INTERNATIONAL TROPICAL TIMBER ORGANIZATION (ITTO)

REDUCING DEFORESTATION AND FOREST DEGRADATION AND ENHANCING ENVIRONMENTAL SERVICES IN TROPICAL FORESTS (REDDES)

PROJECT DOCUMENT

TITLE	IMPROVING THE QUALITY AND COVERAGE OF THE ESTIMATES OF CARBON STOCKS IN THAILAND'S FORESTS AND TREES OUTSIDE FOREST: PHASE I
SERIAL NUMBER	RED-SPD 039/11 Rev.1 (F)
SUBMITTED BY	GOVERNMENT OF THAILAND
ORIGINAL LANGUAGE	ENGLISH

SUMMARY

This new small project proposal, originating from the Kasetsart University Faculty of Forestry (KUFF), aims to develop and pilot-test methodology to construct new equations to estimate carbon stocks in Thailand's natural forests and tree resources outside forest (TROF). The existing tree carbon equations are inaccurate, the national reporting of carbon stocks is incomplete especially in TROF areas, and there is limited knowledge of the methods and benefits of carbon stock assessment among the potential stakeholders. This project shall contribute to well-informed policy decision-making and balanced public debate on climate change mitigation through carbon sequestration by trees.

Through this Phase I project, Thailand is seeking incremental financial assistance and limited technical support from ITTO to develop and pilot-test methods to construct new tree carbon equations. This project strategy is to construct tree carbon estimation equations for selected major tree species groups in a pilot project area (Ngao Demonstration Forest, Lampang province), and to promote carbon stock assessment methods and benefits through a national workshop. The Phase I project outputs are 1) methodology for constructing new tree carbon equations, and 2) an action plan to develop and promote new national equations for the major tree species groups in Thailand. The project main target beneficiaries are the agencies who report carbon stocks, including the Department of National Parks, Wildlife and Plant Conservation (protected forests), the Royal Forest Department (community forests and other reserve forests), the Forest Industry Organization of Thailand (reserve natural forests in plantations for forest certification), Marine and Coastal Resources Department (mangrove and other coastal forests), and TROF private land owners. Other stakeholders include KUFF, Maejo University, Chiangmai University and Thailand Environment Institute (TEI), who are interested in the information for research and education. The KUFF shall implement this project as it is a neutral agency and has the necessary technical forest inventory expertise.

EXECUTING AGENCY	FACULTY OF FORESTRY (KUFF), THE KASETSART UNIVERSITY		
COOPERATING GOVERNMENTS	-		
DURATION	18 MONTHS		
APPROXIMATE STARTING DATE	TO BE DETERMINED		
BUDGET AND PROPOSED SOURCES OF FINANCE	Source	Contribution in US$	Local Currency Equivalent
	ITTO	**113,373**	
	Gov't of Thailand	44,906	
	TOTAL	**158,279**	

Table of Contents

TABLE OF CONTENTS **2**

LIST OF TABLES **2**

LIST OF FIGURES **3**

LIST OF ABBREVIATIONS AND ACRONYMS **4**

MAP OF PROJECT AREA **5**

PROJECT CONTEXT **6**

1.1 ORIGIN 6
1.2 RELEVANCE 6
1.2.1 Conformity with ITTO's objectives and priorities *6*
1.2.2 Relevance to the submitting country's policies *8*
1.3 TARGET AREA 9
1.4 OUTCOMES AT PROJECT COMPLETION 10

PART 2. PROJECT RATIONALE AND OBJECTIVES **11**

2.1 STAKEHOLDERS ANALYSIS 11
2.2 PROBLEM ANALYSIS 12
2.3 OBJECTIVES 13
2.3.1 Development objective and impact indicators *13*
2.3.2 Specific objective and outcome indicators *13*

