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

Institute of Forest Resources Information Techniques, Chinese Academy of Forestry, China
Department of Geographical Sciences, University of Maryland, USA
Global Observation of Forest and Land Cover Dynamics
Guangxi Forest Inventory & Planning Institute, China
Forestry Administration, Cambodia
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Forest Inventory and Planning Institute, Viet Nam
Forest Research Institute Malaysia, Malaysia
National University of Laos, Lao PDR
Royal Forest Department, Thailand
Southwest Forestry University, China

May 24, 2014

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	September 13, 2011	September 13, 2011
Date of completion	August 31, 2013	February 28, 2014
Extension period	Six months	Six months
Project Budget (in USD)		
APFNet's Grant (in USD)	1,028,800	1,028,800
Counterpart Contribution (in USD)	545,850	545,850
Supervisory Agency		
Project Executing Agency	Institute of Forest Resources Information Techniques, Chinese Academy of Forestry, China	
Project Director	Prof. Li Zengyuan	

Project description:
The project was achieved by making intensive use of recent satellite remote sensing technology, establishing regional forest cover maps, documenting forest change processes and estimating carbon storage in the GMS and Malaysia.

Prepared and Submitted by	**Reviewed and Endorsed by**
Project Director signature Date	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

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 major goal of this project is to map forest coverage and carbon storage in the Greater Mekong Subregion (GMS) and Malaysia, which comprises of Cambodia, the People's Republic of China (Yunnan province and Guangxi province), Lao People's Democratic Republic, Malaysia, Myanmar, Thailand, and Viet Nam. This region is rich in forest resources, but the forests are undergoing rapid changes due to human activities.

The project was achieved by making intensive use of recent satellite remote sensing technologies, establishing regional forest cover maps, documenting forest change processes and estimating carbon storage in the GMS and Malaysia. The main outputs of the project are including 1) Remote sensing database, 2) Mid-resolution (30 m) forest map product in 2005 and 2010, 3) Annual forest map product at coarse resolution (500 m) during 2005～2010, and 4) Forest carbon storage mapping product (300 m) of 2005. From our mapping products, most countries had high forestry coverage over 50%. The needle-leaf forests were mainly distributed in Northern Myanmar, Yunnan and Guangxi of China. The forests in Malaysia, Cambodia, Laos, Viet Nam, Thailand and middle-south of Myanmar were dominated by broadleaf forests. Forest coverage was 48.4% and 46.2% in 2005 and 2010 respectively for the whole region. The forest net loss was 2.2% from 2005 to 2010. The forest loss were mainly located in northeast of Myanmar, Laos, Malaysia, and Yunnan province of China. The Forest gain were mainly occurred in eastern Malaysia, northern of Viet Nam, central-north of Myanmar, and Yunnan of China. The high carbon density forests were mainly distributed in the Northern Myanmar and the Northwest Yunnan, the Northeast of Guangxi, border regions of Myanmar-China-Laos and the southern part of Myanmar-Thailand, the center and south of Laos and border regions with Viet Nam, a large part of Malaysia forest.

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1 INTRODUCTION

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. Forest monitoring is important for the estimation and evaluation of the state of forest resources, carbon sequestration, and the results of forest program implementation. It provides a key source of information for the crackdown on illegal logging, forest fire monitoring and early warning and reduction of forest degradation, , forest gain from afforestation and reforestation, and the improvement of forest quality. Also, forest monitoring to support sustainable forest resources management can provide the earth observation data and technical support needed by countries to fulfill their obligations effectively arising from international environmental agreements (e.g., UNFCCC).

The area of the GMS and Malaysia demonstration project ranges from 92.2°E to 119.3°E and 0.8°N to 29.2°N, with a total land area of 317,242,000 ha and a total population of 348 million. It includes Cambodia, the People's Republic of China (Yunnan province and Guangxi province), Lao People's Democratic Republic, Malaysia, Myanmar, Thailand, and Viet Nam. The study area is rich in forest resources, but the forests are undergoing rapid changes due to human activities. The total forest area is 148,128,000 ha (FRA 2010; Yunnan & Guangxi data were from the 7th national forest inventory of China).

The project area consists of a diverse range of geographic landscape including massifs, plateaus and limestone karsts, lowlands, fertile floodplains and deltas, forests (evergreen and semi-evergreen, deciduous, dipterocarp, mangroves, and swamp), and grasslands. The region's geographic variety and consequent variety of climatic zones supports significant biodiversity, with more than 1068 new species discovered during the last ten years. The geographic region encapsulates 16 of the WWF Global 200 ecoregions. The region's biodiversity is ranked as a top-five most threatened hotspot by the Conservation International. High forest coverage and rich forest resource result in large amounts of wood export from this region. The WWF states that the region is particularly vulnerable to global climate change.

2 PROJECT GOAL, OBJECTIVES AND FORMULATION

2.1 Project goal and objectives

The primary goal of the project is to estimate forest coverage and above-ground carbon stock in the Greater Mekong Subregion (GMS) and Malaysia. The proposed approach integrated multi-sources remote sensing data, ground measurements and other thematic geographic data. The outcomes of this project are helpful for understanding how, when and where the forests changed in the GMS and Malaysia. Our proposed approach determined forest coverage and biomass estimates through the following specific objectives:

1) To develop pan-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) To develop a framework for forest carbon estimation using ground measurements, spaceborne lidar sampling data and imagery remote sensing data.
3) To produce forest cover maps of 2005 and 2010 at 30 m spatial resolution and forest cover maps annually from 2005 to 2010 at 500m spatial resolution.
4) To produce a forest carbon storage map for 2005 in the GMS and Malaysia at 300 m spatial resolution.

2.2 Project Design

A project steering committee comprised of national representatives and international experts was established. This committee communicated and made top-level design for the whole project. One representative was recommended for each nation or region. Milestones and main deliverables were discussed by this steering committee.

Institutes with intensive remote sensing technologies and forest resources were organized as an algorithm development and training group. The common data processing and forest information extraction methods were explored and developed. Technical progress and innovative methodologies were regularly synthesized and fed to support operational data processing through training workshops and progress meetings. Some funds for visiting scientists were planned for attendees to visit or study at CAF.

The reference database and middle resolution forest mapping activities were carried out by each country's organizations. Annual forest map of coarse resolution and forest carbon storage map were produced by the methods development team. After the forest coverage and

carbon storage map generated, they were evaluated by a validation team. Then the steering committee analyzed them with other related information. This report is prepared for APFNet and will be released to related communities.

3 PROJECT EXECUTION

3.1 Start-up

The initial stages of the project focused on constituting a project team, making a detail work plan, establishing test sites, and collecting historical reference data and map products in each implementation agency (IA).

A project steering committee was established during the inception workshop of the project in September of 2011. This committee helped to communicate and make top-level design for the whole project. One representative was recommended for each nation or region. The team member includes national representatives and international experts. The tasks and responsibilities of the key members of project management team are described as below (Table 1). Milestones and main deliverables were reported and discussed by this steering committee.

Table 1 Project steering committee

Country	Name	Organization	Title	Working Field
China	Li Zengyuan	IFRIT, CAF	Prof.	Forest remote sensing
USA	John Townshend	University of Maryland	Prof.	Forest remote sensing
Canada	Michael Brady	GOFC-GOLD	Dr.	Land cover
Thailand	Vivarad Phonekeo	Asian Institute of Technology	Dr	Remote Sensing and GIS
Cambodia	H.E Chheng Kimsun	Forestry Administration	Delegate of the Royal Government of Forestry Administration	Management
	Mr. Meas Makara	Department of forest and community forestry management	Director	Management
Guangxi, China	Li Chungan	GXFIPI	PhD	Remote sensing and forest resource monitoring
Laos	Houngphet Chanthavong	Faculty of Forestry, NUoL	Assoc. Prof.	Forest economy
Malaysia	Abdul Rashid Malik	FRIM	Dr.	Research Management and Planning
	Norini Haron	FRIM	Dr.	Research Planning and Corporate
Thailand	Rerngchai Prayoonwet	RFD	Deputy Director General	Forestry
	Songsak Vidtayaudom	RFD	APFNet Focal Point	Forestry

	Sumet Sirilak	RFD	Director of Foreign Relations Division	Forestry
Viet Nam	Nguyen Tuong Van	ICD-VNforest	Ms.	Environmental
	Nguyen Manh Cuong	ICD -Forest	Dr.	GIS and forestry
	Nguyen Ba Ngai	VN Forest	Dr.	Forestry
	Ngo Ut	FIPI	Dr.	Forestry
	Do Xuan Lan	MARD	Dr.	Remote sensing and GIS
Yunnan, China	Xu Hui	Southwest Forestry University	Vice-President of Southwest Forestry University	Forest Management

3.2 Implementation schedule

The project period is from September 1, 2011 to August 31, 2013. As more time was spent for formal contract signature and grant transfer than expectation, we applied a six months extension period in the early of January of 2013. APFNet approved our extension request to extend project period to February 28, 2014. The project activities had been implemented according to the original project work plan and extension as indicated in the Table 2.

