Document No.: 2015P6-THA-PD

Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

PROJECT DOCUMENT

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 of Thailand

Executing Agency: Kasetsart University Faculty of Forestry, Thailand

Project Implementation Duration: 24 months

Basic Information

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 [2015P6-THA]**
Supervisory agency	**Royal Forest Department, Bangkok, Thailand**
Executing agency	**Kasetsart University Faculty of Forestry, Bangkok, Thailand**
Implementation Agency	**Kasetsart University Faculty of Forestry, Bangkok, Thailand**
Project Director: Dr. Khwanchai Duangsathaporn **Tel** (66 2) 5790174 ext. 21 **Email** fforkcd@ku.ac.th **Fax** (66 2) 9428108	
Target area: Ngao Demonstration Forest, Lampang Province, Thailand (see Annex A)	
Project implementation duration: 01/2017 to 12/2018 24 months	
Total budget(USD)	**$253,345**
APFNet grant(USD)	**$199,045**
Conouterpart contribution (USD)	**$54,300**

Project description:

(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 Thailand Environment Institute (TEI) , and Thailand Greenhouse Gas Management Organization (TGO), 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 demonstration project will focus on the major species groups in the pilot forest area of one sectors of Ngao Demonstration Forest (NDF), Lampang Province. A carbon stock map of one 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 sector; 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 carbon 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 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.

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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:	Kasetsart 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
TGO	Thailand Greenhouse Gas Management Organization

Project details

1. BACKGROUND AND RATIONALE

This Project Document (PD) is based on the revised Project Proposal that was submitted to APFNet. It incorporates all of the recommendations of the APFNet Project Appraisal Panel. This project originates from the Kasetsart University Faculty of Forestry (KUFF), Bangkok, Thailand. The rationale for this project 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 economy; 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, Thailand sought 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 is to demonstrate this process in the Ngao Demonstration Forest in Lampang province.

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 economy 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 economy 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 (2015). 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 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 demonstration 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 demonstration project disseminated.

The overall impact is that when the project is completed, there shall be new methodology that can be used by the main stakeholders - RFD, DNP, MRCD and FIO - to develop improved national tree carbon equations. The key message is communicating the importance of, and how to prepare, accurate standing-tree carbon equations, to support the reporting on carbon stocks in Thailand, and carbon stock assessment research and development.

The primary stakeholders are the DNP and RFD who manage the largest natural forest areas with the most carbon stocks in the economy; 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, the Thailand Environment Institute or TEI) and Thailand Greenhouse Gas Management Organization (TGO). 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.

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

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 demonstration project will focus on the major species groups in the project demonstration area (Annex A). Stakeholder representatives shall be invited to participate in the field data collection.

A small Focus Group, consisting of the Project Management Team (PMT) and 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 demonstration project results, and develop an action plan for a future project. Then, a national workshop involving about 40 participants from the relevant government and private agencies shall be held to disseminate the project

[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.

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 demonstration 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 one of four sectors of the NDF demonstration area (Mae Huat sector; ANNEX A) 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.

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*: Determine the number of sample trees and species groups to be sampled. For budget purposes, a preliminary estimate of a total of approximately 450 sample trees was assumed. 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-metre sections up to the first major branch, and Smalian'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 demonstration 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 demonstration area.
4. *Prepare a technical report*: The report shall describe the proposed methodology to construct tree carbon 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, or other sources. The Landsat Data Continuity Mission (LDCM) or Landsat-8 data will be utilized for mapping. It collects data from nine spectral bands which eight of them contain basic 30x30 meters resolution on multi-spectral mode and one fine resolution of 15x15 meters on panchromatic mode. Amongst these data, high resolution image will generate through pansharpening process or merging of high resolution panchromatic and lower resolution multispectral data..
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 of the demonstration area. Determine the accuracy of the carbon stock map using the ground plot estimates.
4. *Prepare final carbon stock map and 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.

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 store project information including the documentation of workshop proceedings and technical reports. The project brochure shall summarize 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. INSTITUTIONAL MANAGEMENT AND COMMUNICATION

The project executing agency is the KUFF (see Annex B). 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 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.

The project organizational chart is given in Annex D. The Executing Agency shall establish a Project Steering Committee (PSC). The PSC members are as follows:

1. Dean of Kasetart University Faculty of Forestry (KUFF), Chairperson
2. Project Director, KUFF, Member (Secretary)
3. APFNet representative, Member (Observer)
4. Director of Division of Wild Fauna and Flora Protection , DNP, 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 and Mr. Prasong Saguantam, Associate Professor, Faculty of Forestry, Kasetsart University; Dr. Kritsadapan Palakit, Lecturer, Mahidol University; Mr. Pichit Lumyai, Lecture, KUFF; Mr. Purin Sikareepaisarn, KUFF; Mr. Narapong Sangram, KUFF, and Miss Chokdee Khantawan and Miss Sunisa Amnatpook.

To improve communication, 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.

6. PROJECT RESOURCES AND FINANCIAL MANAGEMENT

The human resources needed to realize the project activities shall be mostly members of the KUFF, and include the following:

1. Project Director: The Project Director shall be Dr. Khwanchai Duangsathaporn, Assistant Professor and Head of Department, Department of Forest Management, KUFF (Project staff).
2. Tree species ID expert: Dr. Kritsadapan Palakit, Lecturer, Mahidol University, Thailand (national consultant).
3. Biometrician (Dr. Patsi Prasomsin, Associate Professor, Department of Forest Management, KUFF (national consultant).
4. Remote Sensing Expert: Mr. Prasong Saguantam, Associate Professor, Department of Forest Management, KUFF (national consultant).
5. Data Analysts (2): (1) Mr. Pichit Lumyai, Lecturer, Department of Forest Management, KUFF (national consultant); (2) Mr. Purin Sikareepaisarn, Laboratroy of Tropical Dendrochronology, KUFF (national consltants).
6. Technical Assistant (2): (1). Mr. Narapong Sangram (2) Miss Sunisa Amnatpook. (Project staff).
7. Crew Chief (1). Miss Chokdee Khantawan (Project staff).
8. Field crew (8). To be recruited.
9. Drivers (2). To be recruited.
10. Local labor (6). To be recruited.

Please see Annex C for terms of reference (ToR), and Annex H for the curriculum vitae, of the various project personnel.

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

The funding resources, materials and financial inputs needed to realize the activities are given in Annexes G and I, and the project work plan is given in Annex F. The total project budget is $253,345, up to $199,045 is sponsored by APFNet and shall be disbursed as the following arrangement:

(1) USD 101,795 upon entry into force of this Agreement and approval of Annual Work Plan for Project Year One (AWP1);
(2) USD 79,685 upon approval of the first Annual Progress Report (APR1), financial report, audit report, the second Annual Work Plan(AWP2), and

materials required;

(3) USD 17,565 (including USD 8000 for external evaluating may be retained and paid directly by APFNet) upon project evaluating results, financial report, audit report, approval of project completion report and acceptance of project completion.

And Kasetsart University would like to contribute USD 54,300 as counterpart support to this project.

Financial Management

A separate project account will be set up and be managed by the Project Director following the Kasetsart University financial guidelines. Kasetsart University has the responsibility to keep strict budgetary control over the grant for the purpose of implementing the Project, and will keep such grant until its actual disbursement in the bank account.

Detailed budget plan for each Project Year will be developed in line with approved Project Document as an attachment for Annual Work Plan. The procurement of any goods and service in the context of the project financed by APFNet will be carried out in accordance with the budget plan. Any adjustment will be made after written consent from APFNet. Disbursement of costs and expenses will be strictly in line with APFNet requirements.

The Project Director will ensure all kinds of expenses including payment of all administrative and supporting staff be made in accordance with the Project Agreement and locally established procedures. The Project Director shall give financial updates to the PMT and the PSC during their scheduled meetings. The Supervisory Agency and PSC will supervise the authorized use of APFNet fund.

Consistent monitoring of project resources and budget will be completed throughout the project and reported in various reports submitted to APFNet. Biannual and annual progress reports will cover the expenditures, progress, and achieved outputs according to the annual plan in the middle and at the end of each project year. External Audits and financial reports will also be submitted by the EA to APFNet to indicate the opening balance, expenditure incurred to date, and the closing balance for the project account.

In view of this, the Projects will be financially and efficiently managed in addition to being very transparent in the handling of Projects' funds.

7. MONITORING AND EVALUATION

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. The main tools for the M&E shall be the Logical Framework Matrix, the Annual Work Plans and the Project Document. The M&E criteria shall include: relevance, efficiency, effectiveness, impact and sustainability.

