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Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

PROJECT PROPOSAL

To Demonstrate the Development and Application of Standing-Tree Carbon Equations to Improve the Accuracy of Forest-Cover Carbon Stock Estimates in Thailand

Kasetsart University Faculty of Forestry, Bangkok, Thailand

5 June 2015

Project title	**To demonstrate the development and application of standing-tree carbon equations to improve the accuracy of forest-cover carbon stock estimates in Thailand**	
Supervisory agency	**Royal Forest Department, Bangkok, Thailand**	
Executing agency	**Kasetsart University Faculty of Forestry, Bangkok, Thailand**	
Expected project duration: 1/6/2015 to 31/5/2017, 24 months		
Target area: Ngao Demonstration Forest, Lampang Province, Thailand (see Annex B)		
Total budget(USD): $253,345	**Expected APFNet grant(USD): $199,045**	**Conouterpart contribution (USD) (in-kind): $54,300**

Project summary:

(1) Problems to be Addressed:

There is uncertainty in the accuracy of national estimates of Thailand's forest carbon stocks, incomplete reporting of carbon stocks and limited knowledge of the methods and benefits of carbon stocks assessment among the stakeholders. The funding support from APFNet will contribute to building capacity for various governmental agencies to be able to respond to national carbon stock information and international requests. The APFNet shall benefit from information for monitoring progress toward APEC 2020 forest cover objectives (and associated carbon stocks).

(2) Goal and Objective

The overall goal is to provide accurate information on national forest carbon stocks to support informed sustainable forest management policy decision-making and balanced public debate on the benefits of forests in climate change mitigation. The specific objective is to pilot-test the development of accurate standing-tree carbon equations and their application to the preparation of a forest-cover carbon stock map in the Ngao Demonstration Forest, Lampang Province.

(3) Expected Outputs

Output 1: Methodology to construct new tree carbon equations developed and pilot-tested.
Output 2: Application of tree carbon equation to prepare a carbon cover map demonstrated.
Output 3: Action plan to construct and promote national standing-tree carbon equations prepared.
Output 4: Information and knowledge from the project disseminated among stakeholders.

(4) Potential Beneficiaries and Main Stakeholders

The potential target beneficiaries are the government agencies responsible for reporting on carbon stocks, including the Department of National Parks, Wildlife and Plant Conservation (protected forests), the Royal Forest Department (reserved forests and plantations), the Forest Industry Organization of Thailand (plantations), Marine and Coastal Resources Department (mangrove forests), and private land owners. Other main stakeholders include KUFF (the lead forestry agency on research and education in this work), Maejo University, Chiangmai University and Thailand Environment Institute (TEI), who are interested in the information for research and education.

(5) Strategies and Approaches

The proposed approach is to pilot-test the development of equations to estimate tree carbon content as a function of standing tree attributes (total height and DBH). These equations shall be based on non-destructive measurements of tree attributes, including bole volume, DBH, upper stem diameters, and total height, on a sample of standing trees. Several increment cores shall be taken on each sample tree (at 1.3 m height) and core volume and carbon content shall be estimated in the laboratory. The ratio of core carbon content to core volume is used to convert tree bole volume to estimated tree carbon content. The estimated tree carbon content is then related to DBH and height. This pilot project will focus on the major species groups in the pilot area of one or more sectors of Ngao Demonstration Forest (NDF), Lampang Province. A carbon stock map of one or more sectors of the demonstration area shall be prepared to illustrate the application of the tree carbon equations. A focus group meeting shall be held to develop a national action plan to construct and promote national tree-carbon equations. Finally, a national workshop involving about 40 participants from the relevant government and private agencies shall be held to disseminate project information and knowledge.

(6) Key Activities

Output 1: Collect sample tree field data from selected sectors; measure and analyze wood core samples in the laboratory, and measure the core green volume and weight, and determine the oven-dry biomass and carbon content of core samples; construct tree carbon equations; and prepare technical report: The report shall describe the proposed methodology to construct tree biomass equations, including sampling design, data collection and processing, and fitting of the equations.

Output 2: Acquire satellite imagery; model relationship between remote sensing data and ground plot data (from Output 1) and develop preliminary carbon stock map; establish inventory plots on a systematic grid in the selected sector (s) of demonstration area to check carbon stock map; and prepare a carbon-cover map.

Output 3: Establish a focus group meeting; prepare draft action plan; conduct focus-group meeting to develop draft action plan; prepare draft action plan. Output 4: Prepare completion workshop materials; conduct national workshop; prepare project technical reports in English and Thai; prepare manuscripts for publication in refereed journals; **prepare project website and brochure.**
Prepared and Submitted by **(Dr. Khwanchai Duangsathaporn)** Project Proponent Signature on behalf of EA Date Reviewed and Nominated by **(Printing name and title)** Focal Point Signature Date

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ABBREVIATIONS AND ACRONYMS

APFNet:	Asia-Pacific Network for Sustainable Forest Management and Rehabilitation
APR:	Annual Progress Report
DNP:	Department of National Parks, Wildlife and Plant Conservation (Thailand)
DSA:	Daily Subsistence Allowance
FG:	Focus Group
FIO:	Forest Industry Organization of Thailand
GOT:	Government of Thailand
KU:	Kasetart University
KUFF:	Kasetsart University Faculty of Forestry
LTD:	The Laboratory for Tropical Dendrochronology (KUFF)
IPCC:	Intergovernmental Panel on Climate Change
MCRD:	Marine and Coastal Resources Department (Thailand)
MONRE:	Ministry of Natural Resources and Environment (Thailand)
MYR:	Mid-year Report
NESDB:	National Economic and Social development Board
NESDP:	National Economic and Social development Plan
NMPCC:	National Master Plan on Climate Change
NDF:	Ngao Demonstration Forest
NGO:	Non-governmental organization
PD:	Project Director
PMT:	Project Management Team
PSC:	Project Steering Committee
PTC:	Project Technical Committee
REDDE+:	Reducing Deforestation and Forest Degradation and Enhancing Environmental Services
RFD:	Royal Forest Department (Thailand)
SFM:	Sustainable Forest Management
TEI:	Thailand Environment Institute

PROJECT DETAILS

1. BACKGROUND AND RATIONALE

This project proposal expands on the earlier Concept Note. It incorporates the recommendations of the APFNet Project Appraisal Panel **(in bold in text and summarized in Annex F, Appraisal Round 2)**. The proposal originates from the Kasetsart University Faculty of Forestry (KUFF), Bangkok, Thailand. The rationale for this project proposal is that there is uncertainty in the accuracy of national estimates of Thailand's forest-cover carbon stocks, incomplete reporting of carbon stocks and limited knowledge of the methods of carbon stocks assessment among the stakeholders. **This, in turn, affects the national planning and other policy decisions that rely on information on national carbon stocks.**

The carbon stock estimates are inaccurate because the commonly used equations to estimate tree volume are biased (over- or under-estimate tree volume). The bias occurs because (1) the sample trees used to develop the equations was small (because of the need to minimize destructive sampling of trees and lack of instruments to accurately measure standing tree upper stem diameters) and, in some cases, not representative of the country; (2) some of the equations were local volume equations, which used only DBH as the independent variable and did not include tree height; (3) the past equations were focused on areas to be logged (mainly big trees), yet, since the national logging ban, the interested has shifted to protected areas that include smaller trees; and (4) the species grouping was too broad (e.g., volume equations by tree family). The commonly used existing equations are the local tree volume equations developed by Pochai and Nanakorn (1992). These equations developed by the RFD based on upper stem diameter measurements of standing trees using a Spiegel Relascope. However, these equations were developed for one local area in northern Thailand using a small sample of trees. Yet, they are commonly applied nationally. As well, the specific gravity coefficients used to convert volume to biomass were developed based on a small sample of trees. Finally, the generally assumed carbon/biomass **fraction of 0.5 (IPCC 2003), for converting biomass to carbon, is too general. The IPCC indicates that " … higher tier methods may allow for variation with different species, different components of a tree or a stand (stem, roots and leaves) and age of the stand …" (IPCC 2003, page 3.25).**

A new and novel approach has been developed at KUFF to estimate standing tree carbon content as a function of standing tree attributes (total height and DBH), using sample tree increment cores. **Some research has been successfully done by Kasetsart University Faculty of Forestry (KUFF) on ways to directly estimate carbon content on standing trees using wood samples (increment cores) (Duangsathaporn et al. 2011). Other studies have used wood samples to determine carbon content (e.g., Kraenzel, et al. 2003; Wutzler, et al. 2006).** Through this project proposal, Thailand is seeking incremental financial assistance and limited technical support from APFNet to demonstrate this new approach that could be used to develop new national standing-tree carbon equations. These equations could be used to estimate carbon stocks in Thailand's natural forests. This proposal (Phase I) is to pilot-test this process in the Ngao Demonstration Forest in Lampang province. The subsequent Phase II shall be the full-scale development of national carbon equations for all the major tree species groups in Thailand.