Table 2 Overall work plan

Year	2011				2012												2013												2014	
Month	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F
Output 1 Remote sensing database (Sep. 2011 ~ Feb. 2013)																														
Output 2 National-institute-owned ground truth database (Sep. 2011 ~ Feb. 2013)																														
Output 3 Mid-resolution (30m) forest map product in 2005 and 2010 (Dec. 2011 ~ Nov., 2013)																														
Output 4 Annual forest map product at coarse resolution (300~500m) during 2005～2010 (Dec. 2011 ~ Nov., 2013)																														
Output 5 Forest carbon storage mapping product (300~500m) of 2005 (Dec. 2011 ~ Nov., 2013)																														
Output 6 Training and progress workshops (Sep., 2011 & Jun., 2012 & Dec., 2012 & May, 2013 & Nov. 2013 & Jun. 2014)																														
Output 7 The analysis report of forest coverage and carbon storage in each GMS economies and Malaysia (Dec., 2012 & Feb., 2014)																														

- ***Remote sensing database***

The satellite images from Landsat TM/ETM+, IRS LISS, CBERS, MODIS, MERIS and FY-3 were collected and processed. The remote sensing database was created and made available to different users of the project through external hard drives and project website at http://www.apfrm.net/.

- ***National-institute-owned ground truth database***

We designed a distributed database structure of the ground truth data and each IA teams followed the standards to collect the ground truth data. The database contains previous and current land cover maps, field measurements, and forest inventories. These databases are distributed in each IA with same data structure and data access portal. These data provide fundamental training and validation data for remote sensing products.

- ***Annual forest map product at coarse resolution (500m) during 2005～2010***

The forests in the GMS and Malaysia were mapped using MODIS at the 500 m resolution every year during 2005～2010. These annual forest coverage maps were used to explore how the forests changed annually and what forest disaster happened in the GMS and Malaysia.

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

The forests in the GMS and Malaysia were mapped at a fine resolution of 30 m in 2005 and 2010 using Landsat TM/ETM+ and IRS LISS data. These forest maps contain more detail 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 the GMS and Malaysia.

- ***Forest carbon storage mapping product (300m) of 2005***

The forest carbon storage in the GMS and Malaysia was mapped using ICESat GLAS, Landsat, MODIS, MERIS and PALSAR data at coarse resolution 300 m in the epoch of 2005. This wall-to-wall forest carbon baseline map was used to analyze forest quality and its distribution in the GMS and Malaysia.

- ***Training & progress workshops***

Six training and progress workshops were held during the implement of the project. They

focus on progress exchange and training course on remote sensing data processing, forest mapping, and forest biomass/carbon estimation were conducted for project's attendees and related communities. Table 3 shows the activity of each workshop.

Table 3 Main activities of each workshop

Date	Venue	Workshop
September 13-15, 2011	Beijing, China	Inception workshop
June 5-8, 2012	Vientiane, Lao PDR	1st Progress & Training Workshop
Nov. 30 – Dec. 2, 2012	Bangkok, Thailand	2nd Progress and Mid-term Evaluation Workshop
May 8-10, 2013	Kunming China	3rd Progress Workshop
November 4-6, 2013	HoChiMinh, Viet Nam	4th Progress Workshop
June 17-20, 2014	Beijing, China	Completion Workshop

- ***The analysis report of forest coverage and carbon storage in each GMS economies and Malaysia***

Forest resource analysis reports were made based on the map products for each GMS economy and Malaysia. These reports emphasis how the forest coverage changes and driving forces, the forest carbon storage distribution, which linked to the objectives of the APFNet. These contents are the main parts in the technical report and appendix.

3.3 Procurement and consultancy

Some computer equipment had been purchased during the project implementation, including one ThinkPad workstation, one laptop (ThinkPad T420), one video recorder, and 16 external hard drives. According to the government' procurement regulations for the small instrument and equipment of China and Beijing, the procurement plan was reported by IFRIT-CAF and was approved by the finance department of Beijing.

During the implement of the project, many consultancies were performed through experts professional in forest cover and carbon mapping. Table 4 lists the consultancy of each expert.

Table 4 Consultancy

Name	Title	Institution	Activities
Huang Chengquan	Prof.	University of Maryland	(1) Landsat data preparation; (2) Forest change monitoring in GMS region; (3) Forest map product evaluation.
Sun Guoqing	Prof.	University of Maryland	Forest biomass estimation in GMS region.
Che Xuejian	Prof.	Institute of Forest Resources Information Techniques, Chinese Academy of Forestry	Forest cover classification and variation
Vivarad Phonekeo	Dr.	Asian Institute of Technology	Involve in project work plan and assist IFRIT coordinate with project's implementing agency
Liu Fujiang	Dr.	China University of Geosciences	Training on forest cover mapping validation and design work of Myanmar.
Feng Min	Dr.	University of Maryland	Forest map product validation tool development.

3.4 Monitoring, evaluation and reporting

APFNet and IFRIT held training or progress workshop every six months. All implementing agencies attended to present their progress, problems and discuss solutions, next phase plan, as well as the use of grant funds. And the international experts evaluated the results of the work during a meeting held in Bangkok, Thailand from Nov.30 to Dec 2, 2012.

At the same time, IFRIT-CAF made a detail written report to APFNet every quarter, which included: the status of reference database; field data collection for forest mapping; forest cover map of 2005 and 2010 for test sites; forest cover map of 2005 and 2010 of each economy; filed plots summary for forest biomass/carbon estimation and forest carbon map of GMS+ project.

3.5 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 were very encouraging throughout the project implementation. Their active participation was reflected during the field data collection that had enabled indirect transfer of technology to their staff. In general, the project was implemented on schedule except a short extension given to carry out the field survey and updating the forest cover classification activity.

3.6 Project Costs and Funding Sources

The total project funding is $1,574,650, of which $1,028,800 was funded by APFNet and $545,850 by IFRIT-CAF and each implementing agency. Till Feb. 28, 2014, a total of $548,583 was spent according to the budget for completing activities. $79276.45 is accrued (committed and to be spent from March to June) for spending in IFRIT-CAF. There are five categories that had cost overrun and/or change more than 10%. The actual cost of the project of IFRIT-CAF at completion with the estimated cost was compared in Annex B. For the expenditure of other implementing agencies, please see their completion reports. Tables 5 and 6 show the detailed APFNet funding and counterpart funds.

