Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

Terminal Evaluation Report

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

(Project ID: 2011P2/6-CAF)

September, 2011 – February, 2014

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ACRONYMS AND ABBREVIATIONS

AIT	Asian Institute of Technology
APFNet	Asia Pacific Network for Sustainable Forest Management and Rehabilitation
CAF	Chinese Academy of Forestry
CMA	China Meteorological Administration
EA	Executing Agency
ETM+	Enhanced Thematic Mapper
FAO	Food and Agriculture Organization
FRA	Forest Resources Assessment
FRIM	Forest Research Institute Malaysia
GFIPI	Guangxi Forest Inventory and Planning Institute
GLAS	Geosciences Laser Altimeter System
GMS	The Greater Mekong Subregion
GOFC-GOLD	Global Observation of Forest and Land Cover Dynamics
HS	Highly Satisfactory
ICESat	Ice, Cloud and land Elevation Satellite (NASA)
IFRIT	Institute of Forest Resources Information and Techniques
IA	Implementing Agency
IPCC	Inter-governmental Panel on Climate Change
LANDSAT	Land Remote-Sensing Satellite (NASA)
LiDAR	Light Detection and Ranging
LULC	Land Use Land Cover
M&E	Monitoring and Evaluation
MERIS	Medium Resolution Imaging Spectrometer (Europe)
MODIS	Moderate Resolution Imaging Spectroradiometer (NASA)
MRV	Monitoring, Reporting and Verification
MTE	Mid-Term Evaluation
NGO	Non-Governmental Organization
PALSAR	Phase Array type L-band Synthetic Aperture Radar
PDR	Peoples Democratic Republic
REDD+	Reducing Emissions from Deforestation and Degradation
S	Satisfactory
TE	Terminal Evaluation
TM	Thematic Mapper

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EXECUTIVE SUMMARY

This terminal evaluation (TE) report provides a comprehensive assessment of the achievements of the APFNet-funded demonstration project *Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia* from September, 2011 to February, 2014. The demonstration project has largely been completed; the few remaining tasks are expected to be completed within two months.

The TE Team's overall conclusion is that the project was technically sound and implemented and managed in a good manner. The project was completed with cost efficiency by highly qualified and experienced staff and consultants, and with the full involvement of the EA and all the economies in the GMS and Malaysia. There were some project shortcomings, including gaps in project formulation, inconsistency of definition of terms (such as, "forest" and "deforestation") between the EA and the IAs, limited training of IAs in carbon stock modeling and mapping, and long delays in project approval by Myanmar resulting in dropping of biomass field sampling in that economy.

All the project objectives were successfully achieved:

1. Developed a framework and methods for forest mapping and carbon estimation using remote sensing technology.
2. Produced forest cover change maps from 2005 to 2010 and a forest carbon storage map.
3. Enhanced institutional capacity in GMS and Malaysia to perform forest mapping and assessment.

All the project outputs were satisfactorily achieved and well documented:

1. Remote sensing database (Highly Satisfactory).
2. National-institute-owned ground truth database (Highly Satisfactory).
3. Annual forest cover maps at coarse resolution (300~500m) during 2005～2010 with accuracy at least 80%. (Satisfactory).
4. Regional and national forest cover maps at mid-resolution (30m) in 2005 and 2010 with accuracy at least 80% (Satisfactory).
5. Forest carbon storage map at coarse resolution (~300m) of ～2005 (Satisfactory).
6. Staff in the economies were trained in forest cover mapping and biomass field sampling (Highly Satisfactory).
7. Analysis reports of forest coverage and carbon stock (Satisfactory).

The project overall rating is shown in the table below (rating "HS/4" means *very good* with minor shortcomings or risks, and "HS/3" means *good* with moderate shortcomings or risks):

Criterion	*Evaluators' rating*	*Evaluators' Brief Justification*
Relevance of Project Design	HS/4	The project design was highly relevant to contributing to conservation of biodiversity within GMS and Malaysia and globally, and to APFNet's monitoring of progress towards its 2020 forest cover (and associated carbon stocks) objectives, as discussed in Sections 3.1 and 3.4.
Efficiency	HS/4	The project approach of utilizing existing remote sensing technology and data, combined with limited ground field sampling and human intervention, was cost-effective. There were minor shortcomings as discussed in Sections 3.2 and 3.3.
Effectiveness	HS/4	The project was effective in achieving the project objectives and outputs. There were minor shortcomings as discussed in Section 3.3.
Impacts	S/3	The project has had few immediate significant impacts. It shall, however, in the long-term contribute significantly to biodiversity conservation in the GMS and Malaysia, and APFNet 2020 forest-cover objective monitoring, as discussed in Section 3.5.
Sustainability and Duplicability	S/3	There are moderate risks to project sustainability (as discussed in Section 3.6), especially if no follow-up action is taken after project completion. Duplicability is moderately likely as discussed in Section 3.6.
Overall Score	3-4	