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, DUPLICABILITY 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 SITE MAPS AND RELEVANT INFORMATION

The project target area for the demonstration project is the Ngao Demonstration Forest (NDF), Lampang province (Figure 1)

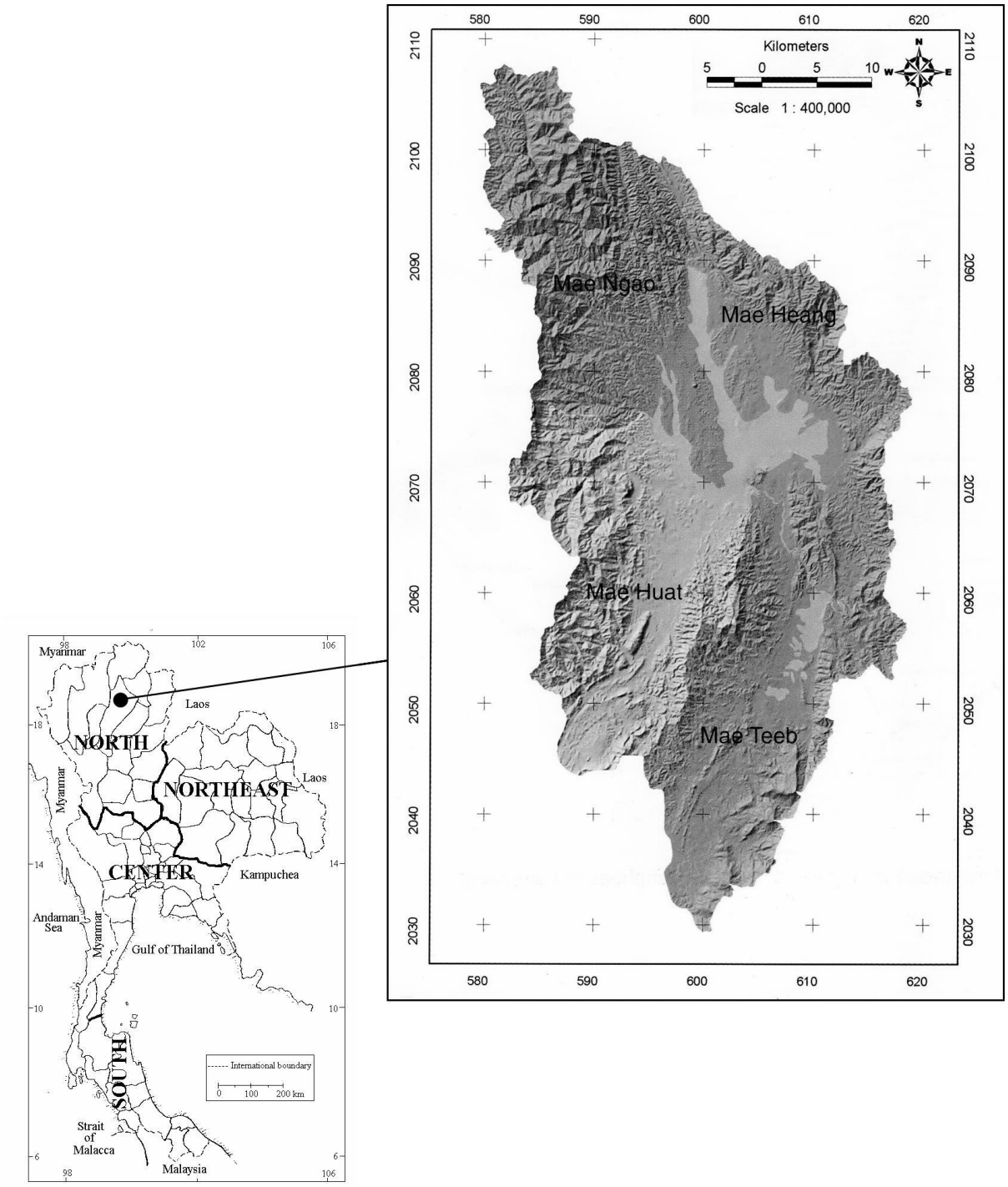

Figure 1. The Project area: Ngao Demonstration Forest, Lampang province, Thailand.

The NDF covers an area of approximately 175,159 hectares, including several forest types (Table 2; Figure 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). It consists of four sectors: Mae Heang, Mae Huat, Mae Ngao and Mae Teeb (Figure 1). 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 to the development of carbon equations for other tree species occurring in TROF areas, such as fruit trees.

Table 1. Land use types in the Ngao Demonstration Forest (NDF) demonstration 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*

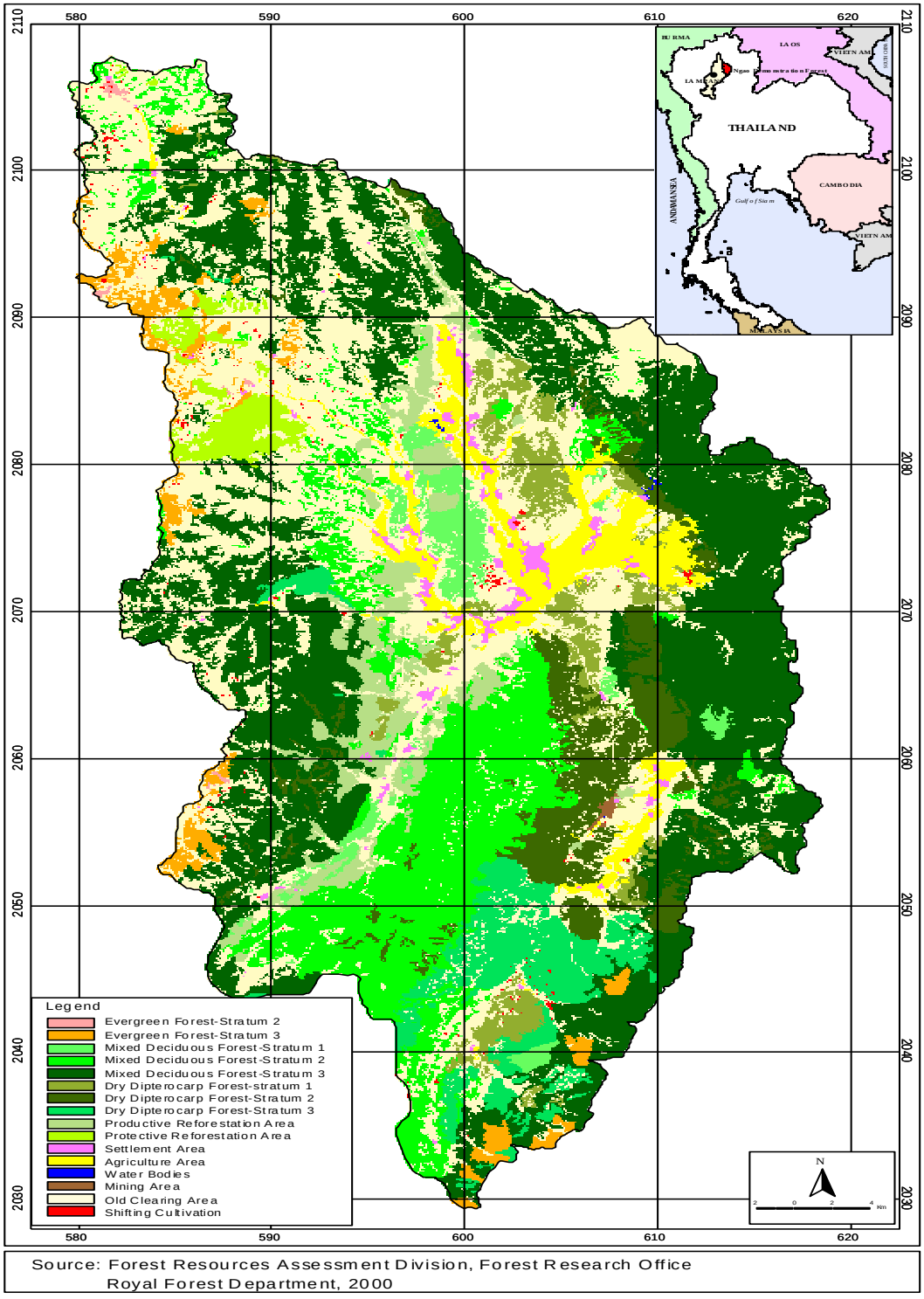

Figure 2. Map of the Ngao Demonstration Forest showing the different forest/land use types.

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

Table 2. Overall mean per-ha values for selected forest resources in the Ngao Demonstration 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 B. 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 economy. 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).

RELEVANT EXPERTISE

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), Mr. Prasong Saguantam (Remote Sensing) and Mr. Pichit Lumyai (forest inventory

and dendrochronology).

ANNEX C. 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. Dr. Kritsadapan Palakit, Mahidol University.
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): Mr. Prasong Saguantam, Associate 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): Mr. Pichit Lumyai, Lecturer, KUFF and Mr. Purin Sikareepaisarn, 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 (2) (consultant)
The Technical Assistants shall assist the Project Director and consultants as required, and 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 (Project staff)
Duties:

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.

Duration: 40 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

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 D: PROJECT MANAGEMENT STRUCTURE AND COMMUNICATION MECHANISM CHART

The Project organizational chart is shown in Figure 4 below.