Table 5 APFNet funding of each economy

Economy	Appropriation[1)]		Appropriation[2)]		Appropriation[3)]		Fund Total
	1st Allocation	Percentage	2nd Allocation	Percentage	Final Allocation	Percentage	
Institute of Forest Resources Information Techniques, Chinese Academy of Forestry & Myanmar	154520	35.14%	285240	64.86%	0	0.00%	439760
Forest Administration of Cambodia	39400	40.66%	38,087	39.31%	19,413	20.03%	96900
Guangxi Forest Inventory and Planning Institute, China	20000	39.37%	20000	39.37%	10800	21.26%	50800
Faculty of Forestry of the National University of Lao PDR	36256	40.00%	36256	40.00%	18128	20.00%	90640
Malaysian Forestry Research and Development Board	38240	40.00%	47800	50.00%	9560	10.00%	95600
Royal Forest Department of Thailand	54240	56.38%	27000	28.07%	14960	15.55%	96200
Forest Inventory and Planning Institute, Viet Nam	44000	40.70%	44000	40.70%	20100	18.59%	108100
Southwest Forestry University, China	20000	39.37%	20000	39.37%	10800	21.26%	50800
Total	**406656**		**518383**		**103761**		**1028800**

Note:

1) Allocated in May, 2012
2) Allocated in June, 2013 (except for IFRIT, CAF)
3) Planned allocated after completion of the project

Table 6 Counterpart funds of each economy

Economy	**Counterpart fund Budget**
Institute of Forest Resources Information Techniques, Chinese Academy of Forestry & Myanmar	238100
Forest Administration of Cambodia	97700
Guangxi Forest Inventory and Planning Institute, China	14850
Faculty of Forestry of the National University of Lao PDR	42400
Malaysian Forestry Research and Development Board	59600
Royal Forest Department of Thailand	33600
Forest Inventory and Planning Institute, Viet Nam	27600
Southwest Forestry University, China	32000
Total	**545850**

3.7 Dissemination

The outputs and findings from this project have already been or will be disseminated to the various interested stakeholders. Some of the project findings and outputs will be published in the form of a technical book, scientific papers and proceedings. The training guide on forest cover mapping and carbon estimation has been disseminated to various stakeholders for training and technology transfer. At the end of the project, relevant government agencies in different economies, particularly the forestry departments will have better understanding on the forest cover and forest changes and will contribute to better management of this ecosystem in the future.

4 PROJECT STAKEHOLDERS' PERFORMANCE

4.1 Executing Agency (project team and project director)

The Executing Agency (EA) is IFRIT, CAF. A common activities committee consisted of each IA and related agencies were established (table 7). Institutes with intensive remote sensing technologies and forest resources were organized as the algorithm development and training group. The common data processing and forest information extraction methods were explored and developed. Technical progress and innovative methodologies were regularly synthesized and fed to support operational data processing through training workshops and progress meetings. Following is the table of common activities committee.

Table 7 Common activities committee

Country	Name	Organization	Title	Expertise
China	Li Zengyuan	Institute of Forest Resources Information Techniques, Chinese Academy of Forestry (IFRIT-CAF)	Dr.	Forest remote sensing
USA	John Townshend	University of Maryland	Dr.	Forest remote sensing
Canada	Michael Brady	GOFC-GOLD	Dr.	Land cover
China	Pang Yong	IFRIT-CAF	Dr.	Lidar remote sensing
Thailand	Vivarad Phonekeo	Geoinformatics Center, Asian Institute of Technology	Dr.	Forest fire monitoring
Malaysia	Khali Aziz Hamzah	Forest Research Institute Malaysia	Dr.	RS and forest management
Myanmar	Aung Aung Myint	Forest Department of Myanmar	Dr.	RS and GIS
Viet Nam	Nguyen Huy Dzung	Forest Inventory and Planning Institute	Dr.	GIS
Thailand	Sukan Pungkul	Forest Survey and Assessment Division, Royal Forest Department	Mr.	Forest Ecology RS and GIS
Laos	Thoumthone Vongvisouk	Faculty of Forestry, NUoL	Mr.	RS&GIS
Cambodia	Chivin Lend	Department of Forestry and Community Forestry, Forestry Administration	Dr.	Forest Management
USA	Huang Chengquan	University of Maryland, College Park	Dr.	Forest mapping and change detection
USA	Sun Guoqing	University of Maryland, College Park	Dr.	SAR remote sensing
USA	Zhu Zhiliang	U.S. Geological Survey	Dr.	Carbon estimation
China	Tan Bingxiang	IFRIT-CAF	Dr.	Remote sensing classification
China	Chen Erxue	IFRIT-CAF	Dr.	SAR remote sensing
China	Liu Jianbo	RADI，Chinese Academy of Sciences (CAS)	Dr.	Remote sensing data
China	Li Xingchao	China Centre For Resources Satellite Data & Application	Dr.	China satellite data

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
WP5: Mid-resolution forest mapping product
WP6: Coarse-resolution forest mapping product
WP7: Forest carbon storage mapping product
WP8: Reporting and dissemination.

WP1, WP2, WP7 and WP8 were led by the Chinese Academy of Forestry and the University of Maryland with inputs from involved countries. The data of WP4 was distributed in each country but was available for use by the entire project. WP4, WP5, WP6 and WP7 were carried out by each IA. Relevant forest mapping techniques and software tools were developed into a streamlined production system in WP1 and WP2. And the production system was distributed to the team of each country through training courses/workshops. The data were distributed to each team, who produced and validated the maps by themselves. Classification and mapping activities for each country were done by each county's team.

4.2 Implementing Agency

Forestry Administration, Cambodia (FA): FA is a government authority under the Ministry of Agriculture Forestry and Fisheries (MAFF) in managing forests and forest resources according to the National Forestry Sector Policy and the Forestry Law. The FA has a unique management and organization structure for the whole country in vertical line, which divided into central, inspectorate, cantonment, division, and triage forestry administration levels.

Guangxi Forest Inventory and Planning Institute (GFIPI): Guangxi Forest Inventory and Planning Institute, which is under the management of the Forest Department of Guangxi Zhuang Autonomous Region's Government, was established in 1953. GFIPI is the exclusive organization with national class A qualification of forest inventory and planning in Guangxi, and its tasks cover forestry, garden, tourism, road and bridge, etc. Furthermore, GFIPI focus on Forest inventory and planning, Forest management, Plantation, Ecosystem monitoring, Forest protection and Biodiversity conservation. There are more than 200 staff currently working full-time at GFIPI. Nearly 120 of them are specialized in forest with graduate or post-graduate

degrees. Their educational background includes Forestry, Ecology, Botany, Zoology, Environment, Soil, Geographic Information System (GIS), Remote Sensing (RS), Global Positioning System (GPS), Computer, Informatics, Economics, etc. In addition, GFIPI has partnered with lots of top experts from other institutions and colleges in relevant areas, such as Chinese Academy of Forestry, Beijing Forestry University and Purdue University.

Faculty of forestry, National University of Laos: The Faculty of Forestry has been developed from the forestry research center. It was supported by the Australian government. However, after the National University of Laos has been established in 1995, the faculty of forestry joined with faculty of agriculture and forestry to be one faculty under the national university of Laos, which was called “Faculty of Agriculture and Forestry”. Since the faculty of agriculture and forestry has 2 campuses including Dong Dok and Na Bong, this faculty was divided into 2 faculties (faculty of forestry and faculty agriculture). The faculty of forestry is the highest forestry education institute in Laos. Under the supervision of the National University of Laos, this is a fully functioning institute on the development of teaching materials on forestry. Because of this function, the faculty has been developed from a forestry training center to the Vientiane Forestry College and has upgraded the current faculty.

Forest Research Institute Malaysia (FRIM): FRIM is one of the leading institutions in tropical forestry research in the world. Founded in 1929, the former Forest Research Institute became a fully-fledged statutory body, governed by the Malaysian Forest Research and Development Board (MFRDB) under the Ministry of Primary Industries, in 1985. Presently, both FRIM and MFRDB are under the purview of the Ministry of Natural Resources and Environment. The Institute sits on a 485.2-ha site adjacent to the Bukit Lagong Forest Reserve in the Kepong municipality, 16 km northwest of Kuala Lumpur. The Institute was awarded the MS ISO 9001:2000 certification in December 2007 and gazetted as a natural heritage on 10 February 2009 under the National Heritage Act 2005. The mission of FRIM is to achieve excellence in scientific research, development and forestry services.

Royal Forest Department of Thailand (RFD): RFD itself created many projects using satellite imagery since the last decade until present. The Forest Resources Assessment Division

(FRAD) was established in 1993 by the RFD and was responsible for satellite image interpretation for the organization. The RFD used data from many different satellites, but LANDSAT was its mainly data source. The data from such satellites are received and processed by Geo-Informatics and Space Technology Development Agency (Public Organization) (GISTDA), Ministry of Science and Technology. Most of Thailand's projects on the application of satellite imagery have been created and run by RFD.

