C_1/A_1*100\%)$
Project staff cost[1]				
Salary	30775	27575	**3200**	**0.1040**
Subtotal				
Consultancy cost[2]				
Local Consultant	1000	1000	**0**	**0.0000**
Travel and related cost[3]				
Oversea Meeting	13000	8128	**4872**	**0.3748**
Meeting and training cost[4]				
Workshop	2500	2417.4	**82.6**	**0.0330**
Meeting	600	259.75	**340.25**	**0.5671**
Training		698	**-698**	
Subtotal	**3100**	**3375.15**	**-275.15**	**-0.0888**
Field activities cost[5]				
Field Measurement	27577.5	23167.5	4410	**0.1599**
Blind Check	5687.5	5575	**112.5**	**0.0198**
Verification and validation	3000	5975	**-2975**	**-0.9917**
Subtotal	**36265**	**34717.5**	**1547.5**	**0.0427**
Publication &Dissemination cost[6]				
Binding Final Report	200	0	**200**	**1.0000**

Annex BDetails of project cost by category (scheduled versus actual)

Office Operation cost[7] Stationary	1000	938.4	**61.6**	**0.0616**
Procurement [8]				
Field Equipment	945	939.75	**5.25**	**0.0056**
Office Equipment	5980	5834	**146**	**0.0244**
Subtotal	**6925**	**6773.75**	**151.25**	**0.0218**
Monitoring, evaluation and audit cost[9]				
Miscellaneous[10]	4613.025	40	**4573.025**	**0.9913**
TOTAL	96878.025	82547.8	**14330.225**	0.1479

Principle for budget estimation:

1. The budget should be calculated in USD rather than any other local currency.
2. Subtotal should be calculated if there is more than one sub-category under each category.
3. The budget should include both funding proposed from APFNet and contribution from other channels. Counterpart contribution should account for no less than 20% of totalbudget, please mark the in-kind contribution in italics and bold.
4. For pilot and demonstration projects, APFNet's grant should be used mainly on the project activities, while the counterpart contribution is suggested to cover the budget items such as rental of office premise, equipment, administrativemanagement, internal monitoring and financial audit.

Annex BDetails of project cost by category (scheduled versus actual)

Notes for budget completion (for each category clarification):

1. Project staff cost: each post should be identified and recorded on a separate budget subline.Full job descriptions should be attached.
   To guarantee efficient use of project fund, the number of the posts should be kept at a minimum levelaccording the specific requirement of each project.
2. Consultancy cost: especially for independent local and international consultants or consultancy firm to assist in project design, conduct external project evaluations and the like. Individual consultants should be offered consultancyservice agreements (terms of reference for each consultant should be attached), firms should be offered institutional contracts.
   Each category should be identified and recorded on a separate budget subline.
   The international consultancy fee may be detained and paid directly by APFNet.
3. Travel and related cost: should be used for budgeting air fare, local travel and per-diem etc for the purpose of project implementation.
4. Meeting and training cost: should be used for budgeting organization and participation in training courses, seminars, workshops and so on, which generally includes the meeting/training venue, facility, hospitality, speakers/experts' fees, interpretation.
   The approximate number of participants should be indicated together with tentative agenda and level of the meeting and trainings.
5. Field activities cost:
   When it is necessary to rent land to implement a project, the cost should be estimated and shown againstthis line.
   The project funding must not be used to purchase land or building.
   The benefit for local staff, the local labor and cost for seedlings, fertilizers, material, goods, tool to facilitate the implementation of project activities at local level, in particular for pilot and demonstration projects, should be estimated and shown on a separate budget subline.
   The cost for other field activities, such as case study and filed survey/research, should be estimated and shown againstthis line.

6. Dissemination & publication cost: should be used for budgeting formulation, editing, printing, publishing of articles, reports, books and information products and outreach activities.

7. Office Operation cost:
   Project administrative management fee and administrative staff cost should be not more than 10% of the total budget.
   Generally, the administrative staff is determined according to the specific requirement of the project, which generally include accountant, documentation officer, driver and so on. Full job descriptions for each position should be attached.
   When it is necessary to purchase or rent premises to implement a project, the cost should be estimated and shown againstthis line.

Annex BDetails of project cost by category (scheduled versus actual)

8. Procurement of equipment:

When it is necessary to purchase or rent equipment or vehicle to implement a project at local level, the cost should be estimated and shown againstthis line. Maintenance of equipment or vehicle should also be budgeted under this line.

9. Monitoring, evaluation and audit cost:internal monitoring, external evaluation and financial audit are a must do to ensure project implementation on track. The cost for external evaluation may be detained and paid directly by APFNet.

10. Miscellaneous: Cost for miscellaneous should be not more than 5% of the total budget.

11. A_1refers to the anticipated amount of APFNet's grant, B_1 refers to the actually imbursed/reimbursed amount of APFNet's grant, C_1refers to the difference between the anticipated and actually imbursed/reimbursed amount of APFNet's grant, D_1refers to the variance rate. Accordingly, A_2, B_2, C_2,D_2,refer to the corresponding amount of the counter part fund.

12.All variance rates above 10% need to explained in the Project Financial Statement of the Project Progress Report, supported by detailed justification irrespective of whether they are negative or positive. The explanations should be specific to the relevant budget items. Please refer to budget heading/budget line and also to logframe outputs and indicators as applicable and include explanations of any changes to the total number of units compared to forecast, or the cost per unit.

Project Completion Report Instruction:

1. Project Director prepares the completion reporton behalf of Executing Agency (EA), responding to APFNet concerns.
2. Submission should be consulted with project partners and endorsed by Project Steering Committee (PSC), with signatures of Project Director and PSC Chair on behalf of EA and PSC;
3. Completion reports should be submitted within2 months after project termination date.

Document No.:
Receiving Date:
(For APFNet Secretariat)

Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

Completion Report

Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia

2011.09-2014.04

Guangxi Forest Inventory and Planning Institute

2014.05

Basic Project Information

Project Title(ID)	Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia (APFNet/2011/PA/004)	
	Approved	Actual
Date of commence	Sep. 1, 2011	Jun. 10, 2011
Date of completion	Aug. 31, 2013	Mar. 30, 2014
Extension period		
Project Budget (in USD)		
APFNet's Grant (in USD)	50,800.00	50,800.00
Counterpart Contribution (in USD)	20,000.00	14,850.00
Supervisory Agency		
Project Executing Agency	Guangxi Forest Inventory and Planning Institute (GXFIPI)	
Project Director	Li Chungan	

Project description:

1) To establish the database of existing data and reference datum.
2) To establish the remote sensing database and generate forest distribution maps in test sites.
3) To measure 100 forest field plots centered by ICESat GLAS footprint from typical forests for biomass estimation.
4) To establish classification validation plots (50 plots for each class) for forest distribution maps evaluation.
5) To produce forest distribution maps of 2005 and 2010.

Prepared and Submitted by	**Reviewed and Endorsed by**
Project Director signature Date	Project Steering Committee Chair signature Date
FOR APFNET USE	
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ED signature Date	PO signature Date

Executive Summary

Forests play a vital role in sustainable development and provide a range of economic, social and environmental benefits, including essential ecosystem services such as climate change mitigation and adaptation. Guangxi province is located in the south of China and the northeast of the Greater Mekong Subregion (GMS). Guangxi is rich in forest resources and biodiversity, but the forests have been undergoing rapid changes due to human activities.

Forest monitoring is very important for the estimation and evaluation of the state of forest resources, carbon sequestration, and the results of forest program implementation. It plays a key part in the crackdown on illegal logging, forest fire monitoring and early warning for forest degradation, the reduction of deforestation, and the improvement of forest quality. Also, forest monitoring to support sustainable forest resources management can result in earth observation data and technical support for countries to effectively fulfill their obligations arising from international environmental conventions.

This will be achieved by making intensive use of most recent satellite remote sensing technology, producing regional forest cover maps, documenting forest change processes and estimating carbon storage in the Guangxi province. As a partner in this project, all the activities under the overall framework of the project have been completed. Three main results of the project are expected as below:

(1) Developing a framework for mapping forest cover using remote sensing technology in Guangxi province.

(2) Producing forest cove maps of 2005 and 2010 in Guangxi province.

(3) Enhancing the capacity of remote sensing imagery processing, classification in Guangxi Forest Inventory and Planning Institute (GXFIPI).

Background and Rationale

Guangxi is China's most important timber -producing areas, annual timber production accounts for about one -seventh of whole country. In Guangxi province, the main landscapes including hilly land, limestone karsts, plain and mesa. Most forests are ever-green which composes of masson pine, Chinese fir, eucalypt and broad-leaf trees. With the high-level management, most plantations have high productivity and quality.

In the last 30 years, GXFIPI had accumulated a plenty of forest inventory data which come from field measurement. These data include forest management inventory data for every 10 years, national continuous forest inventory data for every 5 years and high resolution remote sensing data (SPOT5 and ALOS) covered the whole province. These previous inventory data and remote sensing data will be help to complete the forest mapping.

Goal and Objectives

The primary goal of the project is to estimate forest coverage in Guangxi province using integrated multi-sources remote sensing data, ground measurements and other thematic geographic data. The outcomes of this project help to clarify the changes of forest coverage in Guangxi and improve the capacity of using remote sensing. The specific objectives as following:

(1) Produce forest cover maps of 2005 and 2010 at 30 m spatial resolution in Guangxi province.

(2) Improve the capacity of using remote sensing for forest monitoring through training workshops and implementation of this project.

Outputs and Outcomes

The following outputs and outcomes had been accomplished or produced through this project:

(1) Remote sensing database

The satellite imageries of Landsat TM had been collected and processed. A remote sensing database had been established and make available to different users of the project.

(2) Ground truth database

According to the standards designed by the project steering committee, we had collected the ground truth data and established ground truth database which contains of the continuous forest inventory data and forest management inventory data. These data provided fundamental training and validation data for remote sensing products.

(3) Mid-resolution (30m) forest map product in 2005 and 2010

According to the standard classification system, the forest cover maps of 2005 and 2010 had been produced using Landsat 5 TM images. These forest maps contain more details land cover classes information. This information is useful to discover the driving forces of the forest changes and can provide supporting information for policy maker from local relevant government in Guangxi.

(4) Measurement of 104 field plots covering ICESat GLASS footprint

103 field plots which centered by ICESat GLAS footprint have been measured in three test sites, among them, 34 plots were located in Shangsi county, 33 plots were located in Hengxian county and 36 plots were located in Rongsui county.

Result

The output of CFI of 2005 and 2010 indicated detailed the change of quantity and quality of forest resources in Guangxi, as the CFI was based on the systematic sampling plots by 8 kilometer × 6 kilometer, it could not produce the forest cover map of 2005 and 2010, so it is very difficult to know where the forest change happened.

By means of the overlap analysis of the forest distribution map of 2005 and 2010 produced by the GMS+ project, the detail information of spatial change of forest resources in Guangxi is available, it is very helpful to understand where the forest change had happened which is very useful for policy maker of local government.

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1. INTRODUCTION

Guangxi province is located in southern China, stretches 104°26′ with 112°04′ of eastern longitude and 20°54′ with 26°24′ of northern latitude, with a total area of 2.376 million square kilometers, a population of about 50 million. Mountainous hills, plains, plateaus, karst widely distributed in 78 counties of the region's 110 counties. From north to south, the province extends across mid-subtropical, south subtropical and north tropical, so it is rich in sunlight and plenty in rainfall. After decades of protection and development, Guangxi has rich forest resources, is the most abundant forest resources of provinces in China. According to the 8th review of continuous forest inventory (CFI) in 2010, Guangxi has 13.427 million hectares of forest, equal to 56.51 percent of total land area (percentage of forest cover), and 577.17 million cubic meters of forest stock volume. Among them, 9.041 million hectares are timber forest, 1.782 million hectares are cash forest, 0.341 million hectares are bamboo, and 2.263 million hectares are shrub. There are 4.75 million hectares of natural forest and 4.290 million hectares of artificial forest, accounting for 52.55 % and 47.45 % of forest, respectively. From 205 to 2010, the region has 55.77 million cubic meters of forest volume growth, and the consumption of forest stock volume is 48.225 million cubic meters. With the country's largest, highly intensive plantations (mainly eucalyptus), Guangxi is China's most important timber -producing areas, annual timber production accounts for about one -seventh of whole country.

For decades, a lot of forest resources inventory and survey had been carried out in Guangxi, include the CFI which started in 1977 and reviewed every five years, forest management inventory (FMI) which conducted every ten years, and a variety of the special survey, such as mangroves survey, wetland survey, rocky monitoring, desertified land monitoring and etc. Therefore, Guangxi has accumulated a large number of forest inventory and survey data, high resolution remote sensing data including SPOT5 and ALOS images, etc. Guangxi has also established a database of forest resources, and realized preliminary the digital management of forest resources, provided massive amount of basic data for state and local government to make strategy of forestry development, policies and regulations.

From the CFI, it is clear that the status and change of quantity, quality, structure of forest resources in Guangxi between 1977 and 2010, however, as the CFI was based on the systematic ground sampling plots by 8 km × 6 km, it could not produced forest cover map, so we lock the spatial information of forest change, and are unsure of where the forest changes happened in, which affected the scientific forestry decisions. In addition, Guangxi has not been carried out forest carbon storage estimation so far.

Since the implement of the project of Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia in 2011, we have established the database of Landsat 5TM remote sensing images, produced the forest cover map of 2005 and 2010, estimated the aboveground forest carbon of 2005, enriched the information of forest resources of Guangxi, and then provides much more useful information for state and local policy maker.

1.1 Background and Rationale

With the output of CFI, it is clear that the change of forest quantity and quality had happened in Guangxi, because the CFI is based on the systematic sampling of 8 km by 6 km in the ground, it did not produce the forest distribution map, so it could not proved the information which indicated where the forest change had happened, these information are very useful to formulate the forestry strategies, policies and regulation for state and local government. It is essential for us to produce forest cover map for every 5 or less years.

1.2 Expected Outputs and Outcomes

The following outputs and outcomes will be accomplished or produced through this project:

(1) Remote sensing database

The satellite imageries of Landsat TM, SPOT5 and ALOS will be collected and processed. A remote sensing database will be established and made available to different users of the project.

(2) Ground truth database

According to the standards designed by the project steering committee, we will collect the ground truth data of three test sites to establish ground truth database which contains previous and current land-cover maps, field measurements, and forest inventories. These data will provide fundamental training and validation data for remote sensing products.

(3) Measurement of 100 plots centered by ICESat GLAS footprint in three test sites

Field measurement of 100 plots which centered by ICESat GLAS footprint in three test sites (Shangsi county, Hengxian county, and Rongsui county) need to be finished. These plot information are help to estimate the forest above carbon storage in Guangxi and in the Greater Mekong subregion and Malaysia.

(4) Mid-resolution (30m) forest cover map production in 2005 and 2010

According to the standard classification system, the forests in Guangxi will be mapped at mid-resolution (30m) in 2005 and 2010 using Landsat TM images. These forest maps will contain more details land cover classes information. This information is useful to discover the driving forces of the forest changes and can provide policy decision supporting information to the local relevant government in Guangxi.

(5) High resolution forest cover map production in three test sites

Very high resolution remote sensing images (≤2.5 m), such as SPOT5 HRG and ALOS PRISM, will be used to map forest distribution in three test sites, these maps will have very detail information of forest distribution and will be useful for sustainable forest management.

2. PROJECT GOAL, OBJECTIVES AND FORMULATION (max 1 pages)

2.1 Project Goal

The primary goal of the project is to estimate forest coverage and carbon storage in Guangxi province using integrated multi-sources remote sensing data, ground measurements data and other thematic geographic data. The outcomes of this project would help to indicate the changes of forest coverage in Guangxi and improve the capacity of using remote sensing imagery for mapping forest cover.

2.2 Project Objectives

The specific objectives of the project as following:

(1) Establish the database of remote sensing images, database of ground truth validation.

(2) Produce forest cover maps of 2005, and 2010 using Landsat 5 TM images (spatial resolution is 30 m) in Guangxi province.

(3) Produce a forest carbon storage map for 2005 in Guangxi province at 300-500m spatial resolution.

(4) Improve the capacity of using remote sensing for forest monitoring and forest biomass estimation through training workshops and implementation of this project.

2.3 Project Designing

2.3.1 Strategy and plan

In order to finish the project, obtain the expected objective, following measures were taken in the implementation of the project.

(1) Constituting a project team. Team members came from Guangxi forest inventory and planning institute (GXFIPI), technical officers from forestry bureau of three test sites. There are 21 project team members, of whom 8 persons are from GXFIPI, and 4 persons are from forestry bureau of Shangsi county, 5 persons are from forestry bureau of Hengxian county, 4 persons are from forestry bureau of Rongsui county. All the participants have bachelor degree, some of them have master or Ph D. degree and, have extensive experience in remote sensing image processing, forest classification or forest inventory and surveying.

(2) Making a detail work plan. The project team had analyzed in detail the goals, objectives and output achievements of the project, divided the task into several parts, determined the completion time of each key node, as well as the person responsible for the specific task. The project progress was evaluated regularly based on the plan.

(3) Holding five workshops. In order to unify the technical standard, and ensure the quality of the project output, five workshops had been hold during the implement of the project, of which two image classification workshops were hold in GXFIPI, the topics dealt with the image classification strategy, object-oriented classification, classification accuracy assessment. The other three GLASS measurement workshops were held in three test sites which dealt with the GPS navigation, plots positioning and setting, field measurement, photo taking and so on. Professional experts form GXFIPI went to three test sites to guide the field measurement of the GLASS plots.

(4) Making full use of the database of the implementing agency - GXFIPI, including database of FMI, CFI, and datasets of various specific investigations, as well as the databases of high spatial resolution remote sensing data, such as SPOT5 and ALOS images.

2.3.2 Key stakeholder of the project

GXFIPI is not only one of the implementing agencies, but also the institute which are interest in the outcome of the project output. As one of the most important provincial forestry technical department of Guangxi, GXFIPI is responsible to provide the basic information to the economic and social policy maker, forestry development planning from state and local department of forestry, and local government.

The forestry department of Guangxi province is very interest in the forest cover map of 2005 and 2010.

2.3.3 Risk management and control for the project

In order to ensure the successful completion of the project, the project team careful studied the possible problems which would happen during the project implementation, and took corresponding measures, which include:

(1) The accuracy of image classification lower than the requirements of the project. To avoid this problem, a lot of tests had been conducted for the remote sensing image classification, including supervised classification, unsupervised classification, object-oriented classification, and hybrid method - classified the image into forest land and non-forest land by object-oriented classification, then, supervised classification were applied to the subsets of forest land and non-forest land, respectively. The result indicated that the object-oriented classification had the higher accuracy than other methods, and which could make full use of the database of forest inventory and surveying.

(2) Fields measurement of GLASS plots would be difficult to carry out. 100 plots were distributed in three test sites which is far from each other, and most plots were located in the mountains where were difficult to reach, not only the field measurement was difficult to carry out, but also the progress was difficult to control. As there were good cooperation between GXFIPI and the local forestry bureau of three test sites, three local forestry bureaus were invited as the project partner to conduct the field work of the GLASS plots. Therefore, GXFIPI had compiled *the guidance for setting and measuring the GLASS plot* and held three workshops to train and guided the investigators.

3. PROJECT EXECUTION

3.1 Start-up

3.1.1 Supervisor and project team

The director of GXFIPI was invited to be the supervisor of the project, the dean of section of technology and quality of GXFIPI served as the secretary of the project. The project team constitute of 21 menbers, of whom 8 person were from GXFIPI, 13 person were from local forestry bureaus of three test sites including Shangsi county (FBSSC), Hengxian county(FBHXC) and rongsui county (FBRSC).

3.1.2 Work scope and responsibility of key project personal

The work scope and responsibility of every person of project supervisor and project team as list blow.

Table 3.1 Project executing agency and technical assistance partner

Function	Name	Title	Organization	Responsibility
Project supervisor	Liang Jianping	Supervisor	GXFIPI	Progress controller and finance supervision (2011.09-2013.05)
	Zhao Zehong	Supervisor	GXFIPI	Progress controller and finance supervision (2013.06-2014.04)
Project management board	Li Chungan	Project director	GXFIPI	Full charge of the project and forest cover mapping of 2005 and 2010 of Guangxi using TM images
	Mo Zuping	Project secretary	GXFIPI	Assist the director, particularly in finance management.
Technical assistance partner	Tan Bizeng	Project partner	GXFIPI	Forest cover mapping of 2005 and 2010 of Guangxi using TM images
	Dai Huabing	Project partner	GXFIPI	Forest cover mapping of three test sites using hi-resolution image of SPOT5 and ALOS
	Fu Qiang	Project partner	GXFIPI	forest cover mapping of 2005 and 2010 of Guangxi using TM images
	Ge Yongpan	Project partner	GXFIPI	Field measurement of GLASS plot
	Wei Longbin	Project partner	GXFIPI	Database of remote sensing
	He Baihua	Project partner	GXFIPI	Ground truth database
	Zhang Lianhua	Project partner	GXFIPI	Training and guiding of field measurement of GLASS plot
	Li Gao	Project partner	FBSSC	Field measurement of GLASS plot
	Li Feng	Project partner	FBSSC	Field measurement of GLASS plot
	Lv Qihui	Project partner	FBSSC	Field measurement of GLASS plot
	Qin Wuquan	Project partner	FBSSC	Field measurement of GLASS plot
	Zhong Raoxing	Project partner	FBHXC	Field measurement of GLASS plot
	Nong Cheng	Project partner	FBHXC	Field measurement of GLASS plot
	Li Honghe	Project partner	FBHXC	Field measurement of GLASS plot
	Lin Guochang	Project partner	FBHXC	Field measurement of GLASS plot

Function	Name	Title	Organization	Responsibility
	Yang Yecai	Project partner	FBHXC	Field measurement of GLASS plot
	He Shaoning	Project partner	FBRSC	Field measurement of GLASS plot
	Mo Xinqiang	Project partner	FBRSC	Field measurement of GLASS plot
	Mo Songnian	Project partner	FBRSC	Field measurement of GLASS plot

3.1.3 Management of the project financial

GXFIPI is in charge of management of the project founding, the finance section of GXFIPI is responsible for controlling the expenses of the project founding. Each expenditure was approved and signed by the director of GXFIPI and the dean of the finance section of GXFIPI according to the project progress and the funds expense plan, and national finance regulations.

3.1.4 Monitoring & evaluation and reporting mechanisms

According to the project management requirements, the project director from GXFIPI reported the project progress and the next phase plan regularly to APFNet and the executing agency of the project - the Institute of Forest Resource Information techniques of Chinese Academy of Forestry (IFRIT, CAF).

Each project members reported regularly the progress to project director every month, who conducted a comprehensive assessment of the progress and adjustment tasks of the project members every half year.

3.1.5 Work plan for the first year

Activities to be undertaken in the first year are as following:

(1) WP1: Remote sensing database

The satellite imageries of Landsat 5 TM, SOPT5 and ALOS will be collected and processed by GXFIPI. A multi-resource remote sensing database will be established and made available to every users of the project.

(2) WP2: Ground truth database

The ground truth data will be collected to establish the ground truth database follow the standards designed by the project steering committee. The ground truth data will contain previous and current land-cover maps, field measurements, and forest inventory and surveying data in 2005, 2009 and 2010. These data will provide fundamental training and validation data for remote sensing products.

(3) WP3: Field measurement

In 3 selected test sites (Shangsi County, Hengxian County and Rongshui County), field data will be collected for forest coverage mapping. 100 field plots will be measured which centered by ICESat GLAS footprints. These field data will be used for estimating forest above biomass and carbon storage in Guangxi and in the Greater Mekong subregion and Malaysia.

(4) WP4: Framework and methods development

In Guangxi province, a framework and methods will be developed for forest mapping using remote sensing images. The following methods will be developed. (i). Mid-resolution (30m) forest cover map of 2005 and 2010 of entirely Guangxi using Landsat TM images. (ii).High resolution (2.5 m) forest cover map of 2009 of three test sites using SPOT5 and ALOS images.

(5) WP5: Forest map products in 3 test sites

Produce forest cover change maps of 2009 using high resolution remote sensing imagery of SPOT 5 or ALOS.

Specific schedule is as following:

Table 3.2 Schedule of first year in Guangxi province, China

Activities	2011						2012					
	9	10	11	12	1	2	3	4	5	6	7	8
WP1												
WP2												
WP3												
WP4												
WP5												

3.2 Implementation schedule

Compared to the initial work plan, the outcome of output, completion time had been adjusted to some extent during the implement of the project. The outputs and key activities are listed as follows:

Output 1: Remote sensing database

Activity 1.1: Collected remote sensing data of Landsat 5 TM in 2005 and 2010 from IFIRT and processed, include data format transformation, image layer stack, image subset based on the boundary of Guangxi province.

Activity 1.2: Collected the high resolution remote sensing data of SPOT5 and ALOS from GXFIPI.

Activity 1.3: Established the multi-resolution remote sensing database.

Output 2: Ground truth database

Activity 2.1: Collected the sample plots data in 2005 and 2010 of Guangxi Continue Forest Inventory (GXCFI) from GXFIPI and processed, include coordinate system transformation and attribute table editing.

Activity 2.2: Collected subcompartment data from the forest resources database of Guangxi in 2009 which established by GXFIPI and processed, include coordinate system transformation and attribute table editing.

Activity 2.3: Collected data of mangrove forest distribution in Guangxi by means of the dynamic database of mangrove in Guangxi (1960-2010) which established by GXFIPI and processed, include coordinate system transformation and attribute table editing.

Activity 2.4: Established the multi-resource ground truth database.

Output 3: Forest cover map of 2005 and 2010 using Landsat 5 TM images

Activity 3.1: The framework and method development for forest or land use / land cover classification using Landsat 5 TM images.

Activity 3.2: Algorithm testing.

Activity 3.3: Forest mapping in 2005.

Activity 3.4: Forest mapping in 2010.

Output 4: Forest cover map in 2009 in three test sites using hi-resolution remote sensing image of SPOT 5 and ALOS

Activity 4.1: The framework and method development for forest or land use / land cover classification using SPOT 5 HRG and ALOS PRISM/AVNIR-2 images.

Activity 4.2: Algorithm testing.

Activity 4.3: Forest mapping in 2009 for Shangsi county, Hengxian county and Rongsui county.

Output 5: Measurement of field plots covered ICESat GLAS footprint in three test sites

Activity 5.1: Field plot measurement of GLASS footprint.

Activity 5.2: Standardize the measurement data.

Table 3.3 Anticipated and actual completion time and key points of the results achieved of all activities

Outputs &activities	Completion time		Key points of the results achieved (qualitative or quantitative)	
	Anticipated	Actual	Anticipated	Actual
Output1				
Activity 1.1	Dec., 2011	Jul., 2012	19scenes of TM image of 2005 and 2010 respectively.	Completed according to the plan.
Activity 1.2	Dec., 2011	Dec., 2011	4 scenes of SPOT 5 image in Shangsi, 3 and 4 scenes of ALOS image in Hengxian, and in Rongsui respectively.	Completed according to the plan.
Activity 1.3	Dec., 2011	Jul., 2012	All the data listed above had been integrated in a database.	Completed according to the plan.
Output2				
Activity 2.1	May, 2012	Apr., 2012	Thematic map contained 4946 plots of CFI.	Completed according to the plan.
Activity 2.2	May, 2012	Apr., 2012	Thematic map contained 157 thousand subcompartments of FMI.	Completed according to the plan.
Activity 2.3	May, 2012	May, 2012	Thematic maps of mangrove distribution in 1960/1976, 1990s,2001, 2007, 2010 in Guangxi.	Completed according to the plan.
Activity 2.4	May, 2012	May, 2012	All the data listed above had been integrated in a database.	Completed according to the plan.
Output3				
Activity 3.1	Nov., 2012	Jun., 2013	Methodology of Object-oriented classification and supervised classification.	Completed according to the plan.
Activity 3.2	Dec., 2012	Jul., 2013	Algorithm testing.	Completed according to the plan.
Activity 3.3	Feb., 2012	Nov., 2013	Lower accuracy of classes ≥70 %, total accuracy ≥80 %.	
Activity 3.4	Feb., 2012	Nov., 2013	Lower accuracy of classes ≥70 %, total accuracy ≥80 %.	
Output4				
Activity 4.1	Jun, 2012	Nov., 2013	Methodology of Object-oriented classification and supervised classification.	Completed according to the plan.
Activity 4.2	Jul, 2012	Dec., 2013	Algorithm testing.	Completed according to the plan.
Activity 4.3	Aug., 2012	Jan., 2014	Produce forest cover map in three test sites.	Completed according to the plan.
Output5				
Activity 5.1	Apr., 2012	Aug., 2013	A total of 100 plots, of which, 34 plots in Shangsi, 33 plots in Hengxian, and 33 plots in Rongsui.	A total of 103 plots, of which, 34 plots in Shangsi, 33 plots in Hengxian, and36 plots in Rongsui
Activity 5.2	May, 2011	Nov, 2013	Standardize the measurement data.	Completed according to the plan.