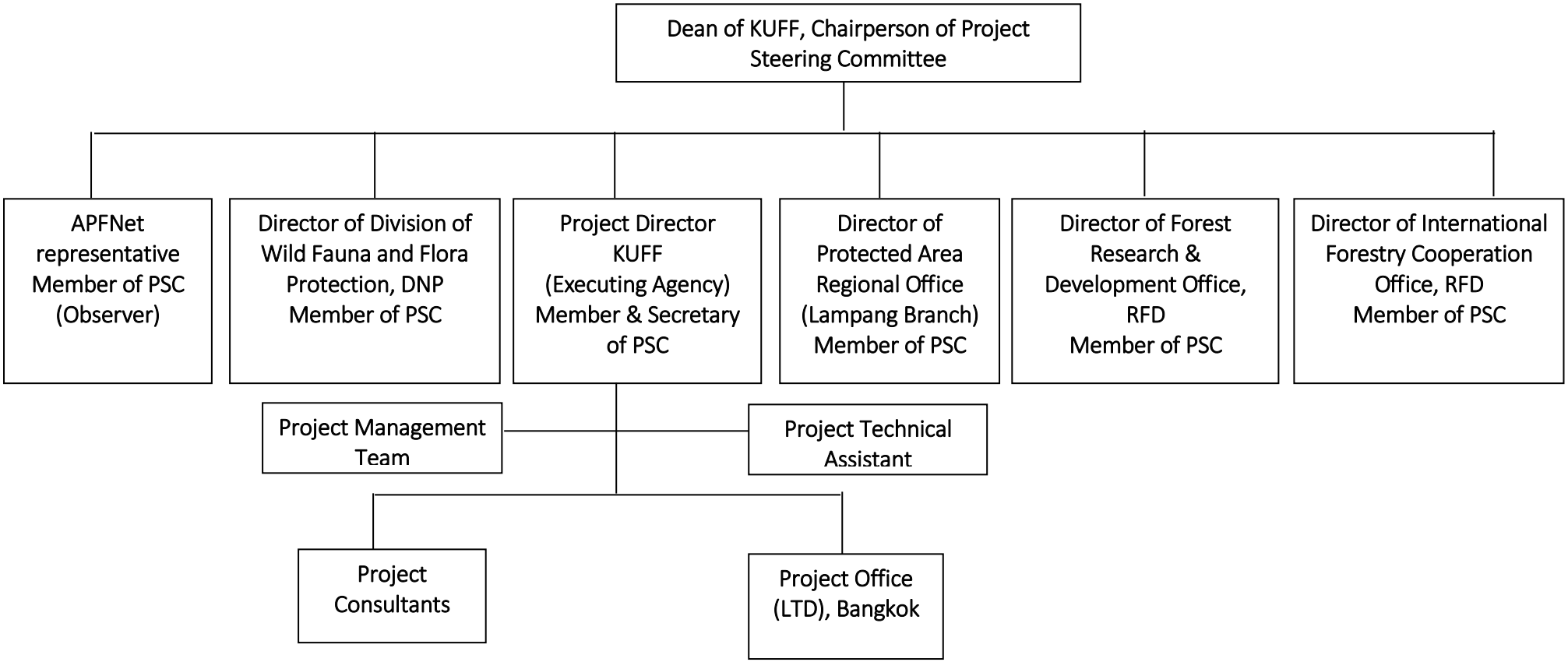

Figure 3. Project organizational chart. KUFF stands for Kasetsart University Faculty of Forestry; RFD is Royal Forest Department; DNP is Department of National Parks, Wildlife and Plant Protection; LTD is the Laboratory for Tropical Dendrochronology, and PSC is Project Steering Committee.

ANNEX E. 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 economy, 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.
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
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 map.	DNP and RFD cooperate to provide secondary data

Activities	2.1 Acquire and classify remote sensing data. 2.2 Model relationships between ground data and remote sensing data 2.3 Collect and compile ground validation data. 2.4 Prepare final carbon stock map and 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 map.	Favorable weather conditions during field work. Remote sensing data available
Output 3	Action plan to construct and promote national tree carbon equations prepared.	Draft Action Plan to develop national equations available.	Examine: Draft Action Plan Minutes of Focus Group meetings	Relevant agencies willing to let their experts participate in meetings
Activities	3.1 Select Focus Group members. 3.2 Conduct one-day FG meeting. 3.3. Prepare draft action plan.	Draft Action Plan to develop national equations available.	Draft 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 from the relevant government and private agencies. 4.3 Prepare workshop proceedings. 4.4 Prepare project technical reports.	Workshop conducted, and technical reports and brochure prepared, and website constructed.	Examine: Two technical reports (in English and Thai). Two manuscripts for publication. Workshop proceedings and list of participants. Project website & brochure.	Relevant agencies willing to let their experts participate in the Workshop.

	4.5 Prepare website and brochure.			

Stakeholders analysis

The list of stakeholders is shown in Table 3 below. The primary stakeholders are the DNP and RFD who manage the largest natural forest areas with the most carbon stocks in the economy; 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, the Thailand Environment Institute (TEI) Thailand Greenhouse Gas Management Organization (TGO). 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 the management of any large forest areas.

Table 3. 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	Government department responsible for	Limted capacity to estimate	Improved estimates of carbon stocks. Provide	Primary project beneficiary;

Stakeholder group	Characteristics	Problems, needs, interests	Potentials	Involvement in the Project
(RFD)	production, other reserve forests; APFNET focal point.	carbon and provide accurate extension information to the public about reserve and community forests.	the public accurate information on climate change mitigation efforts through reserve and community forests.	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				
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.

Stakeholder group	Characteristics	Problems, needs, interests	Potentials	Involvement in the Project
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), Thailand Greenhouse Gas Management Organization (TGO)	KUFF is the main institution of forestry education in the economy. Maejo University has an agroforestry program; Chiangmai University has a Plant Science and Natural Resources program, TEI is an NGO that aims to achieve sustainable development and a better quality of life through partnership, and TGO is an implementing agency on greenhouse gas (GHG) emission reduction in Thailand.	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.

Stakeholder group	Characteristics	Problems, needs, interests	Potentials	Involvement in the Project

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 4). This is mainly because the forest government agencies and industry have limited capacity to estimate carbon stocks.

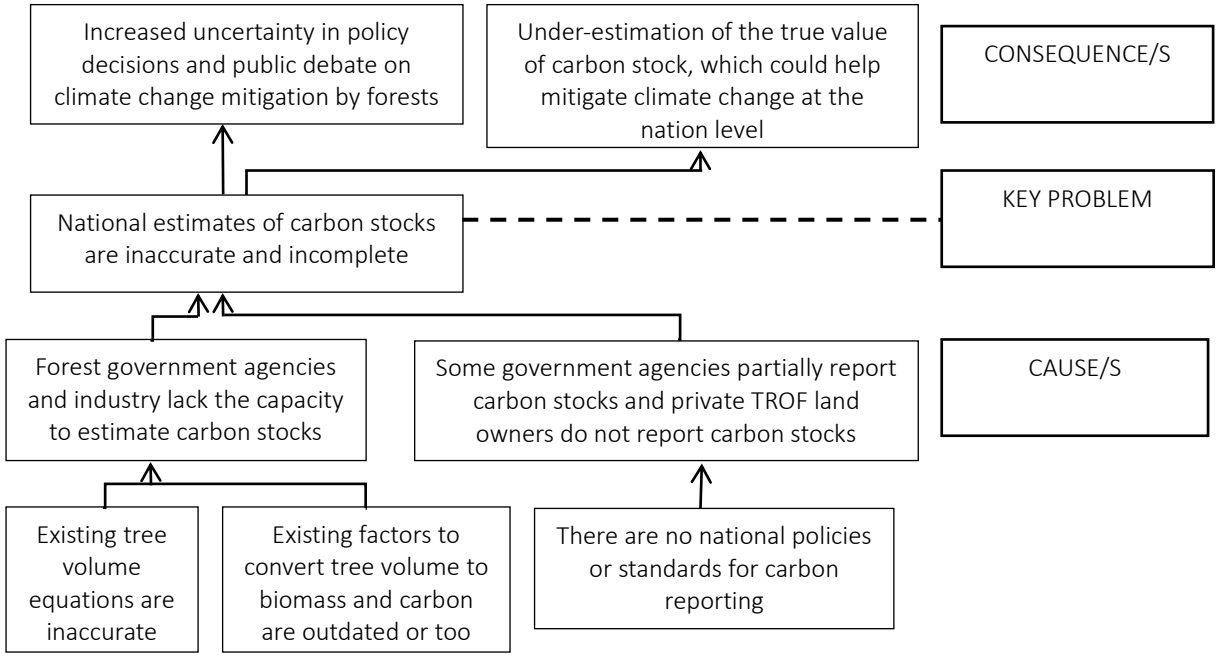

Figure 4. Problem-tree.