PART 3. DESCRIPTION OF PROJECT INTERVENTIONS **14**

3.1 OUTPUTS 14
3.2 ACTIVITIES AND INPUTS 14
3.3 STRATEGIC APPROACHES AND METHODS 14
3.4 WORK PLAN 15
3.5 BUDGET 17

PART 4. IMPLEMENTATION ARRANGEMENTS **23**

4.1 EXECUTING AGENCY AND OGANIZATION STRUCTURE 23
4.2 PROJECT MANAGEMENT 23
4.3 MONITORING AND REPORTING 24

ANNEX 1. PROFILES OF THE EXECUTING AND COLLABORATING AGENCIES **25**

ANNEX 2. TASKS AND RESPONSIBILITIES OF KEY EXPERTS PROVIDED BY THE EXECUTING AGENCY **27**

ANNEX 3. TERMS OF REFERENCE OF PERSONNEL AND CONSULTANTS AND SUB-CONTRACTS FUNDED BY ITTO **28**

ANNEX 4: RESPONSES TO REVIEWER COMMENTS **30**

List of Tables

TABLE 1. EXPLANATION OF THE CONTRIBUTION OF THE PROPOSED PROJECT TO ITTA 2006 OBJECTIVES 7
TABLE 2. RELATIONSHIP OF THE PROPOSED PROJECT TO THE PRIORITY ACTIONS OF ITTO (ITTO ACTION PLAN 2008-2011). 7
TABLE 3. CONFORMITY OF PROPOSED PROJECT WITH REDDES PROGRAMME DELIVERABLES AND MONITORING PROTOCOL. 8
TABLE 4. LAND USE TYPES IN THE NGAO DEMONSTRATION FOREST (NDF) PILOT PROJECT AREA 9
TABLE 5. STAKEHOLDER ANALYSIS TABLE 11
TABLE 6. PROJECT HUMAN RESOURCES, MATERIALS AND FINANCIAL INPUTS, AND RESPECTIVE UNIT COSTS. . 16
TABLE 7. ITTO PROJECT BUDGET BY ACTIVITY 18
TABLE 8. MASTER BUDGET (A CONSOLIDATION OF BUDGET TABLES 6 AND 7) 20
TABLE 9. ITTO YEARLY PROJECT BUDGET 21
TABLE 10. GOVERNMENT OF THAILAND (GOT) YEARLY PROJECT BUDGET 22

List of Figures

FIGURE 1. MAP OF THAILAND (LEFT) AND THE NGAO DEMONSTRATION FOREST (NDF) PILOT PROJECT AREA. 5
FIGURE 2. PROBLEM-TREE. 12
FIGURE 3. OBJECTIVES-TREE. 13
FIGURE 4. PROJECT WORK PLAN 16
FIGURE 5. PROJECT ORGANIZATIONAL CHART. 23

LIST OF ABBREVIATIONS AND ACRONYMS

DNP:	Department of National Parks, Wildlife and Plant Conservation (Thailand)
DSA:	Daily Subsistence Allowance
FIO:	Forest Industry Organization of Thailand
GOT:	Government of Thailand
ITTA:	International Tropical Timber Agreement
ITTO:	International Tropical Timber Organization
KUFF:	Kasetsart University Faculty of Forestry
LTD:	The Laboratory for Tropical Dendrochronology (KUFF)
MCRD:	Marine and Coastal Resources Department (Thailand)
MONRE:	Ministry of Environment and Natural Resources (Thailand)
NDF:	Ngao Demonstration Forest
NGO:	Non-governmental organization
PM:	Project Manager
PMT:	Project Management Team
PTC:	Project Technical Committee
REDDES:	Reducing Deforestation and Forest Degradation and Enhancing Environmental Services
RFD:	Royal Forest Department (Thailand)
SFM:	Sustainable Forest Management
TEI:	Thailand Environment Institute
TROF:	Tree Resources Outside Forest