Forest Inventory & Planning Institute (FIPI): FIPI, Department of Forestry (DOF) - Ministry of Agriculture and Rural Development (MARD) is a governmental organization, specializing on state management in the field of forest inventory and planning. The main task of FIPI is to conduct inventories of forests and forest lands throughout the country, monitor land use land cover change occurred with strong interface between people and forests throughout the country, investigate factors that affect land cover change and the interactions that may exist between them either spatially or temporally, prepare the effective sustainable forest development plans for national, regional and provincial level and for forests of different functions: Production Forests; Protection Forests (including watershed protection forests) and Special Use Forests (including national parks, Nature Reserves, cultural-historical and environmental sites), and carry out researches in the field of environmental protection and biodiversity conservation.

Southwest Forestry University (SWFU): SWFU is the only forestry university in the western part of China. The faculty of Natural Resources (FNR) is the largest teaching unit at SWFU, with a long history of 70 years. It has powerful teaching staffs, advanced equipment, and distinguished achievement in scientific research. It hosts the Research Center of GIS, RS & GPS in Forestry of Yunnan Province, which was established by the Education Department of Yunnan in 2007. It currently has 21 staff members and is linked to the FNR. The research center aims at technology innovation research of Geomatics. There are 3 focuses research fields: 1) forest resources inventory and dynamic monitoring, 2) forest management and digital forestry information sharing; 3) sustainable forest management. At the same time, it is concerned with hot issues and urgent needs of forest management and addresses these issues

by conducting related research and provides needed services.

4.3 Other project partners

The Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD): Dr. Michael Brady (the former executive director) helped to design and initialize this project. He is also a member of the project steering committee.

University of Maryland (UMD): Scientists from the Department of Geographical Sciences and Global Land Cover Facility (GLCF) of University of Maryland were involved in this project. Prof. John Townshend helped to design and initialize this project. He is also a member of the project steering committee. Dr. Sun Guoqing was involved in the GLAS data processing, forest biomass estimation algorithm design and development. Dr. Huang Chengquan was involved in Landsat data processing, forest change detection and map products evaluation.

Asian Institute of Technology (AIT): Dr. Vivarad Phonekeo, Senior Research Associate of AIT, attended this project as a member of the project steering committee to make project work plans and assisted IFRIT in coordinating with the project implementing agencies.

U.S. Geological Survey (USGS): Dr. Zhu Zhiliang helped to design this project and access to the Landast TM/ETM+ data archived at USGS.

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. There is no communication problem.

Communications were achieved through email, phone calls and other internet services. Annual project progress monitoring and evaluation meetings were also held by APFNet in a timely and very systematic manner. There were meetings and discussions with APFNet throughout the project, including visits to different selected study sites in the participating economies. Every agency was also given adequate notice and time to submit report and was always kept informed from time to time on the overall project progress.

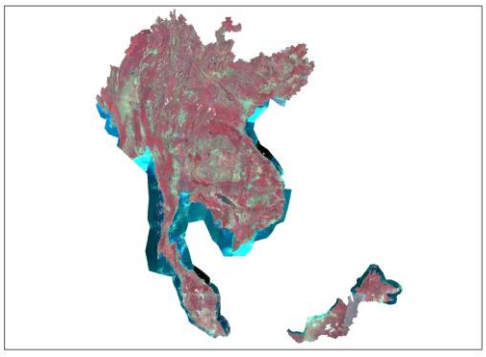
5 RESULTS

5.1 Achievements

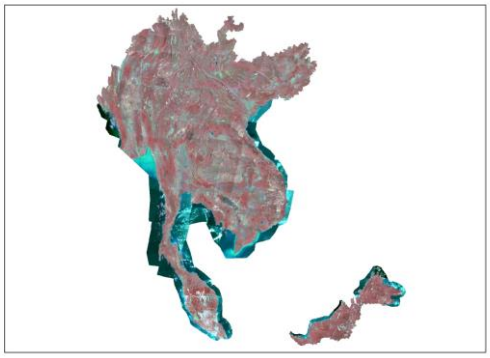
This project focuses on the role of remote sensing and geographic information system in assessment of changes in forest cover and carbon stock, between 2010 and 2005, in GMS region and Malaysia. Three main remote sensing data types were used in this project, namely the Landsat TM, MODIS, and GLAS. About 320 scenes of Landsat TM medium resolution satellite imageries were used to map the forest cover of the whole area for the years 2010 and 2005, about 1,242 tiles of MODIS data were used to map the forest cover of the whole area from the years 2005 to 2010. After performing classification on these images, a total of eighteen land cover classes were identified and mapped. These classification maps contained detailed spatial distribution of land use information. This information is useful particularly for understanding the driving forces of the forest changes and could provide supporting information for the policy makers in the region. A total of 639 plots have been established, with each collocated with the center of a GLAS shot for estimating biomass through the combination of field inventory and GLAS signal. These plots covered different forest types in this region. 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 GMS region and Malaysia.

5.1.1 Remote sensing and reference database

The project collected the satellite images of Landsat TM/ETM+ at mid-resolution 30 m in 2005 and 2010 covering the whole study area (Figure 1), RapidEye imageries with 5 m spatial resolution in 2010 for 18 test sites, ICESat GLAS waveform data for test sites, and time series of MODIS data from 2005 to 2010 for the whole study area.



(a) 2005 Landsat imageries of GMS+



(b) 2010 Landsat imageries of GMS+

Figure 1 An example of remote sensing database

Forest coverage monitoring is based on the acquisition of remote sensing data. Each country got relative remote sensing data through different remote sensing data sources, which laid a solid foundation for forest and carbon mapping of the country and the entire study area.

Each Implementation Agency (IA) measured 100 forest field plots centered by ICESat GLAS footprint from typical forests for biomass estimation and established classification validation plots (50 plots for each class) for forest distribution maps evaluation. These data provided fundamental training and validation data for remote sensing products.

The project designed a distributed database structure of the ground truth data. Each IA followed the standards to collect the ground truth data. The database contained previous and current land cover maps, field measurements, and forest inventories.

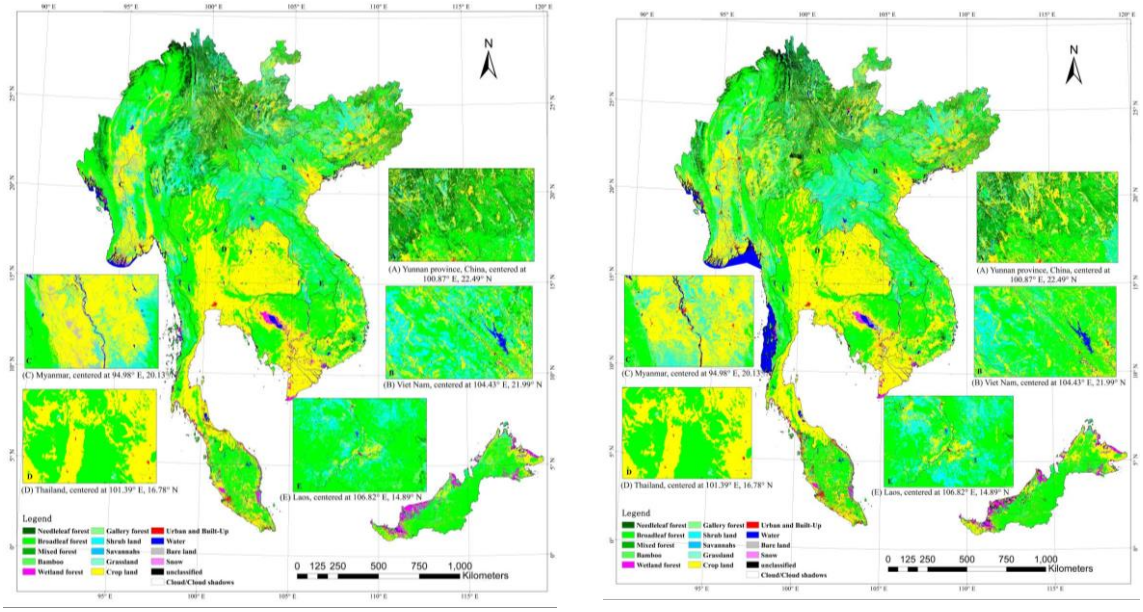
5.1.2 Mid-resolution (30 m) forest map product in 2005 and 2010

The forests in the GMS and Malaysia were mapped at a fine resolution of 30 m in 2005 and 2010 using Landsat TM/ETM+ data. The forest coverage of each economy was shown in table 8. Forest coverage is 48.4% and 46.2% in 2005 and 2010 respectively for the whole region. So the forest net loss is 6% from 2005 to 2010.