Variety of factors lead to the delay of the project plan, include:

(1) A lot of time had spend on images processing and the development of classification algorithms, they had not been finished until the end of Jun 2013, therefore, the production of forest cover map of 2005 and 2010 was delay. Some tests were tried to eliminate the shadow in image processing and the result was obvious in image display, but the effect was not ideal in image classification. Many methods were test in the image classification, including supervised classification, unsupervised classification, object-oriented classification and hybrid classification.

(2) Since 2012, the technical officers from local forestry bureau of three test sites had been busying in the planning of forest land protection and utilization and couldn't carry out the field measurement of GLASS plots. The field work of plot couldn't start until early 2013, and it led to the delay of field work of GLASS plots.

3.3 Procurement

Some computer equipments had been purchased during the project implementation, including two Lenovo computer, a laptop (ThinkPad X201i 32493JC), 2 Seagate hard disks (1000GB). The total expense is $ 6,500, which was $100 less than the original budget ($6,600).

According the government' procurement regulations for the small instrument and equipment of China and Guangxi, the procurement plan was reported by GXFIPI and was approved by the finance department of Guangxi, finally, all equipments were purchased by the procurement center of Guangxi government.

3.4 Monitoring, evaluation and reporting

APFNet and IFRIT held a workshop or meeting every six months, all implementation agencies had to reported their project progress, problem and solution, next phase plan, as well as the use of grant funds.

Meanwhile, GXFIPI had to make a detail written report to IFRIT and APFNet, the content include: project progress, problems and solutions, expenses incurred, work plan for next phase.

3.5 Efficiency and effectiveness

The abundant outcomes had been achieved though the implementation of the project, include:

(1) Forest cover map of 2005 and 2010 of Guangxi, of which the map of 2005 had not been produced before.

(2) 103 plots which centered by ICESat GLASS footprint had been measured, that were helpful for the mapping forest carbon storage in Guangxi and in the Greater Mekong subregion and Malaysia.

(3) Eight professionals from GXFIPI had got excellent training in remote sensing image processing and classification, their ability to deal with remote sensing had been improved significantly.

During the implementation of the project, GXFIPI had contributed $ 48,500 of supportive funds, of which $ 12,000 had been paid for the salaries of project secretary, $2,850 were paid for the miscellaneous, such as paper, notebooks, pens, printer supplies and so on, the other were paid for purchased the remote sensing images. Each project members from GXFIPI had spent two to three months on the project enery year, which was equal to a total of 40 months. Project members from three test sites had spent 20 months on the project all told.

3.6 Project Costs and Sources

The total funding of the project was $77,950, of which $50,800 was funded by APFNet, $ 26,900 was provided by GXFIPI.

The supportive funds was $ 12,050 more than the original plan of $ 14,850, the mainly cause was that two scenes of SPOT5 images had not been calculated in the original budget. In fact, GXFIPI had provided 5 scenes of SPOT5images, 15 scenes of ALOS images for mapping the forest cover of three test sites.

3.7 Dissemination

During the project implementation, the project team had released four pieces of online news related project workshop on the website of GXFIPI.

4. PROJECT STAKEHOLDERS' PERFORMANCE

4.1 The implementation agency of project in Guangxi

As the implementation agency of the project in Guangxi, GXFIPI was responsible for all the project works in the Guangxi province, which main included:

(1) Producing forest cover map of 2005 and 2010 using Landsat 5 TM images;

(2) Producing forest cover map of 2009 in three test sites using high resolution images of SPOT 5 and ALOS, and ;

(3) Guiding the field measurement of GLASS plots in three test sites.

GXFIPI had completed all the project tasks and produced all the project outputs, however, production of forest cover map and field measurement of GLASS plots had been delayed.

In addition, GXFIPI had contributed $ 26,900 of supportive funds, and provided a lot of forest inventory and surveying data, as well as several scenes of hi-resolution images to the project team, all which is very important for accomplishing the project in Guangxi province.

4.2 Other project partners

13 project partners from the local forestry bureau of three test sites were in charge of the field measurement of GLASS plot, they had overcame the difficult of high hills, steep slope, traffic inconvenience and so on, had finished the field work of 103 plots, three plots more than the plan.

All three forestry bureaus of test site had provided free vehicles to the project partners during the field measurement of GLASS plots.

5. RESULTS

Since the project was officially launched in September 2011, the project team has achieved great accomplishment:

Firstly, forest cover maps of 2005 and 2010 of Guangxi have been produced, of which the map of 2005 have not been produced before. With these maps, professional could conduct qualitative and quantitative analysis of the status and change of forest resources between 2005 and 2010 in Guangxi, and the official of forestry department and local government could gain a better understand of the problem and potential of forestry development in Guangxi, which are helpful in making policies for sustainable forest management.

Secondly, members of the project team had received excellent training during the project implement. The training subjects included remote sensing image processing, various methods of image classification, GLASS plot setting and measuring, all of these were very helpful for their career.

Forestry department of Guangxi had paid close attention to the project outcome, they quoted directly the forest cover map of 2005 and 2010 in their plans.

Some researchers were interest in the project output, they used the forest cover map of 2005 and 2010 as the reference data in their studies.

6. SUSTAINBILITY

Forest resources information is the base for sustainable forest management decision, it needs to be updated yearly to keep its up- to- date. The methodology have been used for decades to collect forest change information based on field work has several shortcomings, such as low efficiency, high cost, low accuracy and so on, otherwise, since the launch of SPOT5 in 2002, high resolution remote sensing images had been being available, however, they were so expensive that they were difficult be used in actual implementation, therefore, forest resources information have not been updated effectively so far, this problem had seriously affect the sustainable forest management decisions. Since 2010, China have launched several hi-resolution satellites, such as Mapping satellite-1, Earth resources satellite series, Gaofen-1, with short cycle and low price or free, hi-resolution images have begun widely application in China. Nowadays, It is possible to get forest change information through change detection of remote sensing images, combining with the necessary field work, we can updated the forest resources information accurately, and provide accurate and reliable forest resources information for sustainable forest management decision-making.

Since 2012, GXFIPI has done a lot of test of forest change detection using hi-resolution remote sensing images, and developed the information platform of forest resources. Since the beginning of 2014, yearly update of forest resources information has been carried out for entirely Guangxi.

Annex(es):

Annex A: Implementation schedule
Annex B: Details of project cost by category

Annex A Implementation schedule (scheduled versus actual)

Outputs &activities	Completion time		Key points of the results achieved (qualitative or quantitative)	
	Anticipated	Actual	Anticipated	Actual
Output1				
Activity 1.1	Dec., 2011	Jul., 2012	18 scenes of TM image in 2005 and 2010 respectively.	Completed according to the plan.
Activity 1.2	Dec., 2011	Dec., 2011	4 scenes of SPOT 5 image in Shangsi, 3 and 4 scenes of ALOS image in Hengxian, and in Rongsui respectively.	Completed according to the plan.
Activity 1.3	Dec., 2011	Jul., 2012	All the data listed above had been integrated in a database.	Completed according to the plan.
Output2				
Activity 2.1	May, 2012	Apr., 2012	Thematic map contained 4946 plots of CFI.	Completed according to the plan.
Activity 2.2	May, 2012	Apr., 2012	Thematic map contained 157 thousand subcompartments of FMI.	Completed according to the plan.
Activity 2.3	May, 2012	May, 2012	Thematic maps of mangrove distribution in 1960/1976, 1990s,2001, 2007, 2010 in Guangxi.	Completed according to the plan.
Activity 2.4	May, 2012	May, 2012	All the data listed above had been integrated in a database.	Completed according to the plan.
Output3				
Activity 3.1	Nov., 2012	Jun., 2013	Methodology of Object-oriented classification and supervised classification.	Completed according to the plan.
Activity 3.2	Dec., 2012	Jul., 2013	Algorithm testing.	Completed according to the plan.
Activity 3.3	Feb., 2012	Nov., 2013	Lower accuracy of classes ≥70 %, total accuracy ≥80 %.	
Activity 3.4	Feb., 2012	Nov., 2013	Lower accuracy of classes ≥70 %, total accuracy ≥80 %.	
Output4				
Activity 4.1	Jun, 2012	Nov., 2013	Methodology of Object-oriented classification and supervised classification.	Completed according to the plan.
Activity 4.2	Jul, 2012	Dec., 2013	Algorithm testing.	Completed according to the plan.
Activity 4.3	Aug., 2012	Jan., 2014	Produce forest cover map in three test sites.	Completed according to the plan.
Output5				
Activity 5.1	Apr., 2012	Aug., 2013	A total of 100 plots, of which, 34 plots in Shangsi, 33 plots in Hengxian, and 33 plots in Rongsui.	A total of 103 plots, of which, 34 plots in Shangsi, 33 plots in Hengxian, and36 plots in Rongsui
Activity 5.2	May, 2011	Nov, 2013	Standardize the measurement data.	Completed according to the plan.

Annex B Details of project cost by category (scheduled versus actual)

Expenses (USD)	APFNet Grant				Counterpart Fund			
	Anticipated A_1	**Actual B_1**	**Variance $C_1(A_1-B_1)$**	**Variance rate $D_1(C_1/A_1*100\%)$**	**Anticipated A_2**	**Actual B_2**	**Variance $C_2(A_2-B_2)$**	**Variance rate $D_2(C_2/A_2*100\%)$**
Project staff cost[1] (salary and allowance for project staff and management personnel)					12,000	12,000	0	0.00
Subtotal					12,000	12,000	0	0.00
Consultancy cost[2] (local and international consultants' cost)								
subtotal								
Travel and related cost[3] (air fare, local travel, per-diem and etc)	5,600	5,600	**0**	0.00				
Meeting and training cost[4] (venue, facility, hospitality, speakers/experts' fees , participants accommodation, meeting material, etc)								
Field activities cost[5]	33,800	36,300	**-2,500**	-6.89				
Publication & Dissemination cost[6] (formulation, editing, publishing of articles, reports, books and information products and organization of outreach activities, media activities)								
Office Operation cost[7] (project administrative management fee and administrative staff cost, lease/rental of office premises, office and facility maintenance, etc)	4,800	2,400	**2,400**	100.00				
Procurement [8] (purchase of vehicles, equipment, facilities etc)	6,600	6,500	**100**	1.54	***0***	***12,300***	***-12,300***	***0.00***
Monitoring, evaluation and audit cost[9]	0	0	**0**	0.00	0	0	0	0.00
Miscellaneous[10]	0	0	**0**	0.00	2,850	2,600	0	0.00
Subtotal	50,800	50,800	0	0.00	2,850	14,900	-12,050	-422.58
TOTAL	50,800	50,800	**0**	0.00	14,850	26,900	-12,050	-81.14

Principle for budget estimation:

1. The budget should be calculated in USD rather than any other local currency.
2. Subtotal should be calculated if there is more than one sub-category under each category.
3. The budget should include both funding proposed from APFNet and contribution from other channels. Counterpart contribution should account for no less than 20% of total budget, please mark the in-kind contribution in italics and bold.
4. For pilot and demonstration projects, APFNet's grant should be used mainly on the project activities, while the counterpart contribution is suggested to cover the budget items such as rental of office premise, equipment, administrative management, internal monitoring and financial audit.

Notes for budget completion (for each category clarification):

1. Project staff cost: each post should be identified and recorded on a separate budget subline. Full job descriptions should be attached. To guarantee efficient use of project fund, the number of the posts should be kept at a minimum level according the specific requirement of each project.
2. Consultancy cost: especially for independent local and international consultants or consultancy firm to assist in project design, conduct external project evaluations and the like. Individual consultants should be offered consultancy service agreements (terms of reference for each consultant should be attached), firms should be offered institutional contracts. Each category should be identified and recorded on a separate budget subline. The international consultancy fee may be detained and paid directly by APFNet.
3. Travel and related cost: should be used for budgeting air fare, local travel and per-diem etc for the purpose of project implementation.
4. Meeting and training cost: should be used for budgeting organization and participation in training courses, seminars, workshops and so on, which generally includes the meeting/training venue, facility, hospitality, speakers/experts' fees, interpretation. The approximate number of participants should be indicated together with tentative agenda and level of the meeting and trainings.
5. Field activities cost: When it is necessary to rent land to implement a project, the cost should be estimated and shown against this line. The project funding must not be used to purchase land or building. The benefit for local staff, the local labor and cost for seedlings, fertilizers, material, goods, tool to facilitate the implementation of project activities at local level, in particular for pilot and demonstration projects, should be estimated and shown on a separate budget subline. The cost for other field activities, such as case study and filed survey/research, should be estimated and shown against this line.
6. Dissemination & publication cost: should be used for budgeting formulation, editing, printing, publishing of articles, reports, books and information products and outreach activities.
7. Office Operation cost: Project administrative management fee and administrative staff cost should be not more than 10% of the total budget. Generally, the administrative staff is determined according to the specific requirement of the project, which generally include accountant, documentation officer, driver and so on. Full job descriptions for each position should be attached. When it is necessary to purchase or rent premises to implement a project, the cost should be estimated and shown against this line.
8. Procurement of equipment: When it is necessary to purchase or rent equipment or vehicle to implement a project at local level, the cost should be estimated and shown against this line. Maintenance of equipment or vehicle should also be budgeted under this line.
9. Monitoring, evaluation and audit cost: internal monitoring, external evaluation and financial audit are a must do to ensure project implementation on track. The cost for external evaluation may be detained and paid directly by APFNet.
10. Miscellaneous: Cost for miscellaneous should be not more than 5% of the total budget.
11. A_1 refers to the anticipated amount of APFNet's grant, B_1 refers to the actually imbursed/reimbursed amount of APFNet's grant, C_1 refers to the difference between the anticipated and actually imbursed/reimbursed amount of APFNet's grant, D_1 refers to the variance rate. Accordingly, A_2, B_2, C_2,D_2,refer to the corresponding amount of the counter part fund.
12. All variance rates above 10% need to explained in the Project Financial Statement of the Project Progress Report, supported by detailed justification irrespective of whether they are negative or positive. The explanations should be specific to the relevant budget items. Please refer to budget heading/budget line and also to logframe outputs and indicators as applicable and include

explanations of any changes to the total number of units compared to forecast, or the cost per unit.

Document No.:
Receiving Date:
(ForAPFNet Secretariat)

Asia-Pacific Network for Sustainable Forest

Management and Rehabilitation

Completion Report

Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia: Lao PDR

[Sept 2011- Feb 2014]

Faculty of Forestry, National University of Laos

17 June 2014

BasicProject Information

Project Title(ID)	**Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia: Lao PDR**	
	Approved	Actual
Date of commence	1st September 2011	17 November 2011
Date of completion	30 August 2013	
Extension period	30 February 2013	30 June 2014
Project Budget (in USD)		
APFNet's Grant (in USD)	90,640	
Counterpart Contribution (in USD)	24,400	
Supervisory Agency	Department of Forestry, Ministry of Agriculture and Forestry	
Project Executing Agency	Research Division	
Project Director	Sithong Thongmanivong	

Project description:
This is a complement project to support a regional project named**"Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia"**. The projectis to map the forest and land cover for the whole GMS country and Malaysia. The project applied multi-sources remote sensing data and ground survey to map out forest cover and above ground carbon content.

Prepared and Submitted by	**Reviewed and Endorsed by**
_____	_____
Project Director signatureDate	Project Steering Committee Chair signature Date
FOR APFNET USE	
Reviewed and comments by	**Reviewed and comments by**
_____	_____
ED signature Date	PO signature Date

Executive Summary

The objective of this report is to summarize the outcomes of the project on monitoring forest cover changes and estimating carbon stocks in Laos. The Research Division of the Faculty of Forestry, National University of Laos as executing agency implemented this project since the late of 2011. The results of the project was tosupport the Greater Mekong Sub-region and Malaysia (GMS+) projectto estimate the forest cover and above ground biomass in the GMS+ countries. We investigated and collected existing GIS and RS data from various projects and government organizations. In total 9,975 RS data set, including 8,490 scenes of aerial photosacquired in 2012, 229 silts of Landsat data acquired between 1989 to 2010 and 1,256 silts of RapidEyes images acquired in 2010. In addition, other GIS dataset were also collected. We used a combination approach for image classification, in which the object-based classification (OBC) was used as the base of image processing. We used GPS to collect ground truth data of 850 points to support the image classification and to validate the result of image classification. We conducted forest measurement in the test sites of different forest types base on the ICESAT GLAS footprint. In total, 120 sample plots were established. We complete all the tasks andfinally delivered the data to the Institute of Forest Resource Information Techniques (IFRIT), Chinese Academy of Forestry, China for further analysis.

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1. INTRODUCTION

This completion report gives summaryof the results attempting to assess the forest and land cover changes and to estimate theforest carbon stocks in Laos to support a regional project named "**Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia"**.It wasa two-year project began from 1st September 2011 and extended until the 30th February 2014. The project was funded by the Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet) and technical support by the IFRIT of China. However, its completion was delayed until June 2014 due to some activities were suspended including fieldwork and image processing activities.

2.PROJECT GOAL, OBJECTIVES AND FORMULATION

2.1Project Goal

The overall goal of the project was to analyze and understand the current conditions of forest covers and their changes including the carbon forest for the entire country of Laosduring the period of2005 and 2010.

2.2 Project Objectives

The objectives were to:

1) establish a national remote sensing and GIS database available in the governmental agencies and development projects
2) investigate the forest cover changes for the entire country of Laos between 2005and 2010 and to analyze the causes and driving force to those changes
3) conduct ground truth data collection of each forest and land cover type to support image processing and map validations.
4) conduct forest survey s and estimate the forest carbon stocks in the pilot sites base on the ICESAT GLAS foot print at least 100 sample plots.
5) enhance forest cover mapping capacity and collaboration with government agencies dealing with natural resource management in Laos

2.3 Project Designing

The activities design was developed base on the GMS+ project's framework, underan official cooperation with the Department of Forestry, Ministry of Agriculture and Forestry, and with technical supports from IFRIT. Faculty of Forestry (FoF), National University of Laos (NUoL) was assigned as the main organization responsible for the implementation of this project including image processing, data analyzing, field surveying and evaluating the results. There were 15 team members, including 6 permanent staffs (RS/GIS experts) and 9 temporally technical assistants. The fieldwork was coordinated and collaborated with the local authorities of the forestry sector at the province and district.

The project implementation can be divided to three main parts; (1) forest measurement in the sample plot of different types of forest to support carbon mapping base on the ICESAT GLAS footprint, (2) remote sensing data processing, and (3) ground truth data collection to assessthe image processing results and mapping accuracy assessment.

3. PROJECT EXECUTION

3.1 Start-up

After the projectapproved, we started up with a team mobilization and organize meeting to discuss about the objectives, expected outcome of the project. The project's methodologies and activities were also defined.We then followed up by organizingan internal trainingworkshop for the project team members especially on image processing and methodologies for field data collection.

3.2 Implementation schedule

Almost activities were completely implemented as plan, although some activities werea bit delayed such asfieldwork activity due to climate conditions and the first funding installment process took longer than expected. Thus we had to postpone this work to the later dry season.

3.3 Revision(if any)

A forest survey, planned to carry out in Nam Et, a National Biodiversity Conservation Area was cancelled and changedto the southern province(Champasak) instead. However, the re-location of the forest survey had no anyimpact on the overall project.

As a consequence of updating government personal structure, two of the team members were moved to other organizations (Chanthakart moved to Vientiane Province and Thoumthone wentto study at Copenhagen). Therefore, the team had to include three new members in project.

3.4Procurement and consultancy

We purchased two new personal computers for the image processing and GIS analysis and storage devises to back up the RS datasets. Robogeo software was also purchased to handle with the geo-referencing series of photos from a field.

An external consultant was hired to assist specific tasks such as image processing and final result evaluationof remote sensing processing. This was to ensure the quality and effective outcome of the project output.

3.5Monitoring, evaluation and reporting

During the project implementation, we monitored activity undertaken and outcomes from this project. We assessed project output and works such as the number of specific activities completed and financial used in those activities. We also reported the progress

and achievement periodically base on the implementation plan or additional requested by the IFRIT and APFNET.

However, we had a bit little attention on the project's stakeholders on this issue. We just shared the information and evaluated among our internal team.

3.6Efficiency and effectiveness

All activities were completed and overall objective of the project was achieved, this wasaremarkable success of the project. Although the project had to extent its schedule for another six months, this was normally a case for a large project with unforeseen events.

Even though the project was not yet running any dissemination the result of the study, we foresee that it will provide useful information, which could be utilized by the organizations and research communities. This would contribute meaningfully to the natural resource management, inparticularly the forest resource.

3.7Project Costs and Sources

The project budgets were decided and allocated according to the project activities and followed guidance by IFRIT and APFNet. We used the APFNet fund for the cost operation, while the counterpart fund was used for the office and facilities. The cost for this project was appropriately managed.

3.8Dissemination

The outputs of the project have not yet share with other stakeholders or concern institutions. However, the result has been share among the technical and experts mostly individual consultation. Later, a dissemination workshop will be organized and the project outputs and findings from this project will be disseminated to various interested stakeholders.

4. PROJECT STAKEHOLDERS' PERFORMANCE

4.1Supervisory Agency(if any)

None, but probably only DOF

4.2 Executing Agency(project team and project director)

The project was implemented under the Natural Resource Management and Climate Change Research Center (NMRCC), Research Division, Faculty of Forestry, National University of Laos. The project team comprised of faculty members and researchers who specialize in remote sensing, forest inventory and GIS. The team members and their function were explainedas followings:

1. Dr. Houngphet Chanthavong, the project steering chair, was to take care for the

project organization in general. He also played the roles of coordination with other governmental agencies such as the Department of forestry, National Land Management and National Agriculture and Forestry (NAFES) and other tasks include:

- Facilitated official permission regarding the project activities at the national level and at the field site
- Supervised project implementation and result dissemination

2. Dr. Khamla Phanvilay (project leader), roles included:
   - Lead for project implementation
   - Provide technical advisory for all work packages
   - Support project's technical and financial reports
   - Provide technical support for the project workshop, training and meeting in country

3. Dr. Sithong Thongmanivong, the RS and GIS specialist,
   - Coordinate with other APFNet project partners to share lesson learnt and experiences
   - Support the project activities and monitor work packages/subcontracts,
   - Assist project leader to prepare financial and progress report
   - Organize workshop, training, and meeting

4. Mr. Sengmany Boutthavong, assistant researcher from the Department of Watershed and Land Use Planning, contributed and assisted in RS analysis
5. Mr. SIsouvan Duangmany, Lecturer on RS and GIS, Department of Watershed and Land Use Planning, Faculty of Forestry, assisted in RS analysis
6. Mr. Thanan Khothpathoum, specialist in forest inventory and wildlife, led for the fieldwork activities.
7. Mr. Daovorn Thongphan, responsible for financial management of the project

4.3Other project partners

None

4.4 APFNet

APFNet and IFRIT provided clear guidance and support through the project implementation periodincluding technical support/feed back, technical reporting formatand as well as completion report template.

5.RESULTS

5.1Achievements

5.1.1 Remote sensing/GIS database

We collected existing GIS and RS data from various projects and government

organizations. In total 9,975 RS data set, including 8490 scenes of aerial photos taken in 2012, 229 silts of Landsat data acquired from 1989 to 2010 and 1,256 silts of Rapid Eyes images. In addition, other GIS data were also collected. Table below shows details of the data. They were mostly available at the Research Division at the Faculty of Forestry, National University of Laos.

No.	Types data	Time of acquisition	Data format	Source	Available at FOF
1	Forest and land use	1992	Shape	DOF	
2	Forest and land use	1993	Shape	FCMP/DOF	√
3	Forest and land use	1997	Shape	FCMP/DOF	√
4	Forest and land use	2002	Shape	DOF	√
5	Time series of Landsat data (whole country)	1989-2010	Digital image	MAF	√
6	IKONOS (Luangprbang)	2000	Digital image	FOF	√
7	IKONOS (Vientiane)	2000	Digital image	FOF	√
8	Rapid Eye (Sangthong, Savanakhet, Huaphan)	2010	Digital image	DOF	√
9	RapidEye (Houaphan province)	2012	Digital image	DOF,	√
10	Aster	2000	Digital image	MONRE	
11	ALOS	2005	Digital image	MONRE	
12	Arial-photo	2011	Digital	NGD	√
13	Arial-photo (Sangthong district)	1995	Hard copy	FOF	√
14	Village location	2011	Shape	MAF	√
15	Reservoir	2010	Shape	EDL	√
16	River network	2000	Shape	NGD	√
17	Road network	2000	Shape	MCTPC	√
18	Administration boundary	2010	Shape	NGD	√
19	Contour line		Shape	NGD	√
20	Topographic map scale 1:100,000	1993	Georeferenced	NGD	√

5.1.2 Forest cover in 2005

We used object based classification approach (OBC) combining with visual interpretation techniques to classify the land sate data. The results found that majority of forests distributed along the high altitude or mountainous area, especially between Laos and Vietnam borders from the central to the south. This area is usually difficult to access. Moreover, there was remained dominance of native forests within the national biodiversity conservation areas. However, Broadleaf forests and non-timber forest products (NTFPs) were significantly rich in the north of the country. From the central to the south, there were diverse of forest species, such as *pterocarpus sp, afzetia zylocarpa,*

dalbagia cultrata, etc. The weather conditions in this region could be an influent factor to provide more suitable ecological conditions for plant species.

In figure 1 below shows that shrub lands had the highest percentage, which was account for 36.17 % of total land area. Shrub lands were found widely over the country. This could be a consequence of converting native forests into agriculture, plantation and fallow areas. Broadleaf forests were the second highest, which covered 28.87 % of the total area. Crop land was 9.54 % or 2,201,206.77 hectares, followed by evergreen broadleaf forest, *dipterocarp* and deciduous broadleaf forest was 8.96 %, 6.55 % and 4.25 % respectively. There was about 1.68 % of bamboo and the rests were other land covers.