Objectives Tree

The development and specific objectives are formulated as follows (Figure 5):

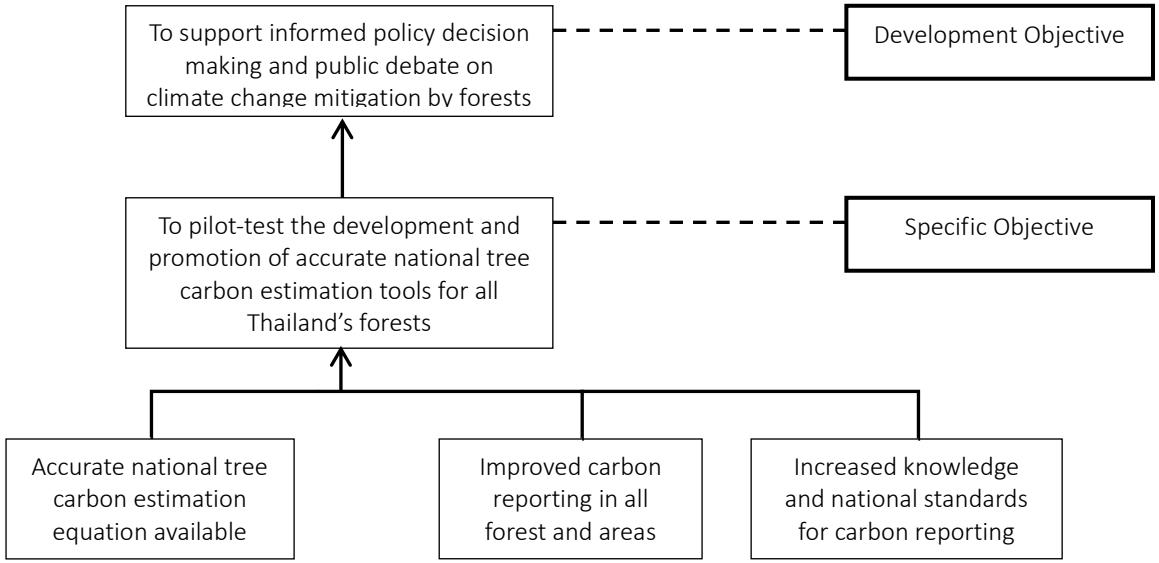

Figure 5. Objectives-tree.

ANNEX F: OVERALL PROJECT WORK PLAN WITH BUDGET BY ACTIVITY

A project work plan has been prepared by activity and is presented in Table 4 below, along with the overall project budget. The workload (inputs) by activity is given in Table 4 below. The human resources, materials and financial inputs needed to realize the activities, as well as the unit costs, are given in Annex I. The project covers a period of 24 months.
The Project Director is responsible for all the project activities.

Table 4. Overall project work plan with budget by activity.

Output/Activity	Responsible Party	Project Year 1 (Month)												Cost (USD)		Project Year 2 (Month)												Cost (USD)		Total (USD)
		1	2	3	4	5	6	7	8	9	10	11	12	APFNet Grant	Counterpart Contribution	1	2	3	4	5	6	7	8	9	10	11	12	APFNet Grant	Counterpart Contribution	
Output 1																														
Activity 1.1	Project Director													60,780	*9,700*															70,480
Activity 1.2	Project Director													22,500	*400*															22,900
Activity 1.3	Project Director													5,250	*1,000*															6,250
Activity 1.4	Project Director																											2500	*450*	*2,950*
Subtotal 1														88,530	*11,100*													2,500	*450*	102,580
Output 2																														
Activity 2.1	Project Director													2,700	*500*															3,200
Activity 2.2	Project Director																											3,200	*600*	*3,800*
Activity 2.3	Project Director																											35,585	*5,750*	*41,335*
Activity 2.4	Project Director																											1,450	*250*	*1,700*
Subtotal 2														2,700	*500*													40,235	*6,600*	50,035

Output 3																													
Activity 3.1	Project Director																										1,100*	*200**	1,300
Activity 3.2	Project Director																										2,000	*750*	2,750
Activity 3.3	Project Director																										2,350	*450*	2,800
Subtotal 3																											5,450	*1,400*	6,850
Output 4	Project Director																												
Activity 4.1	Project Director																										2,700	*500*	3,200
Activity 4.2	Project Director																										11,950	*2,400*	14,350
Activity 4.3	Project Director																										650	*100*	750
Activity 4.4	Project Director																										16,200	*400*	16,600
Activity 4.5	Project Director																											*2,100*	2,100
Subtotal 4																											31,500	*5,500*	37,000
Project Management & miscellaneous**	**Project Director**												10,565	***16,375***													17,565	***12,375***	**56,880**
Total													**101,795**	***27,975***													**97,250**	***26,325***	**253,345**

*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.

** 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).

ANNEX G: PROJECT BUDGET BY CATEGORY

Costs category	APFnet Grant		Counterpart Contribution		Project Year 1		Project Year 2		TOTAL (USD)
	Rate of Unit (USD)	No. of Unit	Rate of Unit (USD)	No. of Unit	APFNet Grant	Counterpart Contribution	APFNet Grant	Counterpart Contribution	
Project staff cost									
Project Director	250/Day	55 Days	50/Day	55 Days	6,875	1,375	6,875	1,375	16,500
Technical Assistant	50 /Day	15 Days			750		750		1,500
Subtotal					**7,625**	**1,375**	**7625**	**1,375**	**18,000**
Consultancy cost									
Biometrician	250/Day	31 Days	50/Day	31 Days	4,250	850	3,500	700	9,300
Remote Sensing Expert	250/Day	33 Days	50/Day	33 Days	2,500	500	5,750	1,150	9,900
Data Analysts	250/Day	76 Days	50/Day	76 Days	7,500	1,500	11,500	2,300	22,800
Dendrochronologist	250/Day	14 Days	50/Day	14 Days	2,500	500	1,000	200	4,200
Tree ID expert	250/Day	41 Days	50/Day	41 Days	6,250	1,250	4,000	800	12,300
Subtotal					**23,000**	**4,600**	**25,750**	**5,150**	**58,500**
Travel and related cost									
Air tickets	200/Day	48 Days			3,000		6,600		9,600
DSA	65/Day	241 Days			7,280		8,385		15,665
Hotel	50/Day	501 Days			15,600		9,450		25,050
Meeting and training cost[4]									
Room rental for workshop	1500/Room	1 Room					1,500		1,500
PSC meetings	1000/Meeting	2 Meeting			1,000		1,000		2,000

Field activities cost									
Crew chief	50/Day	40 Days			1,250		750		2,000
Field crew	25/Day	320 Days			5,000		3,000		8,000
Local labor	15/Day	160 Days			1,500		900		2,400
Drivers	25/Day	80 Days			1,250		750		2,000
Technical Assistant	50/Day	130 Days			2,800		3,700		6,500
Stakeholder & Focus Group			50/Day	74 Days		2,000		1700	3,700
Van rental	70/Day	80 Days			3,500		2,100		5,600
Van fuel	60/Day	80 Days			3,000		1,800		4,800
Field equipment (increment borer)	700/Unit	4 Units			2,800				2,800
Equipment rental			200/Day	40 Days		3,000		5000	8,000
Carbon analysis	35/Tree	450 Trees			15,750				15,750
Core measurements	5/Core	900 Cores			4,500				4,500
Publication &Dissemination cost									
Technical reports translation & printing	7000/Report	2 Reports					14,000		14,000
Workshop participants (GOT salary for participants)			50/Day	40 Days				2,000	2,000
Website			2000/Domain	1 Domain		2,000			2,000
Brochure			21/Copies	100 Copies				100	100
Office Operation cost									
Office supply	120/Month	12 Months			1,440		1,440		2,880
Project administration fee (about 10% of APFNet budget charged by Kasetsart University)						11,000		11,000	22,000
Procurement									
Notebook computer	1000/Unit	1 Unit			1,000				1,000
Monitoring, evaluation and audit cost									
Monitoring and external evaluation (retained by APFNet)	8000/Time	1 Time					8,000		8,000
Financial audit	2000/Time	2 Times				2,000		2,000	4,000
Miscellaneous									
Incidentals					500		500		1,000
Subtotal					**71,170**	**22,080**	**63,875**	**19,800**	**176,925**
TOTAL					**101,795**	**27,975**	**97,250**	**26,325**	**253,345**

Table 5. Workload (inputs) by project activity. (Note: "d" is day, "md" is man-day and "m" is month; see Section 3 for description of the project outputs and activities; "PD" is Project Director and "DSA" is daily subsistence allowance)

Outputs & Activities	Inputs	
	Item, Units	**Quantity**
Output 1:		
Activity 1.1		
	PD, md	10
	Stat. Modeller, md	5
	Data Analysts, md	14
	TreeId expert, md	25
	Crew Chief, md	25
	Inv. Assist., md	200
	Labor, md	100
	Driver, md	50
	Tech. Asst, md	42
	DSA (PD), d	10
	DSA (TreeIDExp.), d	25
	DSA (Stkholders), d	40
	DSA (Other experts), d	12
	DSA (Crew Chief), d	25
	Air ticket (PD)	3
	Air ticket (Experts)	4
	Air tickets (Stkhlders)	8
	Hotel (PM), d	10
	Hotel (TreeIDExpt), d	25
	Hotel (Experts), d	12
	Hotel (Stkhldrs), d	40
	Hotel (Inv. Asst.), d	200
	Hotel (Crew Chief), d	25
	Notebook computer, unit	1
	Car rental, d	50
	Fuel, d	50
	Increment borer, unit	4
Activity 1.2		
	Data Analysts, md	8
	Techn. Asst., md	5
Activity 1.3		
	Stat. Modeller, md	12
	Techn. Asst.	5
Activity 1.4		