The TE Team recommendations are as follows:

1. The EA and IAs should complete all the remaining tasks outlined in Table 1, including finalizing project maps and reports and financial audits, and post them on the project's website as soon as possible.
2. The IAs should conduct workshops in each economy to disseminate the project results and build support among policy makers and other stakeholders in their respective economies.
3. The EA should coordinate efforts to seek funds for duplicating the methods and procedures developed through this project for mapping forest carbon stock in neighboring tropical economies. The results would particularly contribute to transboundary biodiversity conservation efforts.
4. The economies should consider linking the project results with other relevant national initiatives, in particular the REDD+ MRV projects (where they exist or are planned). This would increase the utility of the project results and increase likelihood of project sustainability.
5. The EA and IAs should identify and prioritize the needed follow-up activities for the establishment of a regional forest cover monitoring network, and develop a plan for funding and implementing these activities. The envisaged forest cover monitoring network, which was initially proposed by some of the IAs, would help

sustain the project impacts in the region, and build upon the forest cover and carbon stock mapping approach from this project, by:

a. Developing virtual training methods and conducting training (especially in carbon stock mapping).
b. Acting as an information clearinghouse and experience sharing centre.
c. Harmonizing forest cover and carbon stock classification systems and methods.
d. Updating forest monitoring methodologies and guidelines, to include emerging remote sensing technologies.

Key lessons gleaned from this project include:

1. Ensure project scale and scope is consistent with the allocated time frame. The initial time frame allocation for this project was too ambitious.
2. Early consultation with project partners and stakeholders helps to ensure support and timely approval of project activities. A lot of prior consultation took place in this project, as reported by several IAs.
3. Project indicators should be carefully selected, specifying the quantity and quality of deliverables in the logframe. Many of the indicators stated in this project were vague.
4. Allocate adequate time for fieldwork as part of risk management for bad weather and natural disasters. Several IAs reported field work delays and difficulties due to bad weather.
5. Allocate adequate time for processing documents for project approval to reduce risk of project delays. The approval process caused long delays in starting projects in Cambodia and Myanmar, and cancellation of the field work in Myanmar.
6. Forest cover and carbon storage mapping can be effectively done through multi-agency, multi-economy cooperation and implementation. However, projects with many implementing agencies require EAs with good coordination and management skills and experience, and a well-designed monitoring and evaluation system. The IFRIT performed an excellent job coordinating the project with eight IAs and four other partners, and developed a good monitoring system for the project. In addition, the IAs also had their own internal project monitoring systems.

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1. INTRODUCTION

1.1 Background

This report is concerned with the terminal evaluation (TE) of the APFNet-funded demonstration project *Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia* [Project ID: 2011P2/6-CAF]. The TE aims to assess whether the project goals and objectives have been met effectively, whether an extension is needed, and how the achievements can be sustained. This report includes the TE findings, lessons learned and recommendations for improving future duplication of the project approach for other types of similar projects or in other economies in the region.

This project was officially launched in September, 2011, and completed in February, 2014. The Project area covers the economies of the Greater Mekong Subregion (GMS) and Malaysia. The GMS economies included Cambodia, the People's Republic of China (Guangxi Autonamous Region and Yunnan province), Laos People's Democratic Republic, Myanmar, Thailand and Viet Nam. The Project area is rich in forest resouces and biodiversity, but has been undergoing rapid changes due to human interventions. There is, therefore, a need to monitor the state of these resources, carbon sequestration, and the results of forest program implementation.

The primary goal of this project was to estimate forest coverage and carbon storage in the GMS and Malaysia. The Project main objectives were (based on the Project Logical Framework Matrix):

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 carbon storage map.
3. Enhance institutional capacity in GMS and Malaysia to perform forest mapping and assessment.

The overall approach to achieving these objectives involved making intensive use of recent satellite remote sensing technology, establishing forest cover maps, documenting change processes and estimating carbon storage in the GMS and Malaysia. The expected Project outputs were:

1. Remote sensing database.
2. National-institute-owned ground truth database.
3. Annual forest map product at coarse resolution (300~500m) during 2005～2010.
4. Mid-resolution (30m) forest map product in 2005 and 2010.
5. Forest carbon storage mapping product (300m) of 2005.
6. Training and progress workshops.
7. Analysis report of forest coverage and carbon storage in each of the GMS economies and Malaysia.

The Project Executing Agency (EA) was the Institute of Forest Resources Information Techniques (IFRIT), Chinese Academy of Forestry (CAF), China. The Implementing Agencies (IAs) were:

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

Other project partners included:

- Asian Institute of Technology (AIT), Thailand
- Department of Geography, University of Maryland, USA
- Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD)
- US Geological Survey (USGS)

According to the Project Proposal, the main users (stakeholders) of the project delivarables are economies in the GMS and Malaysia, and organizations interested in the region. These include the scientific community, policy makers of each of the economies' forestry and/or environment agencies, education community, commercial companies, and international or regional organizations.