The rationale for this project relates to the commitment of the Government of Thailand (GOT) to climate change mitigation ad adaptation. Thailand's policy on climate change is described in the Eleventh National Economic and Social Development Plan (NESDP)

(2012-2016) prepared by National Economic and Social Development Board Office (NESDB) of the Prime Minister's Office, and in the National Master Plan on Climate Change (2010-2019) (NMPCC) prepared by the Ministry of Natural Resources and Environment (MONRE).

The eight key areas of managing natural resources and the environment toward sustainability in the Eleventh National Economic and Social Development Plan (2012-2016) are:

1. **Conserve and create security for natural resource and environmental bases by safeguarding and restoring forest and conservation areas**
2. **Shift the development paradigm and redirect the country to a low-carbon and environmentally friendly economy**
3. **Upgrade the ability to adapt to climate change**
4. **Ensure preparedness to respond to natural disasters**
5. **Foster resilience toward trade measures associated with environmental conditions and climate change impacts**
6. **Enhance the role of the country in international arenas as it relates to environmental framework agreements and international commitments**
7. **Control and reduce pollution**
8. **Enhance the natural resource and environmental management system to be more efficient, transparent and equitable**

The three key areas in the National Master Plan on Climate Change (2010-2019) are:

1. **Capacity building to respond and reduce the impacts of climate change**
2. **Reducing emission of greenhouse gases and increasing carbon sinks upon a basis of sustainable development**
3. **Integrating climate change management**

This proposed project aims to strengthen Thailand's ability to monitor, assess and report on its carbon stocks for better policy decision making and balanced public debate on climate change mitigation and adaptation in Thailand.

This project is linked to these policy initiatives as follows. This project's ultimate main output - new and accurate national standard tree carbon equations – would be used to compile carbon stocks from the national forest inventory and monitoring sample plots. This information, in turn, would improve the quality and coverage of carbon stocks estimates in Thailand's forests, and enable Thailand to meet its national and international reporting commitments related to environmental framework agreements and international commitments. It would also support the monitoring of some aspects of the NESDP and NMPCC, such as checking if carbon stocks are increasing or declining. The APFNet would also benefit from this information for monitoring progress toward APEC 2020 forest cover objectives (and its associated carbon stocks).

Forests play a significant role in the implementation of the government's strategic plan. The government has several stringent laws towards the protection and conservation of forest areas, including the Forest Act (1941), National Park Act (1961), National Reserved Forest Act (1964), Wildlife for Reservation and Protection Act (1992), and Plantation Act (1992). Several government agencies enforce these acts. The Royal Forest Department (RFD) is responsible for community forests and other forests outside protected areas The Department of National Parks, Wildlife and Plant Conservation (DNP) mandate is to conserve, promote and rehabilitate wildlife

and plant species by protecting the original conservation areas and rehabilitating the degraded forest areas. The DNP has developed a master plan related to protecting forests to support climate change mitigation. The Marine and Coastal Resources Department (MCRD) has the authority over the mangrove coastal forests. All these three departments are under the supervision of the Ministry of Natural Resources and Environment (MONRE). Several other agencies also deal with forests, including the Forest Industry Organization of Thailand (FIO), which is a state enterprise also within MONRE.

2. GOAL AND OBJECTIVES

The project overall goal is to provide accurate information on national forest carbon stocks to support informed sustainable forest management policy decision-making and balanced public debate on the benefits of forests in climate change mitigation.

The impact indicators are:

1. By 2020 (when the national tree carbon equations have been developed), DNP, RFD, MRCD and FIO and private landowners (30%) have adopted and are reporting on producing carbon stocks using the new national tree carbon equations and tools.
2. The carbon stock estimates are incorporated into the next national strategic plan on climate change by the MONRE. As well, the carbon stock estimates are included in the RFD and DNP "Flagship" climate change project.

The project specific objective is to demonstrate the development of accurate standing-tree carbon equations and their application to the preparation of a forest-cover carbon stock map in the Ngao Demonstration Forest, Lampang Province, Thailand.

The outcome indicators are:

1. Methodology to construct and apply tree carbon equations is available, and, as a by-product, accurate tree carbon equations for the major species groups in three natural forest types in the pilot project area are available.
2. An action plan for the development of national standing-tree carbon equations for all the major tree_species groups in Thailand is available.
3. Information and knowledge from the pilot project disseminated.

When, ultimately, the Phase II is completed, there shall be new national tree carbon equations that can be used by the stakeholders - RFD, DNP, MRCD and FIO - to produce forest carbon stocks reports, and for teaching and research by the universities and other institutions. This shall result in improved accuracy and coverage of carbon stock estimation and reporting in Thailand's forests and TROF, and, ultimately, lead to better information to guide future SFM policy decision-making and balanced public debate on climate change mitigation.

The primary stakeholders are the DNP and RFD who manage the largest natural forest areas with the most carbon stocks in the country; and **MONRE who require carbon stock information to prepare the National Master Plan on Climate Change.** The secondary stakeholders include the MCRD, FIO, **the National Economic and Social Development Board that requires the carbon stock information to prepare the NESDP,** and KUFF and other universities and research institutions (mainly Maejo University, Chiangmai University, **Mahidol University,** and the Thailand Environment Institute or TEI). The MCRD, TROF land owners and FIO control relatively small natural forest or TROF areas with relatively less carbon stocks. The KUFF and the

other universities and research institutions are primarily interested in information to support research and teaching; they are not directly involved in managing of any large forest areas.

Details of the stakeholder analysis and development of the project overall goal and objectives are given in Annex A. The project logical framework matrix is given in Annex G.

3. OUTPUTS AND STRATEGIC ACTIVITIES

Strategic approaches and methods

The proposed approach is to pilot test the development of equations to estimate tree carbon content in natural forests as a function of standing tree attributes such as total height and DBH. These equations shall be based on non-destructive[1] measurements of tree attributes, including volume, DBH, upper stem diameters, and total height on a sample of standing trees. The tree carbon content shall be estimated based on sample cores taken at 1.3 m height, which is a new approach. This pilot project will focus on the major species groups in the pilot area (Annex B). Stakeholder representatives shall be invited to participate in the field data collection.

A small Focus Group, consisting of the Project Management Team (PMT) about 10 experts selected from the relevant government and private agencies shall be formed to develop an action plan and promote the carbon estimation methodology. The meeting shall review the pilot project results, and develop an action plan for the Phase II project. Then, a national workshop involving about 40 participants from the relevant government and private agencies shall be held to disseminate the project information and knowledge. Technical reports and manuscripts shall be prepared for distribution within Thailand and beyond. **Other activities for disseminating the project's outputs shall include: construction and maintenance of a project website, and preparation of the project brochure.**

Outputs

Output 1: Methodology to construct new tree carbon equations developed and pilot-tested

The methodology shall be outlined in a technical report, which shall be submitted to a scientific journal for possible publication. This report shall describe the methodology to collect the sample tree data, to form tree species groups from the sample data, and to fit regression equations relating above-ground bole tree carbon to standing tree attributes such as total height and DBH by species group. As well, the tree carbon equations in the pilot project area shall be presented. Note that estimation of carbon stocks below ground, in the forest litter, and in tree branches and leaves are not considered because the methodology to be pilot-tested here is not suitable for the estimation of these carbon stock components.