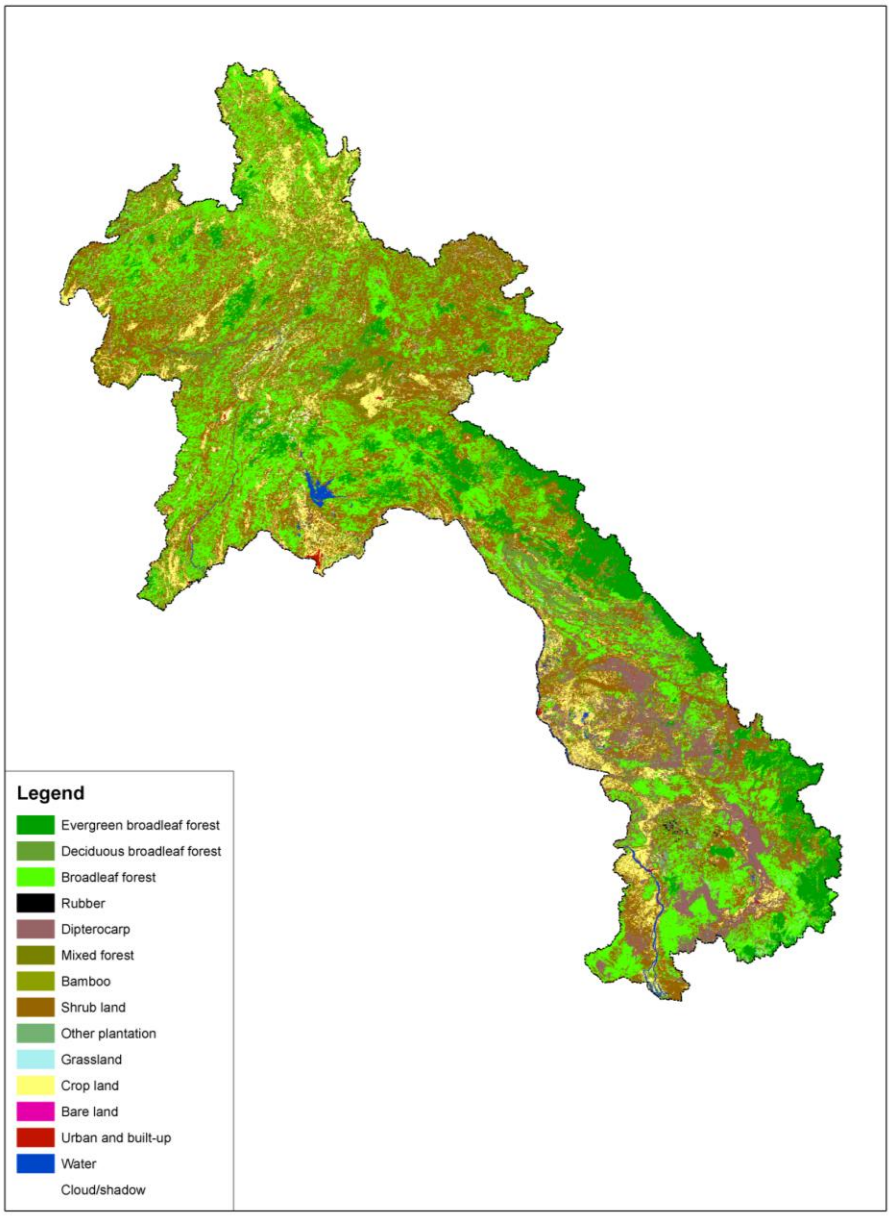


Figure 2. Forest cover map 2005

5.1.3 Forest cover 2010

The forest cover map of 2010 was created based on the Landsat 5 captured in March 2010. The forest distribution in 2010 was not much different from 2005. Shrub, Broadleaf forests and crop lands were still dominant land cover classes across the country. These land covers were responsible for about 77 % of total land, whereas others were roughly 33 % in total. In 2010, an estimation of forest cover was approximately 8 million hectares; 37 % of the total land area (excluding shrub lands).

This was similar to the national estimation of forest covers (40.3 % by MAF). This percentage was just slightly less than that of 2005. According to the national forest cover monitoring report, it was suggested forest covers have dropped rapidly since 1992. This might be confirmed by the same result of our research finding.

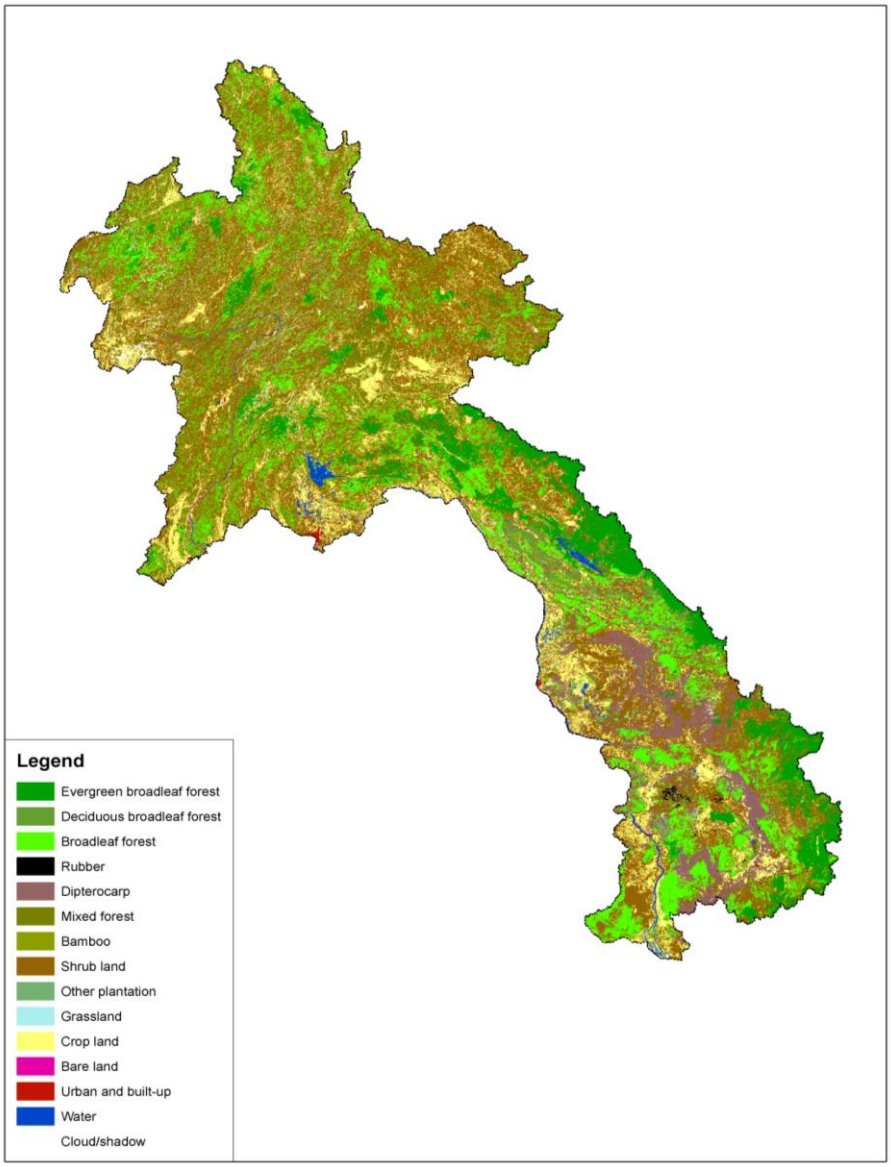


Figure 2. Forest cover map 2010

5.1.4 Changes in forest covers of 2005 and2010

The figure 3 showed the percentage of changes in forest covers for the entire country from 2005 to 2010. Overall, it was found that native forests were decreased, while shrub and agricultural lands were increased. Changes in native forest areas were found over the country, however, the increase in shrub lands appeared mostly in the northern part of Laos. In the North, shrub lands were the most common due to a large area was used for permanent shifting cultivation by upland villagers. This cultivation practice was a circle rotation of land clearance and upland rice production. As a result, there was a less vegetation cover and regrowth due to slash and burn. The expansion of the agriculture was most common in the middle region and south of the country. This was due to its suitable landscape, including less terrain and market accessibility.

Broadleaf forest was the highest rate of forest cover changes in the country, from 2005-2010. It was accountable for 11.64 % of the decreased rate for this period. Other native vegetation cover was lost less than 2 %. Shrub land was responsible for 8.58 % of area expansion, followed by crop lands (5.13 %). Others was considered as less change or remained stable

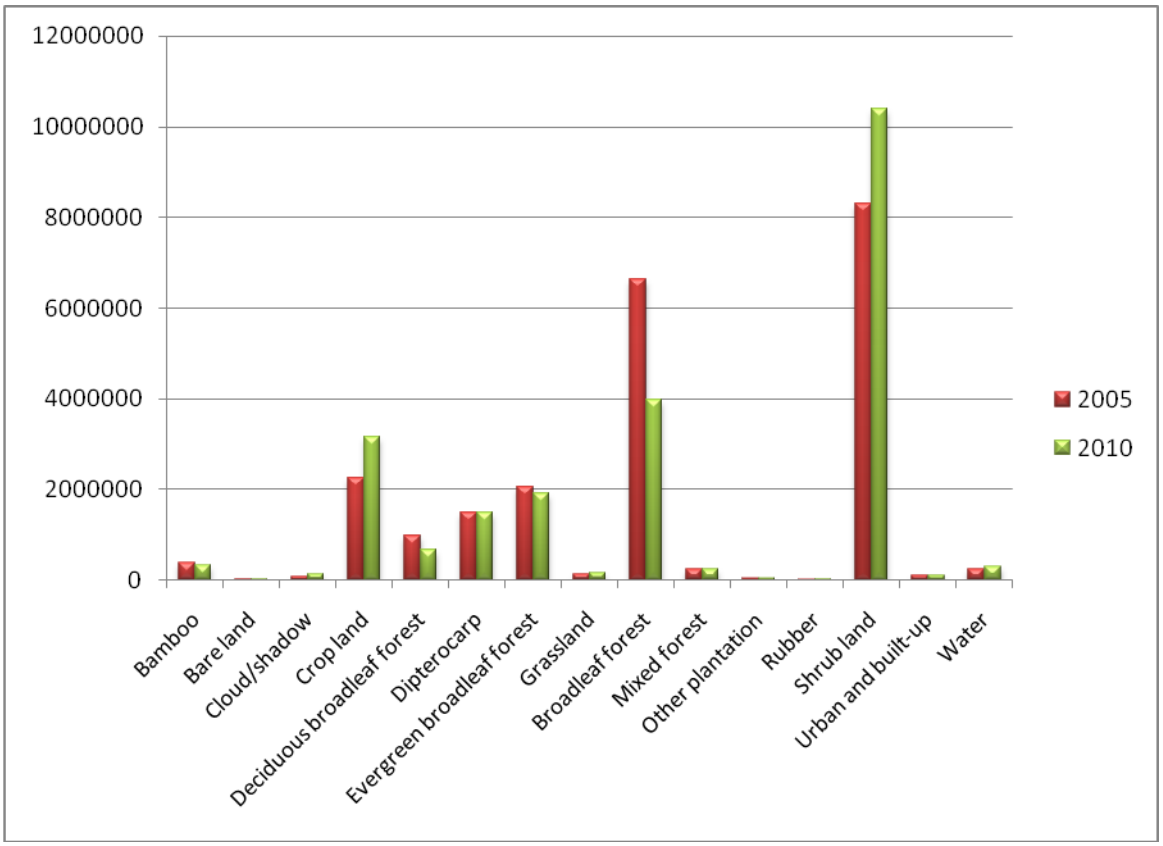


Figure 3. The changes in forest cover from 2005 – 2010 (in hectares)

5.1.5 Changes in forest covers by provinces

The figure 4 indicated that the percentage of changes in forest covers in each province across the country, from 2005 to 2010. Overall, each province showed a different increased rate of shrub and agricultural lands, while most of them represented a decrease rate in Broadleaf forests. Highest rate of an increase in shrub areas was found in Phongsaly, followed by Luangnamtha and Xaiyabouly province. Figure 12 showed that about 362,637 ha of in total land area in Phongsaly was occupied by shrubs during 2005-2010, about 269,522 ha in Luangnamtha and 224,554 ha in Xaiyabouly. The rest of them showed a low to middle range of increase in shrubs (approximately less than 190,000 ha). Crop area was highly found in Xiengkhouang province. From 2005 to 2010, crops covered about 194,034 ha of total land in this province. A similar high rate was found in Houaphan, Bolikhamxai, Champasak and Saravanh, which were roughly 135,000 ha of crops in these regions. Other provinces also showed an increase pattern of crop lands.

In contrast, it was found that native forests or Broadleaf forest areas were decreased in the North region, especially in Xaiyaboulay. This decrease was approximately 352,176 ha of Broadleaf forests. Vientiane, Xaisomboun, Luangnamtha and Huanphan were the second highest rate of depletion in this type of forest. Average of 210,000 ha of Broadleaf forests was lost from 2005 to 2010. However, another type of forest cover was remained stable or little change in each province. More detail was showed in figure 12 below:

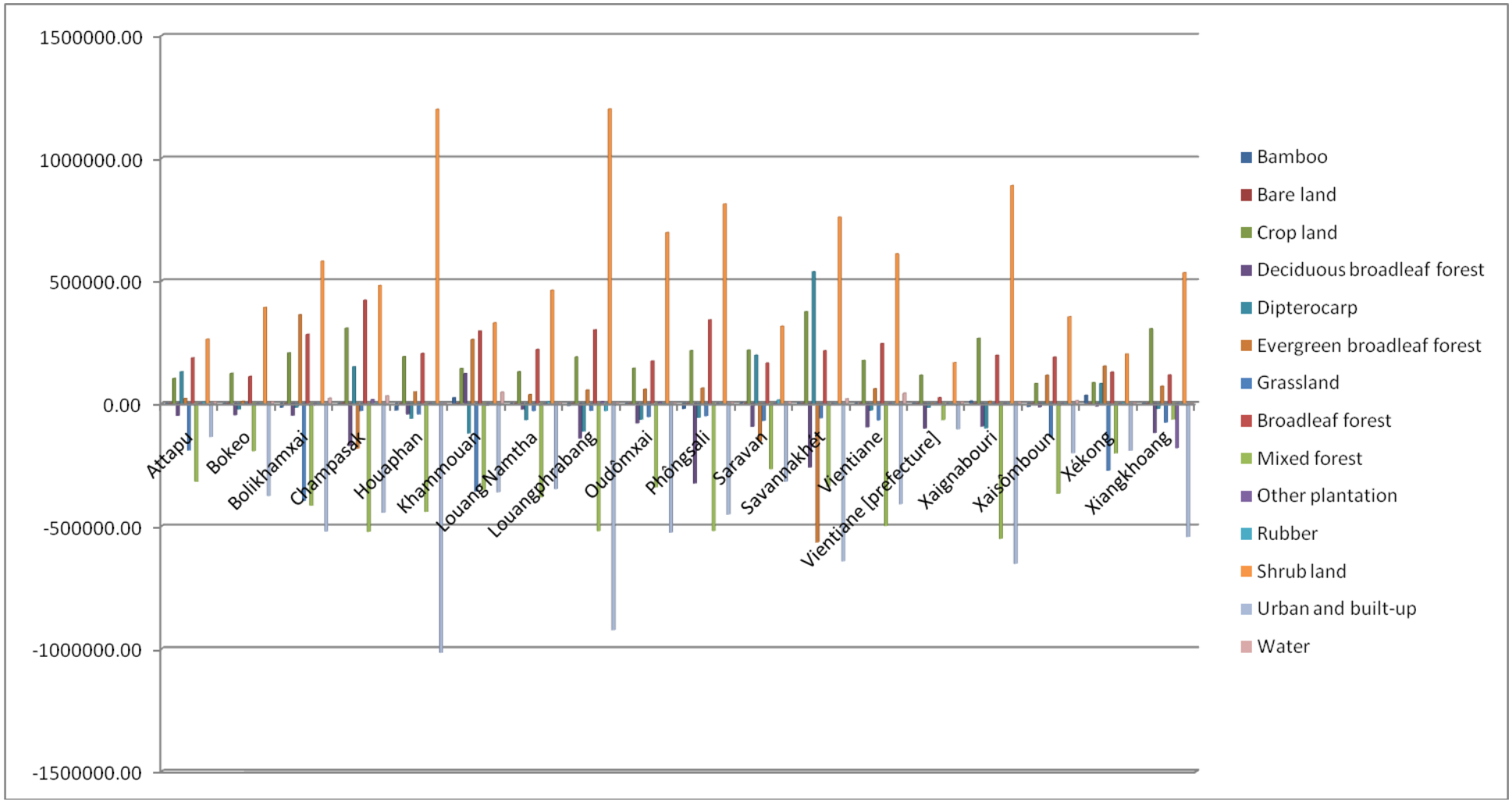
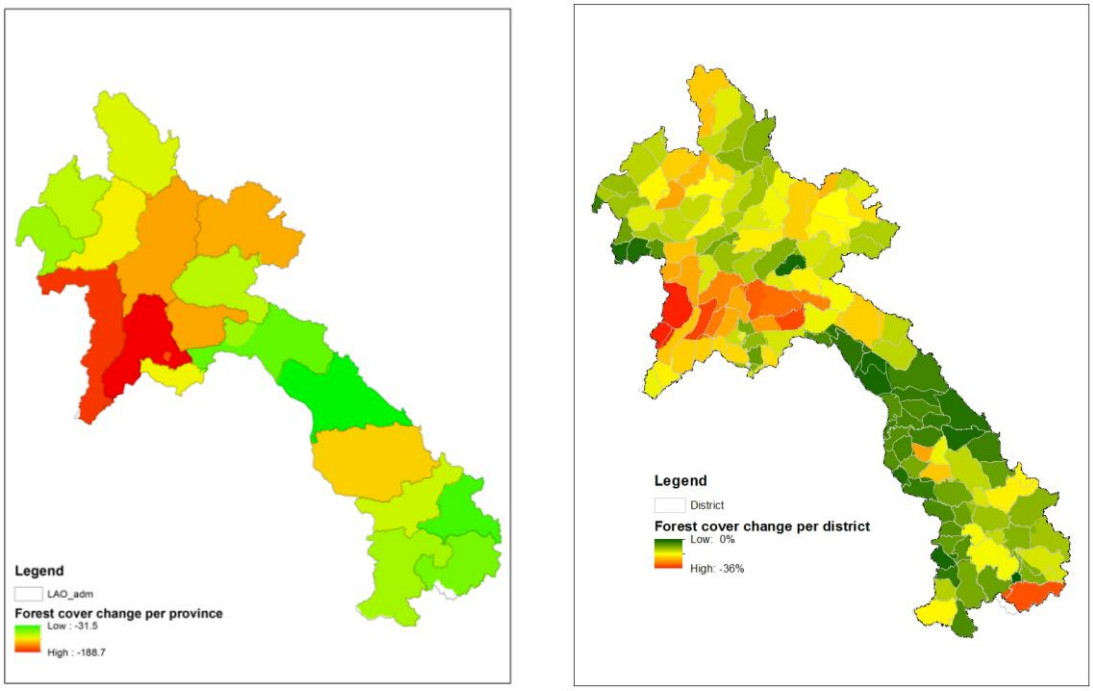


Figure 1. ***A change in forest covers by province from 2005 to 2010***

5.1.6 Hotspots of deforestation across the country

Figure 5 (a) and (b) represent an average rate of deforestation occurred during 2005-2010 in different administrative provincesand districts. In general, the maps show that there was a different level (low - high)_of forest destruction occurred across the country. However, the highest rate of deforestation was found in the central and southern par of the country. Medium change in forest covers was found mostly in the northern andin the south, Khammouan province indicated a low-medium rate of forest loss.



(a) Deforestation by provinces *(b) Deforestation by districts*

Figure 5. Deforestation hotspots from 2006-2012

5.1.7 Forest measurement

We established forest measurement pilot sites base on the ICESAT GLAS footprint. In total, 120 sample plots in three test sites were established to estimate biomass and carbon content in each type of forest. We finally delivered the data to the Institute of Forest Resource Information Techniques (IFRIT), Chinese Academy of Forestry, Chinafor further analysis.

5.1.8 Capacity building

Knowledge transferring is an essential aspect and set as a top-agenda of the project. Thus, two training workshops were organized to promote capacity building for the staff member and three trainingprior to the field activities at the provinces has been carried out.

5.2 Good stories,best practices,intelligence products to be shared in the region

In technical prospective, our approach of image classification was reallygreat. The object base classification could adjust level of analysis, which increased levels of segmentationor scale of image objects. This helped us to separate or identify more homogenous of land cover types. It usually could illustrate different vegetation types in a small area. However this was still some error or misclassification i.e. urban vs. agriculture, shadow and topographic effects, etc. the visualization technique can be use to over come the problem.We believed that this hybrid approach was more suited to analyze the forest covers in our landscape.

5.3Lessons learned and outstanding issues

There were pros and cons on producing precisely and accurately maps at national level. A large scale monitoring might provide lower accurate result, but quick overview of broader landscape while finer or small to medium scale mapping could produce a better accuracy. Besides this issue, there was a different standard of forest types, definitions and classification scheme among the government institution and NGOs. Each institution has their own interest on land cover categorized standard, whichmay resulting confusionwhen using the result.

Issue in data analysis, spectral similarity of different landcover classes could have an impact on our approach applied for monitoring forest/land use cover changes. Additionally, a difference in seasonality could influence to image classification. Growing season and deactivate (dry) season would indicate different response of vegetation. Therefore, seasonal similarity needs to take into account when selecting pairs of satellite images.

5.4Impacts

There was not yet either positively or negatively impact on social, economic and environment from this project. However, it is for see able that theoutputs of this project will have positive impact to the country in general. We also created useful remote sensing/geographic information system data that available for all users. We hope this will enhance coordination between the national university and government institutions. Monitoring forest cover changes by applying a remote sensing approach is considered as an important role in providing information, analysis and tools to support policy makers and other stake holders

in development and implementation of appropriate policies and programs for protecting native forests, improving plantations and maintaining related ecosystem services.Through implementation of this project, the faculty members havestrengthen relationship the staffs of forestrysectors at the national level as well as the local level. This will enhance coordination among institutions and contributing benefits to forest resource management in the proper way.

6. SUSTAINBILITY(max 0.5 page)

The executive agency for this project is located at the university. Our institution is more consistently stabilizedin term of roles and functions in comparison with other institutions. This task is included as a part of mandate of our research activities and will be continuing in the future. However, further investigation, research and development would not be achievable without external technical and financial assistances. This project was basically enhanced one step towards capacity building, which would be useful to maintain and further on-going develop in a field of forestry research.

7.RECOMMENDATIONS

The study provided information on forest/land cover change between 2005 and 2010. It demonstrated a remote sensing technique that used for developing this type of information. This project initiated an important step towards producing important forestry information, which could be used and linked with the reduction of emission from deforestation and forest degradation (REDD) programs. It could be used as part of a carbon stock estimation which required by REDD schemes.Our products produced an overview of recent trends and drivers of deforestation in the country. Although this wasuseful to provide basic information, more simple approach with high accuracy need to be further developed. Information from the project might be also useful for other disciplines where it is important to consider land cover or spatial proximity to other land uses (e.g., land use planning, urban development, and wildlife conservation). However, some recommendations need to be taken into account:

- Further funding support should be continue to investigate the dynamics of forest covers based on this existing based-line database/information produced by the project.

- Alternatives remote sensingdata and approaches shouldfurther effortto produce various kinds of output and at different scale so that the concern organizations and stakeholder can use the result effectively.

- It will be good if APFNet could support establishing a remote sensing/GIS network in this region, either formally or informally so that technologies and knowledge can be share and learn from each other, this will

contribute and support to the sustainable natural resource development in the region.

Annex(es):

Annex A: Implementation scheduleand details of project cost by category

Activities	**2011**				**2012**												**2013**								**Remark**
	9	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Procurement of material and equipment																									15,200
Communication																									5,400
Ground truth and database development																									32,000
Data processing and analysis																									18,000
Workshop and trainings																									8,000
Reports and dissemination																									3,800
Sub-total	-																								82,400
Contingencies 10%																									8,240
Total	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**90,640**

Annex B Implementation schedule(scheduled versus actual)

Activities	Completion Time		Key points of the results achieved (qualitative or quantitative)	
	Anticipated	Actual	Anticipated	Actual
1. Procure all necessary tools and equipment	30.01.2012	30.01.2012	Personal PC and network system	Personal PC and network system
2. Collect existing LULC data and RS GIS dataset from government agencies	30.12.2012	30.12.2013	RS and data	RS and data
3. Organize teams and training to the team about the methods of field data collection	30.01.2012	30.01.2012	Field survey training	Field survey training
4. Conduct field survey for ICESat GLAS footprint	30.12.2012	12.11.2013	100 sample plots	120 sample plots
5. Ground truth database development	30.01.2013	30.12.2013	Ground truth database	Ground truth database
6. Assessment biomass and carbon of sample plots	01.02.2013	30.12.2013	Biomass and carbon database	Biomass and carbon database
7. Organize internal training workshop on image processing	31.05.2012	31.05.2012	RS training course	RS training course
8. Image processing	31.05.2013	31.01.2014	Forest and land cover map	Forest and land cover map
9. Land cover change analysis	31.05.2013	28.02.2014	Change map	Change map
10. Classification validation	31.05.2013	31.03.2014	Classification result	Classification result
11. Final report	31.08.2013	17.06.2014	Final report	Technical report and completion report

Document No.:
Receiving Date:
(ForAPFNetSecretariat)

Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

Completion Report

Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia

September 2011 – Mac 2014

Forest Research Institute Malaysia (FRIM)

15 April 2014

Basic Project Information

Project Title(ID)	Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia	
	Approved	Actual
Date of commence	September 2011	September 2011
Date of completion	31 August 2013	31 Mac 2014
Extension period	6 Months	
Project Budget (in USD)		
APFNet's Grant (in USD)	95,600.00	95,600.00
Counterpart Contribution (in USD)	59,600.00	59,600.00
Supervisory Agency	Ministry of Natural Resources & Environment (NRE)	
Project Executing Agency	Forest Research Institute Malaysia (FRIM)	
Project Director	Dr. Khali Aziz Hamzah	

Project description:

Having access to accurate forest type maps and conditions will give us more accurately predict the carbon sequestration capacity in the forested landscapes. Forest's mapping is very significant for the estimation and evaluation of the forest resources, carbon sequestration, and to support sustainable forest management. It plays a key part in the concentrated effort on illegal logging, forest fire monitoring and early warning for forest degradation, the reduction of deforestation, and the improvement of forest quality. This will be achieved by making intensive use of the most recent satellite remote sensing technology. The primary goal of this project is to estimate the forest coverage and carbon stock in Malaysia. The proposed approach will integrate multi-sources remote sensing data, ground measurements and other thematic geographic data. The outcomes of this project will help to clarify where the forests cover and how much carbon stock on forest area in the Malaysia region.

Prepared and Submitted by	**Reviewed and Endorsed by**
_____	_____
Project Director signature Date 15 April 2014	Project Steering Committee Chair signature Date
FOR APFNET USE	
Reviewed and comments by	**Reviewed and comments by**
_____	_____
ED signature Date	PO signature Date

Executive Summary

Concern over global problems induced by rising CO2 has prompted attention on the role of forest as carbon 'storage' because forests store a large amount of carbon in vegetation biomass and soil. Monitoring techniques based on multispectral satellite-acquired data have demonstrated potential as a means to detect, identify, and map changes in forest cover. This project was focuses on the role of remote sensing and geographic information system (GIS) in assessment of changes in forest cover and carbon stock, between 2010 and 2005, in Malaysia. Three main remote sensing data were used in this project, namely the Landsat TM, MODIS and GLAS. About 56 scenes of Landsat TM medium resolution satellite imageries were use to map the land cover of Malaysia for the years 2010 and 2005. After performing classification on these images, a total of eight land use classes were identified and mapped. The classes were water, shrub land, grassland, built-up area, inland forest, peat swamp forest, mangrove and croplands. These classification maps contained details spatial distribution of land use information. This information is useful particularly to discover the driving forces of the forest changes and could provide supporting information for the policy maker of the Malaysian government.

A total of 100 plots have been established at the center of GLAS data for estimating biomass through the combination of field inventory and GLAS signal. All these plots were located at three different forest types namely the dipterocarp forest, peat swamp forest and mangrove forest which were located at eight different forest reserves in Malaysia. The forest reserves were Pasoh Forest Reserve, Matang Forest Reserve, Gerik Forest Reserve, Bukit Pancur Forest Reserve, BatuTalam Forest Reserve, Lambir Forest Reserve, Sepilok Forest Reserve and Klias Peninsular Forest Reserve. It was found that the distribution of biomass within the plot is ranging from 29.93 – 417.45 tone/ha, 96.06 – 213.10 tone/ha and 145.90 – 410.90 tone/ha for the inland forest, peat swamp forest and mangrove forest, respectively. The trend of forest cover changes over the time span of 5 years was precisely analysed in this project. It was noticed that forest cover has decreased between 2005 and 2010, due to the development of oil palm plantation, horticulture and urban development.

It is envisage that this project would prove the usefulness of remote sensing and geographic information system in forest resource management. The maps produced could serve as a platform for assessing and monitoring forest resources in Malaysia. In conducting this project, close collaboration with the Forestry Department of Peninsular Malaysia, Sarawak Forestry Department and Sabah Forestry Department was very important as managing the forest is under the department's authority. The project benefited tremendously from the cooperation and participation of various stakeholders, in particular the forestry department. Coordination roles played by the executing agency (NRE) were very important to ensure all agencies involved in the project implementation participated actively. There was a slight delay in establishment of biomass plot at the GLAS footprint due to unpredictable weather condition during the field trip. However, the overall project activities planned had been successfully undertaken.