1.2 Terms of Reference

This TE report was prepared by a two-person TE Team under contract to APFNet. The TE Team members were Dr. A. Y. Omule (Lead Consultant), a Canadian independent consultant based in Bangkok, Thailand, and Dr. Prof. Liu Jian (Local Consultant) of the National Satellite Meteorological Centre, China Meteorological Administration, Beijing, China. The report follows the contract terms of reference (Annex 1), and the APFNet monitoring and evaluation guidelines (www.apfnet.cn). It is based on several documents (Annex 3), which include project background documents provided by Mr. Huang Kebiao of APFNet, and completion and technical reports and presentations and discussions by the EA and IAs at the Project Completion Workshop held in June 19-20, 2014 in Beijing, China.

2. EVALUATION DESIGN AND IMPLEMENTATION

2.1 Data Collection

The TE Team made an objective and independent evaluation, following the TE Plan prepared by the Lead Consultant and evaluation program (Annex 2). The evaluation tools used by the TE Team were:

1. *Evaluation Guide* consisting of set of questions covering the criteria of relevance, effectiveness, efficiency, impact, sustainability, and reproducibility. This served as a general guide during data collection and rating by the TE Team (Annex 4).
2. *Project Documentation* (Annex 3).
3. *Project Logframe* to verify completion of the planned project activities and outputs, including sample forest cover maps, forest cover change maps, and forest carbon stock maps (Project Proposal).
4. *Self-administered Questionnaires* (Annex 5) to assess enhancement of institutional capacity for mapping, and assess project impacts, lessons learned. There were only two respondents to the questionnaires. However, the required information was obtained during the Project Completion Workshop held in Beijing in June 17-20, 2014.
5. *Project Completion Workshop* attendance to collect data for the evaluation. The workshop was held in Beijing, China, and attended by representatives from the APFNet, the Executing Agency, and Implementing Agencies.

2.2 Data Analysis

Following the APFNet project evaluation guidelines, the Outputs achievements were rated using APFNet's rating scheme for evaluating project achievements and outcomes, i.e., Highly Satisfactory (4), Satisfactory (3), Moderate (2), Unsatisfactory (1), and Highly Unsatisfactory (0). As well, using the same rating scheme, an overall rating table of project performance (Relevance, Efficiency, Effectiveness, Impacts, and Sustainability and Duplicability) and a brief justification for the rating was prepared. Most notable strengths to build upon, as well as weaknesses, were also identified.

3. ANALYSIS AND FINDINGS

3.1 Design

The overall project design was logical, reasonable and practical. The project logical framework matrix (logframe), outlining the project goal, objectives, indicators, means of verification and assumptions, was well designed. Some observations on the logframe are as follows:

- Project objectives were stated in the logframe, however, a different version of the project objectives appeared in subsequent documents; this caused some confusion. For this evaluation, the TE Team used the objectives as stated in the logframe (Section 1).
- Indicators to monitor and evaluate achievement of goals, objectives, outputs and activities were provided. Some of these indicators, however, did not specify the quantity, quality and timeframe of the deliverables. For example, there was no indication of the target number and qualification of staff to be trained (Objective 3, Output 6).

The project approach of using satellite remote sensing technology with typical ground field sampling, establishing regional forest cover maps, documenting forest cover changes and estimating carbon stock, was appropriate.

The Project was relatively large in scope. It covered an area of approximately 317,242,000 ha, of which approximately 50% was forest, and included several economies. According to the Project Proposal, the planned project overall total budget (EA and IAs) was US$1,266,900, of which US$1,028,800 was APFNet grant, and the remainder counter-part contribution. However, the actual overall total budget expenditures of the APFNet and counter-parts are not yet available; the EA is expected to compile these expenditures.

3.2 Implementation and Management

Project management and administration was satisfactory, despite the involvement of many project IAs and partners. The EA, IA and other Partnership arrangements were well coordinated and managed by the EA, with full cooperation from the IAs and other partners. Highly qualified and experienced project technical expertise in remote sensing and forest inventory was abundant within the EA and the IAs, and this was augmented by a limited number of outside consultants. Additional observations on the project implementation and management are as follows:

- Start-up – The project officially lasted two and half years, six months more than originally planned. Project start-ups varied among the implementing agencies, mainly due to delays in project approval by the different economies. For example, Myanmar only started the project in 2013. Thus, it has been unable to complete some project activities (field biomass data collection for carbon mapping).