Table 8 The forest coverage of each economy between 2005 & 2010 in the GMS and Malaysia

country/area	forest cover 2005(%)	forest cover 2010(%)
Cambodia	59.04	57.01
Guangxi, China	42.88	40.81
Lao	51.50	37.81
Malaysia	67.81	62.82
Myanmar	54.63	39.17
Thailand	33.87	31.57
Viet Nam	40.37	43.78
Yunnan, China	53.41	52.19

Most countries had high forestry coverage over 50%. The needle-leaf forests were mainly distributed in Northern Myanmar, Yunnan and Guangxi of China. The forests in Malaysia, Cambodia, Laos, Viet Nam, Thailand and middle-south of Myanmar were dominated by broadleaf forests. The crop lands were mainly distributed in the Mekong Delta, Central-Eastern of Thailand, Central-South of Myanmar and central part of Guangxi of China. Along the coasts, there were some mangrove forests.



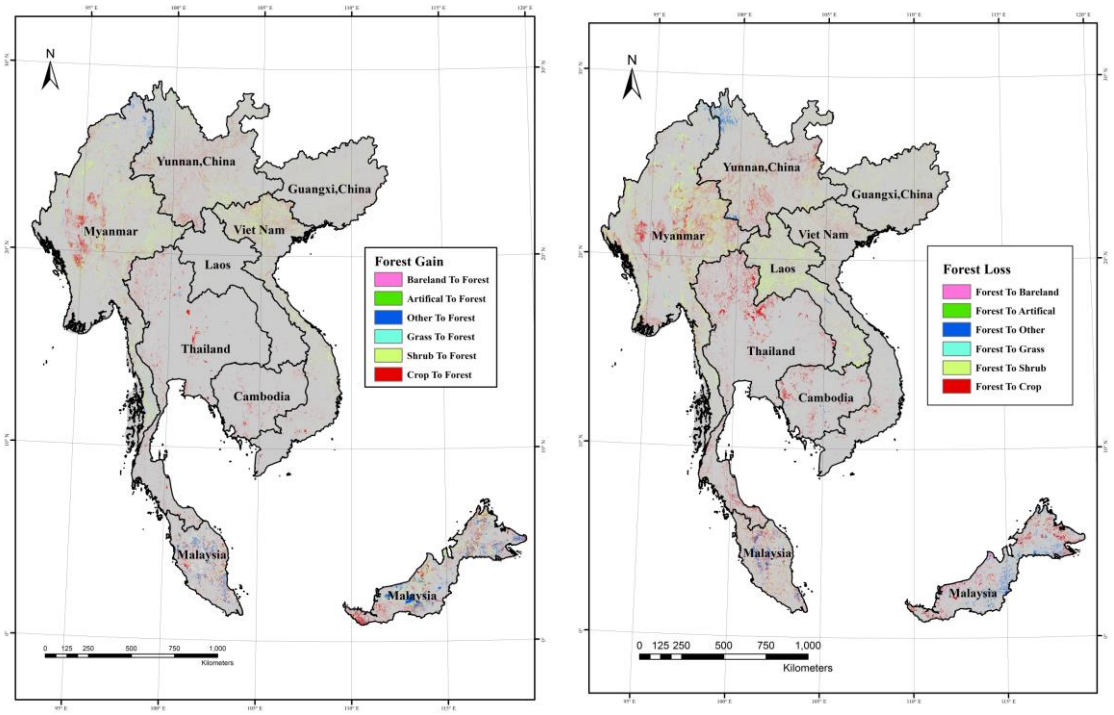
(a) Forest cover map in 2005

(b) Forest cover map in 2010

Figure 2 Forest cover map in GMS and Malaysia

We further mapped the sources of forest gain and loss between 2005 and 2010 in GMS & Malaysia (Figure 3). The transform of forest with shrub, grassland and cropland are dominated types in this region. This shows that the competition of crop land extension and forest recovery is still a critical issue. Meanwhile, some afforestation and conservation policies helped the forest recovery and extension. As shown in Fig. 3(a), the forest gains from cropland are mainly in the central of Myanmar and Yunnan of China. The forest gains from shrub are mainly in the North part of Viet Nam and Myanmar, the southeast and northeast part of Yunnan. As shown in Fig. 3 (b), the forest loss types are mainly in Laos, northeast of Myanmar, northwest of Thailand, and the south of Yunnan. In Laos and the north part of Viet Nam, the dominate type of forest loss is forest degraded into shrub. In Thailand and Cambodia, the dominate type of forest loss is forest changed into cropland. For Myanmar and Yunnan of China, the transforms to shrub and cropland are both happed. Malaysia shows a lot of transforms between forest and other types, which might be caused by the cloud and shadow areas.

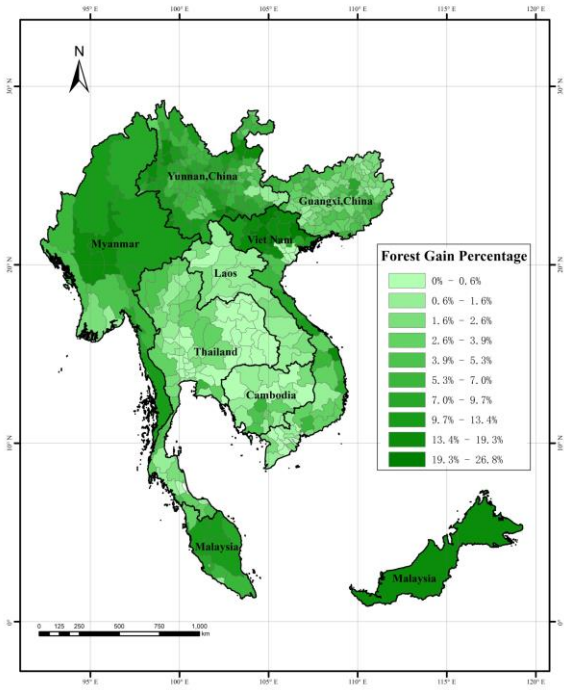
When we compare Fig. 3(a) and (b), most areas have forest loss and gain simultaneously. For those areas with large number of forest gain and loss, forest plays a very import role to local people and economy. For Laos, forest loss happened much more than forest gain, especially for forest degradation.



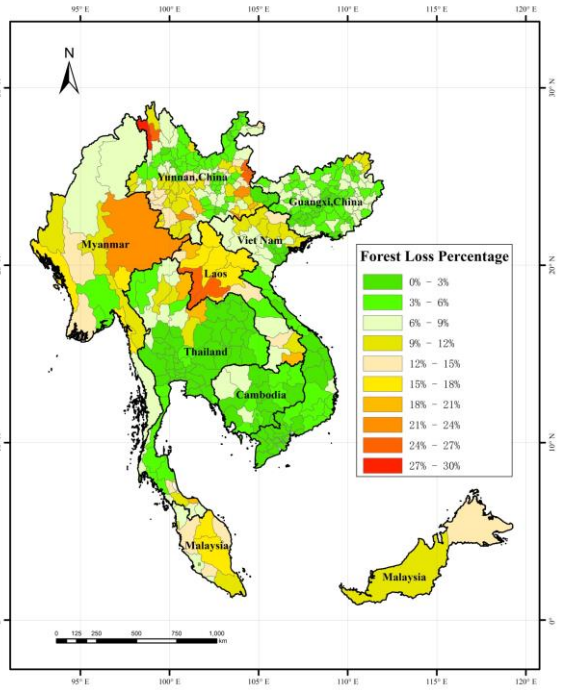
(a) The Sources of Forest Gain (b) The Sources of Forest Loss

Fig. 3 The sources of forest gain and loss between 2005 and 2010 in GMS & Malaysia