The project was designed efficiently such that all the objectives were achieved according to the plan. The execution of the project was in accordance with the milestones and expectation outlined during preparation of the proposal.

In term of expenditure, a total of USD 38,240.00 (first allocation) and USD 47,800.00 (second allocation) of project fund had been received from APFNet. Until 31 March 2014, about USD 63,105.83.00 has been spent and USD 32,061.88 is accrued (committed and to be spent in April) for spending. The overall expenditure is in line with the original work plan activities with the balance of allocation is about USD 432.29 as of 31 March 2014.

One important lesson learnt from the project was in term of the need to have clear understanding on the roles of each project team members start from the beginning of the project. These include the technical team, the administrator and the financial officer. As FRIM is a government agency, the project follows exactly all related government rules and procedure and as such there is no problem encountered during the project implementation.

In term of project monitoring and evaluation the project was monitored both at the ministry (national) level as well as internally at FRIM. These two levels of monitoring helped to ensure that all activities planned be undertaken according to the schedule and objectives targeted earlier achieved at the end of the project.

Overall, the project had been carried out successfully and all intended objectives have been successfully achieved in accordance with the problems raised in the project document, with the full involvement of stakeholders and wise use of resources to produce the outputs.

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1. INTRODUCTION

An increase in CO2 concentration in the atmosphere is considered as one of the main factors that caused the phenomena of global warming and climate change. In the latest assessment report of the Intergovernmental Panel on Climate Change (IPCC), global mean temperature has dramatically increased over the past decades. Malaysia, being a signatory to the UNFCCC, therefore has an obligation to submit the National Communication Report highlighting amongst others the greenhouse gas inventory and policy direction to reduce the impacts of climate change within the country. Concern over global problems induced by rising CO2 has prompted attention on the role of forest as carbon 'storage' because forests store a large amount of carbon in vegetation biomass and soil. As climate change becomes more critical in the future, having access to accurate forest types maps and conditions will give us more accurately predict the carbon sequestration capacity in the forested landscapes. Forest's mapping is very significant for the estimation and evaluation of the forest resources, carbon sequestration, and to support sustainable forest management. It plays a key part in the concentrated effort on illegal logging, forest fire monitoring and early warning for forest degradation, the reduction of deforestation, and the improvement of forest quality. This will be achieved by making intensive use of the most recent satellite remote sensing technology. Malaysia is well known with rich natural tropical forest resources that mostly dominated by trees from the Dipterocarpaceae family. For management purposes, the forested areas in Malaysia are classified into six types of forest according to changes in altitude, composition, flora, habitat, climate and soil characteristics, namely (1) upper montane forest, (2) lower montane forest, (3) upper hill dipterocarp forest, (4) hill dipterocarp forest (5), peat swamp forest, and (6) mangrove forest. All of these forests play a very important role in sustainable development and provide a range of economic, social and environmental benefits, including essential ecosystem services such as climate change mitigation and adaptation. There were eight forest reserve selected as a test site in this project representing three main forest types in Malaysia, namely dipterocarp forest, peat swamp forest and mangrove forest. The forest reserves were Pasoh Forest Reserve, Matang Forest Reserve, Gerik Forest Reserve, Bukit Pancur Forest Reserve, Batu Talam Forest Reserve, Lambir Forest Reserve, Sepilok Forest Reserve and Klias Peninsular Forest Reserve.

1.1 Test Site Descriptions

i. Pasoh Forest Reserve, Negeri Sembilan

The Pasoh Forest Reserve in Negeri Sembilan is under the management of Negeri Sembilan Forestry Department, located at the southeast of Kuala Lumpur. It is lowland Dipterocarps forest characterized by family dominance of Dipterocarpaceae, and by three tree layers namely emergent, main-storey and under storey trees. This forest reserve has attracted many local and foreign scientists to conduct long term

collaborative studies of which some are still on going on biodiversity sustainable management of tropical forests and the role of tropical forests as carbon sinks.

ii. Gerik Forest Reserve, Perak

The Gerik Forest Reserve is under the management of Perak Forestry Department, located at the northeast of Kuala Lumpur. Situated in the state of Perak, at the border of Peninsular Malaysia and Thailand, the stunning landscape of Gerik Forest Reserve Rainforest houses over 3,000 species of flowering plants, including three species of the largest flower in the world, the Rafflesia.

iii. Matang Mangrove Forest, Perak

Covering an area of more than 36,000 hectares and lying on the northern coast of Perak it has been recognised as one of the most well managed expanse of mangrove swamps in the world. Within this mangrove swamp are found multitudes of tree species, birds and marine life which are a haven for nature lovers.

iv. Klias Peninsular, Sabah

The Klias Peninsula is located on the coast of south-western Sabah, forming the north-eastern shore of Brunei Bay, the south-western shore of Kimanis Bay and bounded on the inland side by Banjaran Crocker and on the western side by a ridge on a higher ground. From the total of 90,000 ha of Klias peninsula area, a continuous flat area of peat swamp (60,700 ha), freshwater alluvium (14,500 ha) and coastal transitional swamp (28,500 ha) including 8,700 ha of largely undisturbed mangrove.

v. Sepilok Forest Reserve, Sabah

Sepilok Forest Reserve, situated in the state of Sabah in East Malaysia on Borneo Island, was established in 1931 for experimenting forestry techniques. In 1964 the Sabah Forestry Department set up the orang-utans sanctuary, and in 1988 the Wildlife Department of Sabah took over the administration and management of the sanctuary. It has 4,300 hectares of forest land which is at the edge of the Kabili-Sepilok Forest Reserve. The region is comprised of mangrove and dipterocarp forest, hill forest and tropical heath forest.

vi. BatuTalam Forest Reserve, Pahang

Batu Talam is a forest reserve and is located in Pahang, Malaysia. The estimate terrain elevation above sea level is 380 metres. This forest reserve located at Raub district, 60 km from Raub Town and 180 km from Kuantan Town through Raub-BatuTalam Road. This forest reserve comprise of hill and lowland dipterocarp forest.

vii. Bukit Panchor Forest Reserve, Perak

The Bukit Panchor Forest Reserve is a tract of protected forest in Nibong Tebal, Penang. It covers an area of 445 hectares and reaches a height of 416 meters. Bukit Panchor State Park located in Bukit Panchor Forest Reserve, which was established in 1963 in Seberang Perai Selatan. It was created so that the general public has a recreational area while at the same time, learn to appreciate the forest better. There are 8 hectares set aside as camping ground.

viii. Lambir Forest Reserve, Sarawak

Lambir National Park is probably the world's most complex and diverse forest eco-system. It is only about 40 minutes drive from Miri, Sarawak. In a total area of just 6,952 hectares, this forest area became a habitat of 237 different species of birds, flying squirrels, wild pigs, gibbons, many different types of monkey, various species of deer, and insects and other invertebrates, all combine to create Lambir's rich plant biodiversity. Lambir's 6,952 hectares of sandstone hills have created some very rugged forest terrain, rising to over 450 metres from mean sea level, and covered with lowland dipterocarp forests. This unique topography and environment have made Lambir a major centre for rainforest research activity.

Table 1 Distribution, area and types of forest in Malaysia in 2008 (million ha)

Region	Land area	Natural Forest			Plantation forest	Total Forested land
		Dry inland	Swamp forest	Mangrove forest		
Pen. Malaysia	13.16	5.40	0.30	0.10	0.08	5.88
Sabah	7.37	3.83	0.12	0.34	0.11	4.40
Sarawak	12.30	7.92	1.12	0.14	0.06	9.24
Total	32.83	17.15	1.54	0.58	0.25	19.52

Source: FRA (2010) – Forest Resource Assessment for Malaysia. Report prepared by the Ministry of Natural Resources and Environment Malaysia.

2. PROJECT GOAL, OBJECTIVES AND FORMULATION

2.1 Project Goal

The primary goal of this project is to estimate the forest coverage and carbon stock in Malaysia. The project integrated multi-sources remote sensing data, ground measurements and other thematic geographic data. The outcomes of this project will help to clarify where

the forests cover and how much carbon stock on forest area in the Malaysia region.

2.2 Project Objectives

This project is in line with the global concerns on the climate change issue. It is conducted by FRIM researchers and the objectives are as follow:

1) To develop Malaysia forest cover mapping techniques to monitor forest cover type changes, using both optical and radar remote sensing techniques.
2) To develop a framework for forest above ground biomass estimation using ground measurements, space borne lidar sampling data and imaged remote sensing data.
3) To produce forest cover maps of 2005, and 2010 at 30-50m spatial resolution.
4) To produce a forest above ground biomass map for 2005 in Malaysia at 300-500m spatial resolution.

2.3 Project Designing

To ensure the smooth implementation of this project, a working committee had been established consisting of experts in research and development of remote sensing and forest biomass in this institution. This working committee involving researcher that specialist in forest management, forest inventory, remote sensing and GIS and also representatives from the Forestry Departments in Peninsular Malaysia, Sabah and Sarawak. All committee members have worked together with the responsibility to ensure the project progress as planned base on the following work packages:

WP1: Project design and management
WP2: Methods development
WP3: Remote sensing data acquisition and pre-processing
WP4: Ground truth database development
WP5: Mid-resolution forest mapping product
WP6: Coarse-resolution forest mapping product
WP7: Forest above ground biomass mapping product
WP8: Reporting and dissemination

The proposed demonstration sites in Malaysia were chosen primarily to represent the different forest types available in this country namely the inland dipterocarp forest, the lowland dipterocarp forest, the peat swamp forest and the mangrove forest. Table 3 shows the summary of information of the different sites.

Table 2 Working committee member for demonstration project in Malaysia

Name	Organization	Expertise	Position	Responsibility
Dr Khali Aziz Hamzah	Forest Research Institute Malaysia (FRIM)	Remote sensing and forest management	National Leader and Remote sensing specialist	WP1, WP2, WP8
Mr. Mohd Azahari Faidi	FRIM	Remote Sensing	Remote sensing specialist	WP2, WP3, WP4,
Ms. Rodziah Hashim	FRIM	GIS	GIS specialist	WP5, WP6
Mr. Wan Shukri Wan Ahmad	FRIM	Forest Inventory	Inventory specialist	WP4, WP7
Mr. Muhamad Afizzul Misman	FRIM	Image processing	Geospatial specialist	WP2, WP3, WP4,
Representatives From Forestry Departments	Forestry Department Peninsular Malaysia, Sabah and Sarawak	Forest Management	Forest Management	WP2, WP4,

Table 3 Information of the test sites in Malaysia

Name	Forest Type	Administration
1.Pasoh Forest Reserve, Negeri Sembilan	Lowland Dipterocarp	Permanent Forest Reserve
2. Bukit Pancur Forest Reserve, Perak	Lowland Dipterocarp	Permanent Forest Reserve
3. Batu Talam Forest Reserve, Pahang	Lowland and Hill Dipterocarp	Permanent Forest Reserve
4. Sepilok Forest Reserve, Sabah	Lowland Dipterocarp	Permanent Forest Reserve
5. Matang Mangrove forest, Perak	Mangrove forest	Permanent Forest Reserve
6. Klias Peninsular, Sabah	Peat swamp forest	Permanent Forest Reserve
7. Sepilok Forest Reserve, Sabah	Lowland forest	Permanent Forest Reserve
8. Lambir Forest Reserve, Sarawak	Lowland and Hill Dipterocarp	Permanent Forest Reserve

3. PROJECT EXECUTION

3.1 Start-up

During the starting period of the project, a project team members were identified and recruited within the scientists in FRIM based on their expertise and knowledge on the subject of interest. The team comprises two main experts from the remote sensing group (to focus on satellite data processing) and the ecology group (to focus on forest inventory activity). Upon formation of the team, the first task undertaken by the team was to review the project elements, get updates of the project site, conduct relevant literature reviews, propose project operational framework and detail work plan. Initial consultation with the relevant stakeholders in particular the Forestry Department of Peninsular Malaysia (FDPM) was also undertaken to ensure their continuous support during implementation of the project. The initial stages of the implementation focused on the collection of secondary data, and the compilation and preparation of base map of the project area. Subsequently, a collection of new forest field inventory at the center of GLAS footprint and ground truth mapping activities were gathered. Field surveys were done by using manpower from FRIM and occasionally with support from the state Forestry Department staff.

3.2 Implementation schedule

The project activities had been implemented according to the original project work plan as indicated in the Table 4. There is no new activity inserted in the project work plan.

Table 4 Progress in implementation of the Activities

Activity	Executed (%)	Planned completion	Extended completion	Status
1.1 Project inception workshop	100	13/9/2011	15/09/2011	Completed
1.2 Remote sensing database	100	31/12/2011	31/12/2011	Completed
1.3 National-institute-owned ground truth database	100	31/5/2012	31/08/2013	Completed
1.4 Field data collection in selected test sites	100	31/7/2012	31/10/2013	Completed
1.5 Framework and methods development	100	31/8/2012	30/04/2012	Completed
1.6 Training on forest mapping	100	5-8/6/2012	08/06/2012	Completed
1.7 Forest map products of Malaysia	100	30/4/2013	31/03/2013	Completed
1.8 Validation & Verification	100	31/5/2013	31/03/2013	Completed

Overall the project activities planned had been successfully undertaken. In general the project activities have been undertaken according to the project work plan and no deviation from the original plan, except for the forest inventory activity at the center of GLAS footprint due to the unpredictable weather condition during the activity schedule. In addition, there is no obvious problem encounter during the project implementation.

3.3 Revision

During the implementation of this project, some revision on the project site has been undertaken. Changes of some project site are due to the difficulties in getting access to the forest area and considering of the activity cost at each of the project area. The project site that has been changed is Pekan Forest Reserve, Kuching Wetland National Park and Danum Valley National Park. These project sites have been changed to Bukit Pancur Forest Reserve, Perak and Batu Talam Forest Reserve, Pahang. The other planned project sites had been retained.

3.4 Procurement and consultancy

In general, the flow and the use of the project fund have been appropriated to enable the implementation of the planned activities. There were several forest inventories equipment purchased during the execution of this project including the purchased of Global Positioning System (GPS), Hypsometer, camera and other forest equipment and tool to ensure smooth execution of the forest inventory activity.

3.5 Monitoring, evaluation and reporting

In term of management structure, the project was implemented by FRIM. The project is being monitored by the National Committee on REDD+ Project comprising members from various agencies chaired by a Senior officer from the NRE which carry out meeting twice a year, to govern the implementation of the project. The committee provided guidance on matters pertaining to the implementation of the project and ensures that the project is directed towards achieving its intended goals. At the same time, a Technical Working Committee chaired by a senior officer was also established at NRE to give advice on technical matters and facilitate the data collection and analysis. The progress of the project was monitored through those two committees. The Project Leader was responsible for the preparation of the reports. At the same time, the progress of the project was also monitored through Project Evaluation Meeting (PEM) conducted internally in FRIM on half yearly basis.

3.6 Efficiency and effectiveness

The project was designed efficiently such that all the objectives were achieved according to the plan. The execution of the project was in accordance with the milestones and expectation outlined during preparation of the proposal. The participation and support

given by the targeted stakeholders which are the forestry departments were very encouraging throughout the project implementation. Their active participation among others was reflected during the field data collection that had enabled indirect transfer of technology to their staff. In general, it can be said that the project was implemented on schedule except a short extension given to carry out the field survey and updating the landuse classification activity.

3.7 Project Costs and Sources

A total of USD 38,240.00 (first allocation) and USD 47,800.00 (second allocation) of project fund had been received on 23 May 2012 and 27 August 2013 respectively from APFNet. Until 31 March 2014, about USD 63,105.83.00 has been spent and USD 32,061.88 is accrued (committed and to be spent in April) for spending (refer to Annex C for detail of commitment expenditure).The overall expenditure is in line with the original work plan activities with the balance of allocation is about USD 432.29 as of 31 March 2014. There is an excess use of project budget to undertake forest inventory activities. This is due to the additional time in implementing the field survey activities because of unpredictable weather condition during the implementation of this project. An audit session had been done to the Income and Expenditure Statement of this project by an independent *Jamal, Amin and Partners Chartered Accountant (No AF 1067)* firm Auditor. The result of the audit session and the details of project cost by category are reflected in Annex B.

3.8 Dissemination

The project outputs and findings from this project will be disseminated to the various interested stakeholders. Among others, the project materials and outputs will be published in the form of a technical book, scientific papers and proceedings. In addition, training manuals on forest cover mapping will also be prepared and disseminate to various stakeholders for training and transfer of technology programme. At the end of the project, relevant government agencies in Malaysia, particularly the forestry departments will have better understanding on the forest cover and forest changes in Malaysia and can contribute to better management of this ecosystem in the future.

4. PROJECT STAKEHOLDERS'PERFORMANCE

4.1 Supervisory Agency

Forest Research Institute of Malaysia (FRIM) is one of the leading institutions in tropical forestry research in the world. FRIM is a statutory body governed by the Malaysian Forestry Research and Development Board under the Ministry of Natural resources and Environment, Malaysia (NRE). The NRE is responsible for the managing of natural resources (Forest management, Irrigation and drainage management, Wildlife

management, Minerals management), conservation and management of environment and shelters, management of land survey and mapping administration. As such NRE undertakes the supervisory role (Supervisory Agency - SA) in the implementation of this project in Malaysia. The main responsibilities of the SA are to monitor the project progress and to ensure the successful implementation of all activities specified in the project document.

The project is being monitored by the Technical Committee on REDD+ comprising members from various agencies chaired by a senior officer from the NRE which carry out meeting twice a year, to govern the implementation of the project. The committee provided guidance on matters pertaining to the implementation of the project and ensures that the project is directed towards achieving its intended goals. At the same time, a Technical Working Committee chaired by a senior officer was also established at NRE to give advice on technical matters and facilitate the data collection and analysis.

The project team leader has the responsibility to present the project progress and sought feedback as well as support from the committees during the meetings. In this manner the project team will have the opportunities to update the project progress to the committee from time to time and keep them informed on the advantages of the outputs of the project and the important role plays by the project team members from other participating countries as well as the good financial and technical support given by both donor APFNet and the IFRIT.

4.2 Executing Agency

FRIM is the project Executing agency (EA) which is responsible in undertaking the project implementation in Malaysia. Located 16 km north west of Kuala Lumpur, the 544.3 ha campus of FRIM is surrounded by the Bukit Lagong Forest Reserve. FRIM promotes sustainable forest management and the optimal use of forest resources through the knowledge and technology generated from the various researches conducted.

FRIM has five research divisions, three technical support divisions and three administrative and finance divisions. Of the five research divisions, the Forestry and Environment Division focuses on conservation of forest, climate change and biodiversity by undertaking research and providing data, standards and guidelines in managing tropical forest on a sustainable basis. This division also responsible in undertaking research on the use of remote sensing and carbon monitoring in the forest including the REDD related project. As such this project is being undertaken by a team of researchers from this Forestry and Environment Division in FRIM.

FRIM as the EA has the responsibility for the overall project implementation including:-

i) To plan and execute all project activities specified in the project document,
ii) Recruitment and contracting supporting staffs and consultant,

iii) Accounting and financial management, payment of fees and expenses etc.
iv) Provision and management of office premises,
v) Preparing both technical and financial report to be submitted to the donor agency,
vi) Monitoring and evaluation of project implementation and activities,
vii) Provide support in disseminating project results and output to be shared by other agencies both at local and international,
viii) Provide training and capacity building to stakeholders based on the project finding.

During the starting period of the project, a project team members were identified and recruited within the scientists in FRIM based on their expertise and knowledge on the subject of interest. The team comprises of one project leader and another experts with the remote sensing expertise.

To ensure the smooth implementation of this project, a working committee was established consisting of experts in research and development of remote sensing and forest biomass in FRIM. This working committee comprised of researcher and specialist in forest management, forest inventory, remote sensing and GIS and also representatives from the Forestry Departments in Peninsular Malaysia, Sabah and Sarawak. All committee members work together with the responsibility to ensure the project progress as planned.

As part of project monitoring activity, FRIM as EA was responsible in organizing internal periodic project assessment. The project were assessed and monitored through Project Evaluation Meeting (PEM) conducted by a committee in FRIM on half yearly basis. Monitoring and evaluation also was being done by the national committee at NRE. The Project Leader was responsible for the preparation of annual report as well as quarterly report to be submitted to the authority in FRIM as well as project donor agency.

Dissemination of project outputs was done at various levels including by presenting the results and finding at seminar and workshop, publishing articles related to the study in various publications. Throughout the implementation of the project, a series of technology transfer was undertaken through training on various aspects related to the project including training on the use of remote sensing for forest biomass estimation.

From all those mentioned above, it is no doubt that FRIM as EA had embarked appropriate mechanism in fulfilling its responsibilities and tasks to implement, manage and disseminate the project successfully.

4.3 Other project partners

The project area in Malaysia covers an entire country which comprised of three main regions namely the Peninsular Malaysia, Sabah and Sarawak in Borneo Island. As such partners from these three regions were invited to participate in the project. They include the Forestry Department Headquarters of Peninsular Malaysia, The Sabah Forestry Department and the Sarawak Forest Department. Their main responsibilities among

others are to provide assistance and approval for the project team to undertake field survey in their respective forest areas. In addition they also provide other forest related information such as forest types, management history, and forest status to be used by the project in undertaking data analysis.

Overall, project partners had contributed substantially in various aspects in line with their roles and responsibilities for the project. The information provided and assistance rendered by them had made major contribution in ensuring the success of the project. Without their full commitment no doubt it will be very difficult for the project to achieve its goals and outputs.

In term of work performance, the project relied mostly on the manpower and work force available in FRIM and has no major involvement of contracted works. As such it is easier to monitor and control the project implementation schedule as well as quality of work carried out throughout the project. In general with the internal capacity and work force, the project work had been conducted by the team of field workers efficiently and effectively with high quality of services.

4.4 APFNet

In general APFNet has provided adequate assistance in ensuring the project runs smoothly. Support was given very timely. Guidance was clear which enable good project implementation and management. However, there is some delay in budget disbursement which distracted some of field survey activities. The 1st disbursement was received on 23 May 2012, about three months after official date of project signing, while second disbursement received on 27 August 2013. All this had in one way or another effect the overall implementation of the project activities in particular the field survey works.

Besides that there is no clear problem in term of communication since most of the time it had been well communicated mainly through email and other internet services. The annually project progress monitoring and evaluation were also done by APFNet in a very systematic manner and adequate yearly meeting and discussion had been done throughout the project including visits to different selected study sites in the participating countries. The country also was given adequate notice and time to submit report and always kept informed from time to time on the overall project progress.

5.0 RESULTS

This project was focuses on the role of remote sensing and geographic information system (GIS) in assessment of changes in forest cover and carbon stock, between 2010 and 2005, in Malaysia. Three main remote sensing data were used in this project, namely the Landsat TM, MODIS and GLAS. About 64 scenes of Landsat TM medium resolution satellite imageries were use to map the land cover of Malaysia for the years 2010 and 2005. After performing classification on these images, a total of eight land use classes were identified and mapped. The classes were water, shrub land, grassland, built-up area, inland forest, peat swamp forest, mangrove and croplands. These classification maps contained details spatial distribution of land use information. This information is useful particularly to discover the driving forces of the forest changes and could provide supporting information for the policy maker of the Malaysian government. A total of 100 plots have been established at the center of GLAS data for estimating biomass through the combination of field inventory and GLAS signal. All these plots were located at three different forest types namely the dipterocarp forest, peat swamp forest and mangrove forest which were located at eight different forest reserves in Malaysia. It was found that the distribution of biomass within the plot is ranging from 29.93 – 417.45 tone/ha, 96.06 – 213.10 tone/ha and 145.90 – 410.90 tone/ha for the inland forest, peat swamp forest and mangrove forest, respectively. The trend of forest cover changes over the time span of 5 years was precisely analysed in this project. Results shows that with an appropriate classification method and the helps from several supporting data including field surveys, this project had successfully classified the forest into three major types, which are inland dipterocarp, peat swamp, and mangrove forests. From the results of the image classification, a total forested area of Malaysia for years 2005 and 2010 are about 22,260,598.33 ha and 20,616,423.86 ha respectively. These cover about 67.4% and 62.4% of total land of Malaysia in years 2005 and 2010 respectively. There are about 1,644,174.47 ha (7.39%) reductions of forest areas between these two dates mainly as a result of land development activity for agriculture purposes. The classification accuracies for both maps are 91% and 93% respectively for 2005 and 2010 images.The project provided further recognition of the expanding capacity of space-based remote sensing to meet the requirements of large-area forest mapping and monitoring activities at national to regional scales. This project has achieved significant results towards sustainable forest management practices in Malaysia. With remote sensing technology that offers the information on land cover with different spatial and temporal resolution, it has been one of the main sources for the government, private sectors and policy makers especially in monitoring and managing natural resources in this country. Through this project, FRIM also helps Forestry Department in mapping their forest area as the output of this project provides information on the status of forest areas. Two series of forest cover maps (2005 and 2010) gave them valuable information on the changes of forest areas within that period. This would help them in determining the status of their forest areas whether if there a still forest in that particular area or the forest is degraded because of logging activities undertaken, land conversion, or encroachment activities in that area. Such information is essential to plan and manage their forest area for better sustainable forest management practices.

It is envisage that this project would prove the usefulness of remote sensing and geographic information system in forest resource management. The maps produced could serve as a platform for assessing and monitoring forest resources in Malaysia.

5.1 Achievements

This project has achieved significant results towards sustainable forest management practices in Malaysia. With remote sensing technology that offers the information on land cover with different spatial and temporal resolution, it has been one of the main sources for the government, private sectors and policy makers especially in monitoring and managing natural resources in this country.

Forestry Department of Peninsular Malaysia has taken the initiative on utilizing remote sensing technology as one of the methods in monitoring their forest towards achieving zero illegal logging activities in Permanent Reserved Forest (PRF) in Peninsular Malaysia. Through this project, FRIM also helps Forestry Department in mapping their forest area as the output of this project provides information on the status of forest areas. Two series of forest cover maps (2005 and 2010) gave them valuable information on the changes of forest areas within that period. This would help them in determining the status of their forest areas whether if there a still forest in that particular area or the forest is degraded because of logging activities undertaken, land conversion, or encroachment activities in that area. Such information is essential to plan and manage their forest area for better sustainable forest management practices.

This project also has shown that the important use of remote sensing technology in monitoring forest areas. The achievement has been shared and demonstrated through seminars and others event. FRIM has participated in several seminars that presented some of this projects finding as to highlight the importance of this project in monitoring and managing our natural resources especially forest areas. This should increase awareness among the local citizen's on the status of forest areas in Malaysia. The APFNet as the funder of this project has had a recognition by the local people and the forest authorities through publicity of the seminars.

5.2 Good stories, best practices, intelligence products to be shared in the region

This project has given valuable knowledge and experience to Malaysia. This project has strengthened FRIM's relationship with other agencies such as the Forestry Department of Peninsular Malaysia, Sabah Forestry, Sarawak Forestry and Department of Agriculture & Agro-Based Industry Malaysia. Our activities related to forest inventory has become faster and easy with the cooperation that was given by them. The technique developed from this project such as biomass mapping using both field and remote sensing data is of useful to the country. The information can be used by the authority to better plan and manage the

remaining forests areas in this country. The method and technique developed may also be shared with other countries having similar forest types and habitat in this region such as Indonesia and Brunei.

5.3 Lessons learned and outstanding issues

Development Lessons

The project benefited tremendously from the cooperation and participation of various stakeholders in particular forestry departments. Coordination roles played by the NRE were very important to ensure all agencies involved in the project implementation participated actively. The organization and the management of this project have been successful in implementing the planned operational activities. The design of the project was sufficient to enable an effective implementation of the project. It is important that the coordination be made systematically in order to make the project runs smoothly. Overall the project design including the project planning and financing procedure in FRIM has been carried out efficiently which resulted in the successful implementation of the project and achievement of all targeted objectives. Among others, one important factor in the project design which should be considered in the future is on the allocating some adequate reserve time for field survey activities in anticipating problem to do field survey due to the bad weather as well as difficult accessibility to the project site in unpredictable tropical weather condition as well as tropical forest environment.