- Overall work planning – This was generally sound. However, the project initial term of two years was too ambitious for a project of this magnitude.
- Project finances – The project budget by APFNet of $1,028,800 was appropriate, as was the way it was allocated to various IAs, roughly the same amount for each participating economy. There were some delays in disbursing funds from APFNet to the EA; these delays should have been minimized. Financial statements reported by the IAs and EA in the project Completion Reports appear reasonable, although most of them are unaudited.
- Monitoring and evaluation (M&E) – The M&E was well designed and implemented. Monitoring was done by the EA and by the individual IAs. The EA monitoring was done through progress reports submitted by the IAs to the EA, and regular progress meetings involving the EA, all the IAs and APFNet. The EA also made written report to APFNet every quarter. A mid-term evaluation (MTE) was conducted in December 2012, after the project had been under implementation for about one year. The MTE recommended that the project term be extended for six months from September 1, 2013 to 28 February 2014, to allow time for Myanmar and Cambodia to seek approval from relevant authorities in their economies. APFNet approved the project extension, with no additional funding. This was a good example of adaptive management.

Overall, the demonstration project has been implemented and managed with cost efficiency. Project Completion and Technical Reports, including forest cover and carbon stock preliminary maps, as well as forest cover mapping and field sampling guidelines, have been prepared by the EA and IAs. It remains for the EA and IAs to submit the final maps. The large volume and quality of project documentation shows that both the EA and IAs put in tremendous amount of time and effort into this project.

3.3 Effectiveness and Efficiency

Achievement of Project Objectives

The project was designed and implemented efficiently, with active participation of the EA and all IAs. It was effective in achieving the project objectives:

- Mapping methodology: developed methods for forest mapping and carbon estimation using remote sensing technology;
- Forest cover and carbon storage mapping: produced accurate regional and individual economy forest cover snap-shot and change maps, and regional forest carbon storage distribution map.
- Capacity building: provided training in the short-term, but the capacity to meet the medium to long-term training needs is uncertain. Also, there was no hands-on training in forest carbon modeling, estimation and mapping.

Overall, the project approach was cost-effective by utilizing remote sensing technology and limited ground sampling and minor human intervention.

Achievement of Project Outputs

All the project outputs were achieved successfully, and they are well documented in technical reports by the EA and IAs. The TE Team's overall evaluation of how well the project outputs were achieved, using the APFNet rating scale, is summarized below by output.

1. Remote sensing database

The EA assembled and processed imageries from Landsat TM/ETM+, MODIS and RapidEye. A remote sensing database was created and made available to different users involved in the project through external hard drives and the project website http://www.apfrm.net/. Fine-resolution test sites for mapping small areas using RapidEye and SPOT were also established in the economies; these data provided ground-truth data.

Evaluation: Highly Satisfactory.

2. National-institute-owned ground-truth database

The EA designed a distributed database structure and standards for the ground-truth (reference) data, and each IA followed these standards to collect the ground-truth data within their jurisdictions. The database contents included previous and current land cover maps, field measurements, and forest inventories. These databases were archived and distributed in each IA with same data structure and data access portal. They provide fundamental training and validation data for the project remote sensing products.

Evaluation: Highly Satisfactory.

3. Mid-resolution (30 m) forest maps in 2005 and 2010

Accurate (> 80%) forest cover maps in the GMS and Malaysia were produced by the EA (overall GMS and Malaysia map) and by the IAs (individual economies), at mid-resolution of 30 m in ~2005 and ~2010, and the change between ~2005 and ~2010, using Landsat TM/ETM+ and IRS LISS data. The forest cover classification was based on a land use and land cover (LULC) classification system developed specifically for the project. It had four levels, and the minimum requirement was Level II. The IAs followed the standard classification system and augmenting it with additional information of their interest. However, some economies used different definition of forest; the project mid-term evaluation raised this issue as well. For example, Myanmar used elevation, and not percent forest cover, to classify forests because of the gradual change in forest cover. The method of forest cover classification was, however, flexible and depended on the IA's preference. The produced forest cover and carbon stock maps were on display during the project Completion workshop, and the atlas provided in the Technical Report (Annex 3).

Evaluation: Satisfactory. Definition of "forest" used in some economies was different

from the Project definition. Map accuracy statistics (User's Accuracy, Kappa statistic) were provided; however, standard errors and tests for statistical significance of the Kappa statistic were not reported. Map accuracy statements give a level of comfort to the map users, thus, it is important to report their precision. Validation results in most cases did not include explanations as to why accuracy levels were very low for some classes, e.g., satellite angle changes. Discussion of the driving-forces of the forest cover changes between 2005 and 2010 was general, and the presentations should have included a change matrix in addition to the change maps. Definitions of some terms, such as "forest", forest cover classification" and "deforestation" were not consistent among the IAs.

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

Accurate annual maps (overall accuracy > 85%) were produced by the EA for the GMS and Malaysia using MODIS at coarse resolution of 500 m every year during 2005～2010, for the overall project area. These annual forest coverage maps were used to explore how the forests changed annually by economy in the GMS and Malaysia.

Evaluation: Highly Satisfactory.