Output 2: Application of tree carbon equation to prepare a carbon cover map demonstrated.

A carbon stock map of the NDF demonstration area (or a portion of it) shall be prepared. This application is currently lacking, and is urgently needed by Thailand to support its REDD+ initiatives.

Output 3: Action plan to construct and promote national tree carbon equations prepared.

A focus group meeting involving the PMT and 10 selected experts shall be held to: 1) review project results, and (2) develop an action plan for the full-scale construction of national standing-tree carbon equations for major tree species in Thailand. Implementation of this action plan shall constitute Phase II of the project, and shall ensure that that the desired project impact

[1] Non-destructive methods have to be used because of the national logging ban in Thailand's natural forests since 1987, and it is difficult to get permission to cut so many trees for research purposes.

is achieved.

Output 4: Information and knowledge from the project disseminated among stakeholders
A national workshop involving about 40 stakeholder representatives shall be conducted to disseminate and share the project information and knowledge.

Activities and inputs
For Output 1:

1. *Collect sample tree field data*: The number of sample trees and species groups sampled shall be determined depending on a pre-survey of the variability of carbon stocks among trees and the available budget. However, a preliminary estimate is approximately a minimum total of 300 trees (at least 5 major species and 15 trees per major species). Construct a sample tree selection matrix (tree species x DBH class), and select sample trees using purposive stratified sampling. Estimate the whole-bole volume, V, of each sample tree based on tree bole upper-stem diameters measured with Wheeler Pentaprism Caliper by 2.5-metre sections up to the first major branch, and Newton's formula. Tree DBH, total height, merchantable height, and bark thickness shall also be recorded. The V excludes wood volume in branches and twigs and leaves. Collect two wood sample cores (or cubic pieces) in the North and East directions using an Increment Borer at 1.3 m height for each sample tree, and measure the wet volume and weight of the sample cores.
2. *Analyze wood core samples in the laboratory*: Measure the core green volume and weight, and determine the oven-dry biomass and carbon content of core samples. Determine the carbon content of the sample cores in the laboratory, and calculate R = the ratio of tree carbon content to wet volume. Estimate the tree carbon content, C, by multiplying the wet volume V in step 2 by R, that is, C = V * R.
3. *Construct tree carbon equations*: Group the major trees species into groups using cluster and discriminant analysis and the sample data, and then fit equations for each species group. Fit the carbon equations: C = *f* (Total Height, DBH) for each major species group in the pilot project area. Compare the new equations with the existing equations, to assess the level of uncertainty (bias and precision) of carbon estimates and to determine the improvements that have been made in the new equations compared to the old in carbon assessment in the pilot area.
4. *Prepare a technical report*: The report shall describe the proposed methodology to construct tree biomass equations, including sampling design, data collection and processing, and fitting of the equations.

For Output 2:

1. *Acquire and classify remote sensing data*. Obtain satellite data from KUFF, RFD or DNP.
2. *Model relationships between the ground and remote sensing data*. Acquire various GIS layers of secondary data combined with the ground and remote sensing data to develop regression relationships between satellite data and ground data (from Output 1). Prepare a preliminary carbon stock map.
3. *Collect and compile ground mapping data*. Establish sample plots in the selected sector(s) of the demonstration area. Determine the accuracy of the carbon stock map using the ground plot estimates. *Prepare a technical report*. The report shall describe the remote sensing methodologies applied and the mapping method. It shall include the final carbon map for the demonstration area.
4. *Prepare final carbon stock map and technical report*

For Output 3:

1. *Select Focus Group members.* The Project Director shall seek 10 experts selected from the relevant government and private agencies including RFD, DNP, MONRE etc.
2. *Conduct one-day FG meeting.* A one-day meeting shall be held to develop the draft action plan.
3. *Prepare draft action plan.* The draft action plan shall be prepared by the project staff, and shall include: activities and resources for tree data collection and analysis and tree carbon equation dissemination and promotion; institutional set-up for maintaining and updating the equations; capacity building and resource requirements; and priority actions

For Output 4:

1. *Prepare workshop materials.* Workshop kits, to be distributed to the workshop participants, shall be prepared and include the draft technical reports and action plan.
2. *Conduct workshop involving about 40 participants from the relevant government and private agencies.* The workshop agenda shall include discussion of the project demonstration results, the draft action plan and the next steps.
3. *Prepare workshop proceedings.* This shall involve documentation of the workshop proceedings, including list of participants and their affiliations, and workshop conclusions.
4. *Prepare project technical reports.* The technical reports shall be in English and Thai. As well, the technical reports shall be synthesized into two manuscripts for possible publication in appropriate refereed journals.
5. ***Prepare website and brochure.*** **The project website shall involve project information including the documentation of workshop proceedings and technical reports. The project brochure shell summarizes the project objectives, methodology and outputs.**

4. RISKS AND ASSUMPTIONS

Timely delivery of the proposed project outputs could be affected by the following:

1. Possible delays in the acquisition of the aerial photo or satellite data. Early requisition of the imagery and locating pilot and demonstration sites in areas where the imagery already exists may reduce this risk.
2. Delays in project field work inventory due to rainy season, which limits field travel. This risk could be mitigated by ensuring that budget is available and the project field work be done during the dry season.

5. HUMAN RESOURCES AND CAPACITY ASSESSMENT

The human resources needed to realize the project activities include the following:

- Project Director (national consultant): The Project Director shall be Dr. Khwanchai Duangsathaporn, Assistant Professor and Head of Department, Department of Forest Management, KUFF.
- Tree species ID expert Mr. Prasong Saguantam, Associate Professor, Department of Forest Management, KUFF (national consultant).
- Biometrician (Dr. Patsi Prasomsin, Associate Professor, Department of Forest Management, KUFF (national consultant).
- Remote Sensing Modeler Dr. Weeraphart Khunrattanasiri, Assistant Professor, Department of Forest Management, KUFF (national consultant).
- Data Analysts: (1) Mr. Pichit Lumyai, Lecturer, Department of Forest Management, KUFF (national consultant); (2) Dr. Kritsadapan Palakit, Lecturer, Mahidol University, Thailand (national consultant).

- Technical Assistant (1). To be recruited.
- Crew Chief (1). To be recruited.
- Field crew (8). To be recruited.
- Drivers (2). To be recruited.
- Local labor (6). To be recruited.

Please see Annex E for the terms of reference of the various personnel.

The project executing agency is well equipped with laboratories to support the project.

6. BUDGET, FUNDING RESOURCES AND FINANCIAL MANAGEMENT

The funding resources, materials and financial inputs needed to realize the activities are given in Annexes H and I, and the project work plan is given in Annex I. The total project budget is **$253,345, of which $199,045 is requested from APFNet. The Year 1 total budget is $129,970, of which $101,795 is requested for APFNet**.

A separate project account shall be set up and be managed by the Project Director following the Kasetsart University guidelines. The PD shall give financial updates to the PMT and the PSC during their scheduled meetings. The cost for field staff has been integrated into the project activities and is reflected in the budget. The payment of the administrative staff, technical assistant staff and field staff shall be based on their actual working days for the project and their work performance. For transparency, the project cheques shall be signed by the PD as well as two members of the PMT.

7. MONITORING AND EVALUATION

Management
The project organizational chart is given in Annex C. The Executing Agency (Annex E) shall establish a Project Steering Committee (PSC). **The PSC members are:**

1. **Dean of Kasetart University Faculty of Forestry (KUFF), Chairperson**
2. **APFNet representative, Member (Observer)**
3. **Director of Division of Wild Fauna and Flora Protection , DNP, Member**
4. **Project Director, KUFF, Member**
5. **Director of Protected Area Regional Office13 (Lampang Branch), DNP, Member**
6. **Director of Forest Research & Development Office, RFD, Member**
7. **Director of International Forestry Cooperation Office, RFD, Member**

The PSC directs and supervises the project through approving project work plans, annual progress reports, final reporting documents and key deliverables, revision of project scope (objectives and outputs) and major project changes, and coordinating at policy level to resolve issues and make decisions. The PSC can also fill other key roles as defined by the project. A PSC meeting will be held each project year.