Outputs & Activities	Inputs	
	Item, Units	**Quantity**
	Stat. Modeller, md	5
	Techn. Asst., md	5
	Data Analysts, md	4
Output 2:		
Activity 2.1		
	RS. Modeller, md	10
	Techn. Asst, md	4
Activity 2.2		
	RS Modeller, md	12
	Techn. Asst, md	4
Activity 2.3		
	PD, md	3
	RS Modeller, md	3
	Data Analysts, md	10
	TreeId expert, md	15
	Crew Chief, md	15
	Inv. Assist., md	90
	Labor, md	60
	Driver, md	30
	Tech. Asst, md	40
	DSA (PD), d	3
	DSA (TreeIDExp.), d	15
	DSA (Stkholders), d	3
	DSA (Other experts), d	12
	DSA (Crew Chief), d	15
	Air ticket (PD)	1
	Air ticket (Experts)	4
	Air tickets (Stkhlders)	8
	Hotel (PM), d	3
	Hotel (TreeIDExpt), d	15
	Hotel (Experts), d	12
	Hotel (Stkhldrs), d	24
	Hotel (Inv. Asst.), d	120
	Hotel (Crew Chief), d	15
	Car rental, d	30
	Fuel, d	30
Activity 2.4		
	RS Modeller, md	5
	Techn. Asst, md	4
Output 3:		
Activity 3.1		

Outputs & Activities	Inputs	
	Item, Units	**Quantity**
	Data Analysts, md*	4
	Tech. Asst, md	40
Activity 3.2		
	Data Analysts, md	4
	Tech. Asst, md	2
	Stat. Modeller, md	1
	DSA (Focus Group), d	10
Activity 3.3		
	Data Analysts, md	4
	Tech. Asst, md	2
	Stat. Modeller, md	5
Output 4:		
Activity 4.1		
	Data Analysts, md	10
	Tech. Asst, md	4
Activity 4.2		
	PD, md	1
	Stat. Modeller, md	1
	RS Modeller, md	1
	Data Analysts, md	4
	Tech. Asst, md	4
	TreeIDExpert, md	1
	Air ticket (Wrkshop travel)	20
	DSA (Workshop), d	40
	DSA (PD), d	1
	DSA (Experts), d	8
	DSA (TreeID Expert), d	1
	Print handouts, unit	50
	Room rental, unit	1
Activity 4.3		
	Data Analysts, md	2
	Tech. Asst, md	3
Activity 4.4		
	Data Analysts, md	4
	Tech. Asst, md	4
	Stat. Modeller, md	2
	RS Modeller, md	2
	Publications, unit	4
Activity 4.5		
	Website, domain	1
	Brochure, number copies	100

Outputs & Activities	Inputs	
	Item, Units	**Quantity**
NON-ACTIVITY BASED		
	PD (management), md	55
	Techn. Assist. (management), md	30
	Office Supply, m	24
	PSC meetings, unit	2

*As explained in Table 4, the two Data Analysts shall spend two days each, 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.

ANNEX H: CURRICULUM VITAE OF PROJECT STAFF AND CONSULTANTS

1. Project Director

1.1 Name:

Assist. Prof. Dr. Khwanchai Duangsathaporn

1.2 Date and Place of Birth:

23 April 1972, Surin Province, Thailand

1.3 Nationality:

Thai

1.4 Present positions:

Head, Department of Forest Management, Kasetsart University Faculty of Forestry (KUFF).

1.5 Mailing Address:

Department of Forest Management
Faculty of forestry, Kasetsart University
50 Ngamwongwan Road, Chatuchak District
Bangkok, Thailand, 10900
Tel. : (66 2) 5790174, (66 2) 9428372, Mobile: 089-8272110
Fax : (66 2) 9428108
E-mail : fforkcd@ku.ac.th

1.6 Permanent Address:

97/28, Soi Saimai 61, Saranrom Park, Saimai Road, Saimai District
Bangkok, Thailand, 10220

1.7 Educational background:

Year	*Degree*	*Major*	*University*
1991 – 1995	B.Sc. (Forestry)	Forest Management	Kasetsart University, Thailand
1995 – 1999	M.Sc. (Forestry)	Forest Management	Kasetsart University, Thailand
2001 – 2005	Ph.D. (Forestry)	Forest Management	Kasetsart University, Thailand

1.8 Administrative Experience:

April 2006 – March 2010	Secretary of Administrative Board, Faculty of Forestry, Kasetsart University
April 2010 – November 2010	Deputy Head, Department of Forest Management, Faculty of forestry, Kasetsart University
November 2010 – January 2011	Acting Head, Department of Forest Management, Faculty of forestry, Kasetsart University
2011 – 2013	Deputy Director, Forest Research Center, Faculty of forestry, Kasetsart University
March 2011 – November 2014	Deputy Head, Department of Forest Management, Faculty of forestry, Kasetsart University
August 2014 – Present	Advisor of Internal Security Operations Command of Thailand (ISOC) Division No. 4.
November 2014 – Present	Sub – Committee on Natural Resources and Environment, National Legislative Assembly
November 2014 – Present	Head, Department of Forest Management, Kasetsart University Faculty of Forestry

1.9 Professional training:

Year	***Topic/Institution***
2001	**Planning**/ National Institute of Development Administration, Thailand.
2002	**Optimization Technique in Product Development**/ Kasetsart University,Thailand.
2003	**Strategic Management and Vision for Planning**/

2004	**Sustainable Land Use and Management in South And East Asia**/ Chulalongkorn University, GTZ and WBI.
2005 and 2006	**Methods of Dendrochronology**/ Columbia University, New York, USA.
2008	**Forestry Policy Education Project**/ SEANAFE and RECOFTC
2012	**Quality Management System, Auditor/Lead Auditor, Course No. A17038**/ SGS United Kingdom Ltd.
2012	**Introduction & Awareness ISO 14001:2004**/ SGS Thailand Limited.
2012	**SGS Qualifor FSC FM Lead Auditor's course (e-learning)**/SGS South Africa (Pty) Ltd.
2012	**SGS Qualifor FSC FM Lead Auditor's course (Face to Face)**/SGS South Africa (Pty) Ltd.

1.10 Expertise and interest:

1) Dendrochronology
2) Forest Inventory and Monitoring
3) Forest Policy and Planning

1.11 Teaching experience:

1) Dendrochronology
2) Forest Mensuration
3) Forest Biometry
4) Natural Resource Sampling Methods
5) Advanced Forest Biometry
6) Field Forest Resource Inventory
7) Principles of Forest Management
8) Forest Resource Management Planning
9) Sustainable Timber Management
10) Forest Certification
11) Policy and Strategy in Sustainable Natural Resource Management
12) Forest Law & Administration
13) Natural Resource Policy

1.12 Summary of research experience (2000-Present):

- 2000-2005 Management planning for teak plantation in Thailand (Project leader)

- 2004-2006 Application of tree ring analysis to teak plantation management in Thailand. (Project leader)

- 2005-2008 Tree ring reconstructions of Asian monsoon climate dynamics (Co-research)

- 2006-2007 Structure and growth of teak in plantation and enrichment planting in natural forest (Project leader)

- 2006- 2008 Teak growth assessment in plantations of Forest Industry Organization (Advisor)

- 2007-2008 Management Plan of Phukhieo- Nam Nao Forest Complex, Thailand. (Co-research)

- 2007- 2009 Collaborative studies in tropical Asian dendrochronology: addressing challenges in climatology and forest ecology. (Co-research, supported by APN)

- 2008- 2010 A study on past climate change in the northeast of Thailand by using tree ring analysis (Project leader)

-2010-2011 The Master Plan for Watershed Management of Thailand. (Co-research)

- 2010- 2011 Carbon Sequestration of timber product in teak plantation (Project leader)

- 2010-2010 Quality evaluation of Touchwood Forestry Company Limited's agarwood plantations in prachinburi province, Thailand (Project leader)

- 2011- 2011 Growth and yield estimation of aquilaria trees under managed plantations in Thailand (Project leader)

- 2010- 2014 Impact of climate change on teak growth in natural forest, the North of Thailand. (Project leader)

- 2012 – 2014 Influence of Fire on Tree Growth in Tropical Deciduous Forest at Huai Kha Khaeng Wildlife Sanctuary. (Project leader)

- 2012- 2013 REDD Readiness Preparation Proposal (REDD R-PP) for Thailand (Component leader: REDD-plus Strategy)

- 2013 -2013 The Development of Community Forestry in Thailand (The country reports commissioned for the study on Community

Forestry in Asia and the Pacific: Pathway to Inclusive development (Project leader)

- 2014 – 2015 Investigate the Growth Patterns and Carbon Sequestration of

Natural and Planted Teak to Support Sustainable Forest Management in Northern Thailand. (Project leader)

- 2014 – 2015 The Thailand Master Plan for Forest Resources Protection and Administration. (Co-research and Committee)

- 2014 – 2015 The National Strategic Plan for Forest Land Administration and Conflict Resolution. (Project leader)

- 2015– Present A Study of the Growth Patterns of Major Tree Species under Climate Variability in Nakhon Ratchasima Province. (Project leader)

1.13 Papers (2000-Present):

1) Skulmeerit, C and Duangsathaporn, K. 2000. Effects of Thinning on Growth of *Pinus kesiya* Royle ex Gordon at Bo Luang Plantation, Amphoe Hot, Changwat Chiang Mai. Journal of Thai Forestry Research, Vol. 2 No. 1. Bangkok, Thailand.