5. *Forest carbon storage map (300m resolution) of 2005*

The EA prepared a preliminary forest carbon storage map in the GMS and Malaysia using ICESat GLAS, Landsat, MODIS, MERIS and PALSAR data at coarse resolution of 300 m in the epoch of 2005. The mapping involved calibrating space borne Lidar biomass estimates with ground-based biomass estimates, fused with remote sensing imagery, and converting the above-ground tree biomass into carbon stock estimates using the IPCC guidelines conversion factor (0.5). The ground field data to calculate biomass were collected by the IAs. This wall-to-wall forest carbon baseline map was used to analyze forest quality and its distribution in the GMS and Malaysia. The Myanmar field biomass data were not collected due to Project late start-up in this economy. The preliminary carbon storage map data were compared with the FAO FRA2010 reference data, and the two data sources appeared generally comparable.

Evaluation: Satisfactory. The EA shall produce a final carbon storage map after further validation and integration of updated information from the IAs. The field data should be re-compiled to remove trees below the specified tree diameter limit (5.0 cm). Some economies used different tree diameter limits, presumably to meet their needs as well. While the IAs collected field data, they did not have hands-on experience with the carbon stock mapping.

6. *Training & progress workshops*

The EA organized six training and progress workshops during the implementation of the project. They focused on progress reporting, exchange of experiences, and training courses on remote sensing data processing, forest mapping, and forest biomass/carbon estimation. Lists of training workshops participants and training materials are posted on

the project website.

Evaluation: Highly Satisfactory. The training workshops were conducted well, with adequate documentation of training materials. There were opportunities for exchange of experiences and knowledge among the project participants during the regular project progress meetings. Virtual training could be considered in the future, to access more audience.

7. Analysis report of forest coverage and carbon storage in each GMS economies and Malaysia

The EA and IAs produced forest resource analysis reports based on the map products for each GMS economy and Malaysia. These reports, which were part of Outputs 3, 4 and 5, emphasized how the forest coverages changed in time and space, and the forest carbon storage distribution. These reports are contained in the project Completion and Technical Reports. This information can be used by APFNet for monitoring progress toward its 2020 forest cover (and associated carbon stocks) objectives.

Evaluation: Satisfactory. Data limitations, such as differences in definitions, should be included in all the reports produced.

Outstanding Tasks

Tasks remaining to be completed by the EA and IAs, and remaining project APFNet budget balance, are outlined in Table 1.

Table 1. Outstanding tasks for the EA and IAs.

Economy	*Outstanding tasks*	*APFNet budget*
IFRIT	1. Final Map and Validation of forest carbon stock. 2. Compile project actual total expenditure (EA and IAs) of APFNet and counter-part contributions.	Project balance US$129,276.
Cambodia	1. Final mid-resolution forest-cover maps. 2. Financial audit.	Project balance US$14,330.
Quangxi Autonamous Region(China)	1. Financial audit.	Project balance US$0.
Laos	1. Provide budget statement. 2. Financial audit.	Budget statement not available.
Malaysia	1. Accuracy assessment of Sabah and Sarawak portions of the Malaysia forest cover map. 2. Re-compile field biomass data to exclude trees < 5 cm DBH.	Project balance US$432.
Myanmar	1. Field biomass sampling, and test sites for fine resolution mapping. 2. Financial audit.	Project start delayed; balance US$50,000.
Thailand	1. Financial audit.	Project unaudited US$43,585 (to August 2013).
Viet Nam	1. Financial audit.	Project unaudited balance US$3,500.
Yunnan province (China)	1. Correct mistakes found in misclassification of crop land and forest land. 2. Financial audit.	Project balance US$3000 proposed to used for publication and dissemination of results

3.4 Relevance

The project was timely and highly relevant to conservation of biodiversity within GMS and Malaysia and globally. It provided initial forest cover monitoring information, to assess how, where and when forest cover changed in the GMS and Malaysia, and baseline information for monitoring forest carbon stock for the region. This information can be used by APFNet to monitor progress towards its 2020 forest cover (and associated carbon stocks) objectives. The project provided relevant experiences for other similar projects in the future, as documented in the project Completion Reports.

3.5 Impacts

The TE Team has no immediate evidence to suggest any positive or negative long-term project impacts on social, economic or environmental aspects. However, in the long-term, the project can be highly effective in contributing to biodiversity conservation and APFNet monitoring of its 2020 forest cover objective in the GMS and Malaysian economies and globally. Guidelines for forest cover and carbon stock mapping in the region are available. Meanwhile, in the short-term, the information from the project is already being used in some economies. For example, in the Guangxi province, the forest cover maps are being used by the Forest Department of Guangxi to prepare management plans, and by researchers as reference data. The potential impact of the project's carbon distribution and estimates for REDD+ MRV (monitoring, reporting and verification) requirements has been highlighted by several economies, including Cambodia, Laos and Myanmar.

The project has also helped strengthen the relationships among various agencies within the economies. Documented examples of this are between FRIM and the Forest Department in Malaysia and between the Faculty of Forestry, National University of Laos and the forestry sector in Laos. These strengthened relationships have an impact on future implementation of similar projects.

The future directions for the project are currently being discussed by the EA, IAs and APFNet.