The Executing Agency shall set up a Project Management Team (PMT). This team shall include the Project Director and other project national experts. The PMT will meet regularly to review project progress. The PMT members are: Dr. Khwanchai Duangsathaporn, Head of Department of Forest Management and Assistant Professor, Faculty of Forestry, Kasetsart

University; Dr. Patsi Prasomsin, Associate Professor, Faculty of Forestry, Kasetsart University; Mr. Prasong Saguantam, Associate Professor, Faculty of Forestry, Kasetsart University; Dr. Kritsadapan Palakit, Lecturer, Mahidol University; and Mr. Pichit Lumyai, Lecture, KUFF.

Reporting

The project reporting shall be as follows:

(a) Project Progress Reports – Project progress reports shall be prepared by the Executing Agency every 6 months. They will be submitted to the APFNet in the middle of a project year (Mid-year report, MYR) to present progress, achievements, problems and costs as a regular reporting tool. At the end of each project year, an annual progress report (APR) shall be submitted along with financial documents, publications, and products from key deliverables. The MYR will be submitted within 20 calendar days of end of each reporting period, annual progress report to be submitted within 30 calendar days of end of project year.

(b) Project Completion Report - Within 45 days of project completion the Executing Agency shall prepare and submit to the APFNet the project Completion Report.

(c) Project Technical Reports – Upon completion of the various project outputs, technical reports will be prepared by the Executing Agency. The PMT shall review the technical reports. These reports will be submitted to the APFNet.

Monitoring and ~~internal~~ evaluation

~~Internal m~~Monitoring and evaluation (M&E) shall be undertaken on a periodical basis by the PMT, as per the APFNet guidelines, to check project progress and project team performance and to ensure that project implementation is directed towards achieving intended objectives.

Plan for internal M&E shall be formulated for each project year with responsible persons, baseline and indicators clearly identified. The M&E results shall be shared and among relevant parties in timely manner. –External evaluation will be conducted by the end of the project.

8. DISSEMINATION AND SUSTAINABILITY

Information and knowledge from the project shall be disseminated through the following channels:

1. A national workshop consisting of about 40 participants from the relevant agencies within Thailand.
2. Two technical reports documenting the demonstrated methodologies, results and lessons learned. The technical reports shall be translated into Thai for distribution within Thailand. The English versions shall be submitted to APFNet.
3. Two manuscripts, which will be a synthesis of the technical reports, shall be drafted and submitted to appropriate refereed journals for possible publication, for wider international audience.
4. **Project website.**
5. **Project brochure, summarizing the project objectives, methodology and outputs.**

The expectation of the project exit strategy is that, after project completion, KUFF shall be endorsed to continue the project activities. In particular, the KUFF would seek funds to implement the Action Plan developed from this project. Potential sources of funds include:

1. Government of Thailand

2. APFNet and other donor agencies

The KUFF is well placed to lead the national effort because it has a critical mass of expertise (professors and graduate students) to develop and maintain the national tree carbon equations. The forestry undergraduate students are a cost-effective means to collect the field data for developing the national equations. The impacts of this project shall be long-lasting, in particular, in terms of accurately quantifying the levels of carbon sequestration in Thailand's forests.

9. REFERENCES

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ANNEX A. PROJECT STAKEHOLDER AND PROBLEM ANALYSIS

Stakeholders analysis

The list of stakeholders is shown in Table 1 below. The primary stakeholders are the DNP and RFD who manage the largest natural forest areas with the most carbon stocks in the country; and **MONRE headquarters who require carbon stock information to prepare the National Master Plan on Climate Change.** The secondary stakeholders include the MCRD, FIO, **the National Economic and Social Development Board that requires the carbon stock information to monitor the NESDP, APFNet**, and KUFF and other universities and research institutions (mainly Maejo University, Chiangmai University and the Thailand Environment Institute or TEI). The MCRD, TROF land owners and FIO control relatively small natural forest or TROF areas with relatively less carbon stocks. The KUFF and the other universities and research institutions are primarily interested in information to support research and teaching; they are not directly involved in managing of any large forest areas.

Table 1. Stakeholder analysis table

Stakeholder group	Characteristics	Problems, needs, interests	Potentials	Involvement in the Project
Primary stakeholders				
Department of National Park, Wildlife and Plant Conservation (DNP)	Government department responsible for protected forests.	Limited capacity to estimate carbon and demonstrate environemntal benefits of protected forests.	Improved estimates of carbon stocks. A cost benefit analysis of protecting forests for carbon sequestration.	Primary project beneficiary; shall provide input on tree species priorities and groupings; and participate in field data collection.
Royal Forest Department (RFD)	Government department responsible for production, other reserve forests; APFNET focal point.	Limted capacity to estimate carbon and provide accurate extension information to the public about reserve and community forests.	Improved estimates of carbon stocks. Provide the public accurate information on climate change mitigation efforts through reserve and community forests.	Primary project beneficiary; shall provide input on tree species priorities and groupings; and participate in field data collection.
MONRE	**Ministry responsible for preparing the national climate change plan.**	**Need information for planning.**	**Informed decision-making.**	**Potential users of carbon stock information.**
Secondary stakeholders				

Stakeholder group	Characteristics	Problems, needs, interests	Potentials	Involvement in the Project
Marine and Coastal Resources Department (MCRD)	Government department responsible for mangrove forests.	Limited capacity to estimate carbon in mangrove and other coastal forests.	Improved estimates of carbon stocks. Demonstrate benefits of mangrove forests for carbon sequestration versus other uses such as shrimp farming.	Secondary project beneficiary; shall provide input on tree species priorities and groupings.
Forest Industry organization (FIO)	The main government state agency responsible for plantation management.	Limited capacity to estimate carbon in high-value protected natural forests (plantation certification requirement, and carbon credits).	Improved estimates of carbon stocks. The FIO may considedr adapting methodology developed here for equations for their plantations species.	Secondary project beneficiary; shall provide input on tree species priorities and groupings.
NESDB	**Agency responsible for preparing NESDP.**	**Need information for planning**	**Informed decision-making.**	**Potential users of carbon stock information.**
Kasetsart University Faculty of Forestry (KUFF) and other universities and research insititions (Maejo University, **Mahidol University**, Chiangami University and Thailand Environmental Institute or TEI)	KUFF is the main institution of forestry education in the country. Maejo University has an agroforestry program; Chiangmai University has a Plant Science and Natural Resources program, and TEI is an NGO that aims to achieve sustainable development and a better quality of life through partnership.	Limited information to support research and teaching.	Information to support research and teaching.	KUFF is the Project implementing agency; and shall also provide the national expetrise needed to develop the tree carbon equations.

Problem analysis

The key problem to be addressed is that the national estimates of carbon in Thailand's natural forests areas are inaccurate and incomplete (Figure 1). This is mainly because the forest government agencies and industry have limited capacity to estimate carbon stocks.