Operational Lessons

The design of the project was sufficient to enable effective implementation of the entire project. Close collaboration with the Supervising Agency had enabled all necessary decision to implement the project achieved on time and without delay. Early consultation with the partners including the forestry departments helped in getting support and approval from them to undertake field survey in all study sites. The project implementation also took into consideration the active involvement of the state forestry department staff, in particular during the field survey. This indirectly led to an interest by the staff to learn and gain more knowledge related to the work. In addition, the local community residing in the vicinity of the project sites had also been engaged in the field survey work. This indirectly contributed to their additional income as well as creating awareness on the importance of managing forest resources for future generation.

Another important lesson learnt from the project was in term of the need to have clear understanding on the role of each project team members start from the beginning of the project. These include the technical team, the administrator and the financial officer. As FRIM is a government agency, the project follows exactly all related government rules and procedure and as such there is no problem encountered during the project implementation.

In term of project monitoring and evaluation as indicated earlier the project was monitored both at the ministry (national) level as well as internally at FRIM. These two levels of monitoring helped to ensure that all activities planned be undertaken according to the schedule and objectives targeted earlier achieved at the end of the project.

With regard to the use of fund, overall the flow and use of fund have been appropriate to enable the implementation of the planned activities. However, the mechanism to disburse the fund by the donor agency to the executing agency could be improved so as not to delay the disbursement which may results in the delay of undertaking the planned project activities.

5.4 Impacts

The outputs of this project have given positive impact to the country in general and forestry sector in particular. This project has strengthened the relationship between FRIM and other agencies such as Forestry Department. This would give the opportunity for both agencies to work together in the future to in order to further strengthen the implementation of sustainable forest management practices in this country. Results obtained from this project especially spatial information such as forest maps produced from this project helps in defining forest areas with more accurate. The use of remote sensing data in monitoring and managing forest resources has become essential in recent years and in the future.

Procedure and methodology developed both in term of digital image processing as well as field survey for biomass estimation in this project no doubt will give better information to the related agency in managing forest resources in this country. It may provide inputs for the policy makers and forest managers on designing appropriate strategy to manage forest for both socio-economy and environmental requirements.

6. SUSTAINBILITY

The project which provides information on forest biomass and carbon in Malaysia no doubt had complements the sustainable management and utilization of the forest resources in Malaysia. The carbon and biomass distribution maps will be used by the relevant authority in this country to plan for better resource management taking into consideration of local and global climate change related issues. This would provide direct benefits for the country and the region. The information on forest carbon distribution and its important will also protect the forest ecosystem and contributes towards the conservation of biological diversity. This will provide benefits not only to Malaysia but also to the global community.

The output generated from the project will have a long term effect and it is important to be sustainably managed. It is anticipated that FRIM will plays an important role to ensure the project sustainability beyond the project life span.

FRIM as the EA in Malaysia benefited in terms of enhancement of its knowledge and capacity in carrying out the mapping and assessment of forest carbon and biomass. As such FRIM is in the better position to continue monitor the project beyond the project life span (i.e after the APFNet financial support). It is important for FRIM to continue the initiative as such should find a way to allocate sufficient fund every year to maintain the database and update as well as monitor all information gathered in this project. As such, the sustainability of this project is very promising in-line with the Malaysian Government commitment in managing the forest resource on a sustainable basis.

The outcome of this project has also generated relevant information required for the preparation of climate change related reports, as required by the country for international negotiations and meeting.

7. RECOMMENDATIONS

The methodology and procedure in mapping forest biomass and carbon can also be replicated in other similar forest environment in this region. It is recommended that FRIM provides the expertise and knowledge gained from this project to help other tropical countries in this region such as Indonesia and Brunei to map their forest biomass and carbon content. It is suggested that APFNeT provide fund to implement the activity mentioned above.

During the project implementation, early consultation with the state authority helped in getting support and approval from them to undertake the project in the proposed study areas. As such for the future, it is recommended that any project should put an emphasis in taking necessary stakeholder consultation process as early as possible to ensure the smooth project implementation.

Overall, the project objectives have been successfully achieved in accordance with the problems raised in the project document, with the full involvement of stakeholders and wise use of resources to produce the outputs. It is recommended that similar activities be updated continuously by using other new existing satellite data such as Landsat 8.

Annex(es):

Annex A: Implementation schedule
Annex B: Details of project cost by category

Annex A: Implementation schedule

Activity	Executed (%)	Planned completion	Extended completion	Status
1.1 Project inception workshop	100	13/9/2011	15/09/2011	Completed
1.2 Remote sensing database	100	31/12/2011	31/12/2011	Completed
1.3 National-institute-owned ground truth database	100	31/5/2012	31/08/2013	Completed
1.4 Field data collection in selected test sites	100	31/7/2012	31/10/2013	Completed
1.5 Framework and methods development	100	31/8/2012	30/04/2012	Completed
1.6 Training on forest mapping	100	5-8/6/2012	08/06/2012	Completed
1.7 Forest map products of Malaysia	100	30/4/2013	31/03/2013	Completed
1.8 Validation & Verification	100	31/5/2013	31/03/2013	Completed

Annex B: The result of the audit session and the details of project cost by category

REPORT ON FUND FOR
"FOREST COVER AND CARBON MAPPING IN THE GREATER MEKONG SUBREGION AND MALAYSIA PROJECT"
AS AT 31ST MARCH, 2014

JAMAL, AMIN & PARTNERS
Chartered Accountants

REPORT ON FUND FOR "FOREST COVER AND CARBON MAPPING IN THE GREATER MEKONG SUBREGION AND MALAYSIA PROJECT"
AS AT 31ST MARCH, 2014

Project Number	**APFNet/2011/PA/004**
Project Title	**Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia**
Project Duration	**24 months**
APFNet Contribution	**USD95,600**
Date of Contract	**19 March 2012**
Executing Agency	**Institute of Forest Resource Information Techniques, Chinese Academy of Forestry, China (IFRIT)**
Implementing Agency	**Forest Research Institute Malaysia (FRIM)** **52109 Kepong, Kuala Lumpur.** **Malaysia.** **Tel : 603-6279 7201** **Fax : 603-6272 9852** **Email: khali@frim.gov.my**
Auditor	**Jamal, Amin and Partners** **(No : AF 1067)** **Chartered Accountants** **No. 60-2B, 2nd Floor, Jalan 2/23A,** **Off Jalan Genting Klang,** **Taman Danau Kota, Setapak,** **53300 Kuala Lumpur**

JAMAL, AMIN & PARTNERS
Chartered Accountants
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A Member Firm of Malaysian Institute of Accountants (AF 1067)
A Member Firm of Labuan Offshore Financial Services Authority - LOFSA (AAL 0022)

INDEPENDENT AUDITORS' REPORT TO THE REPRESENTATIVE OFFICER OF ASIA-PACIFIC NETWORK FOR SUSTAINABLE FOREST MANAGEMENT AND REHABILITATION

We have audited the accompanying Income and Expenditure statement of the project "FOREST COVER AND CARBON MAPPING IN THE GREATER MEKONG SUBREGION AND MALAYSIA" as at 31 March 2014 and the cash flow statements for the period then ended. The preparations of these statements are the responsibility of FOREST RESEARCH INSTITUTE MALAYSIA's (FRIM) management. Our responsibility is to express an opinion on these statements based on our audit.

We conducted our audit in accordance with approved auditing standards in Malaysia. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the Income and Expenditure and cash flow statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosure in these statements. An audit also includes assessing the accounting principles used and the significant estimates made by the management of FOREST RESEARCH INSTITUTE MALAYSIA (FRIM). We believe that our audit provides a reasonable basis for our opinion.

In our opinion, the Income and Expenditure and cash flow statements audited by us present fairly, in all material respects, the financial position of the project "FOREST COVER AND CARBON MAPPING IN THE GREATER MEKONG SUBREGION AND MALAYSIA" at 31 March 2014, and the results of its activities and cash flows for the period then ended.

JAMAL, AMIN & PARTNERS
(No : AF 1067)
Chartered Accountants

AMINUDDIN BIN YAHAYA
(No : 1669/11/14(J))
Chartered Accountant

Kuala Lumpur
Dated: 14th April, 2014

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INCOME AND EXPENDITURE STATEMENT
FOR THE PERIOD FROM 1 SEPTEMBER 2011 TO 31 MARCH 2014

Component	Original Amount (A)	Expenditures To Date			Available
		Accrued (B)	Expended (C)	Total (D) {B+C}	Funds (E) {A–D}
	USD	USD	USD	USD	USD
1. Funds managed by executing Agency					
1. Inception funds	-	-	-	-	-
Component Total	-	-	-	-	-
2. Consultants	-				
2.1 Full Time Research Officer	-				
2.2 Temporary Research Officer	24,000.00	6,080.95	14,772.64	20,853.59	3,146.41
Component Total	**24,000.00**	**6,080.95**	**14,772.64**	**20,853.59**	**3,146.41**
3. Management assistants					
3.1 Technical/Financial assistants	4,800.00	1,271.86	-	1,271.86	3,528.14
Component Total	**4,800.00**	**1,271.86**	**-**	**1,271.86**	**3,528.14**
4. Study tour & travel expenses					
4.1 Accommodation for site visit	20,000.00	7,825.12	18,512.03	26,337.15	(6,337.15)
Component Total	**20,000.00**	**7,825.12**	**18,512.03**	**26,337.15**	**72,674.30**
5. Survey/ case study & sub-contracts					
5.1 Mapping component	5,000.00	6,225.76	-	6,225.76	(1,225.76)
5.2 Carbon stock component	-	-	-	-	-
Component Total	**5,000.00**	**6,225.76**	**-**	**6,225.76**	**(1,225.76)**
6. Training & workshops					
6.1 Accommodation for training & workshops attend	13,000.00	-	12,981.60	12,981.60	18.40
Component Total	**13,000.00**	**-**	**12,981.60**	**12,981.60**	**18.40**
7. Equipment					
7.1 GPS Hadheld x 1 for survey plot planning	1,500.00	-	890.30	890.30	609.70
7.2 Hypsometer x 1 for tree height and canopy coverage measurement	1,500.00	-	2,826.71	2,826.71	(1,326.71)
7.3 Diameter tapes (20m) x 1 for tree diameter measurement	100.00	-	-	-	100.00
7.4 Measuring tapes (100m) x 1 for survey plot measurement	100.00	-	-	-	100.00
7.5 Other forester kits	800.00	-	571.45	571.45	228.55
Component Total	**4,000.00**	**-**	**4,288.46**	**4,288.46**	**(288.46)**

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INCOME AND EXPENDITURE STATEMENT (Cont.)
FOR THE PERIOD FROM 1 SEPTEMBER 2011 TO 31 MARCH 2014

Component	Original Amount (A)	Expenditures To Date			Available
		Accrued (B)	Expended (C)	Total (D) { B + C }	Funds (E) { A – D }
	USD	USD	USD	USD	USD
8. Flowing Materials					
8.1 List separately all materials to be purchased	4,000.00	3,179.65	591.26	3,770.91	229.09
Component Total	**4,000.00**	**3,179.65**	**591.26**	**3,770.91**	**229.09**
9. Office accommodation and administration					
9.1 Office rental costs	-	-	-	-	-
9.2 Local transportation costs	16,000	2,709.06	11,966.03	14,675.09	1,324.91
9.3 Office supplies & expenses (stationery, utilities, phone etc.)	4,800	4,769.48	312.98)	5,082.46	(282.46)
9.4 Foreign Exchange	-	-	(319.17)	(319.17)	319.17
Component Total	**20,800**	**7,478.54**	**11,959.84**	**19,438.38**	**1,361.62**
GRAND TOTAL	**95,600**	**32,061.88**	**63,105.83**	**95,167.71**	**432.29**

CASH FLOW STATEMENT
FOR THE PERIOD FROM 1 SEPTEMBER 2011 TO 31 MARCH 2014

Component	Ref	Date	Amount	
			in USD	Local Currency RM
A. Fund received from ITTO				
1. First instalment	7121513	23/05/2012	38,240.00	116,249.60
2. Second instalment	7132298	27/08/2013	47,800.00	155,350.00
3. Third instalment				
Total Funds Received:			**86,040.00**	**271,599.60**
B. Expenditures by executing agency				
1. Inception funds			-	-
Component Total			-	-
2. Consultants				
2.1 Full Time Research Officer			-	-
2.2 Temporary Research Officer			14,772.64	46,460.06
Component Total			**14,772.64**	**46,460.06**
3. Management assistants				
3.1 Technical/Financial assistants			-	-
Component Total			-	-
4. Study tour & travel expenses				
4.1 Accommodation for site visit			18,512.03	58,220.31
Component Total			**18,512.03**	**58,220.31**
5. Survey/ case study & sub-contracts				
5.1 Mapping component			-	-
5.2 Carbon stock component			-	-
Component Total			-	-
6. Training & workshops				
6.1 Accommodation for training & workshops attend			12,981.60	40,827.16
Component Total			**12,981.60**	**40,827.16**

CASH FLOW STATEMENT (Cont.)
FOR THE PERIOD FROM 1 SEPTEMBER 2011 TO 31 MARCH 2014

Component	Ref	Date	Amount	
			in USD	Local Currency RM
7. Equipment				
7.1 GPS Hadheld x 1 for survey plot planning			890.30	2,800.00
7.2 Hypsometer x 1 for tree height and canopy coverage measurement			2,826.71	8,890.00
7.3 Diameter tapes (20m) x 1 for tree diameter measurement			-	-
7.4 Measuring tapes (100m) x 1 for survey plot measurement			-	-
7.5 Other forester kits			571.45	1,797.20
Component Total			**4,288.46**	**13,487.20**
8. Flowing Materials				
8.1 List separately all materials to be purchased			591.26	1,859.50
Component Total			**591.26**	**1,859.50**
9. Office accommodation and administration				
9.1 Office rental costs			-	-
9.2 Local transportation costs			11,966.03	37,633.17
9.3 Office supplies & expenses (stationery, utilities, phone etc.)			312.98	984.32
9.4 Foreign Exchange			(319.17)	(1,003.79)
Component Total			**11,959.84**	**37,613.70**
Total expenditures to-date			**63,105.83**	**198,467.93**
Remaining Unclaimed Funds (A-B)			**22,934.17**	**73,131.67**

Annex C: List of Committed Expenditure

No.	Item	Amount (USD)
1	Temporary Research Officer	6,080.95
2	Financial Assistant (Independent Auditor)	1,271.86
3	Accommodation for site visit (Field survey Mac 2014 and April 2014)	7,825.12
4	Mapping Component (Ground survey data collector)	6,225.76
5	Flowing Materials (Others)	3,179.65
6	Local Transportation Cost (Field survey Mac 2014 and April 2014)	2,709.06
7	Report Preparation, Printing and Currier Service	4,769.48
	Total	USD 32,061.88

Document No.:
Receiving Date:
(For APFNet Secretariat)

Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

Completion Report

Forest Cover and Carbon Mapping in the Greater Mekong Sub-region and Malaysia

[September 1, 2011 to August 31, 2013]

[Royal Forest Department, THAILAND]

[June 12, 2014]

Basic Project Information

Project Title(ID)	Forest Cover and Carbon Mapping in the Greater Mekong Sub-region and Malaysia	
	Approved	Actual
Date of commence	31 October, 2012	September 1, 2011.
Date of completion	August 31, 2013	February 28, 2014
Extension period	August 31, 2013- February 28, 2014	
Project Budget (in USD) 129, 800		
APFNet's Grant (in USD)	96,200	96,200
Counterpart Contribution (in USD)	33,600	33,600
Supervisory Agency	None	
Project Executing Agency	Royal Forest Department	
Project Director	RFD Deputy Director General	

Project description:

The aim of this project is to produce forest and carbon maps of 2005 and 2010 for Thailand which is part of the Greater Mekong Sub Region and Malaysia area.

Prepared and Submitted by	**Reviewed and Endorsed by**
Project Manager signature Date Sept 4, 2014	Project Steering Committee Chair signature Date Sept 4, 2014

FOR APFNET USE

Reviewed and comments by	**Reviewed and comments by**
ED signature Date	PO signature Date

Executive Summary

The project "Forest Cover and Carbon Mapping in the Greater Mekong Subregion (GMS) and Malaysia" was initiated by the Chinese Academy of Forestry (CAF) and sponsored by Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet). The project period was originally 24 months, September 1, 2011 – August 31, 2013. Due to the difficulties of project operation and huge data workloads among member countries, CAF has requested to APFNet to officially extent the project duration until February 28, 2014. The executing agency of Thailand is Royal Forest Department (RFD), Ministry of Natural Resources and Environment. Regarding the project budget for Thailand, the total amount was 129,800 USD, in which is supported by AFPNet is 96,200 USD and added as counterpart fund of 33,600 USD by the RFD. The RFD proposed the objectives for the project were set up as: (1) To establish the database of existing data and reference datum (2) To establish the remote sensing database and generate carbon maps in test sites (3) To measure forest field plots centered by ICESat GLAS footprint from typical forests for biomass estimation (4) To establish classification validation plots for forest distribution maps evaluation and (5). To produce forest distribution maps of 2005 and 2010 for Thailand.

Thailand project comprises of all involved officers and also have project consultant to guide and support project operations. The RFD appointed the deputy director general to be Thailand project director and involved related offices to be project committees. Many staffs who expertise in related research filed were appointed to in charge project work packages.

The project outcomes have been developed in various kinds of productions and aspects. The remote sensing database such as satellite imageries of Landsat, THEOS IKONOS and GLAS footprints data were created and achieved. The main productions of forest maps for 2005 and 2010 were created in both vector and raster format. In the field data measurement, various data were collected to validate forest area and to apply for biomass and carbon calculation. Technical support from CAF and knowledge exchange was gained during various workshops under the project. It reveals that the forest area of Thailand for 2005 and 2010 are 173,398.09 sq. km. and 161,967.27 sq. km. or 33.79 % and 31.57 % of country area (513,115.02 sq. km.). The data of national plots survey under International Timber Trade Organization (ITTO) project was introduced for accuracy validation by using Kappa index analysis. It shows that overall classification accuracy of forest map 2005 and 2010 were 84 % and 85 % which are acceptable. The sample plots was laid at 4 study sites to measure forest tree characteristics for the preparations to calculate the biomass of forest stand. There were 97 plots centered by GLAS footprints collected which less than project requirement at 100 plots dues to area inaccessible. To validate forest map classification there were 172 sample points of each forest classification collected such as 50 plots of evergreen broadleaf forest, 88 plots of deciduous forest and 34 points of mangrove forest and the project required 50 points per each forest type. All data produce under Thailand project have been submitted to CAF for further analysis to produce regional forest and carbon maps. The overall output of the project will be very useful and valuable information to support the global warming mitigation and it will bring the strengthen linkage among member countries cooperation in the future.

TABLE OF CONTENTS

1. INTRODUCTION

Thailand is located in a tropical and temperate zone and is essentially a forest country. The forests are divided into 2 main categories such as tropical evergreen forest and deciduous forest. The evergreen forests are divided into 4 main types such as tropical evergreen forest, coniferous forest or pine forest, swamp forest and beach forest. The tropical evergreen forest can be classified into 3 types such as moist evergreen forest, dry evergreen forest and hill evergreen forests. The swamp forest can be further classified into 2 types such as peat swamp forest and mangrove forests. The Deciduous forests are classified into 3 types such as mixed deciduous forests, dry dipterocarp forests and savannah.

In the past, Thailand was covered with dense forests distributed all over the country, except in some areas of the great central plain where the forest had been removed to make way for agriculture. The first project concerned with forest resources assessment in Thailand was conducted by the Ordnance Survey Department in 1961. The panchromatic aerial photographs of medium scale 1: 25,000 were interpreted for the main land use classification. It reported that the existing forest of Thailand in 1961 amounted to 273,628.50 sq. km or 53.33 percent of the total area of the country. In 1975 aerial photographs at the large scale of 1:15,000 were applied for cadastral survey for land titling and other multi-purpose in Thailand. The forest cover in Thailand has been reducing continuously due to the rapid development of the economy in various fields, in particularly, the occupation of forest area for settlement and living. The latest report on 2014 from the RFD shows that the forest area covers 31.57 % of the total area of the country, which is obtained using the interpretation of Landsat 5 data. The reduction of the forest area has negative influence to the environmental and natural resources issues, in particularly, more and severe disasters have been occurred due to global warming, the release of the greenhouse gases, e.g. carbon dioxide.

Based on the regional collaborations between the GMS countries with Malaysia in forest cover and carbon estimation mapping, which were initiated by APFNet and CAF for forest resources management, which can be support to reduce global warming, Thailand, in particularly, the RFD which is the main governmental organization that work on forest management of the country, understand the project collaboration between the GMS members will benefit to the development of the forest cover mapping for Thailand and to encourage the reduction of global warming issue. The project of Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia was very important and useful.

2. PROJECT GOAL, OBJECTIVES AND FORMULATION

2.1 Project Goal

The target of this project is to obtain forest map of 2005 and 2010 and to conduct field survey to gain data for forest map validation and carbon mapping. To establish the regional cooperation among GMS countries and Malaysia for Sustainable Forest Management (SFM)

2.2 Project Objectives

(a) To establish the database of existing data and reference datum.

(b) To establish the remote sensing database and generate carbon maps in test sites.

(c) To measure forest field plots centered by ICESat GLAS footprint from typical forests for biomass estimation.

(d) To establish classification validation plots for forest distribution maps evaluation.

(e) To produce forest distribution maps of 2005 and 2010 for Thailand.

2.3 Project Designing

The RFD takes this project high priority because the outcomes from the project will be very valuable. The project committee comprises of executive officer, director of related offices, researchers, forest technical officers, field officers, administrative persons and also project consultant. The project goal and target established by CAF and APFNet were introduced to project team then duties had been designated. Then the specify objective of Thailand had designate and action was established. The project framework was disseminated to all project staffs. The project monitoring was regularly operated by Executive committee. Several meeting among project team conducted to update the project progressive and discuss upon occurring problem. The alternative plans always established and ready for the unexpected phenomenon. Under the project there were in various channels conducted to fulfill the staff communication. The project work office was designated to separate area from the others this increased efficiency of project operation. To produced main products of the project such as forest maps 2005 and 2010 and field data collections high performance computer and accessories had been procurement. The rules of project staff were disseminated to central and regional offices to ensure that theirs leaders and colleagues recognized theirs extra works.

3. PROJECT EXECUTION

3.1 Start-up

In the first instance the RFD appointed the members of the committee responsible for this project. The committee was then sub divided into three sections;

- The Executive Committee which included the Project director, the Project Manager and her assistant. The role of this sub section was to establish the overall planning of the project and budget allocation.
- The Operations Committee led by Project Coordinator (Mr. Sukan Pungkul) included researchers, technical forestry officers, field surveyors and laboratory operators. The role of this sub section was to analyze existing satellite imageries and collect data from field surveys to update the information and produce maps for Thailand in 2005 and 2010. This team attended regular workshops around the GMS region.
- The Administrative Committee included office workers from various departments within the RFD whose purpose was to help with the administrative duties.
- Dr. Vivarad Phonekeo from AIT acted as the Project Consultant.

Once the members of each committee was confirmed a general meeting was held on January 15, 2013, to establish the action plan for implementation of the project. The Operation Committee and administrative Committee met regularly and reported back to the Executive Committee on the ongoing progress of the plan. The Executive Committee was responsible for the allocation and monitoring of the budget throughout the project. The implementation schedule is shown in Annex A.

3.2 Revisions to project.

There were no major changes made in the project.

3.3 Major Problems experienced

The main problem when setting up the project was the delay in budget and contract approval by the various departments within the Thai Government. This meant we were delayed in setting up the field surveys and therefore much of the early work was completed in the office. Another significant delay was caused in 2011 by the severe flooding of Bangkok and many surrounding districts, which cause difficulties to staff to not able to get into the RFD on a daily basis as well as not being able to get out into the field to complete any surveys up to four months. The various people involved in the project have worked consistently over the past 2 years to complete the project on schedule, although APFNet has extended the project for one more year.

3.4 Procurement and consultancy

We have purchased a new computer notebook and digital cameras, GPS, computer notebooks, various computer accessories and office equipment for implementing this project. All purchasing items were strictly followed the guidelines as laid down by the RFD. All of the receipts were archived on file.

A working contract was prepared (in Thai) to have Dr. Vivarad Phonekeo to work in the team as the consultant for conducting consultancy activities during the whole duration of the project. He received monthly salary of 30,000 baht for which he provided support and advice in the establishment of the action plan, made regular visits to evaluate the implementation of the action plan helped analyzing of the filed surveys.

3.5 Monitoring, evaluation and reporting

Regular meetings of the Operations Committee were held throughout the project. In these meetings, the progress of the project was reported by various members and any concerns discussed and related issues subsequently. As Project Coordinator, Mr. Sukan Pungkul was responsible for briefing the progress to the Project Manager, Ms. Warawan Tanakitrungruang on a regular bases. Any issues that she raised was then taken by the Project Manager back to the Operations Committee for further discussion and implementation.

3.6 Efficiency and effectiveness

The project team met all targets that were setup within the time framework . The main initiative is to complete forest mapping of Thailand for 2005 and 2010. These maps will help to reduce any previous inconsistency in previous Thailand Forest maps of 2000, 2004, 2008 and 2011. The secondary initiative is to collect data from sample plots measuring 70x70 metres from Kanachanaburi, Petchaboon, Ubon Ratchanthani and Trat provinces. All provinces have samples of the different types of forest found in Thailand. This survey helps us to calculate the biomass of each survey plot, which will then be converted into Carbon which related to the GLAS Footprint data.
The final task was to collect 50 sample points from each forest classification in many different provinces around Thailand. These sample points will help us to analyze the different forest areas in the maps of 2005 and 2010. In order to complete the above tasks about 50% of the total budget was used 20% over our estimated range.

3.7 Project Costs and Sources

The above survey plots were already designated by ICESAT and were located in difficult to access regions, such as high in mountainous regions. This meant access took longer than expected and required us renting tents for up to 10 days at a time, therefore overspending on the budget.

It was decided by the Executive Committee to send more than the required representatives to some of the meetings held around GMS countries. This was helpful to younger colleagues to gain valuable experience, and definitely this is again exceeded the planned budget. See financial statement which is attached (Annex B.)

3.8 Dissemination

Regular meetings of the various committees were held throughout the project. Meetings between identified members of each committee also met throughout the project, for example the Project Coordinator and Operation committees met several times with the Project Manager. Several information circulars to supplement the meetings were sent to all members. Anyone who attended a GMS workshop had to write a report which was sent to all members of the executive Committee and the Direct General of RFD. A sample is attached. (Annex C)

4. PROJECT STAKEHOLDERS' PERFORMANCE

4.1 Supervisory Agency (if any)

We had one person in a supervisory role and this information is already give in reference point 3.4

4.2 Executing Agency (project team and project director)

The information regarding the executive Committee members job descriptions in relation to this project can be found in Annex D.

The RFD has a hierarchical system of monitoring performance. The Project Coordinator and project operation committee were checked by the Project Manager. The Project Manager performance was checked by the Project Director, Deputy Director General of the RFD. The final check on his performance is made by the Director General.

4.3 Other project partners

Again this can be referred to view the reference at Section 3.4.

The performance was monitored by the Project Manager.

4.4 APFNet

APFNet sent a representative to all GMS workshops. The representative was able to answer general questions and discuss problems in detail. The organization's website is easily accessible and has comprehensive and easy to follow information which helped throughout the project. The organizations staff were very active and replied to emails sent as soon as possible, giving clear advisory information. They also disseminate leaflets giving up to date information.

5. RESULTS

5.1 Achievements

On the completion of the project all targets and objectives were fully accomplished. Thailand forest maps of 2005 and 2010 were produced from Landsat 5. The study sites forest maps of 2005 and 2010 were produced from various satellite images. Field data collection for biomass calculation and forest maps verification were established.