3.6 Sustainability and Duplicability

The project results are likely sustainable. The reasons for this include:

1. Awareness level has been significantly raised within the economies regarding the potential use of the project products to meet their provincial, national and international obligations.
2. Forest cover maps were prepared by agencies within the economies using mostly existing infrastructure and in-house staff.
3. The project is already built into existing national initiatives in some economies, such as REDD+ MRV

However, we are unable to assess socio-political risks, and the level of continuous commitment of financial resources to forest cover and carbon monitoring by the economies in the region.

The project experiences have been documented sufficiently to enable duplication elsewhere in the region. This is apparent as several economies were able to locally implement the project with little technical difficulty. As well, the project is disseminating the project results widely through its website and other means. Malaysia is proposing to duplicate the project in the economies of Indonesia and Brunei (with which it shares borders), if funding is available. This would be useful for Malaysia for transboundary

biodiversity conservation. It is anticipated that each implementing agency will play an important role to ensure the project sustainability beyond the project life span. The results from this project will continue to be useful for forest monitoring.

3.7 Dissemination

The outputs and findings from this project have already been disseminated to the various interested stakeholders. Some of the project findings and outputs have been or will be published in the form of a technical book, graduate student theses, 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. In addition to these efforts, workshops should be conducted within each economy to disseminate the project results and to build support for the project from the policy decision-makers and other stakeholders (e.g., NGOs). Several project documents can be found in the project's website (www.apfrm.net).

4. RESULTS AND CONCLUSIONS

4.1 Results

The TE Team's overall evaluation findings, based on the APFNet evaluation rating and score format, are summarized in Table 2. The project design, effectiveness, efficiency, impact, sustainability, and duplicability results were discussed in detail earlier in Section 3.

Table 2. Project overall rating table. Rating "HS/4" means *very good* with minor shortcomings or risks, and "HS/3" means *good* with moderate shortcomings or risks.

Criterion	*Evaluators' rating*	*Evaluators' Brief Justification*
Relevance of Project Design	HS/4	The project design was highly relevant to contributing to conservation of biodiversity within GMS and Malaysia and globally, and to APFNet to monitor progress towards its 2020 forest cover (and associated carbon stocks) objectives, as discussed in Sections 3.1 and 3.4.
Efficiency	HS/4	Overall, the project approach of utilizing existing remote sensing technology and data, combined with limited ground field sampling and human intervention, was cost-effective. There were minor shortcomings as discussed in Sections 3.2 and 3.3.
Effectiveness	HS/4	The project was effective in achieving the project objectives and outputs. There were minor shortcomings as discussed in Section 3.3.
Impacts	S/3	The project has had some short-term significant impacts, and will in the long-term contribute significantly to biodiversity conservation as discussed in Section 3.5. However, it remains to be seen if financial and political risks to achieving the long-term goals are significant or not.
Sustainability and Duplicability	S/3	There are moderate risks of project sustainability (as discussed in Section 3.6), especially if no follow-up action is taken after project completion. Duplicability is moderately likely as discussed in Section 3.6.
Overall Score	3-4	

4.2 Conclusions

Overall, the project has been implemented in a good manner. The project objectives have been successfully achieved, with the full involvement of the EA and all the participating economies in the GMS and Malaysia. The project outputs were well documented (Section 3). There were some project shortcomings, including gaps in

project formulation, inconsistency of definition of terms such as “forest”, “forest cover classification” and “deforestation” between the EA and the IAs, limited training of IAs in carbon stock modeling and mapping, and delays in project approval by Myanmar resulting in dropping of biomass field sampling in that economy.

This demonstration project developed methods and guidelines for forest cover and carbon stock mapping, and produced a series of maps depicting forest cover and change and carbon stock in the GMS and Malaysia. This highly relevant project will in the future contribute significantly to biodiversity conservation efforts and sustainable forest management in the GMS and Malaysia and globally, and APFNet’s 2020 forest cover objective monitoring, by providing forest cover and carbon monitoring methodology and information.

5. RECOMMENDATIONS AND LESSONS LEARNT

5.1 Recommendations

The TE Team recommendations are as follows:

1. The EA and IAs should complete all the remaining tasks outlined in Table 1, including completion of project maps and reports and financial audits, and post them on the project's website as soon as possible.
2. The IAs should conduct workshops in each economy to disseminate the project results and build support among policy makers and other stakeholders in their respective economies.
3. The Executing EA should coordinate efforts to seek funds for duplicating the methods and procedures developed through this project for mapping forest carbon stock in neighboring tropical economies. The results would particularly contribute to transboundary biodiversity conservation efforts.
4. The economies should consider linking the project results with other relevant national initiatives, in particular the REDD+ MRV projects (whey they exist or are planned). This would increase the utility of the project results and increase the likelihood of project sustainability.
5. The EA should identify and prioritize the needed follow-up activities for the establishment of a regional forest cover monitoring network, and develop a plan for implementing these activities. The proposed forest cover monitoring network, which was initially proposed by some of the IAs, would help sustain the project impact in the region, and build upon the forest cover and carbon stock mapping approach from this project, by:
    a. Developing virtual training methods and conducting training (especially in carbon stock mapping).
    b. Acting as an information clearinghouse and experience sharing centre.
    c. Harmonizing forest cover and carbon stock classification systems and methods.
    d. Updating forest cover monitoring methodologies and guidelines, to include emerging remote sensing technologies.