2) Prasomsin, P. and Duangsathaporn, K. 2005. Field Forest Mensuration. Faculty of forestry, Kasetsart Univ., Bangkok. Thailand. 93 p.

3) Duangsathaporn, K. and Prasomsin, P. 2005. Tree Ring Analysis for Estimating Teak Growth in a Forest Plantation. Mahasarakham University annual conference. Mahasarakham,Thailand.

4) Duangsathaporn, K. and Prasomsin, P. 2005. Application of Linear Programming in Forestry: Management Planning for a Forest Plantation. Co-operative Research Network conference. Bangkok, Thailand.

5) Duangsathaporn, K., Prasomsin, P and Buckley, B.M. 2006. Application of tree ring analysis to teak plantation management in Thailand. 7thInternational Conference on Dendrochronology, June 11-17, 2006 Beijing, China.

6) Buckley, B.M., Duangsathaporn, K., Palakit, K., Butler, S., Syhapanya, V., Xaybouangeun, N., 2007. Analyses of growth rings of Pinus merkusii from Lao P.D.R. For. Ecol. Manage. Volume 253, Issues 1-3, 15 December, 2007, Pages 120-127.

7) Buckley, B.M., Palakit, K., Duangsathaporn, K., Sanguanthum, P., Prasomsin, P., 2007. Decadal scale droughts over northwestern Thailand over the past 448 years: link to the tropical Pacific and Indian Ocean sectors. Clim. Dynam. Volume 29, Number 1 / July, 2007.

8) Palakit, K. and Duangsathaporn, K. 2008. Climatic Signals Derived from Pine (*Pinus merkusii*) in Easternmost Thailand. FORTROP II International Conference "Tropical Forestry Change in a Changing World" November 17-20 2008. Kasetsart University, Bangkok, Thailand.

9) Lumyai, P. Duangsathaporn,K. Diloksumpun,S. Palakit, K. and Srinoppawan, K. 2008. Pine growth variation and its climate response: The challenges for climatic reconstruction in central Thailand. FORTROP II International Conference "Tropical Forestry Change in a Changing World" November 17-20 2008. Kasetsart University, Bangkok, Thailand.

10) Phatsong,S. and Duangsathaporn,K. 2010. Culm Utilization and Growing Stock in Natural Forest of *Dendrocalamus membranaceus* Munro : A Case of Huay Mae Hin Forest, Ngao District, Lampang Province. The 49th Kasetsart University Annual Conference, 3-6 February 2010. Kasetsart University, Bangkok, Thailand.

11) Arunsripradit,T., Jintana, V. and Duangsathaporn,K. 2010. Some Environmental Factors Relating Growth of *Avicennia alba* Bl. and *Avicennia marina* (Forsk.) Vierh. The 49th Kasetsart University Annual Conference, 3-6 February 2010. Kasetsart University, Bangkok, Thailand.

12) Tongson, P., Duangsathaporn,K. and Prasomsin P. 2011. Yield assessment of tree resources outside the forest using sector sampling: a case study of a public park, Bangkok metropolis, Thailand. Kasetsart J. (Nat.Sci.) 45: 396-403. (Corresponding author)

13) Palakit, K., S. Siripattanadilok, and K. Duangsathaporn. 2012. False ring occurrences and their identification in teak (Tectona grandis L.F.) in northeastern Thailand. Journal of Tropical Forest Science. 24(3): July 2012. (in press)

14) Duangsathaporn, K. and k, Palaki. 2013. Climatic Signals Derived from the Growth Variation and Cycles of *Pinus merkusii* in Easternmost Thailand.
Thai Journal of Forestry.

15) Dugchalerm, S., K. Duangsathaporn, and P. Prasomsin. 2014. A Study on Forest Inventory Techniques for Non-Timber Forest Products (NTFPs) Inventory in Ban Chong Khaeb Samakkhi Community Forest, Sai Yok District, Kanchanaburi Province. Journal of Forest Management 8(16).

16) Palakit, K., K. Duangsathaporn., S. Siripattanadilok, and P. Lumyai. 2015. Effects of Climate Variability on Monthly Growth of *Aglaia odoratissima* and *Hydnocarpusilicifolia* at the Sakaerat Environmental

Research Station (SERS), Northeastern Thailand. *Environment and Natural Resources J. Vol 13, No.1.*

17) Sikareepaisarn, P., K. Duangsathaporn, Y. Omule, P. Prasomsin and P. Lumyai. 2014. Comparison of Trees Growth Measurement Using Diameter Tape and Manual Band Dendrometer. Science and Technology RMUTT Journal.
Vol.4 No.2.

2. Tree species ID expert

2.1 Name:

Dr. Kritsadapan Palakit

2.2 Date and Place of Birth:

29 December 1978, Phang-nga Province, Thailand

2.3 Nationality:

Thai

2.4 Present positions:

Lecturer, Faculty of Environment and Resources Studies, Mahidol University

2.5 Mailing Address:

Educational, Research and Environment Technology Initiative Center
Faculty of Environment and Resource Studies, Mahidol University
2, Moo 6, Mae Tha Sub-district, Mae Tha District
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2.6 Permanent Address:

116, Moo 1, Thapput Sub-district, Thapput District
Phang-nga Province, Thailand, 82180

2.7 Educational background:

Year	*Degree*	*Major*	*University*
1996 – 1999	B.Sc.	Environmental Science and Technology	Mahidol University, Thailand
2001 – 2004	M.Sc.	Technology of Environmental Management	Mahidol University, Thailand
2006 – 2013	Ph.D. (Forestry)	Forest Ecology	Kasetsart University, Thailand

2.8 Administrative Experience:

-

2.9 Professional training:

Year	*Topic/Institution*
2003	Methods of Dendrochronology. Columbia University, New York, USA: 6 Weeks
2005	Advance Methods in Dendrochronology. Columbia University, New York, USA: 3 Months

2.10 Expertise and interest:

1) Dendrochronology and its applications (i.e. Climatic modeling from tree-ring analysis)
2) Environmental science
3) Forest ecology and environment
4) Tree and wood anatomy

2.11 Teaching experience:

1) Life and Environment
2) Ecology

2.12 Summary of research experience (2000-Present):

-

2.13 Papers (2000-Present):

1) **Palakit, K.**, N. Pumijumnong, D. Singharatchawanlop, and A. Rienprapan. 2002. Relationship between tree-ring of *Pinus merkusii* and

climate data. Regional conference on long-term ecological research (LTER) in East Asia. 29-30 July 2002. Faculty of Forestry, Kasetsart University, BKK.

2) **Palakit, K.**, N. Pumijumnong, and B. Buckely. 2004. Dendroclimatilogical studies in Teak : a case study at Mae hong son provice, Thailan. Environment and Natural Resources Journal. 2: 71-80. (in Thai)

3) **Palakit, K.,** B. Buckely, K. Duangsathaporn, E.R. Cook, P. Sanguantham, P. Prasomsin, and N. Pumijumnong. 2006. Dendroclimatic investigations with teak from Thailand: A 448 yr extended chronology and its climate-growth response. 7th International Conference on Dendrochronlogy: Cultural Diversity, Environmental Variability. 11-17 June 2006. Beijing. China.

4) Buckley, B.M., **K. Palakit,** K. Duangsathaporn, P. Sanguantham, and P. Prasomsin, 2007. Decadal scale droughts over northwestern Thailand over the past 448 years: links to the tropical Pacific and Indian Ocean sectors. Climate Dynamics. 29: 63-71.

5) Buckley, B.M., K. Duangsathaporn, **K. Palakit,** S. Butler, V. Syhapanya, and N. Xaybouangeun, 2007. Analyses of growth rings of *Pinus merkusii* from Lao P.D.R. Forest Ecology and Management. 253: 120-127.

6) **Palakit, K.,** and K. Duangsathaporn, 2008. Climatic signals derived from pine (*Pinus merkusii*) in easternmost Thailand. FORTROP II International Conference "Tropical Forestry Change in a Changing World" November 17-20 2008. Kasetsart University, Bangkok, Thailand.

7) Lumyai, P., K. Duangsathaporn, S. Diloksumpun, **K. Palakit,** and K. Srinoppawan, 2008. Pine growth variation and its climatic response: The challenges for climatic reconstruction in central Thailand. FORTROP II International Conference "Tropical Forestry Change in a Changing World" November 17-20 2008. Kasetsart University, Bangkok, Thailand.

8) **Palakit, K.**, S. Siripattanadilok and K. Duangsathaporn. 2012. Internal and external factors affecting tree-ring formation of six tree species in northeastern Thailand. Proceedings in 1st ASEAN Plus Three Graduate Research Congress. 1-2 March 2012. Chiang Mai, Thailand.