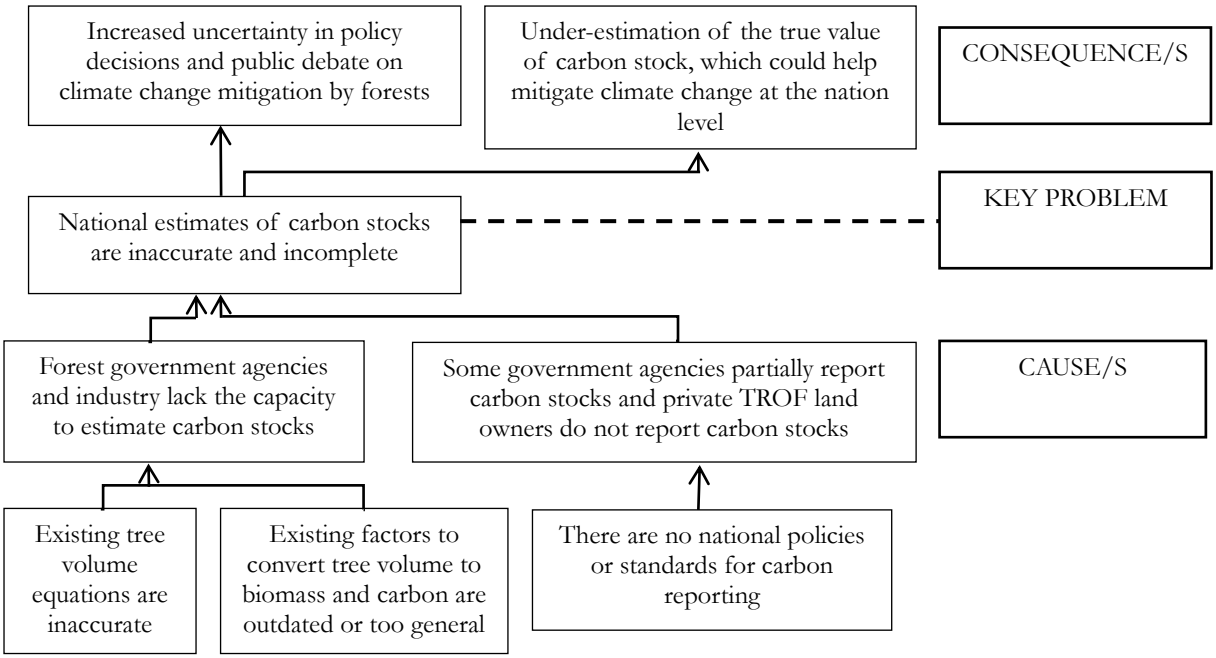

Figure 1. Problem-tree.

Objectives Tree

The development and specific objectives are formulated as follows (Figure 2):

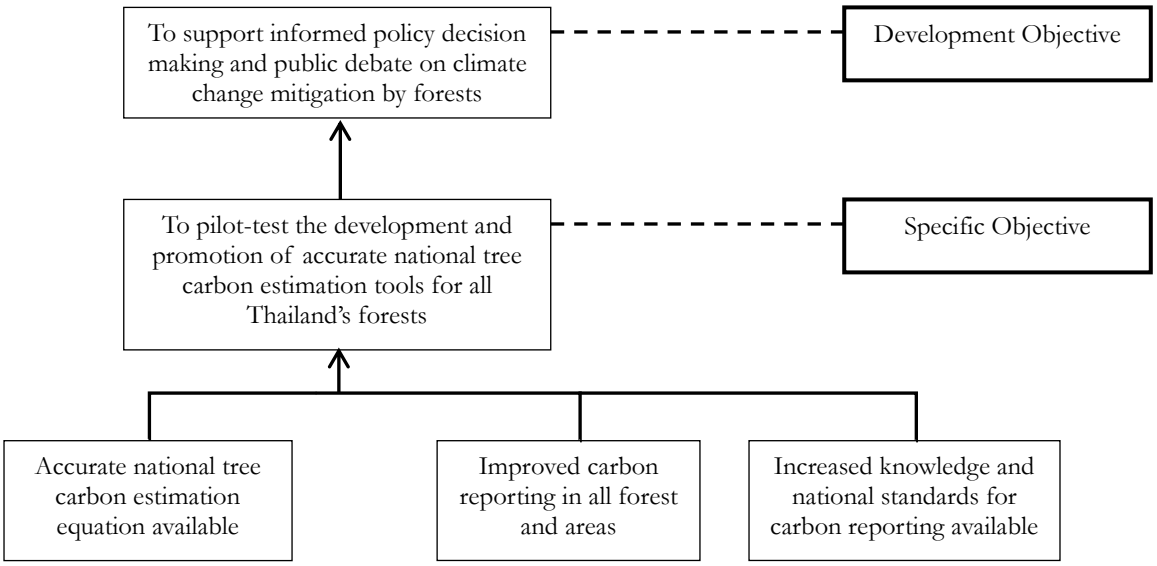

Figure 2. Objectives-tree.

ANNEX B. PROJECT AREA

The project target area for the pilot project is the Ngao Demonstration Forest (NDF), Lampang province (Figure 3)

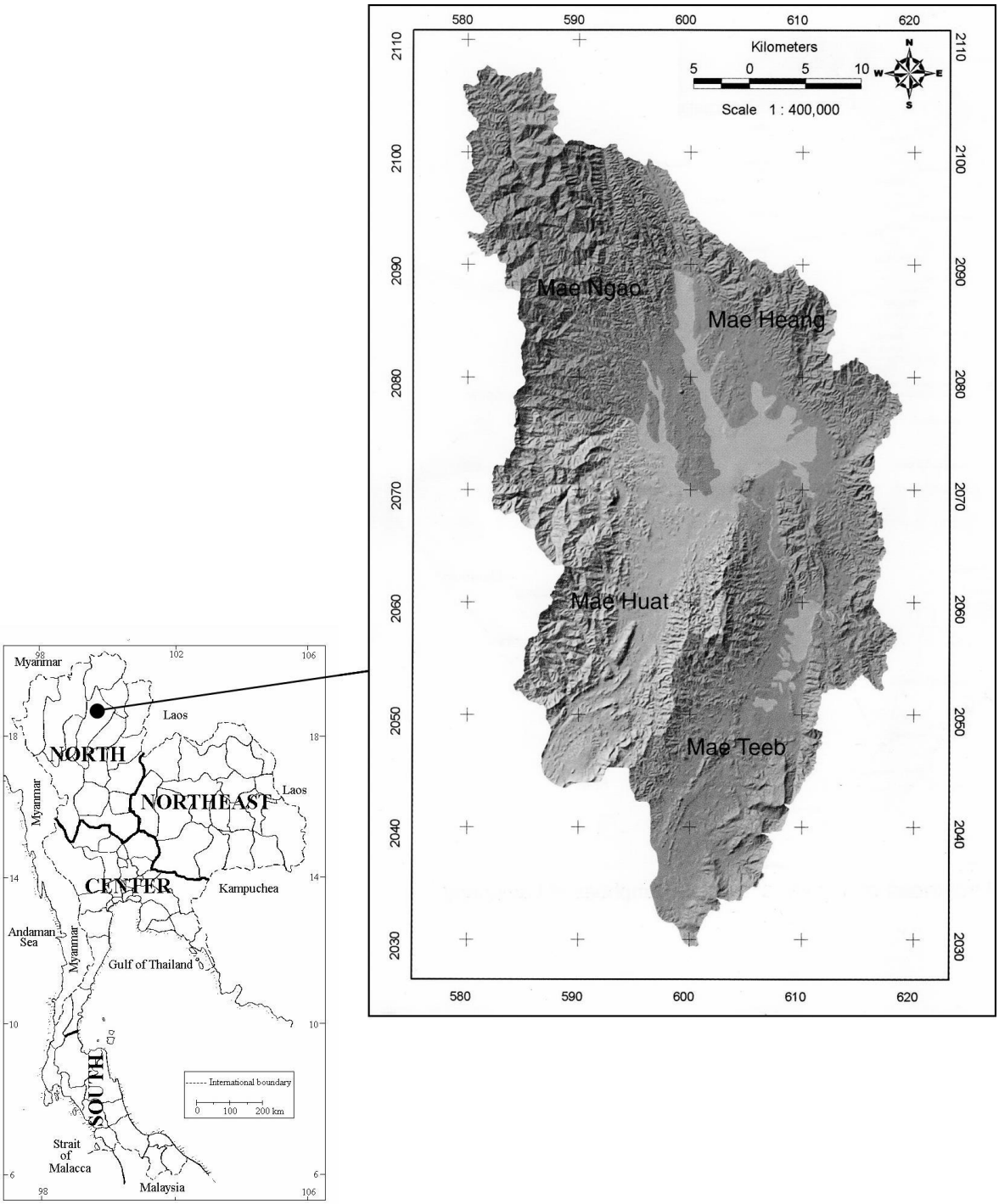

Figure 3. The project area: Ngao Demonstration Forest, Lampang province, Thailand.