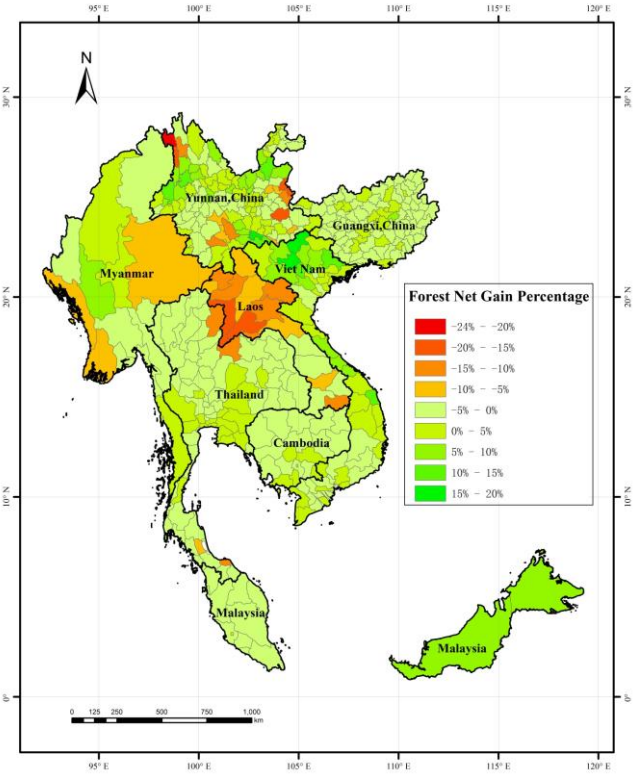
To link these forest gain and loss to administration unit, we summarized the change map at province level (for Myanmar, Laos, Viet Nam, Cambodia, Thailand, and Malaysia) and county level (for Yunnan and Guangxi of China) in Figure 4. From 2005 to 2010, the Xaignabouri, Vientiane and Attapeu provinces of Laos are mainly forest loss area. The Magwe of Myanmar, Ha Giang, Yen Bai, and Lang Son provinces of Viet Nam, show significant increase of forest. Pattani in the south of Thailand also shows significant forest loss during this period.



(a) Forest Gain Percentage Between 2005 and 2010 at Province/County Level in GMS & Malaysia



(b) Forest Loss Percentage Between 2005 and 2010 at Province/County Level in GMS & Malaysia

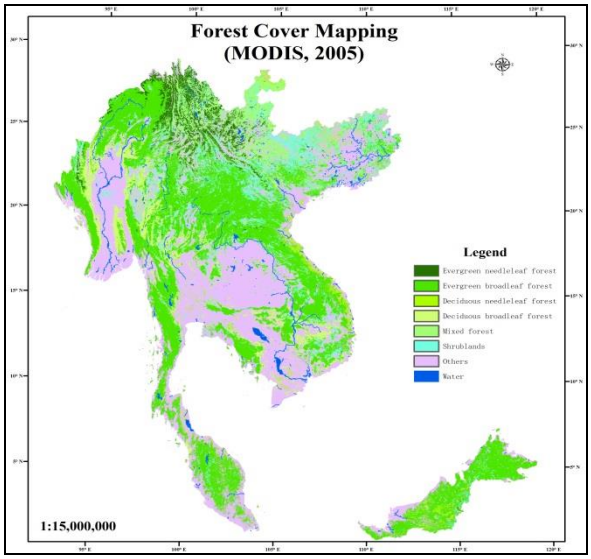


(c) Forest Net Gain/Loss Percentage Between 2005 and 2010 at Province/County Level in GMS & Malaysia

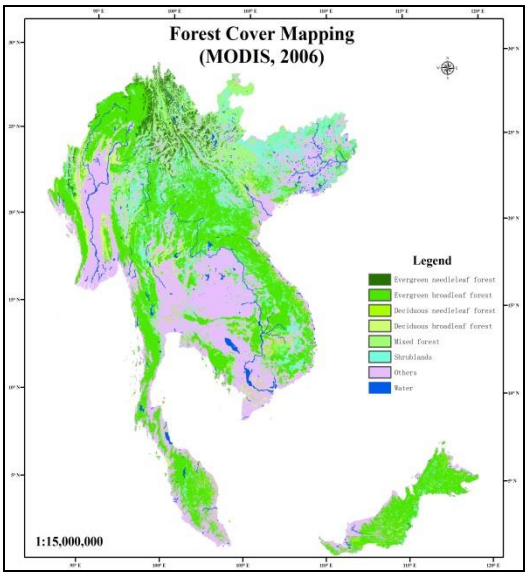
Fig. 4 The Provincial level forest gain and loss analysis between 2005 and 2010 in GMS & Malaysia

5.1.3 Annual forest map product at coarse resolution (500 m) during 2005～2010

The forests in the GMS and Malaysia were mapped using MODIS at coarse resolution of 500 m annually during 2005～2010. These annual forest coverage maps were used to explore how the forests changed annually and what forest disaster happened in the GMS and Malaysia.



a



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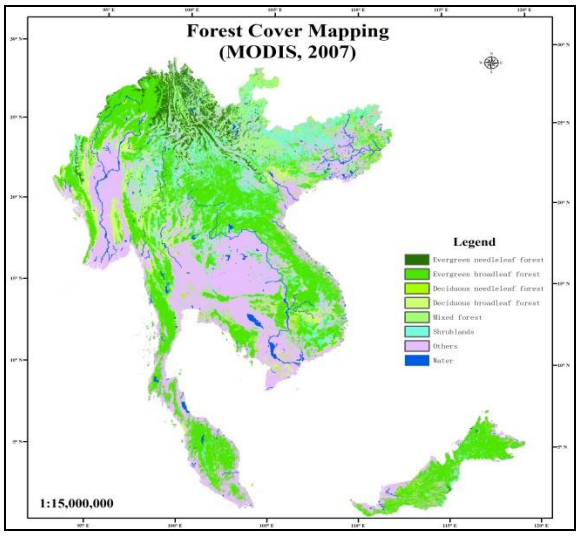

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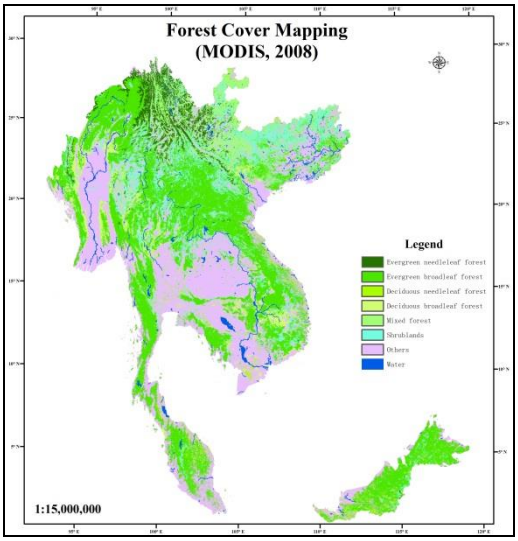

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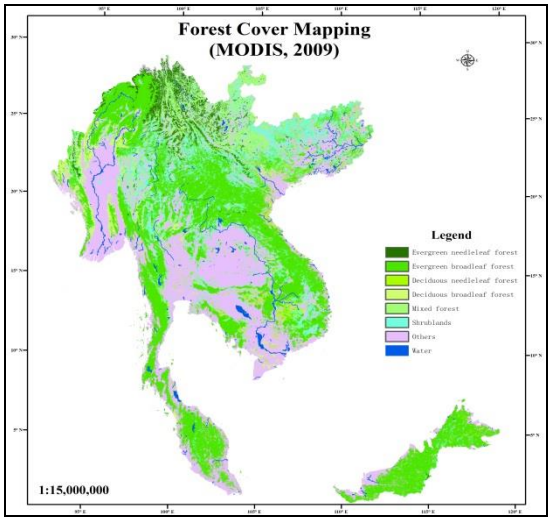

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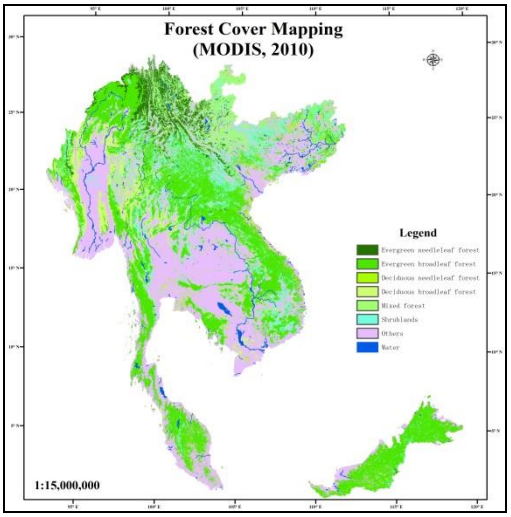

f

Figure 5 Forest cover map of the GMS+ project (year 2005 ~2010 from a to f)

5.1.4 Forest carbon storage mapping product (300 m) of 2005

The project used field measurements and airborne Lidar to train the sapceborne Lidar data, then extended these discrete carbon estimations to a continuous map after fusion with imagery remote sensing data. The forest carbon storage map had a spatial resolution of 300 m in the epoch of 2005. The high carbon density forests were mainly distributed in the Northern Myanmar and the Northwest Yunnan, the Northeast of Guangxi, border regions of Myanmar-China-Laos and the southern part of Myanmar-Thailand, the center and south of Laos and border regions with Viet Nam, a large part of Malaysia forest.