The RFD recognized the project as being of extreme importance to the department and made it a high priority. All staff members worked with enthusiasm and eagerly await the results. Field officers introduced the project to the local community of the project sites to ensure that they recognize staff and support the project. Field officers met with local village leaders to explain the objectives of the project and help develop a sense of pride in their forest. Because of this project, the staff from various administrative levels of the RFD have learnt more experience about APFNet. The organizations technical information, innovative leadership and funding of projects such as this helps to develop sustainable forest management (SFM). The RFD project team always mentioned APFNet to local officers. The knowledge and creative ideas from this project are now applied to regular works to increase the efficiency and reduce resources consumption.

5.2 Good stories, best practices, intelligence products to be shared in the region

It was good to be involved with other CMS countries and Malaysia and under the leaderships of CAF; the benefit will be the completion of regional forest and carbon maps, which will support efforts to reduce global warming. The RFD which is the main governmental organization involved in forest management, understanding the project will help in the development of the forest cover mapping for Thailand. Several workshops organized by CAF to update the project activities and results were very impressive. Technical support and the sharing of information among the GMS countries are very helpful for the project operation in Thailand. Good relationship and collaboration which were established between member countries will help to strengthen the Sustainable Forest Management (SFM) in the region.

5.3 Lessons learned and outstanding issues

The biggest single point that we have learnt in this project was the importance of organizing and managing the right team work. In terms of allocating the right people into the right job and the importance of working together as a single unit to achieve the objectives.

Long and short term planning is vital to successfully completing projects of this magnitude, however, it is also important to have a plan " B" in case of unexpected events disrupting the original plan of action.

The controlling of the budget is extremely important and for projects like this to succeed the administration in charge of the budget should adhere strictly with the original budget plans.

5.4 Impacts

The project had a very positive impact with the various local communities. The most important being that the village heads fully understood the importance of protecting their local forest in terms of carbon storage. There is less encroachment into forest lands and local people are more aware of the need not to encroach on forest land, although this has caused some financial hardship to some local people. We are beginning to see some improvement in the relationships between RFD and local communities and hope this will continue.

6. SUSTAINBILITY

The RFD will continue to produce forest maps and have already submitted budgets to the government to carry on with this project. We have already established closer working relationships with organizations within Thailand, such as universities, research institutes and experts in this field. We aim to produce more detailed forest and carbon maps.

7. RECOMMENDATIONS

- We need to introduce another type of remote sensing data, such as Hyper Spectral Image and/or LIDAR to calculate the carbon stock. These remote sensing data can detect the characteristics of tree better than optical data that we presently use.
- We need to develop the mathematical equation that we use to calculate the forest carbon according to the type of forest in the region. The GMS region comprises different types of forest and each type should have their own equation for calculating carbon stock.
- Each country has its own system of forest classification. The system used here

in Thailand is different to that given by CAF. We need to work together to come up with a standardized classification system that is universally accepted.

- All countries in the GMS region need to learn the method of carbon calculation rather than sending data to CAF to calculate the information. We need to have a workshop to be able to implement this.
- For any major project such as this, we need to have discussed a plan "B" At the start of future projects the organizing committee needs to establish an alternative action plan from the very beginning.
- All GMS countries need to establish their own budget which will enhance the financial support given by APFNET. This additional budget will cover any unforeseen expenditure, but more importantly will ensure there are no delays in the project whilst waiting for overseas funding.
- All colleagues around the GMS region who have been working on this project have at the same time had to complete their own regular work. It would be advantageous to either extend the project to 3 years or for individual countries to recognize the workload and give extra time to complete it. CAF should instigate in the first instance, a meeting of all GMS countries Director General of forest organizations. At the inaugural meeting it should be fully explained the in depth workload involved in completing the project.

Annexes:

Annex A: Implementation schedule of the project.

Outputs /Activities	Executing Committee	Schedule (in month)						
		1-4	5-9	10-13	14-19	20-24	25-27	28-29
1.Review of existing information of the study sites and establishing background database	Ex Com Oper Com	x						
2. Remote sensing data establishment	Oper Com		x	x				
3.Training forest mapping	Oper Com			x	x			
4. Field data collection in selected test sites	Oper Com				x	x	x	
5.Framework and methods development	Oper Com Consultant					x	x	
6.Forest map products of Thailand and test sites	Oper Com					x	x	
7. Validation & Verification of forest map products in test sites	Oper Com Consultant					x	x	
8. Framework and method development for above ground biomass estimation	Oper Com Admin Com Consultant					x		
9. Field survey for above ground biomass estimation in the study sites	Oper Com			x	x	x	x	
10. Submit data and Report	Ex Com Oper Com Admin							x

*Ex Com stands for Executive Committee
*Oper Com stands for Operation Committee
*Admin stands for Administrative Committee

Annex B: Details of project financial statement

Component	Original	Expenditures To-date			Available
	Amount (A)	**Accrued (B)**	**Expended (C)**	**Total (D) { B + C }**	**Funds (E) { A - D }**
1. Inception funds	5,000	0	0	0	5000
2.Consultants	20,000	0	3,000	3,000	17,000
3. Management assistants	14,400	0	18,680	18,680	-4,280
4.Study tour & travel expense	30,000	0	46,837	46,837	-16,837
5.Survey/ case study & sub contracts	0	0	0	0	0
6.Training&workshop:	10,000	0	9,360	9,360	640
7.Equipment	8,640	0	7,249	7,249	1,391
8.Office accommodation and administration	8,160	0	3,911	3,911	4,249
Grand Total	**96,200**		**89,037**	**89,037**	**7,163**

Annex C: Details of project cost by category (scheduled versus actual) until June30, 2014

Expenses (USD)	APFNet Grant				Counterpart Fund			
	Anticipated A_1	Actual B_1	Variance $C_1(A_1-B_1)$	Variance rate $D_1(C_1/A_1*100\%)$	Anticipated A_2	Actual B_2	Variance $C_2(A_2-B_2)$	Variance rate $D_2(C_2/A_2*100\%)$
Project staff cost[1] (salary and allowance for project staff and management personnel)	14,400	18,680	-4,280	-29.72	4,000	4,800	-800	-20
Subtotal	14,400	18,680		-	-	-	-	-
Consultancy cost[2] (local and international consultants' cost)	20,000	3,000	17,000	85	-	-	-	-
subtotal	20,000	3,000	-	-	-	-	-	-
Travel and related cost[3] (air fare, local travel, per-diem and etc)	30,000	46,837	-16,837	-56.12	13,500	15,000	-1,500	-11.11
Meeting and training cost[4] (venue, facility, hospitality, speakers/experts' fees , participants accommodation, meeting material, etc)	-	-	-	-	-	-	-	-
Field activities cost[5]	10,000	9,360	640	6.4	-	-	-	-
Publication &Dissemination cost[6] (formulation, editing, publishing of articles, reports, books and information products and organization of outreach activities,	-	-	-	-	-	-	-	-

media activities)								
Office Operation cost[7] (project administrative management fee and administrative staff cost, lease/rental of office premises, office and facility maintenance, etc)	-	-	-	-	-	-	-	-
Procurement [8] (purchase of vehicles, equipment, facilities etc)	-	-	-		6,000	6,000	0	0
Monitoring, evaluation and audit cost[9]	-	-	-	-	-	-	-	-
Miscellaneous[10]	8,160	3,911	4,249	52.07	1,600	1,600	0	0
Subtotal								
TOTAL	8,640	7,249	1,391	16.09	6,900	7,500	-600	-8.69

Annex D: A sample of minute, the project committee meeting on October 30, 2013

รายงานการประชุม

โครงการวิจัยการทำแผนที่ป่าไม้และแผนที่ก๊าซคาร์บอนไดออกไซด์ในประเทศกลุ่มอนุภูมิภาคลุ่มน้ำโขง และประเทศมาเลเซีย

(Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia) ครั้งที่ ๑

วันอังคารที่ ๓๐ ตุลาคม ๒๕๕๕ เวลา ๑๐.๐๐ น. ณ ห้องประชุมสำนักส่งเสริมการปลูกป่า

.....

ระเบียบวาระที่ ๑ เรื่องที่ประธานแจ้งให้ที่ประชุมทราบ

ประธานแจ้งในที่ประชุมว่านายชลธิศ สุรัสวดี (ผู้อำนวยการโครงการวิจัยฯ)ติดราชการจึงมอบหมายให้นายฐานุพงษ์ เรืองจิรวิทย์ (รองผู้อำนวยการโครงการ) เป็นประธานในที่ประชุม และขอให้ที่ประชุมร่วมกันพิจารณาประเด็นข้อกังวลในการปฏิบัติงานโครงการวิจัยฯ ๒ ข้อ คือ

๑. เรื่องระยะเวลาที่เหลือ ๑ ปี สำหรับปฏิบัติงานโครงการ ควรมีการบริหารให้โครงการวิจัยฯเสร็จทันกำหนดเวลา

๒. เรื่องแผนการปฏิบัติงาน ควรมีเป้าหมายกำกับแผนงาน (MileStone) ที่ชัดเจน ให้มีการนำเทคโนโลยีที่เหมาะสมมาใช้สำหรับการปฏิบัติงาน และหากเกิดปัญหาในการปฏิบัติงานให้คณะทำงานควรช่วยกันพิจารณาและหาแนวทางแก้ไขในทันที

ระเบียบวาระที่ ๒ เรื่องแจ้งเพื่อทราบ

ประธานในที่ประชุมมอบให้ นางวราวรรณ ธนะกิจรุ่งเรือง (ผู้จัดการโครงการวิจัยฯ) ชี้แจงดังนี้

๒.๑ รายละเอียดของโครงการดังนี้

๑. ความเป็นมา วัตถุประสงค์ และผลลัพธ์ของการเข้าร่วมดำเนินโครงการวิจัยฯ

๒. แจ้งที่ประชุมทราบว่าได้คัดเลือกพื้นที่สำหรับเป็นแปลงตัวอย่างศึกษาของโครงการในประเทศไทย ๓ แห่ง คือ

๑. ป่าสาธิตอำเภองาว จังหวัดลำปาง

๒. อุทยานแห่งชาติผาแต้ม จังหวัดอุบลราชธานี

๓. พื้นที่ป่าชายเลน จังหวัดตราด

/๒.๒ แจงรายละเอียด

๒.๒ แจ้งรายละเอียดคำสั่งแต่งตั้งเจ้าหน้าที่ปฏิบัติงานโครงการวิจัย ตามคำสั่งกรมป่าไม้ที่ ๔๑๓๙/๒๕๕๕ ลงวันที่ ๓๑ สิงหาคม ๒๕๕๕ เรื่อง แต่งตั้งเจ้าหน้าที่ปฏิบัติงานโครงการวิจัยเรื่อง การทำแผนที่ป่าไม้และแผนที่ก๊าซคาร์บอนไดออกไซด์ในประเทศกลุ่มอนุภูมิภาคลุ่มน้ำโขงและประเทศมาเลเซีย และคำสั่งกรมป่าไม้ที่ ๔๑๓๘/๒๕๕๕ ลงวันที่ ๓๑ สิงหาคม ๒๕๕๕ เรื่อง ให้จัดตั้งสำนักงานโครงการวิจัยเรื่อง การทำแผนที่ป่าไม้และแผนที่ก๊าซคาร์บอนไดออกไซด์ในประเทศกลุ่มอนุภูมิภาคลุ่มน้ำโขงและประเทศมาเลเซีย

๒.๓ แจ้งการเตรียมความพร้อมการประชุมเชิงปฏิบัติการระยะกลาง (Midterm Workshop) ของโครงการวิจัย ซึ่งจะจัดในวันที่ ๓๐ พฤศจิกายน ๒๕๕๕ ถึงวันที่ ๒ ธันวาคม ๒๕๕๕ ณ โรงแรมเจ้าพระยาปาร์ค ถนนรัชดาภิเษก กรุงเทพฯ ซึ่งมีผู้เข้าร่วมจากประเทศ จีน เวียตนาม ลาว มาเลเซีย ไทย ประมาณ ๓๐ คน และแจ้งร่างกำหนดการประชุม

ระเบียบวาระที่ ๓ เรื่องอื่นๆ

นายสุเมธ ศิริลักษณ์ (รองผู้จัดการโครงการวิจัยฯ) มีข้อเสนอแนะเพิ่มเติมในการทำงานดังนี้

๑. สำหรับการทำงานกับหน่วยงานระหว่างประเทศควรมีการเตรียมพร้อมเรื่องของสำนักงาน และการประสานงานต้องสะดวกรวดเร็ว

๒. การทำงานควรทำเป็นระบบ ให้ถูกต้องตามระเบียบราชการและต้องมีเอกสารหลักฐานเก็บไว้ด้วย

๓. ควรมีการจัดทำ กรอบการทำงาน (Log Framework) ที่ชัดเจน

นางวราวรรณ ธนะกิจรุ่งเรือง (ผู้จัดการโครงการวิจัยฯ) แจ้งเรื่องเพื่อทราบเพิ่มเติมดังนี้

๑. ที่ตั้งสำนักงานโครงการวิจัยฯ ตั้งอยู่ที่ชั้น ๖ อาคารสุรัสวดี ขณะนี้อยู่ในระหว่างปรับปรุงสำนักงาน

๒. ขณะนี้กำลังดำเนินการขอหมายเลขโทรศัพท์ภายในสำหรับใช้ติดต่องานโครงการวิจัยฯ

๓. แนะนำเจ้าหน้าที่โครงการ ๓ คน คือ

๑. นางอรประภา ศิริอ่อน	ทำหน้าที่ผู้ช่วยวิจัยโครงการ
๒. นายฉัตรพงศ์ สมหมาย	ทำหน้าที่ผู้ช่วยวิจัยโครงการ
๓. นางสาวสุพิศตรา นาถมทอง	ทำหน้าที่ผู้ช่วยวิจัยโครงการ

/๔.แจ้งจะเสนอ

๔. เสนอให้มีการจัดประชุมเจ้าหน้าที่ระดับปฏิบัติงานโครงการวิจัยฯภายในเดือนพฤศจิกายน ๒๕๕๕ เพื่อชี้แจงรายละเอียดการดำเนินงานและการออกปฏิบัติงานภาคสนาม

ปิดประชุม เวลา ๑๑.๓๐ น.

อรประภา ศิริอ่อน
.....
(นางอรประภา ศิริอ่อน)
ผู้จดรายงานการประชุม
ผู้ช่วยวิจัยโครงการ

.....
(นางวราวรรณ ธนะกิจรุ่งเรือง)
ผู้ตรวจรายงานการประชุม
นักวิชาการป่าไม้ชำนาญการพิเศษ
ผู้จัดการโครงการวิจัยฯ

รายชื่อผู้เข้าร่วมประชุมครั้งที่ ๑

วันที่ ๓๐ ตุลาคม ๒๕๕๕

โครงการวิจัยเรื่อง การทำแผนที่ป่าไม้และแผนที่ก๊าซคาร์บอนไดออกไซด์ในประเทศกลุ่มอนุภูมิภาคลุ่มน้ำโขงและประเทศมาเลเซีย

(Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia)

ณ ห้องประชุมสำนักส่งเสริมการปลูกป่า เวลา ๑๐.๐๐ น.

.....

ลำดับที่	รายชื่อ	ตำแหน่ง	ลายเซ็น	หมายเหตุ
๑	นายชลธิศ สุรัสวดี	รองอธิบดีกรมป่าไม้ (ผู้อำนวยการโครงการ)	ติดราชการ	
๒	นายฐานุพงษ์ เรืองจิรวิทย์	ผู้อำนวยการสำนักงานความร่วมมือด้านป่าไม้ระหว่างประเทศ (รองผู้อำนวยการโครงการ)		
๓	นางวราวรรณ ธนะกิจรุ่งเรือง	นักวิชาการป่าไม้ชำนาญการพิเศษ (ผู้จัดการโครงการ)		
๔	นายสุเมธ ศิริลักษณ์	นักวิชาการป่าไม้ชำนาญการพิเศษ (รองผู้อำนวยการโครงการ)		
๕	นายสุกันต์ พึ่งกุล	นักวิชาการป่าไม้ชำนาญการ	สุกันต์	๕๗๖
๖	นางสาวนฤมล นุชเปลี่ยน	นักวิชาการป่าไม้ชำนาญการ		๕๘๐

ลำดับที่	รายชื่อ	ตำแหน่ง	ลายเซ็น	หมายเหตุ
๗	นางสาวปิยะฉัตร ช่วยปลอด	นักวิเทศสัมพันธ์ปฏิบัติการ		
๘	นายปรีชา องค์ประเสริฐ	นักวิชาการป่าไม้ชำนาญการ		
๙	นายฉัตรพงศ์ สมหมาย	ผู้ช่วยวิจัยโครงการ	ฉัตรพงศ์ สมหมาย	
๑๐	นางสาวสุพิศตรา นาถมทอง	ผู้ช่วยวิจัยโครงการ	สุพิศตรา นาถมทอง	
๑๑	นางอรประภา ศิริอ่อน	ผู้ช่วยวิจัยโครงการ		

Annex E: Project executing agency and technical assistance partner

Name	**Organization**	**Title**	Contact information (address, telephone, fax and e-mail)
Project Management Board			
RFD Deputy Director	Royal Forest Department	Inspector of Royal Forest Department Acting Project Director	-
Mr. Thanupong Ruangjirawit (Retired)	-	- Acting Project Deputy Director	To be appointed
Ms. Warawan Tanakitrungruang	Forest Research and Development Office	Forestry Technical Officer, Senior Professional Level Acting Project Manager	warawan47@hotmail.com
Mr.Sumet Sirilak	International Forestry Cooperation Office, RFD	Forestry Technical Officer, Senior Professional Level Acting Project Manage Assistance	ssluckforest@hotmail.com
Technical Assistance Partners			
Mr.Sukan Pungkul (Project Coordinator)	Forest Survey and Assessment Division, RFD	Forestry Technical Officer, Professional Level	mr.sukan@gmail.com
Ms. Narumol Noochplian	Forest Protection and Fire Control Office	Forestry Technical Officer, Professional Level	ms.narumol@gmail.com
Mr. Narong Koonkhunthod	Forest Plantation Extension Office	Forestry Technical Officer, Professional Level	kmnarong@yahoo.com
Mr. Buncha Rungrojana	Forest Resource Management Regional Office No. 7 (Ubon Ratchathani)	Forestry Officer, Experienced Level	dinpone@hotmail.com

Name	Organization	Title	Contact information (address, telephone, fax and e-mail)
Mr. Kumron Leadprathom	Forest Resource Management Regional Office No. 9 (Chonburi)	Forestry Technical Officer, Professional Level	kumron57@hotmail.com
Mr. Theerawat Kenmee	Forest Survey and Assessment Division, RFD	Forestry Technical Officer, Practitioner Level	varanus63@gmail.com
Mr. Kraiwut Siri-on	Forest Resource Management Regional Office No. 5 (Saraburi)	Forestry Technical Officer, Practitioner Level	mrkraiwut68@gmail.com
Ms. Piyachat Chuayplod	International Forestry Cooperation Office, RFD	Foreign Relations Officer, Practitioner Level	ch_piyachad@hotmail.com
Dr. Vivarad Phonekeo	Geoinformatics Center (GIC), Asian Institute of Technology (AIT)	Senior Researcher and Terra/Aqua MODIS Ground Receiving Station Manager Acting Project Consultant	vivarad@ait.ac.th

Project address:
Forest Cover and Carbon Mapping Project
International Forestry Cooperation Office, Royal Forest Deaprtment
Royal Forest Department, 61 Phaholyothin Road, Ladyao Sub-district, Chatuchak District, Bangkok 10900, Thailand, Tel: (662)-561-4292-3 Ext. 5786 Fax):662)-579-7583

Document No.:
Receiving Date:
(For APFNet Secretariat)

Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

Completion Report

Project Title

Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia

[January 1, 2012-June 30, 2014]

Executing Agency: Institute of Forest Resources Information Techniques (IFRIT), Chinese Academy of Forestry (CAF);
Technical assistance Partner: Forest Inventory & Planning Institute (FIPI)
Viet Nam Administration of forestry (VNForest)

Date of submission: Feb, 2015

Basic Project Information

Project Title(ID)	**Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia**	
	Approved	Actual
Date of commence		
Date of completion	June 30, 2014	May 30, 2014
Extension period	June 30, 2014	June 30, 2014
Project Budget (in USD)		
APFNet's Grant (in USD)	**108,100**	**102,304**
Counterpart Contribution (in USD)	27,000	27,000
Supervisory Agency	VNForest; IFRIT; APFNet	
Project Executing Agency	Forest Inventory and Planning Institute (FIPI) , Vietnam Administration of Forestry (VNForest)	
Project Director	Dr. Nguyen Huy Dzung – Deputy Director of FIPI	
Project description:		

Prepared and Submitted by: **Dr. Nguyen Huy Dzung** _____ Project Director signature Date 6/2/2015	**Reviewed and Endorsed by:** **Dr. Nguyen Phu Hung** _____ Project Steering Committee Chair signature Date
FOR APFNET USE	
Reviewed and comments by _____ ED signature Date	**Reviewed and comments by** _____ PO signature Date

Executive Summary

The Project “Forest Cover and Carbon Mapping in the Greater Mekong Sub-region and Malaysia” is implemented by IFRIT/CAF together with the Partners in Greater Mekong Sub-region and Malaysia and funded by APFNet. The project had studied and interpreted satellite images for mapping of forest cover and carbon stoke in the Mekong River Sub-region and Malaysia (GMS+)

Vietnam is one of the countries in the project area. FIPI of Vietnam participated in the project via a contract between APFNet – IFRIT and FIPI signed on the date …

From November 2011, the project held some inception workshops in Nan Ning QuangXi and Beijing –China, discussed technical methods applied and prepared implementation plan. From February 2012 to April 2014 the project had been being implemented in accordance with the tasks allocated in the contract of each partner for each each year; two workshops were held in different partner countries for discussing about progress, project plan and conducting field check in some test sites. The final project closing workshop will be held in Beijing of China on 17-20 June, 2014 to discuss the project results.

In Vietnam, the project partner had produced maps of forest cover for three test sites in three national parks which have three representative forest types of Vietnam. Maps were made by interpretation of satellite images of mid-resolution and field check. Those three test sites are Tam Dao National Park where there is evergreen broadleaved natural forest; and Xuan Thuy National Park where there is mangrove ecosystem; and Yokdon National park where there is deciduous broadleaved forest.

Based on the result achieved in three test sites, maps of forest cover for whole Vietnam have been produced by interpretation of satellite images of mid-resolution and verification data collected from field check.

In the test sites, biomass data of 100 plots were collected for calculation and mapping of forest biomass stock.

The project had produced maps of forest cover of 2005 and 2010 for whole Vietnam with the state of the art technology and reached an accuracy of 85%. These are very important documents for analysis of forest changes and for identification of critical areas of forest changes, finding the driving forces behind the changes as well as development of sustainable forest management projects in such areas. The project results also provided input for implementation of REDD projects at local level. Mapping methods used in the project are also extensively referred and applied to the similar projects at regional and provincial levels of Vietnam.

TABLE OF CONTENTS

1. INTRODUCTION

PROJECT TITLE: Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia (GMS+)

EXECUTING AGENCY: Institute of Forest Resources Information Techniques (IFRIT), Chinese Academy of Forestry (CAF);

TECHNICAL ASSISTANCE PARTNERS:

- Forest Research Institute Malaysia (FRIM);
- Forestry Administration of Cambodia;
- Royal Forest Department of Thailand;
- Forest Inventory & Planning Institute of Viet Nam;
- Faculty of forestry of National University of Laos;
- Forest Department of Myanmar
- Guangxi Forest Inventory & Planning Institute (GFIPI), China;
- Southwest Forestry University, China.

DURATION

30 months, 1 Jan 2012- 30 June 2014

Suported by: Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet)

The proposed demonstration sites in Viet Nam were chosen primarily to represent the different forest types available in this country namely the inland hill dipterocarp forest and the mangrove forest. The estimated budget is about USD 108,100.

Years of historical forest status maps 2005 and 2010 will be produced by pilot project (3 test site) and for whole country;

Data sources: historical aerial photographs and mid-resolution satellite images taken in more or less the same year of the being produced forest status maps, historical forest cover and land use maps and other auxiliary data, and field surveys. The remote sensing and auxiliary data has been collected and/or provided by the partner;

Viet Nam has 13 mil. Ha of forest in around 33mil.ha of total land. The UNFCCC recognizes Viet Nam as one of the top five most affected countries in the world as a result of climate change. Although not suffering from excessive levels of deforestation typical of some other countries in the region, deforestation is locally significant in Viet Nam, especially in the Central Highlands. Furthermore, natural forests continue to be more fragmented and degraded and its quality is therefore declining. Over two-thirds of Viet Nam's natural forests are considered poor or regenerating, while rich and closed-canopy forest constitutes only 4.6 percent (in 2004) of

the total. Fast economic growth within the country and the drive to export commodities is an underlying driver of the deforestation and forest degradation within Viet Nam. There are growing efforts by the authorities to combat these problems but the pressures are intensifying. If the value of the forest is able to compare with that of the alternatives, then this could act as a strong incentive to arrest these trends. Therefore, GMS+ project very well supported the sustainable forest management strategy of Vietnam in the context of climate change adaptation.

2. PROJECT GOAL, OBJECTIVES AND FORMULATION

2.1Project Goal

The primary goal of the project is to estimate forest coverage and above-ground carbon stock in the Greater Mekong Subregion (GMS) and Malaysia.

2.2 Project Objectives

1. Develop a framework and methods for forest mapping and carbon estimation using remote sensing technology;
2. Produce forest cover change maps from 2005 to 2010 and a forest above ground biomass map; and
3. Enhance institutional capacity in GMS and Malaysia to perform forest mapping and assessment.

The main objectives of pilot project are: (i) to create high quality historical forest status maps of 3 test site and whole country; (ii) to provide basic data for a study on analyses the trends of deforestation and forest degradation, and major driving forces behind these changes; and (iii) to be used for identifying areas critical for the implementation of REDD and mainstreaming REDD implementation into district level land-use planning.

- Produce forest coverage dynamic maps of 2005 and 2010 at 30~50m spatial resolution and one period forest above ground biomass map in the test site.
- To develop forest cover mapping technique to monitor the forest cover type changes in local level using remote sensing techniques
- Demonstration projects to show the value of the new technologies, e.g., forest carbon tracking.

2.3 Project Designing

The designed project consists of following work packages (WP):

WP1: Project design and management (including training)

WP2: Methods development (including Algorithms)

WP3: Remote sensing data acquisition and pre-processing

WP4: Ground truth database development (compiling existing data)

WP5: Mid-resolution forest mapping product

WP6: Coarse-resolution forest mapping product

WP7: Forest carbon storage mapping product

WP8: Reporting and dissemination

IFRIT is an agency overally responsible for implementation of the project. The partners will cooperate with IFRIT in implementation of some activities of the project within the partner's country territory. Overall result of the GMS+ project will be consolidated and analysed by IFRIT.

Quarterly, each partner submited the report on progress achieved in previous quarter and implementation plan for next quarter to IFRIT. Every six month, IFRIT held a workshop to present the project progress and elaborated plan for next term as well as discussed the lessons learnt in terms of technique applied in the project and adjusted project acivity and monitoring.

3. PROJECT EXECUTION

3.1 Start-up

After having contract signed with APFNet and IFRIT, FIPI has outlined necessary steps for implementation of the project.