The NDF covers an area of approximately 175,159 hectares, including several forest types (Table 2). It is located north-west of Lampang Province in northern Thailand between 18º 20' and 19º 05' north latitude, and 99º 45' and 100º 05' east longitude (Figure 3). The NDF, established in 1961 and the only Demonstration Forest in Thailand, has a long history of being the base for the introduction, testing and adaption of new forest management techniques. This project shall focus only on the Evergreen, Mixed-Deciduous and Dry Dipterocarp forests (60.79% of the total NDF area). The equations developed in these forest types can be applied to estimate carbon in forest trees occurring in TROF areas. However, consideration should be given in the future (perhaps in Phase II) to the development of carbon equations for other tree species occurring in TROF areas, such as fruit trees.

Table 2. Land use types in the Ngao Demonstration Forest (NDF) pilot project area

Land use	Area (ha)	Percent cover (%)
FOREST AREA		
Evergreen Forest	4,172.13	2.38
Mixed Deciduous Forest	78,082.92	44.58
Dry Dipterocarp Forest	24,222.51	13.83
Productive plantation	7,061.67	4.03
Protective Plantation	2,548.89	1.46
TOTAL (FOREST)	*116,088.12*	*66.28*
NON-FOREST AREA		
Settlement Area	4,724.85	0.98
Agriculture Area	8,095.32	4.62
Old Clearings	45,868.92	27.90
Deforested Area (1989-93)	203.85	0.12
Water Bodies	49.86	0.03
Mining Area	128.52	0.07
TOTAL (NON-FOREST)	*59,071.32*	*33.72*
GRAND TOTAL	*175,159.44*	*100.00*

The forest resources in the NDF pilot project site are shown in Table 3.

Table 3.Overall mean per-ha values for selected forest resources in the Ngao Model Forest (Source: ITTO project "Preparatory Studies to Install a Continuous Monitoring System for the Sustainable Management of Thailand's Forest Resources". PD 2/99 Rev. 2 (F), 2002, Royal Forest Department, Bangkok, Thailand)

Land use/Forest type	*Tree volume (m^3/ha)*	*Tree stems (No./ha)*	*Bamboo length (m/ha)*	*Rattan length (m/ha)*
Mixed Deciduous forest	89	419	35738	10
Old Clearing area	24	215	22520	61
Dry Dipterocarp forest	116	951	2952	0
Agriculture area	17	102	3742	0
Productive Reforestation area	63	654	26013	0
Evergreen forest	159	560	14407	180
Protective Reforestation area	32	313	29288	0
Settlement area	24	258	8296	0
Shifting cultivation area (1989-2000)	12	245	29077	0
Mining	6	120	0	0
Other	74	301	23203	19

ANNEX C. PROJECT ORGANIZATION

The Project organizational chart is shown in Figure 4 below.

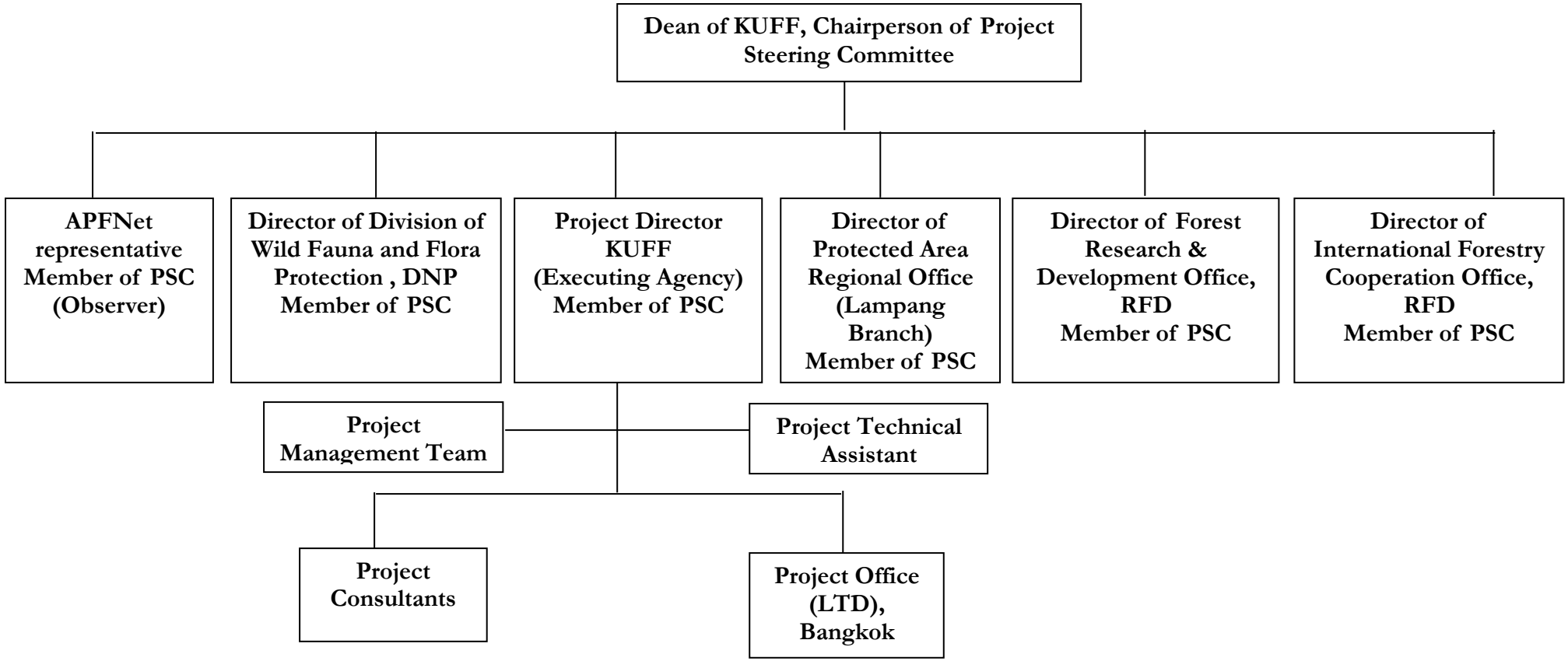

Figure 4. Project organizational chart. KUFF stands for Kasetsart University Faculty of Forestry; RFD is Royal Forest Department; DNP is Department of National Parks, Wildlife and Plant Protection; LTD is the Laboratory for Tropical Dendrochronology, and PSC is Project Steering Committee.

The project executing agency is the KUFF (see Annex D). The KUFF has the necessary forest inventory technical expertise to implement this project. The KUFF shall nominate the Project Director and other team members. It shall also provide project office facilities. The RFD, DNP, MRCD, and FIO shall collaborate in the project implementation by providing support in terms of their respective relevant carbon policy and guidelines, and providing input to tree species priorities and groupings, and field implementation. The RFD is also the APFNet focal point in Thailand, and has also implemented several relevant APFNet projects in the past. The KUFF Laboratory of Tropical Dendrochronology (LTD) shall be used as the Project Office, for the measurement of increment core volumes and data analysis. The LTD was established in 2005, and is involved in research in tree growth and yield and analysis of past environmental change using dendrochronological techniques.

ANNEX D. EXECUTING AGENCY: Kasetsart University Faculty of Forestry, Bangkok, Thailand (KUFF)

HISTORY

The Faculty of Forestry was founded on the first of May in 1936 as the Forest School under the jurisdiction of the Royal Forest Department in the Ministry of Agriculture. The school was located on an area formerly controlled by a logging company in Phrae province in northern Thailand and it offered a two-year diploma course. In 1938, the Forest School was renamed as the Forestry School and in 1940 its curriculum was changed from a two-year to a three-year course. Further changes occurred in 1943, when the Forestry School was transferred from the Royal Forest Department to affiliate with the newly-established Kasetsart University in the Bangkhen District of Bangkok, but the School remained located in Phrae province. One year later, in 1944, the Forestry School was changed into the College of Forestry and a five-year bachelor's degree course in forestry was offered for the first time. Then in 1956, the College of Forestry was relocated from Phrae province to the Kasetsart University campus in Bangkhen, Bangkok, with a new status as the Faculty of Forestry. Later, in 1964, the curriculum was adjusted into a four-year course, in line with the other faculties of Kasetsart University. Since then, it has been the only faculty in Thailand that offers higher education and degrees in forestry and related fields.