9) **Palakit, K.**, S. Siripattanadilok and K. Duangsathaporn. 2012. False ring occurrences and their identification in teak (Tectona grandis) in north-eastern Thailand. Journal of Tropical Forest Science. 24(3): 387-398.

10) **Palakit, K.**, K. Duangsathaporn, and S. Siripatanadilok. 2013. Leaf phenology and climatic factors influencing monthly wood increment of teak. National Forest Conference: Forestry for Society. 6-8 March 2013.

Faculty of Forestry, Kasetsart University. BKK.

11) **Palakit, K.**, K. Duangsathaporn, S. Siripatanadilok, S. Ritthisorna, W. Chumworathayeea, J. Teekaa, and K. Bunpa. 2014. Effects of climate variability on growths of two dominant tree species with lower canopy at the Sakaerat Environmental Research Station (SERS), Nakhon Ratchasima province, Thailand. The 1st Environment and Natural Resources International Conference (ENRIC 2014). 6-7 November 2014. BKK, Thailand.

12) **Palakit, K.,** K. Duangsathaporn, S. Siripatanadilok and P. Lumyai. 2015. Effects of Climate Variability on Monthly Growth of *Aglaia odoratissima* and *Hydnocarpus ilicifolia* at the Sakaerat Environmental Research Station (SERS), Northeastern Thailand. Environment and Natural Resources J. 13(1): 1-12.

3. Remote Sensing expert

3.1 Name:

Associate Prof. Mr. Prasong Saguantam

3.2 Date and Place of Birth:

5 July 1955, Bangkok Province, Thailand

3.3 Nationality:

Thai

3.4 Present positions:

Instructor

3.5 Mailing Address:

Department of Forest Management
Faculty of forestry, Kasetsart University
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3.6 Permanent Address:

222/234 Viphavadee Rd. Soi 60. Talad Bangkane, Laksi District,
Bangkok, 10210

3.7 Educational background:

Year	*Degree*	*Major*	*University*
1975 – 1978	B.Sc.(Forestry)	Forest Management	Kasetsart University, Thailand
1979 – 1982	M.Sc.(Forestry)	Forest Management	Kasetsart University, Thailand

3.8 Administrative Experience:

Year	*Topic/Institution*
November 26, 2002 - November 25, 2006	Head, Department of Forest Management, Faculty of Forestry, Kasetsart University

3.9 Professional Training:

1) Training Course on Vegetation Analysis and Remote Sensing Techniques.May 7- June 17, 1982. BTOTROP, Bogor, Indonesia.

2) Tenth UN/FAO International Training Course on Remote Sensing Applied to Monitoring Forest Land. May 6-13, 1985. FAO, Rome, Italy.

3) Forest Inventory in Tropical Countries. September 20-October 19,1989. SUAS/SIDA. Sweden.

4) Application of Remote Sensing and GIS in Environment and Natural Resources Management. April 6-May 6, 1992. DSE, Feldafing, Germany.

3.10 Conference/Workshop

1) UNDP/ESCAP Regional Conference on Multi-Level Remote Sensing for Forestry Application. October 8-12, 1984, Manila, Philippines.

2) IDRC/TTD Workshop on Resources Inventory by Remote Sensing. September6-23, 1987. Peking University, Beijing, People Republic of China.

3) The Symposium on Joint Research Project on the Enhancement and Application of the Remote Sensing Technology between ASEAN Countries and Japan. February 5-7, 1991. STA/RESTEC/NRCT, Bangkok.

4) European International Space Year Conference 1992. March 30-April 4,1992.CEC/ESA/DARA, Munich, Germany.

5) Workshop on SAR Data Analysis and Application. March 2-4,

1993. NRCT/NASDA. Bangkok.

6) IGBP Workshop on Methodology for Land use and Land cover Changes. March 21-25, 1994. UNDP/GEF. Chiang Mai, Thailand.

7) Expert Consultation on Forest Resources Monitoring System. February 27- March 3, 1995. FAO/RAPA. Bangkok, Thailand.

8) GIS AM/FM Asia'95. August 21-24, 1995. AARS/AIT.NRCT/GISA. Bangkok, Thailand.

9) Japanese Satellite Data Utilization and Application. February 29,2000.NRCT/NASDA. Bangkok, Thailand.

10) NPUST-KU Bilateral Conference 2004.8-12 November 2004. National *Pintung.* University of Science and Technology, Taiwan.

11) EADS Astrium (France) and GISTDA.2005.Workshop on the Application of SPOT and THEOS Data.27-28 January 2005. Bangkok.

12) Japan Aerospace Exploration Agency (JAXA) and GISTDA.2005.The 2 nd Seminar on Advanced Land Observing Satellite (ALOS) Pilot Project in Thailand. February 22, 2005. Bangkok.

3.11 Teaching experience:

Year	***Subject***	***University***
1982-2015	1. Principles of remote Sensing 2. Aerial Photogrammetry and Photo-interpretation 3. Passive and Active Remote Sensing 4. Satellite Imagery for Resources Survey 5. Field Forest Inventory	Kasetsart University, Thailand

3.12 Summary of research experience (2000-Present):

Year	***Subject***	***Funding Source***
2008	Thailand Forest Area Mapping	The Royal Forest department
2012	Landuse for Peat Swamp Forest Assessment after 2012 Forest Fire by THEOS Image	Kasetsart University
2013	Fuel Mapping for Forest Fire Risk in Peat Swamp Forest	Research Council National

3.13 Papers (2000-Present):

1) Buckley, B.M., Palakit, K., Duangsathaporn, K., **Sanguanthum, P**., Prasomsin, P., 2007. Decadal scale droughts over northwestern Thailand over the past 448 years: link to the tropical Pacific and Indian Ocean sectors. Clim. Dynam**.** Volume 29, Number 1 / July, 2007.

4. Biometrician

4.1 Name:

Associate Prof. Dr. Patsi Prasomsin

4.2 Date and Place of Birth:

16 January 1962, Roi Et Province, Thailand

4.3 Nationality:

Thai

4.4 Present positions:

-Associate Professor at. Department of Forest Management, Kasetsart University Faculty of Forestry (KUFF).
-Assistant to the President, Kasetsart University

4.5 Mailing Address:

Department of Forest Management
Faculty of forestry, Kasetsart University
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Bangkok, Thailand, 10900
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Fax : (66 2) 9428108
E-mail : fforpsp@ku.ac.th

4.6 Permanent Address:

10/185 Nawamin 93 Bueng Kum, Bangkok 10240, Thailand
Tel (662) 379-2062

4.7 Educational background:

Year	*Degree*	*Major*	*University*
1981 – 1985	B.Sc. (Forestry)	Forest Management	Kasetsart University, Thailand
1986 – 1988	M.Sc. (Forestry)	Forest Management	Kasetsart University, Thailand
1991 – 1995	Dr. rer.nat.	Forest Biometry and Inventory	University of Freiburg, Freiburg i.Br., Germany

4.8 Expertise and interest:

1) Forest Biometry
2) Forest Inventory
3) Forest Management

4.9 Teaching experience:

1) Forest Biometry
2) Forest Mensuration
3) Advanced Forest Biometry
4) Natural Resource Inventory
5) Field Natural Resource Inventory
6) Methods of Forest Resource Inventory
7) Forest Growth and Yield Modeling
8) Mathematical Programming for Forest Resource Management
9) Forest Resource Management

4.10 Summary of research experience (2000-Present):

2004-2006	Application of tree ring analysis to teak plantation management in Thailand. (Co-research)
- 2006-2007	Structure and growth of teak in plantation and enrichment planting in natural forest (Co-research)
- 2006- 2008	Teak growth assessment in plantations of Forest Industry Organization (Advisor)
- 2008- 2010	A study on past climate change in the northeast of Thailand by using tree ring analysis (Co-research)
- 2010- 2011	Carbon Sequestration of timber product in teak plantation (Co-research)
- 2010- 2014	Impact of climate change on teak growth in natural forest, the North of Thailand. (Co-research)
- 2014 – Present	Investigate the Growth Patterns and Carbon Sequestration of Natural and Planted Teak to Support Sustainable Forest Management in Northern Thailand. (Co-research)
- 2014 – Present	To demonstrate the development and application of standing-tree carbon equations to improve the accuracy of forest-cover

carbon stock estimates in Thailand. (Co-research, supported by Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet)

- 2014– Present A Study of the Growth Patterns of Major Tree Species under Climate Variability in Nakhon Ratchasima Province. (Co-research)

- 2014 – Present The National Strategic Plan for Forest Land Administration and Conflict Resolution. (Co-research)

1.11 Papers (2000-Present):

1) **Prasomsin, P.** and Duangsathaporn, K. 2005. Field Forest Mensuration. Faculty of forestry, Kasetsart Univ., Bangkok. Thailand. 93 p.

2**)** Duangsathaporn, K. and **Prasomsin, P.** 2005. Tree Ring Analysis for Estimating Teak Growth in a Forest Plantation. Mahasarakham University annual conference. Mahasarakham,Thailand.

3**)** Duangsathaporn, K. and **Prasomsin, P.** 2005. Application of Linear Programming in Forestry: Management Planning for a Forest Plantation. Co-operative Research Network conference. Bangkok, Thailand.