For implementation of the project, Vietnam has established steering and monitoring committee as follows:

Table 1: Project steering and monitoring committee

Name	**Organization**	**Title**	**Email**	**Telephone**	**working field**
Nguyen Phu Hung	ICD-VNforest	Dr.	hungfipi@vnn.vn	084912094190	Forestry
Nguyen Tuong Van	ICD-VNforest	Msc.	van.fssp@hn.vnn.vn	084912350526	Environmental
Ngo Ut	FIPI	Dr.	ngoutdn@gmail.com		Forestry

National team for project implementation has been formed with following members and tasks:

Table 2: National team member for demonstration project

Name	**Organization**	**Title**	**Email**	**Telephone**	**Position in the project**	**note**
Nguyen Huy Dzung	FIPI	Dr.	huydungfipi@gmail.com	84-903283647	Director (in partner)	
Vo Van	FREC/ FIPI	Msc.	vhongfipi@gmail.com	84-976101269	Techical Adviser	

Hong						
Le Dinh Cuong	FIPI	Msc.	cuongledinh@yahoo.com		Accountance	
Ngo Ut	FIPI	Dr.	ngoutdn@gmail.com		Forestry	
Vu Tien Dien	FREC/FIPI	Msc.	dienfrec@gmail.com	84-1696994569	Remote sensing expert	
Tran Van Ho	FREC/FIPI	Forest Ing.	tranhofipi@gmail.com	84-985173508	Forest Inventory expert	
Pham Tuan Anh	FIPI	IT exprt	phamanhfipi@gmail.com	84-913550752	IT expert, GIS	
Bui Kim Chi	FREC/FIPI	Forest Ing.	chifrec@gmail.com	84-973090035	GIS and Remote sensing expert	
Pham Manh Ha	FREC/FIPI	Forest Ing.	hafrec@gmail.com	84-125890401	GIS and Remote sensing expert	
Nguyen Manh Hung	FREC/FIPI	Msc.	hungnmfipi@gmail.com	84-915108956	GIS and Remote sensing expert	
Nguyen Tuan Viet	FIPI	Forest Ing.			officer	

Additionally, two Sub-FIPIs located near to the test sites also participated in implementation of some activities allocated by FIPI at the test sites in the area responsible by Sub-FIPI.

The project is managed by a Vice Director of FIPI and He acted as the project director of the project and was responsible for the project. The Directors of FIPI and Steering Committee (including representatives of VNFOREST) were responsible for steering and monitoring.

The specific activities of the project were, by FIPI, directly allocated to the national team or subcontracted with Sub-FIPI or other experts of FIPI.

The project results were checked by the Project Management Board before handing them over to IFRIT

3.2 Implementation schedule

Tabe 3 : General Work plan

Project Title: Forest Cover and Carbon Mapping in pilot project of Viet Nam													
Month	**-3**	**4-6**	**7-9**	**10-12**	**13-15**	**16-18**	**19-21**	**22-24**	**25 -27**	**28 -30**			partner
Activity 1: Inception													FIPI

Activity 2: management assistans													FIPI
Activity 3:Study tour and travel													FIPI
Activity 4:Survey and case study/sub contract													FIPI
Activity 5: Training & Domestic workshop to be organized													FIPI
Activity 6: equipment													FIPI
Activity 7: Flowing Materials													FIPI
Activity 8: office Accomodation and administration													FIPI
Act. 9: Reporting and dissemination													FIPI

The yearly reports revealed that FIPI achieved all results as planned in time. However, the final report (reporting and analyzing) has been produced behind the schedule because in the final stage of the project, some experts had other duties overlapped with the project activities and they could not achieve project result as expected.

3.3 Revision (if any)

In the project implementation process, requirement in the project result to be produced by FIPI has been adjusted. Annual national maps of forest cover of 2005-2010 produced based on satellite images of low resolution (MODIS) had been replaced by annunal national maps of forest cover of 2005-2010 made based on satellite image of mid-resolution. Mapping of carbon stoke of the whole area also had been produced by IFRIT while FIPI was just to collect biomass data from 100 plots in the test sites for carbon stoke mapping.

During project implementation, in FIPI side, there was a change in the position of the project Director. In the first year, Dr. Nguyen Phu Hung was Director of the project, but then he moved to VNFOREST and in the second year, Dr. Nguyen Huy Dzung became Director of the project. The change of Director has delivered some impact on the project management and implementation in short time, but it was not serious for the project as the whole.

3.4 Procurement and consultancy

The contracts for procurement of equipments for the project were made based on competitive

and transparent basic. The purchase was ordered based on the criteria of the lowest price and technical specification accepted.

Other services like offices, consultancy and sub-contracts for implemetation of the project activities were decided based on the basic of sole source selecton within FIPI and sub-FIPI.

3.5 Monitoring, evaluation and reporting

Method for the project implementation is that, at first, senior experts received technical skill via training courses and workshops held by GMS+ and reading of technical guidelines, instruction, and result from discussion with the partners and then, the senior exprts transferred technical skill and lessons learnt to the other team members for implementation of the project activities.

The output of the project produced by consultants and members are internally checked and appraised by the Project Management Board (PMB);

Every three months, FIPI sent the project progress reports and premilinary results to IFRIT for review to seek feedback and, every six months, IFRIT held a workshop to review progress reports and project implementation plans. Based on the feedback and comments from IFRIT, FIPI revised and completed the project results.

Moreover, exchnages of the experiences between experts and participants in the workshop were also very helpful for us to achieve the project result.

3.6 Efficiency and effectiveness

-The GMS+ has achieved the project objcetives as planned as follows:
(i) has been create high quality historical forest status maps of 3 test site and whole country 2005 and 2010; (ii) provided basic data for a study on analyses the trends of deforestation and forest degradation, and major driving forces behind these changes; and (iii) to be used for identifying areas critical for the implementation of REDD and mainstreaming REDD implementation into district level land-use planning.

- Produce forest coverage dynamic maps of 2005 and 2010 at 30~50m spatial resolution and one period forest above ground biomass map in the test site.

- To develop forest cover mapping technique to monitor the forest cover type changes in local level using remote sensing techniques

- Demonstration projects to show the value of the new technologies, e.g., forest carbon tracking.

Application of remote sensing technical and use of free of charge reference data and documents in mapping of forest cover has increased accuracy of the maps and saving of time

and resources for mapping of forest cover for the huge regions as well as for the whole contry in such short time (2 years).

3.7 Project Costs and Sources

Acorrding to the signed contract, budget allocated to FIPI about 108,100 USD which has been rightly used for implementation of the prject activities as budget lines in the contract. However, 20% of the budget had not yet been transferred to the partner and therefore some activiies like domestic workshops have been delayed.

Actual budget of the project was disbursed in comparison with the budget estimated in the annex B as follows: Anticipated budget: 108,100 USD and Actual Budget 104,600 USD

3.8 Dissemination

Activities of the project have been implemented in the test sites; maps of forest cover for the test sites and for the whole country have been made; documents related to the GMS+ project and reports of FIPI for different workshops have been completed and printed; data base and satellite images provided by the project and different maps of forest covers, made by FIPI in 1990-2010, were also referred to and used in national mapping of reference emission level (REL) in 2013-2014. Results of periodical workshops held by the project were reported to FIPI and VNFOREST by the project team.

In the international workshops held by UN-REED project, FAO-NFA project, AFOCO project and, in which FIPI participated, activities of the GMS+ project also have been mentioned in reports as examples of the researches concerned.

4. PROJECT STAKEHOLDERS' PERFORMANCE

4.1 Supervisory Agency(if any)

International Cooperation Department- VNFOREST is responsible for monitoring of the project activities. Its duties were to monitor and support implementation of the project activities, proceed administrative procedures, review progress reports for periodical workshops and well as the final report of the project closing workshop.

4.2 Executing Agency (project team and project director)

After having the contract signed with APFNet and IFRIT, FIPI decided to form project management board as follows:

Project Director in the first year: Dr. Nguyen Phu Hung, Vice Director of FIPI; Project Director;
Project Director of the second year: Dr. Nguyen Huy Dzung, Vice Director of FIPI, because Dr. Nguyen Phu Hung moved to VNFOREST; The Project Director was responsible for overall implementation of the project, and sub-contracting with consultants, and was the person, on behalf of FIPI, worked with other concerned partners;

Senior technical officer of the Project was Mr. Vo Van Hong who is specialized in remote sensing and GIS for forestry. This officer was responsible for technical design for the activities specified in the signed contract. He instructed his project technical staff to implement project activities and he was also responsible for technical checking of project results and writing technical reports.

Accountant of the project was Mr. Le Dinh Cuong who is also accountant of FIPI. The accountant was responsible for financial and accounting issues of the project.

Administrative officer of the project was Nguyen Tuan Viet. He was responsible for administrative activities of the project in FIPI.

Additionally, FIPI also had formed consultant group and sub-contracted with two sub-FIPI for implementation of the project.

All activities of PMB and consultant group are instructed and managed by FIPI.

4.3 Other project partners

Dus to project sites are scattered in different region of the country, since FIPI had sub-contracted with two sub-FIPIs in implementation of some project activities. In particular, Central Highland Sub-FIPI was sub-contracted to implement activities in the test site 3 (Yok Don National Park); East-North Sub-FIPI was sub-contracted to implement activities in the test site 1 (Tam Dao National Park).

Activities allocated to sub-contractors were clearly defined in the contracts with technical requirement and progress of the work. Operation and implementation of the activities were checked and reviewed by PMB in accordance with the regulation.

4.4 APFNet

During project implementation, APFNet supported and provided timely and clear guidance on project impmentation. The project budget was provided sufficiently but disbursement was somehow behind the schedule as the advance was usually made at the end of a year while the project activities have to be implemented from the right beginning of a year. APFNet also kept FIPI contacted regularly via workshops and progress reporting that to creat comfortable condition for the project implementation. APFNet had also conducted independent assessment of the project implementation while considering proposal for the second phase of the project.

5. RESULTS

5.1 Achievements

i) change of policy, regulations and public behavior,

The project had identified areas of critical forest changes in the period 2005-2010 as well as

the driving force behind the changes. The project highlighted that the reasons of deforestation were fast conversion of forestland to other landuse, to rubber plantation, development of hydropower plants which affected cropping land, therefore local people have to clear forest for expansion for caltivation. These kinds of information were dissiminated to the local authorities, where there are large areas of forest, to work out measures for mitigation of deforrstation.

ii) Critical and large scale deforestation takes place in regions like in High Plataux where forests are till under management of the state while in the other regions, where forests were allocated to private sectors and households, deforestation is less. Thus, the project also recommended to continue to allocate forests to local people for promoting sustainable forest management, economic developmet, poverty reduction and hunger eradication because propotion of poor households in such areas is dominated.

iii) Via implementation of the project, FIPI, Sub-FIPI, related agencies, Forestry Sector and local people in the test site, where the project team worked, received richer information about APFNet and its role in strategical support in sustainable forest management of the countries in the regions. Participation in the project had strengthened capacity, skill for FIPI staff via workshops, trainings and exchange experinces between China and GMS+ countries. Collaboration between APFNet and IFRIT-CAF; FIPI and other partners has been greatly enhanced. FIPI forestry technical officers now have a better understanding of RS/GIS technology for frest cover and carbon mapping and will use this expertise in future work.

iv) The project reults helped in optimization of long-terms project planning, especially priority should be given to the projects in the areas of large scale of forest changes which were identified by GMS+ project. The areas of large scale of forest changes need more support for sustaibale forest management for the time to come with more active participation of local communities.

5.2 Good stories, best practices, intelligence products to be shared in the region

In the project implementation process, knowledge in remote sensing such as classification of coast resolution and mid-resolution satellite images for mapping at regional level and skill in biomass data collection in the field with foot print of GLAS satellite for ampping and modelling biomass stoke for different forest types were strengthened; GIS skill in forest changes analysis for project staff were also strengthened.

Technical reports, digital map database, satellite image database, systems of key photo samples, field verification points, bio-mass data of 100 plots… are outputs of the project. These outputs should serve as references for next researches. The project outputs are also reference for VNFOREST in revision of policy to be promulgated for sustainable forest management in sensitive areas.

The data sharing through the outcomes mapping work is now being used as an important reference by other organizations.

As outcomes data are distributed more widely, this list will continue to grow.

5.3 Lessons learned and outstanding issues

·Development Lessons:

Lessons learnt gained from project design revealed the more detailed design of the project and more consensus of the partners of the participating countries will be the more success of the project. During implementation phases, periodical exchanges of experinces are needed for adjustment if obstacles are existed. One crucial point need to be carefully considered in the Phase II of the project is how to enhance and improve technical guidelines with higher detail level for specific project activities in order to produce the more harmonized outputs between the partners as well as for the project as the whole.

·Operational Lessons:

Management and implementation of the GMS+ project are relevant with IFRIT which is the main project implementer and with other partner countries of the region who implementing the project by sub-contracting with IFRIT và APFNet

Management and monitoring of finance issues was implemented by IFRIT. The partners implemented project activities first and then, sent the progress reports to IFRIT for review and the result of that will be a basic for transferring advance to the partners (every year, advance was 40%; 20% of the total budget was disbursed when required activities and outputs indicated in the signed contract fully completed and produced). Management and monitoring of finance issues in such a way was relevant with common principle, however, annual advance usually stransferred to the partners at the end of a year, thus it somehow affected the implementation of the project in that year because the partner was short of budget for operation..

5.4 Impacts

Government, NGOs, and donors target sustainable forest management, implementation, and monitoring toward globally GHG emission reduction within the forest loss Hotspot.

Significant progress has already been made towards this goal, with investment by a number of partners.

The result of the study showed that although the total forest area of Vietnam increased but in some regions, the forest area has strongly decreased in the Central Highlands and the South East regions.

Total forest area in Vietnam increased rapidly over the last 10 years thanks to the 5 million hectares reforestation Project of the Government. As a result of this, the areas of the broad-leaved timber tree plantation forest and the naturally regenerated evergreen broadleaf

forest are quickly increased.

The cause of deforestation in Vietnam, in addition to logging, is also due to the conversion of the forests to other uses such as planting rubbertrees, expanding agricultural land, construction of the hydroelectrict plants…

To limit deforestation in Vietnam in the coming period, priority should be given to conducting REDD + projects in the seriously reduced forest areas. Forest management work should be better enhanced. Forest destruction to establish rubber plantation should be stopped, because, the current statistical data showed that the area of rubber plantation has already exceeded the expected plan due to the farmer households growing rubber trees by themselves,not following the oriented planning.

6. SUSTAINBILITY

Currently, VNFOREST is implementing 5-year national forest inventory programme and studying the the REL for the whole country for the periods 1990-1995-2000-2005-2010-2015 based on interpretion of multi-dated satellite images and existed maps. So the skill and technical knowledge in mapping of forest cover based on remote sensing technique will be further used for the new projects and programmes by FIPI/VNForest. Moreover, VNForest is managing UN-REDD phase II project, since the result of the project also will be used as references for selection of the REDD pilot sites.

Project GMS + chaired by IFRIT with the technical cooperation of the partners in the Mekong River Subregion and Malaysia with the financial support of APFNet has very highly promoted the effect in strengthening the capacity in use of the remote sensing images for forest cover mapping for the participating agencies. Project GMS + helped create a database on remote sensing, National-level forest cover maps and the entire GMS + period 2005-2010 for scientific research and implementation of REDD + projects at regional and national level.

Based on the application of the mid-resolution satellite image and GIS technologies to forest cover mapping by the periods of 2005 – 2010 is very effective, low cost and usefull application for national or regional wide. Result of the interpretation and classification of the satellite image, forest mapping and accuracy calculation by the period of 2005 – 2010 has reflected very objectively.

7. RECOMMENDATIONS

The forsest cover mapping based on Mid-resolution satellite image not only used satellite image but all so used auxiliary reference GIS data to overlay and upgrade the accuracy.

Though this work is (and must remain) based on globally and regional standard methods and criteria, some level of flexibility was required to account for regional variation in data availability and the local context. For instance, the outcomes definition process for forest and land cover classification is need for flexibility in FAO delineation rules.

The engagement of other partners has been essential. Engaging other organisations working in the test site, such as Sub-FIPI, local forestry government, Forestry Management Boards… has also contributed to the success of this project.

In addition, we learned the importance of discussing project design and steps with all parties, and reaching agreement prior to beginning data collection and analysis, thereby improving efficiency.

Annex(es):

Annex A: Implementation schedule

Annex B: Details of project cost by category

Output/Activity	Completion time		Key points of the results achieved (qualitative or quantitative)	
	Anticipated	Actual	Anticipated	Actual
Act.1: Inception	1	3		
Act.2: Management Assistants	24	30	Act. Of Management Board 30 month	Act. Of Management Board 30 month
Act. 3: Study tour & Travel Expenses				
Act.3.1 Data acquisition in the filed area	15	15	Historical dadata :map, file,	Historical dadata :map
Act.3.2 International RS Symposium	23	30	Symposium	Symponium
Act.3.3: Progress meeting	23	23	3 progress meeting	4 progress meetings
Act. 3.4: Attending the domestic Symposium	23	23	Domestic Symposium	Domestic Symposium
Act. 4: Survey/Case study & sub-contracts:	24	24		
Act.4.1 Survey/Case study: Mid-resolution satellite image classification and pilot sites forest types mapping 2005 and 2010	13	13	Forest type Map of 3 test site, 2005 and 2010	Forest type Map of 3 test site, 2005 and 2010
Act.4.2 Survey/Case study: coarse resolution image mapping 2005-2010	24	24	Forest cover map of whole country, 2005 and 2010	Forest cover map of whole country, 2005 and 2010
Act.4.3 Survey / case study & sub-contracts: forest above ground biomass mapping	24	24	100 ground Biomas plots	100 ground Biomas plots

				For biomass mapping modeling	For biomass mapping modeling
Act. 5: Training & Domestic workshop to be organized		20-24	30	Trai ninh & workshop	3 domestic Training course.
Output 6: Equipment		3-12	12	Equipment set for activities	Equipment set for activities
Output 7: Flowing Materials		18	18	Materials for activities	Materials for activities
Output 8: Office accommodation and administration.		24	30	Office accommodation and administration	Office accommodation and administration
0utput 9: Reporting and dissemination		24	30	(1)Technical Report (2)Completion Report (3) Final cial Report.	(1)Technical Report (2)Completion Report (3) Final cial Report.

Annex A Implementation schedule (scheduled versus actual)

Annex B Details of project cost by category (scheduled versus actual)

Expenses (USD)	APFNet Grant				Counterpart Fund			
	Anticipated A_1	Actual B_1	Variance $C_1(A_1-B_1)$	Variance rate $D_1(C_1/A_1*100\%)$	Anticipated A_2	Actual B_2	Variance $C_2(A_2-B_2)$	Variance rate $D_2(C_2/A_2*100\%)$
Project staff cost[1] (salary and allowance for project staff and management personnel)								
Project Director	12,000	12,000	**0**	**0**	12,000	12,000	**0**	0
TA Team leader	9,600	9,600	**0**	**0**	9,600	9,600	**0**	0
Accountants	3,600	3,600	**0**	**0**	3,600	3,600	**0**	0
officers	2,400	2,400	**0**	**0**	2,400	2,400	**0**	0
Subtotal	**27,600**	**27,600**	**0**	**0**	**27,600**	**27,600**	**0**	0
Consultancy cost[2] (local and international consultants' cost)								
Act.4.1 Survey/Case study: Mid-resolution satellite image classification and pilot site forest types mapping 2005	23,655	21,854	1,801	7.62				
Act.4.2: Survey / Case study: Annual coarse resolution image mapping 2005-2010	19,075	18,158	917	4.81				
Act.4.3 Survey / case study & sub-contracts: forest above ground biomass	6,640	6,036	604	9.10				
subtotal	**49,370**	**46,048**	**3,322**	6.73				

Annex B Details of project cost by category (scheduled versus actual)

Travel and related cost[3] (air fare, local travel, per-diem and etc)								
Act.3.1 Data acquisition in the filed area	6,000	5,571	429	7.15				
Act.3.2 International RS Symposium	1,620	1,425	195	12.04				
Act.3.3: Progress meeting of the project :	2,800	1,955	845	30.18				
Act. 3.4: Attending the domestic Symposium	1,080	1,075	5	0.46				
Sub Total	**11,500**	**10,026**	**1,474**	12.82				
Workshop and training cost[4] (venue, facility, hospitality, speakers/experts' fees , participants accommodation, meeting material, etc)	7,631	7,631	**0**	0				
Sub Total	**7,631**	**7,631**	**0**	**0**				
Field activities cost[5]	0	0	**0**	0				
Publication &Dissemination cost[6] (formulation, editing, publishing of articles, reports, books and information products and organization of outreach activities, media activities)	0	0	**0**	0				
Office Operation cost[7] (project administrative management fee and administrative staff cost, lease/rental of office premises, office and facility maintenance, etc)								

Annex B Details of project cost by category (scheduled versus actual)

Output 8: Office accommodation and administration	4,800	4,800	**0**	0				
Sub total	**4,800**	**4,800**	**0**	0				
Procurement [8] (purchase of vehicles, equipment, facilities etc)								
Output 6: Equipment:	5,000	5,000	**0**	0				
Output 7: Flowing Materials:	1,200	1,200	**0**	0				
Sub total	**6,200**	**6,200**	**0**	0				
			0	0				
Monitoring, evaluation and audit cost[9]	0	0	**0**	0				
Miscellaneous[10]								
Inception fund	1000	0	**1000**	100				
Subtotal	**1000**	**0**	**1000**	100				
TOTAL	**108,100**	**102,304**	**5,796**	**5.36**	**27,600**	**27,600**	0	0

Principle for budget estimation:

1. The budget should be calculated in USD rather than any other local currency.
2. Subtotal should be calculated if there is more than one sub-category under each category.
3. The budget should include both funding proposed from APFNet and contribution from other channels. Counterpart contribution should account for no less than 20% of total budget, please mark the in-kind contribution in italics and bold.
4. For pilot and demonstration projects, APFNet's grant should be used mainly on the project activities, while the counterpart contribution is

suggested to cover the budget items such as rental of office premise, equipment, administrative management, internal monitoring and financial audit.

Notes for budget completion (for each category clarification):

1. Project staff cost: each post should be identified and recorded on a separate budget subline. Full job descriptions should be attached.
   To guarantee efficient use of project fund, the number of the posts should be kept at a minimum level according the specific requirement of each project.
2. Consultancy cost: especially for independent local and international consultants or consultancy firm to assist in project design, conduct external project evaluations and the like. Individual consultants should be offered consultancy service agreements (terms of reference for each consultant should be attached), firms should be offered institutional contracts.
   Each category should be identified and recorded on a separate budget subline.
   The international consultancy fee may be detained and paid directly by APFNet.
3. Travel and related cost: should be used for budgeting air fare, local travel and per-diem etc for the purpose of project implementation.
4. Meeting and training cost: should be used for budgeting organization and participation in training courses, seminars, workshops and so on, which generally includes the meeting/training venue, facility, hospitality, speakers/experts' fees, interpretation.
   The approximate number of participants should be indicated together with tentative agenda and level of the meeting and trainings.
5. Field activities cost:
   When it is necessary to rent land to implement a project, the cost should be estimated and shown against this line.
   The project funding must not be used to purchase land or building.
   The benefit for local staff, the local labor and cost for seedlings, fertilizers, material, goods, tool to facilitate the implementation of project activities at local level, in particular for pilot and demonstration projects, should be estimated and shown on a separate budget subline.
   The cost for other field activities, such as case study and filed survey/research, should be estimated and shown against this line.

6. Dissemination & publication cost: should be used for budgeting formulation, editing, printing, publishing of articles, reports, books and information products and outreach activities.

7. Office Operation cost:
   Project administrative management fee and administrative staff cost should be not more than 10% of the total budget.

Annex B Details of project cost by category (scheduled versus actual)

Generally, the administrative staff is determined according to the specific requirement of the project, which generally include accountant, documentation officer, driver and so on. Full job descriptions for each position should be attached.

When it is necessary to purchase or rent premises to implement a project, the cost should be estimated and shown against this line.

8. Procurement of equipment:

When it is necessary to purchase or rent equipment or vehicle to implement a project at local level, the cost should be estimated and shown against this line. Maintenance of equipment or vehicle should also be budgeted under this line.

9. Monitoring, evaluation and audit cost: internal monitoring, external evaluation and financial audit are a must do to ensure project implementation on track. The cost for external evaluation may be detained and paid directly by APFNet.

10. Miscellaneous: Cost for miscellaneous should be not more than 5% of the total budget.

11. A_1 refers to the anticipated amount of APFNet's grant, B_1 refers to the actually imbursed/reimbursed amount of APFNet's grant, C_1 refers to the difference between the anticipated and actually imbursed/reimbursed amount of APFNet's grant, D_1 refers to the variance rate. Accordingly, A_2, B_2, C_2,D_2,refer to the corresponding amount of the counter part fund.

12. All variance rates above 10% need to explained in the Project Financial Statement of the Project Progress Report, supported by detailed justification irrespective of whether they are negative or positive. The explanations should be specific to the relevant budget items. Please refer to budget heading/budget line and also to logframe outputs and indicators as applicable and include explanations of any changes to the total number of units compared to forecast, or the cost per unit.

Project Completion Report Instruction:

1. Project Director prepares the completion report on behalf of Executing Agency (EA), responding to APFNet concerns.
2. Submission should be consulted with project partners and endorsed by Project Steering Committee (PSC), with signatures of Project Director and PSC Chair on behalf of EA and PSC;
3. Completion reports should be submitted within 2 months after project termination date.

Document No.:
Receiving Date:
(For APFNet Secretariat)

Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

Completion Report

Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia

[September, 2011-February, 2014]

Yunnan China

May，25，2014

Basic Project Information

Project Title(ID)	Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia	
	Approved	Actual
Date of commence	September,2011	September,2011
Date of completion	August,2013	February,2014
Extension period	Six months	Six months
Project Budget (in USD)		
APFNet's Grant (in USD)	50,800	
Counterpart Contribution (in USD)	12000 in kind	12000 in kind
Supervisory Agency	Division of Science and technology, Southwest Forestry University	
Project Executing Agency	Faculty of forest, Southwest Forestry University	
Project Director	Yue Cairong	

Project description:

Found by APFNet, forest cover maps of 2005 and 2010 in Yunnan were produced by use of satellite remote sensing technology.

Prepared and Submitted by **Yue Cairong** _____ Project Director signature Date	**Reviewed and Endorsed by** **Xu Hui** _____ Project Steering Committee Chair signature Date
FOR APFNET USE	
Reviewed and comments by _____ ED signature Date	**Reviewed and comments by** _____ PO signature Date

- ## Executive Summary

Forests play a vital role in sustainable development and provide a range of economic, social and environmental benefits, including essential ecosystem services such as climate change mitigation and adaptation. The Greater Mekong Subregion (GMS) and Malaysia comprises Cambodia, the People's Republic of China (Yunnan province and Guangxi province), Lao People's Democratic Republic, Malaysia, Myanmar, Thailand, and VietNam. This region is rich in forest resources and shows quick change of forest resources.

Forest monitoring is very important for the estimation and evaluation of the state of forest resources, carbon sequestration, and the results of forest program implementation. It plays a key part in the crackdown on illegal logging, forest fire monitoring and early warning for forest degradation, the reduction of deforestation, and the improvement of forest quality. Also, forest monitoring to support sustainable forest resources management can result in earth observation data and technical support for countries to effectively fulfill their obligations arising from international environmental conventions.

This will be achieved by making intensive use of most recent satellite remote sensing technology, establishing regional forest cover maps, documenting forest change processes and estimating carbon storage in the GMS and Malaysia. Three main results of the project are expected as below:

i) Develop a framework of forest mapping and carbon estimation using remote sensing technology in the GMS and Malaysia.

ii) Produce forest coverage dynamic maps from 2000 to 2010 and one period forest above ground biomass map in the GMS and Malaysia.

iii) Enhance forest remote sensing capacity of forest institutes in the GMS economies and Malaysia, forest owners and participatory communities.

TABLE OF CONTENTS

1. INTRODUCTION

The GMS and Malaysia demonstration project range from 92.2° to 119.3° east longitude and 0.8° to 29.2° north latitude with total land area of 317,242,000 ha and total population of 348 million which comprises Cambodia, the People's Republic of China (Yunnan province and Guangxi province), Lao People's Democratic Republic, Malaysia, Myanmar, Thailand, and Viet Nam. A total forest area of 148,128,000 ha reported by FRA 2010 (Yunnan & Guangxi data were from the 7th national forest inventory of China).