STRUCTURE AND FACILITIES

At present, the Faculty of Forestry consists of six departments: Forest Biology; Forest Engineering; Forest Management; Forest Products; Conservation; and Silviculture; and three centers: the Amnoy Kowanit Computer Center; the Forest Research Center; and the Wood Science and Technology Research Center. Each department provides teaching and laboratory practice for its undergraduate and graduate students meeting the highest academic standards. All the faculty's laboratories are well-appointed with modern equipment, enabling the academic staff and graduate students to carry out advanced research in forest science with the aim of maximizing the use of both natural resources and the environment on a sustainable basis. There are 78 experienced academic staff members of whom about 80% are doctoral graduates from both within and outside the country. In addition to the comprehensive learning facilities on the Kasetsart University Bangkhen Campus in Bangkok, the Faculty of Forestry has five field stations where students and staff undertake practical research and learning projects. These stations are located throughout Thailand, with two in the north (Chiang Mai and Lampang provinces), one in the northeast (Nakhon Ratchasima province), one in central Thailand (Prachuap Khiri Khan Province) and one in the south (Phangnga province). The objectives of these stations are twofold, providing: training sites for undergraduate students to become familiar with forestry fieldwork; and research sites for graduate students and faculty staff.

CURRICULA

Undergraduate Programs

The Faculty of Forestry has three Bachelor of Science (BSc) degree programs involving a four-year enrolment: BSc (Forestry); BSc (Wood Science and Technology); and BSc (Pulp and Paper Technology). There is also a five-year double-degree program from which students graduate with two degrees, a BSc (Forestry) and a BA (Sociology and Anthropology). Students in the four-year BSc programs are required to complete a minimum of 138 credits, with a minimum of 216 credits for the five-year double-degree program. For the BSc (Forestry) program, students have to choose from one of eight majors at the end of their second year. The options are: Forest Biological Science; Forest Engineering; Forest Management; Parks, Recreation and Tourism; Silviculture; Social Forestry; Watershed and Environmental Management; and Wildlife and Range

Management. Students who enroll in the double-degree-program are required to choose Social Forestry as their major.

Graduate Programs
The Faculty of Forestry offers nine graduate degree programs involving course work and a thesis: MSc (Forestry) Wood Products; MSc (Forest Resource Management); MSc (Forest Biological Science); MSc (Forest Engineering); MSc (Watershed and Environment Management); MSc (Parks, Recreation and Tourism); MSc (Social Forestry); MSc (Silviculture Technology); PhD (Forestry).

Graduate students are required to complete a minimum of 36 credits (24 credits of course work and 12 credits of thesis) and 48 credits (12 credits of course work and 36 credits of thesis) for the MSc and PhD programs, respectively. In addition, students in the PhD (Forestry) program can choose to do a thesis according to their specific interest in the following fields: forest ecology; forest resource management; watershed and environment management; and silviculture. The MSc (Forest Resource Administration) program involves course work either with or without a thesis. It is a special masters-level degree program offered on weekends (Saturdays and Sundays) to suit people who work during the week. All graduate programs are offered in Thai.

International Degree Programs
There are two international degree programs offered in English: an MSc (Tropical Forestry) requiring 36 credits (24 credits of coursework and 12 credits of thesis); and a PhD (Forestry) with specialized subjects in tropical forestry requiring 48 credits (12 credits of coursework and 36 credits of thesis).

EXPERTISE IN DEVELOPOING MATHEMATICAL EQUATIONS

There are several faculty members with considerable research and teaching expertise in disciplines relevant to this project – forest biometrics, forest inventory and forest measurements. They include Dr. Khwanchai Duangsathaporn (forest measurements and dendrochronology), Dr. Patsi Prasomsin (forest biometrics and growth and yield), and Mr. Prasong Saguantam (forest inventory and dendrology).

ANNEX E. TERMS OF REFERENCE OF PERSONNEL AND CONSULTANTS FUNDED BY APFNet

Project Director (Consultant)
The Project Director shall be Dr. Khwanchai Duangsathaporn, Assistant Professor, Faculty of Forestry, Kasetsart University. He will liase with APFNet and will assume the general responsibility of overseeing project implementation. The Project Director's duties will include (55 days):

- Identifying the necessary personnel, with approval of PSC, to establish a PMT, and managing and assessing team work and performance.
- Developing work plans, preparing project progress reports, and leading completion of other project related documents required by the project and APFNet.
- Coordinating the project activities at various levels to ensure the project implementation in budget, on schedule, and within scope.
- Subcontracting services in consultation with PMT.
- Monitoring the project progress from financial and technical aspects, organizing the internal monitoring, and keeping PSC and APFNet updated with the project progress.
- Securing acceptance and approval of deliverables from PSC and APFNet through efficient communication.
- Report Project progress to the Dean of KUFF;

Dr Khwanchai shall also provide expert advice in forest measurements and dendrochronology (specifically on extraction and handling of tree cores) (14 days).

Tree species ID expert (Consultant): Mr. Prasong Saguantam, Associate Professor, KUFF
The Tree species ID expert shall assist the field crew in tree species identification.
Duration: 41 days at $250 per day
Start date: To be detailed once project has started (tied to the first installment)
End date: Project completion
Duty place(s): Bangkok, Thailand

Remote Sensing expert (Consultant): Dr. Weeraphat Khunarattasiri, Assistant Professor, KUFF
The Remote Sensing expert shall acquire satellite imagery, model the relationship between ground data and satellite image signatures, and produce a carbon stock map.
Duration: 33 days at $250 per day
Start date: To be detailed once project has started (tied to the first installment)
End date: Project completion
Duty place(s): Bangkok, Thailand

Biometrician (Consultant): Dr. Patsi Prasomsin, Associate professor, KUFF
The Biometrician shall develop carbon equations, acquire satellite imagery, model the relationship between ground data and satellite image signatures, and produce a carbon stock map.
Duration: 33 days at $250 per day
Start date: To be detailed once project has started (tied to the first installment)
End date: Project completion
Duty place(s): Bangkok, Thailand

Data Analyst (2) (Consultant): Dr. Kritsadapan Palakit, Lecturer, Mahidol University; and Mr. Pichit Lumyai, Lecturer, KUFF.

The data analysts shall assist in the editing and analysis of the data and construction of the tree

carbon equations.
Duration: 76 days at $250 per day
Start date: To be detailed once project has started (tied to the first installment)
End date: Project completion
Duty place(s): Bangkok, Thailand

Technical Assistant (consultant)
The Technical Assistant shall assist the Project Director and consultants as required, ensure the Project records and correspondences are properly maintained.
Duration: 180 days at $50 per day
Start date: To be detailed once project has started (tied to the first installment)
End date: Project completion
Duty place(s): Bangkok, Thailand

Crew Chief
1. Oversee the field measurements and mentor the crews.
2. Responsible for field data quality control and assurance.
3. Verify and correct data errors identified by the Inventory Assistants.
4. Ensure field crews welfare, and liaise with the Project Director.
5. Ensure required field equipment is available and working effectively.

Field crew
Conduct tree field measurements under the direction of the Crew Chief.

Drivers
1. Drive field crew to and from fieldwork locations.
2. Ensure the vehicles are well maintained and in good mechanical condition, and report any defects to the Crew Chief.

Local labor
1. Assist the field crew with tree measurements and plant identification.
2. Clear the paths for passage in dense forest, and setting up camp.

ANNEX F: RESPONSES TO PROJECT APPRAISAL PANEL RECOMMENDATIONS

Appraisal Round 1

APFNet Project Appraisal Panel	Amendments made	Page #
1. Add description of positive relations between project output and forestry policy development	A description on the project rationale in relation to climate change policy has been provided	4-5
2. Expect technical reports and meetings, project should add further dissemination activities and include approach for dissemination of project results.	An additional project output (Output 4) and activities have been developed regarding dissemination of project results.	6-8
3. The budget seems adequate; however, more resources and activities should be earmarked for dissemination of project results.	The APFNet and GOT budgets have been increased slightly to achieve the new Output 4 and related activities.	Annexes H and I.
4. The budget shall be further streamlined, otherwise the budget justification shall be provided.	The budget has been streamlined and budget justification has been done.	Annexes H and I.