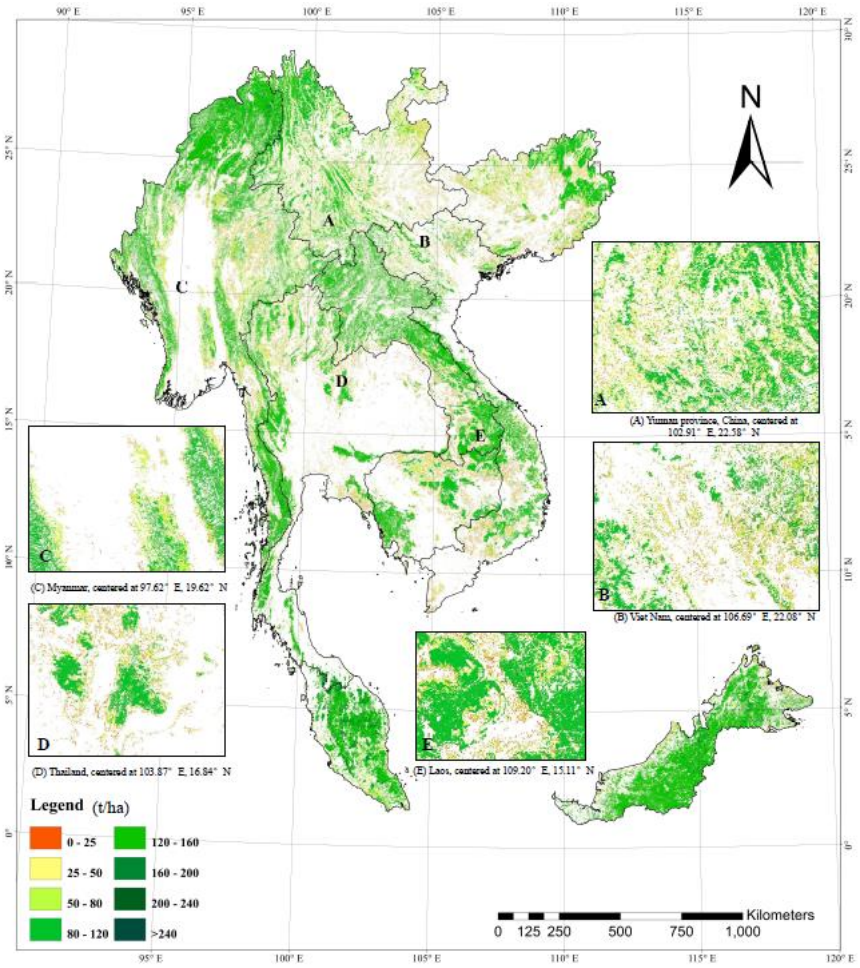

Figure 6 Forest carbon estimation in the GMS & Malaysia

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

This project has provided valuable knowledge and experience to each economy in GMS region and Malaysia. Through this project, the relationships among the involved economies have been strengthened. The technique developed from this project such as biomass mapping using both field and remote sensing data is useful to all the economies. The information can be used by the authority to better plan and manage forests in this region. The methods and techniques developed may also be shared with other economies having similar forest types and habitat in this region.

5.3 Lessons learned and outstanding issues

The project benefited tremendously from the cooperation and participation of various

stakeholders, particularly the forestry departments. Coordination roles played by IFRIT-CAF were very important to ensure all agencies involved in the project implementation participated actively. The organization and 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 has been carried out efficiently which resulted in the successful implementation of the project and achievement of all targeted objectives. One important factor in the project design which should be considered in the future is to allocate some adequate time for paper work to go through different institutions. Field survey activities need to be planned in anticipation of potential problems such as tropical weather conditions that may delay field trips and difficulties to access some plot locations in the tropical forest environment.

The design of the project was sufficient to enable effective implementation of the entire project. Close collaboration with the implementing agencies had enabled that all necessary decisions to implement the project were 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.

5.4 Impacts

The outputs of this project have given positive impact to the economies in general and the forestry sector in particular. This project has strengthened the relationships between each implementing agency and other stakeholders such as FRIM and Forestry Department in Malaysia. This would give the opportunity for both agencies to work together in the future in order to further strengthen the implementation of sustainable forest management practices in this economy. Results obtained from this project, especially the spatial map products such as forest maps can help in defining forest areas with better accuracy. The use of remote sensing data in monitoring and managing forest resources has become essential in recent years and

will remain important in the future.

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

6 SUSTAINBILITY

The information on forest distribution and changes provided by this project will benefit forest policy makers and management activities. Biomass and carbon in GMS and Malaysia certainly are important issues in the sustainable management and utilization of the forest resources in this region. The carbon and biomass distribution maps will be used by the relevant authority in each economy to plan for better resource management by taking into consideration of local and global climate change related issues. They provide essential information for protection the forest ecosystem and contribute towards the conservation of biological diversity. This project will provide benefits not only to the region 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 each implementing agency will plays an important role to ensure the project sustainability beyond the project life span. The outcome of this project has also generated relevant information required for the preparation of climate change related reports, as required by the economy for international negotiations and meeting. The results from this project will continue to be useful for forest survey for a long time.

7 RECOMMENDATIONS

The methods and procedures developed through this study for mapping forest biomass and carbon can also be applied in other similar forest environment in this region. It is recommended that each economy provides the expertise and knowledge gained from this project to help other tropical economies in this region to map their forest biomass and carbon content.

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 on initiating necessary stakeholder consultation processes as early as possible to ensure the smooth project implementation.

Overall, the project objectives have been successfully achieved, and the problems raised in the project document have been adequately addressed, 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 and coming satellites data such as Landsat 8, Setinel-1/2 and GF-1 satellites.

With multi-period forest map products, the change products contain where the forest gain and loss happened, where the forest gains come from and where the forest lost go. This information is very helpful for forest policy makers and management activities. More policy and social economy factors analysis will be very helpful to investigate more advanced knowledge in this aspect.

Annexes

Annex A: Implementation schedule

Annex B: Details of project cost by category

Annex C: Completion report of each economy

Annex A: Implementation schedule

Outputs &activities	Completion time		Key points of the results achieved (qualitative or quantitative)	
	Anticipated	Actual	Anticipated	Actual
Output 1 Remote sensing database	Sep. 2011 ~ Feb. 2013	Sep. 2011 ~ Feb. 2013	At least two times coverage of mid-resolution and five times coverage of coarse-resolution satellite data.	Landsat TM/ETM+ data of 2005 and 2010, MODIS data from 2005 to 2010, RapidEye data of test sites in 2010
Activity 1.1 A standard workflow of data processing will be figured out.	Sep. 2011 ~ Feb. 2013	Sep. 2011 ~ Feb. 2013	Some developed routines with commercial software of ENVI	A standard workflow of data processing was figured out.
Activity 1.2 Remote data collection and database construction and distribution	Sep. 2011 ~ Feb. 2013	Sep. 2011 ~ Feb. 2013	Some standard about data archives and distribution	Landsat TM/ETM+, MODIS, RapidEye have be collected
Output 2 National-institute-owned ground truth database	Sep. 2011 ~ Feb. 2013	Sep. 2011 ~ Feb. 2013	The database will be distributed in each country with same data structure and data access portal of ground references information. These data will provide fundamental training and validation data for remote sensing products.	Data geographic coverage, acquired date and attributes
Activity 2.1 database structure design, data collection, database construction and distribution	Sep. 2011 ~ Feb. 2013	Sep. 2011 ~ Feb. 2013	Some standard about data archives and distribution	Data archives and distribution
Output 3 Coarse resolution forest map product: Annual forest map	Dec. 2011 ~ Nov., 2013	Dec. 2011 ~ Feb., 2014	Forest coverage dynamic maps at coarse resolution (300~500m) every	Data geographic coverage, accuracy, and image date