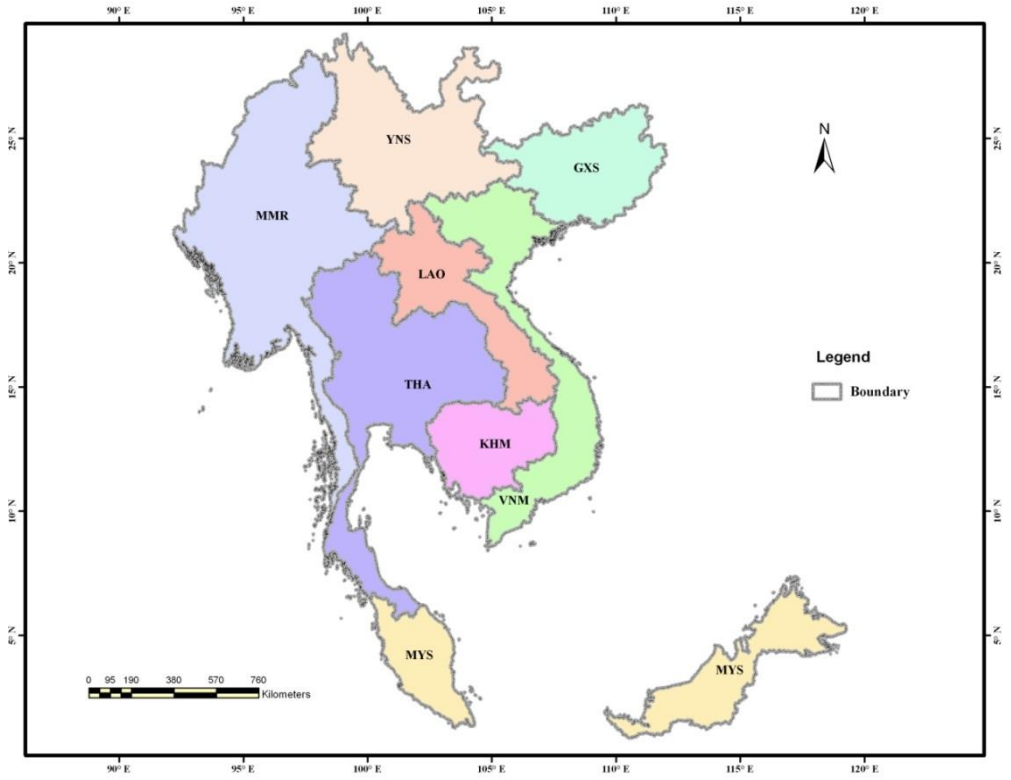


Fig. 1 Study Area of the GMS and Malaysia Demonstration Project

The main users of the proposed project are economies in the GMS and organizations interest in the region, which include the scientific community (e.g. national forest institutes, IPCC, GEO-FCT, GOFC-GOLD), policy makers of each economies' forestry and/or environment agencies, education community (e.g. the Forestry University of Vietnam, Southwester Forestry University of China, AIT), commercial companies (e.g. pulp companies like APP), and – in the context of cooperation and scientific support – also international or regional organizations (e.g. FAO, APFNet, ASEAN or MRC).

2. PROJECT GOAL, OBJECTIVES AND FORMULATION

2.1Project Goal

The primary goal of the project is to estimate forest coverage and above ground biomass in the Greater Mekong Subregion (GMS) and Malaysia. The proposed approach will integrate multi-sources remote sensing data, ground measurements and other thematic geographic data. The outcomes of this project will help to clarify how, when and where the forests changes in the GMS and Malaysia. Our proposed approach will determine forest coverage and biomass estimates through the following specific objectives:

1) To develop GMS and Malaysia forest cover mapping techniques to monitor forest cover type changes in the region, using both optical and radar remote sensing techniques.

2) Develop a framework for forest above ground biomass estimation using ground measurements, spaceborne lidar sampling data and imaged remote sensing data.

3) Produce forest cover maps of 2005, and 2010 at 30-50m spatial resolution and forest cover maps annually from 2005 to 2010.

2.2 Project Designing

The whole work plan of Yunnan, China are as following:

1) Project interception workshop. Sep 13 ~ 15, 2011: Present in the project interception workshop, and discuss over sub-contracts and make detail work-plan.

2) Framework and methods development. Sept. ~ Dec. ,2011: A framework and methods will be developed for forest mapping and above ground biomass estimation using remote sensing technology.

3) Field measurement and data collection. Nov.,2011~ May. 2013: The field measurement standard will be set up firstly. and Algometric equations of biomass calculation for main forest species in Yunnan, especially in test sites will be collected and verified. collecting the ground truth data for improving forest map classification and biomass estimation, which include 50 or more plots centered by ICESat GLAS footprint and 200 plots for forest distribution maps evaluation .and Allometric equations for dominated forest species in Yunnan in Yunan, will be collected and verified. .4) The middle resolution (30m)Forest mapping for the whole Yunnan. Nov. 2012.~ June, 2013: forest cover maps of 2005 and 2010 for the whole Yunnan will be produced. The forest map of Yunnan in

2005 will be modified and refined based on the more detail ground truth data.

6) Forest cover change maps from 2005 to 2010 and forest above ground biomass map in Yunnan will be produced. Above mentioned annual forest coverage maps will be used to explore how the forests changed annually and what forest disaster happens in Yunnan, China. Meanwhile, the forest above ground biomass in Yunnan, China will be mapped using ICESat GLAS, MODIS, and/or MERIS at coarse resolution (300 ~ 500 m) in 2005.

3. PROJECT EXECUTION

3.1 Start-up

3.1.1 Field survey

The field measurement standard will be set up firstly. and allometric equations of biomass calculation for main forest species in Yunnan, especially in test sites will be collected and verified.

1) Field survey data for biomass estimation.

At least 100 forest field plots centered by ICESat GLAS footprint from typical forests for biomass estimation should be measured.

2) Field survey data for forest distribution maps evaluation..

Classification validation plots (at least 50 plots for each class) for forest distribution maps evaluation Should be established.

3.1.2 Produce forest cover maps.

The project should produce forest cover maps of 2005, and 2010 in test sites and the whole Yunnan province at 30 ~ 50 m spatial resolution.

The project team were divided into 3 groups. Group 1 (two people) were responsible to establish training data, and the Group 2(four people) were responsible for TM classification ,post classification processing and mosaic the classification results of TM scene by scene. Group 3 were responsible for accuracy assesment.

Group	people	Position
1	2	training data
2	4	Classification\Post processing\Mosaic

3	1	Accuracy Assesment

3.2 Implementation schedule

(1) Remote sensing data acquisition and pre-processing.

The available remote sensing database, which come from Landsat TM/ETM+, HJ-1A/1B, CBERS, MODIS, MERIS and FY-3, were collected.

(2) Field measurement and data collection.

1)100 forest field plots centered by ICESat GLAS footprint from typical forests for biomass estimation were measured.

2)Cassification training plots (at least 50 plots for each class) for forest classification were collected.

(3) Forest cover maps of 2005, and 2010 at 30 ~ 50 m spatial resolution

Produce forest cover maps of 2005, and 2010 in test sites and the whole Yunnan province

(4) Forest cover maps annually from 2005 to 2010 at 300 ~ 500 m spatial resolution

Produce forest cover change maps from 2005 to 2010 and forest above ground biomass map in the whole Yunnan province

3.3 Revision (if any)

1) The Completion time of schedule “Field measurement and data collection” and “Forest cover maps of 2005, and 2010 at 30 ~ 50 m spatial resolution” have been delayed.

2) The schedule “Forest cover maps annually from 2005 to 2010 at 300 ~ 500 m spatial resolution” was cancelled. It will be completed by Chinese Academy of Forestry Sciences.

3.4 Monitoring, evaluation and reporting

The progress report meeting was held in Laos, Thailand, Kunming and Vietnam. At these meetings, we have report the progress of the project. And the international experts have evaluated the results of the work. Summarize the work progress which includes the status of reference database; field data collection for forest mapping; forest cover map of 2005 for test sites; forest cover map of 2010 of each country; filed plots summary for forest biomass/carbon estimation and preliminary forest carbon map of GMS+ project.

3.5 Efficiency and effectiveness

The project completed the following content：

(1) The program has produced forest cover maps of 2005, and 2010 in test sites and the whole

Yunnan province at 30 ~ 50 m spatial resolution.

(2) Collecting the sample data of of all kinds of land cover.

Category	Count
Needleleaf Forest	54
Broadleaf Forest	51
Mixed Forest	50
Grassland	50
Crop land	50
Bamboo	50
Shrub land	50
Rubber	50

(3) Surveying and collecting the sample biomass of GLAS point

County	Count
mengla	16
jinghong	28
yiliang	10
chuxiong	45
kunming	4
Total	103

(4) $ 50,800 was invested to complete the entire 390,000 square kilometers of Yunnan Province forest classification mapping. The funds of this project are effectively utilized to complete remote sensing image classification and identification work of the large-scale regional scope.

3.6 Project Costs and Sources

The Total buget of project in Yunnan was 50800 US$, the actual cost for the project implementation is about 47800 US$. Southwest Forestry University, as an executing agency, has gave 12000 US$ in kind of Counterpart contribution. The Surplus funds 3000US$ will be used for the publication and dissemination of the results.The details of cost information are shown in Annex B.

3.7 Dissemination

The following paper was released：

(1)WANGDONG. Study on Land Cover Classification of Remote Sensing Image Based on Random Forests Algorithm[Master thesis]. Kunming: Southwest forestry university, 2014.

(2)ZHANGYUNFEI. The Study of Pixel Unmixing Based on TM Data[Master thesis]. Kunming: Southwest forestry university, 2014.

(3)MAMING. Study on Changes of Land-use and Vegetation Coverage Based on MODIS Data in Yunnan Province[Master thesis]. Kunming: Southwest forestry university, 2014.

(4)LINHAIYAN. Optimization Parameters Based on SVM Classification of Remote Sensing Image [Master thesis]. Kunming: Southwest forestry university, 2014.

(5)YUYANG. The Analysis on Driving Force of Kunming Land use and Cover Dynamic Monitoring[Master thesis]. Kunming: Southwest forestry university, 2014.

(6)FANHUAIGANG, et al. Remote Sensing Classification and Land Use Change Based on Support Vector Machine in Yiliang County [J]. Forest Inventory and Planning, 2014,(2).

(7)ZHANGYUNFEI, et al. Method of Multi-spectral Remote Sensing Endmember Extraction Based on Classification Result [J]. Science & Technology Vision, 2014(5):47-48.

(8)MAMING, et al. Study on Comparison of Different Classification Methods of Land Cover Based on TM images [J]. Journal of Green Science and Technology, 2014(3):1-4.

(9)LINHAIYAN, et al. Remote Sensing Image Classification by EnMAP-Box Model[J].Journal of southwest forestry University,2014,(2):67-71.

(10)WANGDONG, et al. Classification of TM Remote Sensing Image Based on Rondom Forests [J].Forest Inventory and Planning,2014,(2).

4. PROJECT STAKEHOLDERS' PERFORMANCE

4.1 Supervisory Agency

1) In the process of the project, we made self-examination regular to check whether the results of the work was qualified and the planning work task was completed on schedule.

2) Inviting experts on remote sensing from Yunnan Normal University, Yunnan University and Kunming University of Science and Technology to give guidance in technical method, evaluate and discuss the results of the work.

3) Science and Technology Department of Southwest Forestry University supervised the project regularly to make sure that whether the working plan to be completed on schedule.

4.2 Executing Agency (project team and project director)

A team for APFNet Project in Yunnan, China was established before the implementaion of the project Most of them came from the Research Center of Geomatics and Its Application in Forestry at Southwest Forestry University. The reference database and middle resolution forest mapping

activities will be carried out by the team. Annual forest map of coarse resolution and forest above ground biomass map will be done by the methods development team. After each forest coverage and above ground biomass map generated, they will be evaluated by a validation team.

Tab. Team member for APFNet project in Yunnan, China

Name	Organization	Expertise	Position
Prof. Yue Cairong	SWFU	Remote Sensing &GIS	WP1 & WP8
Prof. Xu Hui	SWFU	Forest Management	Unit representative
Prof. Luo Mingcan	SWFU	Forest Management	WP2 & WP8
Prof. Xu Tianshu	SWFU	Forest Management	WP2 & WP6
Dr. Zhang Chao	SWFU	Remote Sensing &GIS	WP4 & WP7
Dr. Wang Leiguang	SWFU	Algorithm Development	WP2 & WP7
Mr. Yuan Hua	SWFU	Remote Sensing	WP3 & WP5
MS. Zhang Wangfei	SWFU	GIS	WP6
Mr. He Chao	SWFU	Remote Sensing	WP2& WP6
Mr. Li Hao	SWFU	Forest Inventory	WP7

The working packages are as:

WP1: Project design and management (including training)

WP2: Methods development (including Algorithms)

WP3: Remote sensing data acquisition and pre-processing

WP4: Ground truth database development (compiling existing data)

WP5: Mid-resolution forest mapping product

WP6: Coarse-resolution forest mapping product

WP7: Forest above ground biomass mapping product

WP8: Reporting and dissemination

4.3 APFNet

(1) Hosting the intermediate inspection meeting in Thailand,and inviting international experts to evaluate the results of the work,and giving the written evaluation report and the amendments.

(2) guaranteeing the timely disbursement and reimbursement of APFNet's grant.

3)keeping necessary communication with project executing agency and partners in proper

facilitation in undertaking project activities and project dissemination.

4) giving timely evaluation of the project during the project implementation and providing feedbacks in to the next phase project planning and management.

5. RESULTS

5.1 Achievements

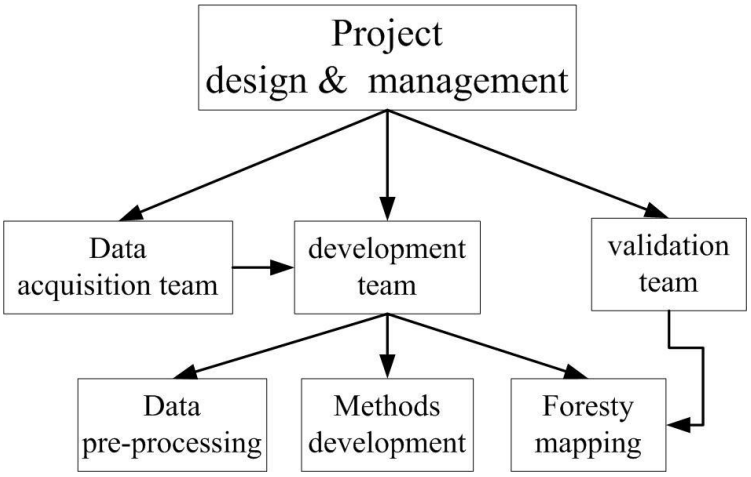
(1)Through research, we find out the spatial distribution of forest types and area of each type by the method of remote sensing image classification in whole Yunnan region. Data sources used in the study is a medium-resolution remote sensing image TM, this scale of the research is the first time in Yunnan.In this study, remote sensing images of the study region were respectively classified on 2005 and 2010 in Yunnan. We obtained characteristic changes of forest types and the area of each forest types in Yunnan through comparison.

(2)Experience in forest management and spatial technology application in forest management of neighboring countries have been widely exchanges. This project has improved our ability of scientific research in forest mapping and remote sensing image classification.

5.2 Good stories, best practices, intelligence products to be shared in the region

According to the steering committee of APFNet Project, the team have established in Yunnan. The reference database and middle resolution forest mapping activities have been completed by the team. In accordance with the requirements of the committee, the team has been clear about the responsibility and the tasks have been divided into several parts.

Figure project management structure



Before the task decomposition, the team developed activities route including the technology of all parts. The remote sensing images have been acquired by data acquisition team. The data pre-processing team analyzed each of Landsat5 TM image data that have been acquired by Landsat5 satellite in year of 2005 and 2010.The result shows that the region contains cloud in TM images is less than 5%. The information is entirely in header file of TM images, so it is convenient to finish the data pre-processing such as atmospheric correction.

Collecting references about vegetation form of forest in Yunnan, the main references is"Yunnan Forest" >(published by Yunnan science & technology press in china,1984) and "Yunnan Vegetation" (published by science press in china,1987). In addition, our team attained forest resource survey data from the local forestry government department.

Building up image classification standards, including color categories sample characteristics. The development team classified TM images of Mengla and Yiliang by applying the standard of image classification. The results of classification deal with wrong classified regions that are examined accuracy by forest resource survey data. The validation team checked that region in the field of inspection and got a real ground truth data distribution. As well as, Glas biomass investigation are carried out with vegetation coverage map.

5.3 Lessons learned and outstanding issues

Before Landsat5 TM classification and forest mapping, remote sensing images must be pre-processing. The one of most important is the atmospheric correction operation. Atmospheric correction should be using FLAASH model for Landsat5 TM image. The research shows that atmospheric correction will seriously affect the NDVI values, thereby affecting the accuracy of classification.

At the beginning of the study, our team has attempted to use support vector machine as classifier, and achieved better classification results at test sites of Mengla and Yiliang. However, we found that classification time consumption will increase dramatically with the increase of classification samples in a scene of TM image classification. Normally, time of SVM parameters optimization is about 5-7 days in 6 classes of classification samples for one scene of TM remote sensing image. So finally we selected the Random Forest classifier that can get suboptimal classification accuracy. Although the classification accuracy of results is no higher than SVM classifier, but the Random Forest classifier can get relatively higher accuracy in a reasonable time.

Image classification unit is a scene of TM image. In the initial experimental design, we plan to make Administrative Region as image classification unit, for example Dali prefectue region as a classification unit. If we do so, we need to mosaic together the relevant TM image of this region. However, due to the different acquisition time and the effect of atmospheric environment, the spectral of image is lack of consistency. And then Image classification process is very difficult. So we finally decided to classify a scene remote sensing image as a classification unit once a time.

Classification TM images have been carried out by Random Forest classifier that is in ENMAP-box tool developed from the German ENMAP team. Studies have shown that Random Forest classifier accuracy is higher level than traditional classification accuracy, such as the maximum-likelihood classifier and minimum distance classifier

After the completion of remote sensing classification, the post-process must be implemented in the classification results. The main goal is to correct classification error based on forest resources survey data and field survey data. After completion of the post-class processing, mosaic processing of post-processed images completed in ERDAS which can reasonably stitch two image's classification mismatched at the overlap of neighboring TM image.

5.4 Impacts

Forests play a vital role in sustainable development and provide a range of economic, social and environmental benefits, including essential ecosystem services such as climate change mitigation and adaptation.

The project is the first attempt in the Mekong sub-region of Yunnan Province forest type classification study. Our team has got a better classification accuracy and results. Especially we learned a lot of experience and methods in the classification process, for instance we found that Classification method of SVM will consume a lot of time in the process of parameter optimization and classification in a large scale TM processing.

Yunnan forest mapping is very important for the estimation and evaluation of the state of forest resources, carbon sequestration, and the results of forest program implementation. As well as forest mapping plays a key part in the crackdown on illegal logging, forest fire monitoring and early warning for forest degradation, the reduction of deforestation, and the improvement of forest quality.

Forest mapping is key parts of forest monitoring that will support sustainable forest resources

management can result in earth observation data and technical support for countries to effectively fulfill their obligations arising from international environmental conventions.

6. SUSTAINBILITY

Forest mapping workflows in Yunnan are portability and can be generalized to a large extent if the local governments are focused on the conveniences posed to their daily work. The achievement of Project will continue to be an important data in the forest survey for a long time because of its results with stability. Most forestry sectors are aware of the importance of forest mapping but find it difficult to accomplish forest mapping which requires professional technology and staff.

Project development and design totally account of the replicated or disseminated application of the project in planning stage. The framework of APNET Project was considering the cost of the technology. Especially, the technical aspects of forest mapping must therefore be the primary objective of any forest management to be instituted. The main technical aspects include: image atmospheric correction, obtain NDVI, obtaining samples, the classification model training, image classification, the classification process, accuracy assessment, image mosaic and so on.

ENVI is able to complete the majority of the remote sensing processing functions, such as Atmospheric correction, NDVI calculations, obtaining samples, post-processing, and accuracy test. Image classification and classification model training can be completed by forest random classifier in EnMAP-box. ERDAS was done in mosaic image. These software is easily to use and flexible.

7. RECOMMENDATIONS

The project has generated baseline data and tools for further development of effective forest management and forest mapping programmes in Yunnan.

The project recommends the following for implementation:

The multi-source remote sensing information database should be created and make available to different users of the project. So certainly, these images came from Landsat5 TM should become the main source of information. Other images should be secondary sources of information, including images of high spatial resolution and high spectral resolution. In the course of project implementation, remote sensing information sources seem sole and difficult to acquire

classification features by selection of classification samples. Therefore, it is biggest obstacle for improving the classification accuracy. In order to solve this problem, our team made a suggestion about using multi-source information for classification. The information from remote sensing images should result from various of sensors, such as MODIS, NOAA, CBERS, SPOT, QB and so on. Specially, these images of high spatial resolution are limited range in satellite observation area, but it can be more clearly reflect the feature characteristics of the shape through visual interpretation and image segmentation technology in relatively small range.

A distributed ground truth database also should be established. These data come from previous and current land cover maps, field measurements, and forest inventories data. Sample selection always depended on ground truth data in the classification mapping of the project, as well as the process in the classification accuracy is also dependent on this data which prove to be ground truth data or image. Actually, Yunnan's area is about 400,000 square kilometres, it means that data collection is unrealistic in a wide range of field investigation. So ready-made data collection is extremely important during the course of project implementation. This kinds of data usually come from different departments of government.

Classification system should be built up based on research results published about Spatial distribution of forest vegetation in Yunnan and preliminary analysis posed to remote sensing image.

The selection of classification samples are justified by field measurements and forest inventories data.

The classifier should be selected according to its accuracy of predictable such as forest random classifier and SVM classifier.

Annex(es):

Annex A: Implementation schedule
Annex B: Details of project cost by category

Annex A Implementation schedule (scheduled versus actual)

Outputs &activities	Completion time		Key points of the results achieved (qualitative or quantitative)	
	Anticipated	Actual	Anticipated	Actual
Remote sensing data acquisition and pre-processing.	Oct.,2011~May, 2012	Oct.,2011~May, 2012	The available remote sensing database, which come from Landsat TM/ ETM+, HJ-1A/1B, CBERS, MODIS, MERIS and FY-3, will be collected.	Landsat TM, MODIS, have be collected
Field measurement and data collection.	Nov.,2011~ Dec. 2012	Nov.,2012~Dec. 2013	GLAS points:100 Each class:50	GLAS points:100 Each class:50 (not totally)
forest cover maps of 2005, and 2010 at 30 ~ 50 m spatial resolution	Jan.,2013~ Aug., 2013	Jan.,2013~Dec., 2013	forest cover maps of 2005, and 2010 in test sites and the whole Yunnan province	forest cover maps of 2005, and 2010 in test sites and the whole Yunnan province
forest cover maps annually from 2005 to 2010 at 300 ~ 500 m spatial resolution	Aug.,2013~Dec., 2013	**Cancel**		

Annex B Details of project cost by category (scheduled versus actual)

Expenses (USD)	APFNet Grant				Counterpart Fund			
	Anticipated A_1	Actual B_1	Variance $C_1(A_1-B_1)$	Variance rate $D_1(C_1/A_1*100\%)$	Anticipated A_2	Actual B_2	Variance $C_2(A_2-B_2)$	Variance rate $D_2(C_2/A_2*100\%)$
Project staff cost[1] (salary and allowance for project staff and management personnel)	4900	4900	**0**	**0**				
Subtotal	4900	4900	**0**	**0**				
Consultancy cost[2] (local and international consultants' cost)	4320	2320	**2000**	46.30**%**				
subtotal	4320	2320	**2000**	46.30**%**				
Travel and related cost[3] (air fare, local travel, per-diem and etc)	11000	10000	**1000**	9.00**%**				
Meeting and training cost[4] (venue, facility, hospitality, speakers/experts' fees , participants accommodation, meeting material, etc)	10000	10000	**0**	0				
Field activities cost[5]	12000	12000	**0**	0				
Publication &Dissemination cost[6] (formulation, editing, publishing of articles, reports, books and information products and organization of outreach activities, media activities)	N/A	2000	**-2000**	0				
Office Operation cost[7] (project administrative management fee and administrative staff cost, lease/rental of office	2880	2880	**0**	0	6000	6000	0	0

Annex B Details of project cost by category (scheduled versus actual)

premises, office and facility maintenance, etc)								
Procurement [8] (purchase of vehicles, equipment, facilities etc)	5700	4700	**1000**	17.50**%**	6000	6000	0	0
Monitoring, evaluation and audit cost[9]	N/A	1000	**-1000**					
Miscellaneous[10]								
Subtotal								
TOTAL	50800	47800	**3000****		12000	12000	0	0

**:The Surplus funds 3000US$ will be used for the publication and dissemination of the results in cominging year.

Principle for budget estimation:

1. The budget should be calculated in USD rather than any other local currency.
2. Subtotal should be calculated if there is more than one sub-category under each category.
3. The budget should include both funding proposed from APFNet and contribution from other channels. Counterpart contribution should account for no less than 20% of total budget, please mark the in-kind contribution in italics and bold.
4. For pilot and demonstration projects, APFNet's grant should be used mainly on the project activities, while the counterpart contribution is suggested to cover the budget items such as rental of office premise, equipment, administrative management, internal monitoring and financial audit.

Notes for budget completion (for each category clarification):

1. Project staff cost: each post should be identified and recorded on a separate budget subline. Full job descriptions should be attached.
   To guarantee efficient use of project fund, the number of the posts should be kept at a minimum level according the specific requirement of each project.
2. Consultancy cost: especially for independent local and international consultants or consultancy firm to assist in project design, conduct external project evaluations and the like. Individual consultants should be offered consultancy service agreements (terms of reference for each consultant should be attached), firms should be offered institutional contracts.

Annex B Details of project cost by category (scheduled versus actual)

Each category should be identified and recorded on a separate budget subline.

The international consultancy fee may be detained and paid directly by APFNet.

3. Travel and related cost: should be used for budgeting air fare, local travel and per-diem etc for the purpose of project implementation.
4. Meeting and training cost: should be used for budgeting organization and participation in training courses, seminars, workshops and so on, which generally includes the meeting/training venue, facility, hospitality, speakers/experts' fees, interpretation.

   The approximate number of participants should be indicated together with tentative agenda and level of the meeting and trainings.
5. Field activities cost:

   When it is necessary to rent land to implement a project, the cost should be estimated and shown against this line.

   The project funding must not be used to purchase land or building.

   The benefit for local staff, the local labor and cost for seedlings, fertilizers, material, goods, tool to facilitate the implementation of project activities at local level, in particular for pilot and demonstration projects, should be estimated and shown on a separate budget subline.

   The cost for other field activities, such as case study and filed survey/research, should be estimated and shown against this line.

6. Dissemination & publication cost: should be used for budgeting formulation, editing, printing, publishing of articles, reports, books and information products and outreach activities.
7. Office Operation cost:

   Project administrative management fee and administrative staff cost should be not more than 10% of the total budget.

   Generally, the administrative staff is determined according to the specific requirement of the project, which generally include accountant, documentation officer, driver and so on. Full job descriptions for each position should be attached.

   When it is necessary to purchase or rent premises to implement a project, the cost should be estimated and shown against this line.

8. Procurement of equipment:

   When it is necessary to purchase or rent equipment or vehicle to implement a project at local level, the cost should be estimated and shown against this line. Maintenance of equipment or vehicle should also be budgeted under this line.

9. Monitoring, evaluation and audit cost: internal monitoring, external evaluation and financial audit are a must do to ensure project implementation on track. The cost for external evaluation may be detained and paid directly by APFNet.
10. Miscellaneous: Cost for miscellaneous should be not more than 5% of the total budget.
11. A_1 refers to the anticipated amount of APFNet's grant, B_1 refers to the actually imbursed/reimbursed amount of APFNet's grant, C_1 refers

to the difference between the anticipated and actually imbursed/reimbursed amount of APFNet's grant, D_1 refers to the variance rate. Accordingly, A_2, B_2, C_2,D_2,refer to the corresponding amount of the counter part fund.

12. All variance rates above 10% need to explained in the Project Financial Statement of the Project Progress Report, supported by detailed justification irrespective of whether they are negative or positive. The explanations should be specific to the relevant budget items. Please refer to budget heading/budget line and also to logframe outputs and indicators as applicable and include explanations of any changes to the total number of units compared to forecast, or the cost per unit.

Project Completion Report Instruction:

1. Project Director prepares the completion report on behalf of Executing Agency (EA), responding to APFNet concerns.
2. Submission should be consulted with project partners and endorsed by Project Steering Committee (PSC), with signatures of Project Director and PSC Chair on behalf of EA and PSC;
3. Completion reports should be submitted within 2 months after project termination date.