5.2 Lessons learnt

Key lessons gleaned from this project include:

1. Ensure project scale and scope is consistent with the allocated time frame. The initial time frame allocation for this project was too ambitious.
2. Early consultation with project partners and stakeholders helps to ensure support and timely approval of project activities. A lot of prior consultation took place in this project, as reported by several IAs.
3. Project indicators should be carefully selected, specify the quantity and quality of deliverables in the logframe. Many of the indicators stated in this project were vague.

4. Allocate adequate time for fieldwork as part of risk management for bad weather and natural disasters. Several IAs reported field work delays and difficulties due to bad weather.
5. Allocate adequate time for processing documents for project approval to reduce risk of project delays. The approval process caused long delays in starting projects in Cambodia and Myanmar, and cancellation of the field work in Myanmar.
6. Forest cover and carbon storage mapping can be efficiently done through multi-agency, multi-economy cooperation and participation. However, projects with many implementing agencies require EAs with good coordination and management skills and experience, and a well-designed monitoring and evaluation system. The IFRIT performed an excellent job coordinating the project with eight IAs and four other partners, and developed a good monitoring system for the project. In addition, the IAs also had their own internal project monitoring systems.

ANNEX 1: TERMINAL EVALUATION TEAM TERMS OF REFERENCE

1. Background

The project *Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia [Project ID: 2011P2/6-CAF]*, officially launched in September, 2011, aims to develop a framework and methods for forest mapping and carbon estimation in the regional scale by using optical and radar remote sensing technology. 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 general objectives of the project are:

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

The outputs of the project are as follows:

- Annual forest map product at coarse resolution (300~500m) during 2005~2010;
- Mid-resolution (30m) forest map product in 2005 and 2010;
- Forest carbon storage mapping product (300~500m) of 2005;
- The analysis report of forest coverage and carbon storage in each GMS economies and Malaysia.

APFNet has granted US$1,028,800 among the total budget of S$1,538,550 to support the 30-months project, and terminal evaluation (TE) will be executed by an expert team to provide a comprehensive assessment of the achievement of the project from September 1, 2011 to February 31, 2014.

2. Responsibilities and tasks

1. Development of TE Plan as the foundation for evaluation in team work and consulting with APFNet and Executing Agency (before May 20, 2014);
2. Conduction of evaluation, including desk work, attending the TE meeting in Beijing, China in first half of June 2014, interviews with project stakeholders and executing partners, to acquire information and data in terms of the results and issues encountered;
3. Development and dissemination evaluation result by July 15, 2014.

3. Duration

The consultant will be engaged immediately upon the completion of the selection procedure, and expected to complete the mission in a maximum of 8 working days. A

visit to Beijing, China is needed in first half of June 2014 to meet with project stakeholders to evaluate the real situation of the project.

4. The expected outputs

An evaluation plan with

- Role and responsibility of TE team and specific tasks for each TE team member
- Clear evaluation scope (what is to be assessed)
- Evaluation criteria indicators (according what to assess)
- Proper methods & approaches of collecting & analyzing data (based on what to and how to assess)
- Other supporting documents (such as questionnaire, scoring sheets, etc.)

Terminal evaluation report with

- Findings;
- Lessons learned and recommendations for improvement, including recommendations for the revision of project strategy, approach, outputs and activities, if necessary;
- Recommendations for a strategy for future replication of the project approach for other types of projects, for other economies in the region;
- Description of best practices in a certain area of particular importance for the project;
- Supporting documents developed for the evaluation.

5. Evaluation cost

APFNet will pay the consultant for the service with equivalent of US$400 (four hundred US dollars only) per day before tax. The fee will be paid, based on the actual working days, to the bank account provided by the Consultant. Tax will be deducted by APFNet from the Consultant's remuneration in accordance with Tax Regulation in China.