Appraisal Round 2

APFNet Project Appraisal Panel Recommendation	Amendments made	Section #
1. Add description of positive relations between project output and forestry policy development. Meanwhile, add more activities on disseminating project outputs besides the workshop.	1) A description on the project rationale in relation to climate change policy has been provided. 2) Additional activities for dissemination have been added, including a website and brochure; the GOT budget component was increased by $2,100, in-kind contribution from $52,200 to $54,300, to cover these additional activities.	1 3, Annex A
2. Some theories and methodologies such as IPCC good practice guidance for LULUCF and CBM are suggested to be well cited in the proposal supporting the scientificity of the proposed carbon equations as well as for providing evidences on the enhanced accuracy.	The IPCC good practices guidance has be referenced in the text.	1
3. Add more information on 1) forest resources in potential project site, 2) workload of each activity as well as 3) stakeholders and target beneficiaries, and also provide information about composition of Project Steering Committee.	1) Forest resource statistics in the potential pilot site area have been added (Table 3). 2) Workload of each activity has been added (Table 5). 3) Additional stakeholders on policy have	Annex B Annex H

APFNet Project Appraisal Panel Recommendation	Amendments made	Section #
	been included. List of PSC members has been included.	2 &Annex A 7

APFNet Comments (3 June 2015)

APFNet Project Appraisal Panel	Amendments made	Page/Table #
1. Since Royal Forest Department is one of the stakeholders of this project and also coordinate the development of this project proposal, it is suggested that the Royal Forest Department act as the Supervisory agency of this project. Please kindly communicate with RFD to see if it is possible to have RFD as the supervisory agency.	KUFF discussed issue with the Royal Forest Department and we both agreed that the RFD become the Supervising Agency.	Title page
2. Table 4: It seems that the activity 3.1 is a procedure of setting up an expert group. It's not that clear that why USD1300 budget is needed for such a procedure. Please explain a bit.	Two Data Analysts shall spend two days each, describing the project background and role of the Focus Group (FG) experts to stakeholders, prior to solicitation of experts from among the stakeholders and the eventual invitation of experts by the Project Director as FG members. The APFNet grant of $1,100 is the fee for the two Data Analysts and the Counter-part contribution of $200 is in-kind contribution of the university salary of the Data Analysts during this project assignment.	Table 4, footnote *
3. Table 4: Please specify the items included as "Project Management" cost. (It's supposed that expenses for Inception workshop, monitoring and evaluation and audit, and PSC meetings are included as Project Management cost, is it?) .	The Project Management cost includes two components: 1) APFNet grant fees for the Project Director ($13,750), Technical Assistant ($6,380), Office Supply ($2,880), two PSC meetings ($2,000), and Project Monitoring and Evaluation by APFNet ($8,000); and 2) the Counter-part in-kind contribution for Project audit ($2,000), university salary for the Project Director, and Kasetsart University standard external project overhead charge of 10% (about $22,000).	Table 4, footnote **
4. Table 5: What is the role of the data analysts in activity 3.1?	As explained in Table 4 footnote *, two Data Analysts shall spend two days each,	Table 5, footnote *

APFNet Project Appraisal Panel	Amendments made	Page/Table #
	describing the project background and role of Focus Group (FG) experts to stakeholders, prior to solicitation of experts from among the stakeholders and the eventual invitation of experts by the Project Director as FG members.	
Editorial comments on page 9, 10 and Figure 4.	All the editorial comments were accepted and incorporated. The page numbers were re-numbered	8,9,10 and Figure 4

Annex I: Project budget by category

ANNEX G. Project logical framework matrix

Items	Intervention logic	Objectively verifiable indicators of achievement	Sources of information and means of verification	Assumptions
Goal	The overall goal is to provide accurate information on national forest-cover carbon stocks to support informed sustainable forest management policy decision-making and balanced public debate on the benefits of forests in climate change mitigation.	By 2020, after the carbon equations are developed for the whole country, the relevant agencies (such as DNP, RFD, MRCD, FIO and MONRE) have adopted the national equations for carbon stock estimation and reporting.	Review carbon stock reports prepared by the relevant agencies.	Commitment of the relevant agencies in adopting the new carbon equations.

Annex I: Project budget by category

Objectives	The specific objective is to demonstrate the development of accurate standing-tree carbon equations and their application to the preparation of a forest-cover carbon stock map in the Ngao Demonstration Forest, Lampang Province	• Methods to construct and apply tree carbon equations are available. • Tree carbon equations for the major tree species groups are available for the NDF. • Carbon-stock map is available for selected area of NDF. • Action plan to develop national tree carbon equations is available. • Information and knowledge from project disseminated through a national workshop and project technical reports and manuscripts.	Review: • Project technical reports and manuscripts. • Action Plan • Minutes of meetings of Focus Group. • Workshop proceedings and list of workshop attendees.	• Weather is favorable during the field data collection. • The laboratory for measuring carbon content is available.
Expected Outputs **Output 1**	Methodology to construct new tree carbon equations developed and pilot-tested.	Methodology and developed carbon equations are available.	Examine: • Field and laboratory data sheets • Field inventory plots and sample trees database. • Technical reports	• Favorable weather conditions during the field data collection. • The laboratory for measuring carbon content is operational

Annex I: Project budget by category

Activities	1.1 Collect sample tree field data. 1.2 Measure and analyze wood core samples in the laboratory. 1.3 Construct tree carbon equations. 1.4 Prepare technical reports	Methodology and developed carbon equations are available	Examine: • Field inventory data sheets • Field inventory plots and sample tree database. • Technical reports documenting the tree database, and the carbon equations and methodology.	• Favorable weather conditions during the field data collection. • The laboratory for measuring carbon content is available.
Output 2	Application of tree carbon equations to prepare carbon-stock cover map demonstrated.	Carbon-stock cover map for selected sectors of the NDF are available.	Examine: • Field inventory data sheets • Field inventory plots and sample tree database. • Technical reports documenting the tree and secondary databases • Carbon-stock cover maps.	• DNP and RFD cooperate to provide secondary data
Activities	2.1 Establish inventory sample plots on a systematic grid in selected sectors of the demonstration area. 2.1 Develop sample tree database, including tree carbon estimates. 2.3 Acquire various GIS layers of secondary data, and prepare carbon-stock cover map. 2.4 Prepare technical report.	Carbon stock map prepared	Examine: • Field inventory data sheets • Field inventory plots and sample tree database. • Technical reports documenting the tree and secondary databases • Carbon-stock cover maps.	• Favorable weather conditions during field work. • Remote sensing data available
Output 3	Action plan to construct and promote national tree carbon equations prepared.	Action Plan to develop national equations available.	Examine: • Action Plan • Minutes of Focus Group meetings	Relevant agencies willing to let their experts participate in meetings

Annex I: Project budget by category

Activities	3.1 Assemble a Focus Group consisting of about 10 experts from relevant agencies. 3.2 Conduct focus group meeting to develop action plan. 3.3. Prepare action plan and funding proposal.	Action Plan to develop national equations available.	• Action Plan. • Minutes of Focus Group meetings.	Relevant agencies willing to let their experts participate in the Focus Group meetings
Output 4	Information and knowledge from the project disseminated and shared among stakeholders	Information and knowledge shared among the relevant stakeholders.	Examine: • Two technical reports (in English and Thai). • Two manuscripts for publication. • Workshop proceedings and list of participants.	Relevant agencies willing to let their experts participate in the Workshop.
Activities	4.1 Prepare workshop materials 4.2 Conduct workshop involving about 40 participants. 4.3 Prepare two project technical reports in English and Thai. 4.4 Prepare two manuscripts for submission to refereed journals.	Workshop conducted, and technical reports and manuscripts prepared.	Examine: • Two technical reports (in English and Thai). • Two manuscripts for publication. • Workshop proceedings and list of participants.	Relevant agencies willing to let their experts participate in the Workshop.