4) Duangsathaporn, K., **Prasomsin, P** and Buckley, B.M. 2006. Application of tree ring analysis to teak plantation management in Thailand. 7th International Conference on Dendrochronology, June 11-17, 2006 Beijing, China.

5) Buckley, B.M., Palakit, K., Duangsathaporn, K., Sanguanthum, P., **Prasomsin, P**., 2007. Decadal scale droughts over northwestern Thailand over the past 448 years: link to the tropical Pacific and Indian Ocean sectors. Clim. Dynam**.** Volume 29, Number 1 / July, 2007.

6) Tongson, P., Duangsathaporn,K. and **Prasomsin P**. 2011. Yield assessment of tree resources outside the forest using sector sampling: a case study of a public park, Bangkok metropolis, Thailand. Kasetsart J. (Nat.Sci.) 45: 396-403.

7) Gunthasorn, P., **Prasomsin, P.** and K. Duangsathaporn. 2011. Growth of Teak(*Tectona grandis L.f.)* in Unthinned Plantation. Thai J. For. 30(1) : 57-65.

5. Data analysis (1)

5.1 Name:

Mr.Pichit Lumyai

5.2 Date and Place of Birth:

18 August 1984, Nakhon Pathom province, Thailand

5.3 Nationality:

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5.4 Present positions:

-Lecturer at Department of Forest Management, Kasetsart University Faculty of Forestry (KUFF).
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5.7 Educational background:

Year	***Degree***	***Major***	***University***
2003 – 2006	B.Sc. (Forestry)	Forest Resource Management	Kasetsart University, Thailand
2007 – 2008	M.Sc. - (Forest Resource Management)	Forest Resource Management	Kasetsart University, Thailand

M.Sc. Thesis: Climatic Effects on Growth of *Pinus merkusii* Jungh. & de Vriese in Phutoei National Park, Suphan Buri Province.

2010 – Present Ph.D. (Forestry) Forest Resource Kasetsart University,

Management Thailand

Ph.D. Thesis: Impact of climate variability on growth of Teak in natural forest

in Northern Thailand (in progress).

5.8 Administrative Experience:

-

5.9 Professional training:

Year	*Topic/Institution*
2012	Participated in Short Term Intensive Course in International Environment Leaders Training for Sustainable Living with Environmental Risk . (16 – 29 September 2012) Yokohama National University, Japan.

5.10 Expertise and interest:

1) Forest Biometry
2) Forest Resources Inventory
3) Dendrochronology

5.11 Teaching experience:

1) Forest Biometry
2) Advanced Forest Biometry
3) Natural Resource Sampling Methods
4) Dendrochronology
5) Principles of Forest Management
6) Sustainable Timber Management
7) Forest Law & Administration
8) Field Forest Mensuration
9) Field Forest Resource Inventory
10) Field Forest Management

5.12 Experience

1) Staff in Southeast Asian Dendrochronology (SEA-DENDRO) Workshop.(24 – 26 May 2006) Faculty of Forestry, Kasetsart University.
2) Participated in the FORTROP II International Conference, Tropical Forestry CHANGE IN A CHANGING WORLD. (17 – 20 November 2008) Kasetsart University.
3) Teacher assistance in The Laboratory of Tropical Dendrochronology Faculty of Forestry Kasetsart University, Thailand. (Since 2006 to present).
4) Participated in Short Term Intensive Course in International Environment Leaders Training for Sustainable Living with Environmental Risk. (16 – 29 September 2012) Yokohama National University, Japan.

5) Staff in Short Term Training Course on Dendrochronology. (4-8 February 2013) Faculty of Forestry, Kasetsart University.

5.13 Summary of research experience:

- 2013 – 2014 Research for Wang Nam Keaw Demonstration Forest Development Plan. (Co-research)

- 2014 – Present To demonstrate the development and application of standing- tree carbon equations to improve the accuracy of forest-cover carbon stock estimates in Thailand. (Data analysis, supported by Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet)

- 2014– Present A Study of the Growth Patterns of Major Tree Species under Climate Variability in Nakhon Ratchasima Province. (Co-research)

- 2015 – Present Paleoclimate Evaluation by using Dendrochronology Technique on Highland for Water Conservation in Royal Project Area. (Project leader)

5.14 Papers:

1) **Lumyai, P**., K. Duangsathaporn, S. Diloksumpun, K. Palakit**,** and K. Srinoppawan, 2008. Pine growth variation and its climatic response: The challenges for climatic reconstruction in central Thailand. FORTROP II International Conference.

2) **Lumyai, P**., K. Duangsathaporn. 2013. 230 years temperature reconstructed from Pine annual rings in central Thailand. Nation Forestry conference.

3) **Lumyai, P**., K. Duangsathaporn, 2014. Climatic Effects on Teak Growth in Northern Thailand. (Poster sessions). XXIV IUFRO World Congress.

4) Palakit, K**.,** K. Duangsathaporn, S. Siripatanadilok and **P. Lumyai**. 2015. Effects of Climate Variability on Monthly Growth of *Aglaia odoratissima* and *Hydnocarpus ilicifolia* at the Sakaerat Environmental Research Station (SERS), Northeastern Thailand. Environment and Natural Resources J. 13(1): 1-12.

6. Data analysis (2)

6.1 Name:

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6.2 Date and Place of Birth:

29 June 1988, Nakhon Ratchasima Province, Thailand

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6.4 Present positions:

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6.7 Educational background:

Year	***Degree***	***Major***	***University***
2006 – 2010	B.Sc. (Forestry)	Forest Resource Management	Kasetsart University, Thailand
2011 – 2015	M.Sc. (Forest-Resource Management)	Forest Resource Management	Kasetsart University, Thailand

M.Sc. Thesis: Influence of Climatic Factors on the Growth of Major Tree Species in Mixed Deciduous Forest at Huai Kha Khaeng Wildlife Sanctuary, Uthai Thani Province

6.8 Administrative Experience:

-

6.9 Professional training:

-

6.10 Expertise and interest:

1) Forest Biometry
2) Dendrochronology
3) Forest Inventory

6.11 Teaching experience:

-

6.12 Experience :

1) Teacher assistance in The Laboratory of Tropical Dendrochronology Faculty of Forestry Kasetsart University, Thailand. (Since 2011 to present).
2) Staff in Short Term Training Course on Dendrochronology. (4-8 February 2013) Faculty of Forestry, Kasetsart University.

6.13 Summary of research experience :

-

6.14 Papers :

1) **Sikareepaisarn, P**. , K. Duangsathaporn , O. Yenemurwon , P. Prasomsin and P. Lumyai, 2014. Comparison of Trees Growth Measurement Using Diameter Tape and Manual Band Dendrometer. Science and Technolagy RMUTT Journal. Vol.4 No.2 (2014) : 51-58

7. Technical Assistant

7.1 Name:

Mr. Narapong Sangram

7.2 Date and Place of Birth:

25 July 1987, Surin Province, Thailand

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7.4 Present positions:

-Master degree student, Kasetsart University Faculty of Forestry (KUFF).

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7.7 Educational background:

Year	*Degree*	*Major*	*University*
2008 – 2010	B.Sc. (Forestry)	Forest Biological Science (Silviculture-option)	Kasetsart University, Thailand
2010 – Present	M.Sc. (Forest-Resource Management)	Forest Resource Management	Kasetsart University, Thailand

M.Sc. Thesis: The Effect of Gas and Particulate Matter from Electricity Generation Process on Teak Growth Surrounding Mae Moh Power Plant, Lampang Province

7.8 Administrative Experience:

-

7.9 Professional training:

-

7.10 Expertise and interest:

1) Forest Policy and Planning
2) Forest Inventory and Monitoring
3) Dendrochronology

7.12 Experience

1) Teacher assistance in The Laboratory of Tropical Dendrochronology

Faculty of Forestry Kasetsart University, Thailand. (Since 2010 to present).

2) Staff in Short Term Training Course on Dendrochronology. (4-8 February 2013) Faculty of Forestry, Kasetsart University.

7.13. Summary of research experience:

-

7.14. Papers (2000-Present):

-

8. Co-technical Assistant

8.1 Name:

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8.2 Date and Place of Birth:

13 November 1991, Lampang Province, Thailand

8.3 Nationality:

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8.4 Present positions:

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Lamphun, Thailand, 51000

8.7 Educational background:

Year	***Degree***	***Major***	***University***
2010 – 2013	B.Sc. (Forestry)	Forest Management	Kasetsart University, Thailand

8.8 Expertise and interest:

1) Forest Policy and Planning

2)Dendrochronology

9. Crew Chief

9.1 Name:

Miss Chokdee Khantawan

9.2 Date and Place of Birth:

04 September 1991, Nakhonsawan Province, Thailand

9.3 Nationality:

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9.4 Present positions:

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9.7 Educational background:

Year	*Degree*	*Major*	*University*
2010 – 2013	B.Sc. (Forestry)	Forest Management	Kasetsart University, Thailand
2014 – Present	M.S. (Forestry Resource Management)	Forest Management	Kasetsart University, Thailand

9.8 Expertise and interest:

1) Dendrochronology
2) Forest Growth