ANNEX 2: EVALUATION PROGRAMME

The total duration of the terminal evaluation was 8 days, and conducted according to the following proposed schedule:

Activity	*Approximate Duration (days)*	*Completion Date*	*Consultant*
1. Preparation: Prepare draft and final TE Plan	1	May 20, 2014	Dr. A.Y. Omule
2. Preparation: Desk review of project documents	1	May 20, 2014	Dr. A.Y. Omule & Dr. Liu Jian
3. Evaluation: Send out via email interview questionnaires to the Training workshop participants and EA and GMS and Malaysia focal points	0.5	May 30, 2014	Dr. A.Y. Omule
4. Evaluation: Travel from Bangkok to Beijing for the TE workshop		June 18, 2014	Dr. A.Y. Omule
5. Evaluation: Attend the TE workshop in Beijing, China	2	June 19-20, 2014	Dr. A.Y. Omule & Dr. Liu Jian
6. Evaluation: Travel back to Bangkok from Beijing		June 21, 2014	
7. Evaluation: Follow-up on workshop questions via email	0.5	June 21-26, 2014	Dr. A.Y. Omule
8. Draft report: Prepare draft TE report	2.5	July 4, 2014	Dr. A.Y. Omule
	1.5	July 4, 2014	Dr. Liu Jian
9. Review: Draft report review by APFNet, EA, and GMS and Malaysia focal points		July 7-18, 2014	Dr. A.Y. Omule & Dr. Liu Jian
10. Final report: Prepare final TE report	0.5	July 21, 2014	Dr. A.Y. Omule & Dr. Liu Jian

ANNEX 3: REFERENCE DOCUMENTS

TE Team reviewed the following documents as part of the terminal evaluation:

1. APFNet. 2013. APFNet Manual for Project Identification, Implementation and Management (PIIM)" (attachment: "Guidelines for APFNet Project Monitoring and Evaluation") available from the project website www.apfrm.net.
2. China Audit International Certified Public Accountants Co., Ltd. 2014. Special Audit Report for Asia-Pacific Network for Sustainable Forest Management and Rehabilitation. Audited Subject No.: APFNet/2011/PA/004.
3. IFRIT and IAs. 2014. Completion Report *Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia* project.
4. IFRIT and IAs. 2014. Technical Report *Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia* project.
5. IFRIT. 2011. Proposal for project *Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia* project.
6. IFRIT and IAs. 2011. Overall work plan for project *Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia project*.
7. IFRIT and IAs. 2011. Annual work plan for project *Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia* project.
8. IFRIT and IAs. 2013. Annual work plan for project *Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia* project.
9. Omule, A.Y. 2014. Terminal Evaluation plan for the APFNet-funded project *Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia.*
10. Wu Guonxiang and Suwit Ongsomwang. 2012. Midterm Evaluation Report *Forest Cover and Carbon Mapping in the Greater Mekong Subregion and Malaysia* project September, 2011 - August 2012.
11. Training and progress report workshops documentation, available on the project website (www.apfrm.net).

ANNEX 4: EVALUATION GUIDE

A proposed evaluation guide, showing the evaluation criteria and sample questions, which is to be used by the TE Team, is shown below.

Criteria	*Example Questions*
Relevance	1. Is the project relevant to APFnet thematic forest cover 2020 monitoring objectives? 2. Did the project addressing the needs of target beneficiaries at the sub-regional and national levels? 3. Does the project provide relevant lessons and experiences for other similar projects in the future?
Effectiveness	1. Has the project been effective in achieving the expected objectives and outcomes, given the budget, timeframe, institutional partners and individual economy realities? 2. How were risks and risk mitigation managed? 3. What lessons and experiences can be drawn in regard to effectives for other similar projects in the future?
Efficiency	1. Was project support provided in an efficient and timely way? 2. How efficient were the partnership arrangements for the project? 3. Did project utilize local capacity in implementation? 4. What lessons and experiences can be drawn in regard to effectives for other similar projects in the future?
Impact	1. How effective is the project in achieving its long-term objective? 2. What are the impacts or likely impacts of the project? 3. What are the future directions for the project results?
Sustainability	1. Were sustainability issues adequately integrated into the project design? 2. Did the project adequately address financial and institutional and capacity development sustainability? 3. Are there significant threats to sustainability?
Duplicability	1. Is there potential to scale up or replicate the project activities? 2. Has project experiences been documented sufficiently to allow for replication? 3. What are the main challenges that may hinder reproducibility effort?

ANNEX 5: SELF-ADMINSTERED QUESTIONNAIRES

A. Questionnaire for Training Workshop participants

Data & Information Needed	*Responses*
1. Were the training workshop objectives met?	
2. Has the project methodology presented in the workshop been adopted by you and your colleagues?	
3. What experiences and skills did you gain at the workshop?	
4. Have training workshop experiences been documented sufficiently to allow sharing with your colleagues?	
5. Any other training workshop benefits?	
6. What were the workshop failures?	

B. Questionnaire for the Executing Agency and the GMS and Malaysia Economy participants

Data & Information Needed	*Responses*
1. What were the implementation difficulties the project faced?	
2. What is the Project impact (e.g., has project methodology been adopted)?	
3. What were the experiences and skills gained by your staff?	
4. What awareness was created?	
5. To what extent were the Project objectives achieved?	
6. How efficient was the project design?	
7. What was the adequacy of funds and funds disbursement by APFNet?	
8. Was there close cooperation with stakeholders	
9. How are the project results being used now to achieve sustainable forest management?	
10. Any other project benefits?	
11. What were the project failures?	