product at coarse resolution (300~500m) during 2005～2010			year during 2005～2010.	
Activity 3.1 Forest information extraction methods from coarse resolution (300~500m) will be developed.	Dec. 2011 ~ Nov., 2013	Dec. 2011 ~ Feb., 2014	Some developed routines with commercial software of ENVI	Methodology for coarse resolution forest cover map
Activity 3.2 Forest classification for whole region	Dec. 2011 ~ Nov., 2013	Dec. 2011 ~ Feb., 2014	Some developed routines with commercial software of ENVI	500 m spatial resolution forest cover map from 2005 to 2010
Output 4 Mid-resolution forest map product: forest map product at mid-resolution (30~50m) of 2005 and 2010	Dec. 2011 ~ Nov., 2013	Dec. 2011 ~ Feb., 2014	Forest map product at mid-resolution (30~50m) of 2005 and 2010	Data geographic coverage, accuracy, and image date
Activity 4.1 Forest information extraction methods from mid-resolution (30~50m) will be developed.	Dec. 2011 ~ Nov., 2013	Dec. 2011 ~ Feb., 2014	Some developed routines with commercial software of ENVI	Methodology for middle resolution forest cover map
Activity 4.2 Forest classification for each country.	Dec. 2011 ~ Nov., 2013	Dec. 2011 ~ Feb., 2014	Some developed routines with commercial software of ENVI	Middle resolution forest cover map in 2005 and 2010 of 30 m spatial resolution.
Output 5 Forest carbon storage map product: Forest carbon storage map product at coarse resolution (300~500m) in 2005	Dec. 2011 ~ Nov., 2013	Dec. 2011 ~ Feb., 2014	Forest carbon storage map product at coarse resolution (300~500m) in 2005	Forest carbon storage map of 2005 of 300 m spatial resolution.

Activity 5.1 Forest carbon storage estimation methods from multi-sources remote sensing data will be developed	Dec. 2011 ~ Nov., 2013	Dec. 2011 ~ Feb., 2014	Some developed routines with commercial software of ENVI	Forest carbon storage estimation method
Activity 5.2 Forest carbon storage estimation for each country.	Dec. 2011 ~ Nov., 2013	Dec. 2011 ~ Feb., 2014	Some developed routines with commercial software of ENVI	Forest carbon storage map of 2005
Output 6 Training workshops Training courses and study tours on remote sensing data processing, forest mapping, and forest biomass/carbon estimation	Sep., 2011 & Jun., 2012 & Dec., 2012 & May, 2013 & Nov. 2013 & Jun. 2014	Sep., 2011 & Jun., 2012 & Dec., 2012 & May, 2013 & Nov. 2013 & Jun. 2014	Training documents	Workshop summary, photos, videos, participants list.
Activity 6.1 Institutes with intensive remote sensing technologies or forest resources will be organized as an algorithm development and training group. Technical progress and innovative methodologies will be regularly synthesized and feed to support operational data processing trough training workshops and progress meetings.	Sep., 2011 & Jun., 2012 & Dec., 2012 & May, 2013 & Nov. 2013 & Jun. 2014	Sep., 2011 & Jun., 2012 & Dec., 2012 & May, 2013 & Nov. 2013 & Jun. 2014	Training documents and algorithms development.	Workshop summary, photos, videos, participants list. Training guide.
Output 7 Reports of forest coverage and carbon storage in each GMS economies and Malaysia	Dec., 2012 & Feb., 2014	Dec., 2012 & Feb., 2014	The forest resource analysis report will be prepared using the map products for each GMS economy and Malaysia.	Progress report quarterly, year report, and completion report.

Activity 7.1 After each forest coverage and carbon storage map generated, they will be evaluated by a validation team. Then the science team will do analysis with other related information.	Dec., 2012 & Feb., 2014	Dec., 2012 & Feb., 2014	Reports will be prepared for APFNet and released to related communities.	Progress report quarterly, year report, and completion report.

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

Expenses (USD)	APFNet Grant				Counterpart Fund			
	Anticipated	Actual	Variance	Variance rate	Anticipated	Actual	Variance	Variance rate
	A_1	B_1	$C_1(A_1-B_1)$	$D_1(C_1/A_1*100\%)$	A_2	B_2	$C_2(A_2-B_2)$	$D_2(C_2/A_2*100\%)$
1. Inception funds								
Subtotal								
2. Consultants								
2.1 Please list all consultants employed under this project	81000	13161.71	67838.29	83.75				
2.2 Key regional monitoring	30000	10010.36	19989.64	66.63				
Subtotal	**111000**	**23172.07**	**87827.93**	**79.12**				
3. Management assistants								
3.1 Please list all management assistants employed under this project								
salary	12000	23278.99	-11278.99	-93.99	57600	57600	0	0
stipend of scientists	15000	8997.12	6002.88	40.02				
stipend of graduate students	15000	17291.80	-2291.80	-15.28				
per-diem	1800	0.00	1800.00	100.00				
Travel cost	11800	6398.57	5401.43	45.77				
Subtotal	**55600**	**55966.48**	**-366.48**	**-0.66**	**57600**	**57600**	**0**	**0**
4. Study tour & travel expenses								

4.1 Please list separately all missions to be undertaken								
Data acquisition in the pilot area	20000	20867.56	-867.56	-4.34				
International Remote Sensing Symposium	6200	30388.08	-24188.08	-390.13				
Study in aboard (visiting scientist grant)	21000	12402.24	8597.76	40.94				
Progress meeting of the project	24000	10264.83	13735.17	57.23				
Attending the domestic symposium	1280	681.22	598.78	46.78				
Subtotal	**72480**	**74603.93**	**-2123.93**	**-2.93**				
5. Survey/ case study & sub-contracts								
5.1 Please list separately all sub-contracts to be issued								
sub-contracts								
GOFC-GOLD	10000	0.00	10000.00	100.00				
USGS	10000	1282.78	8717.22	87.17				
UMD	30000	5560.36	24439.64	81.47				
Subtotal	**50000**	**6843.14**	**43156.86**	**86.31**				
6. Training & workshops								
6.1 Please list separately all training/workshops to be organized								
2011 workshop	20000	22441.11	-2441.11	-12.21				
2012 training workshop	20000	22216.45	-2216.45	-11.08				
2013 workshop	20000	17263.60	2736.40	13.68				
Subtotal	**60000**	**61921.16**	**-1921.16**	**-3.20**				

7. Equipment								
7.1 Please list separately all equipments to be purchased								
Envi/ERDAS Software	20000	11729.34	8270.66	41.35				
Subtotal	**20000**	**11729.34**	**8270.66**	**41.35**				
8. Flowing Materials								
8.1 List separately all materials to be purchased								
High Resolution Optical Satellite Data	26400	12160.38	14239.62	53.94	7600	7600	0	0
High Resolution Radar Data	21600	24504.20	-2904.20	-13.45	2700	2700	0	0
Topographic Map(100Km*100Km)	11400	2813.08	8586.92	75.32	7600	7600	0	0
TM					87000	87000	0	0
ENVISAT					54000	54000	0	0
Subtotal	**59400**	**39477.66**	**19922.34**	**33.54**	**158900**	**158900**	**0**	**0**
9. Office accommodation and administration								
9.1 Office rental costs					21600	21600	0	0
9.2 Local transportation costs	5280	6757.00	-1477.00	-27.97				
9.3 Office supplies & expenses (stationery, utilities, phone etc.)	6000	4496.57	1503.43	25.06				
9.4 Tax	0	25516.21						
Subtotal	**11280**	**36769.78**	**-25489.78**	**-225.97**	**21600**	**21600**	**0**	**0**
TOTAL	**439760**	**310483.56**	**129276.44**	**29.40**	**238100.00**	**238100.00**	**0**	**0**

Annex C: Completion report of each economy