MAP OF PROJECT AREA

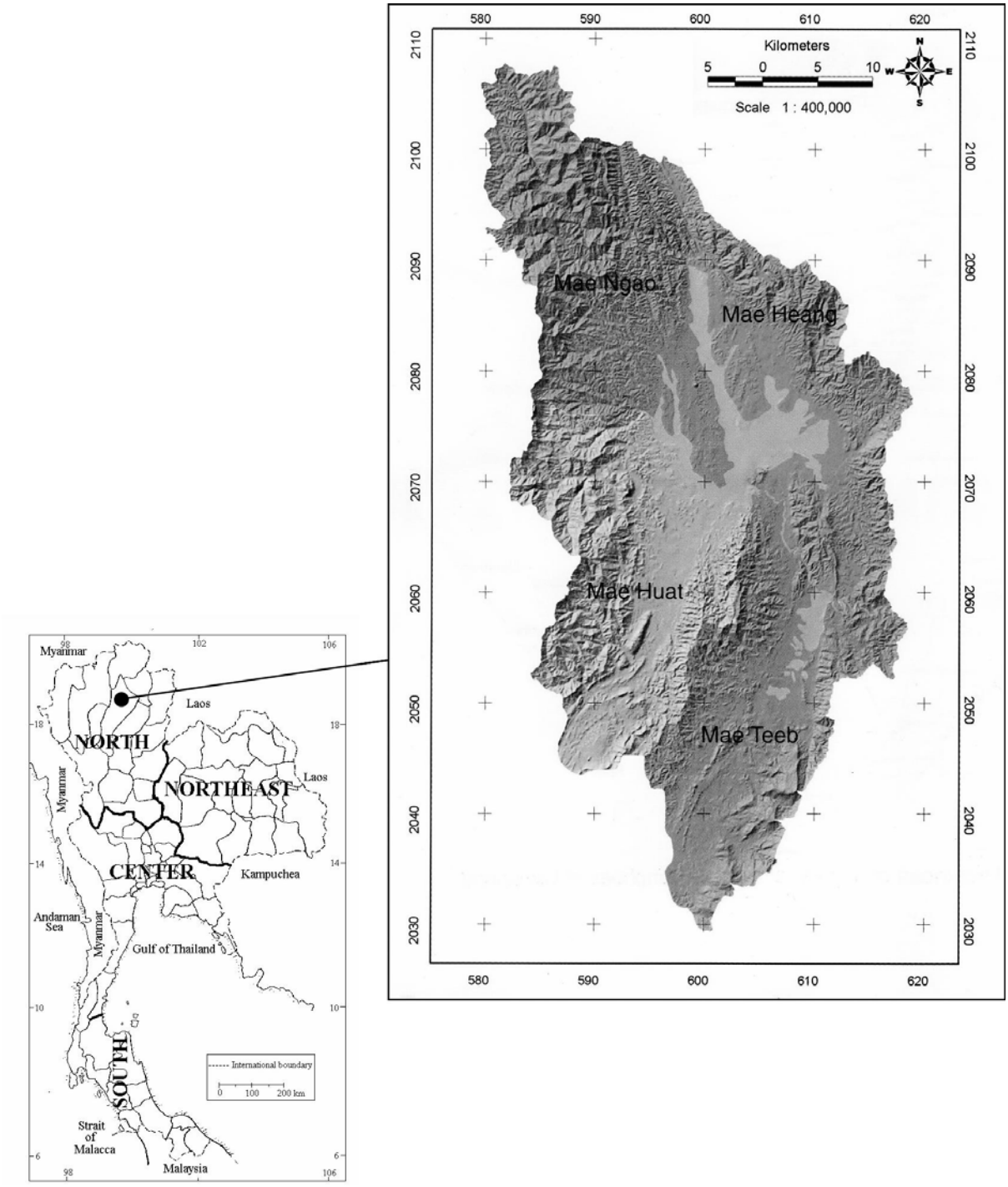

Figure 1. Map of Thailand (left) and the Ngao Demonstration Forest (NDF) pilot project area.

The NDF is divided into four sectors (Mae Heang, Mae Huad, Mae Ngao and Mae Teeb), It covers an area of approximately175,159 hectares that includes natural and plantation forests (66%) and non-forest areas (34%). This pilot project shall focus only on the natural forests - Evergreen, Mixed-Deciduous and Dry Dipterocarp forests - which cover approximately 61% of the total NDF area.

PROJECT CONTEXT

1.1 Origin

This new small project proposal originates from the Kasetsart University Faculty of Forestry (KUFF), Bangkok, Thailand. The stimulus for this project proposal was a recommendation from the final workshop of the ITTO Project PD195/03 Rev. 2 (F), that the Government of Thailand (GOT):[1]

> *"Develop new tree standard volume equations since the current local volume equations may no longer be applicable, and models to convert volume to Carbon content."*

This workshop was attended by participants from the Royal Forest Department (RFD), Department of National Parks, Wildlife and Plant Conservation (DNP), Forest Industry Organization of Thailand (FIO) and universities. The related issue at this workshop was that, while permanent plots have been established throughout the country on a 20 km x 20km grid to measure tree and other vegetation attributes, the estimates of tree volume and carbon were questionable. This is 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 diameters) and, in some cases, not representative of the country; (2) some of the equations were local volume equations, which used only DBH as the independent variable and did not include tree height; (3) the past equations were focused on areas to be logged (mainly big trees), yet, since the 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 existing equations are local tree volume equations developed by Pochai and Nanakorn (1992).[2] 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 conversion factor of 50% for biomass to carbon is too general.

There is, therefore, uncertainty in the national estimates of forest carbon stocks, incomplete reporting of carbon stocks especially in tree resources outside forest (TROF) areas, and limited knowledge of the methods and benefits of carbon stocks assessment among the stakeholders. Through this project proposal, Thailand is seeking incremental financial assistance and limited technical support from ITTO to develop and promote new national tree carbon equations to be used to estimate carbon stocks in Thailand's natural forests and TROF.

This Phase I proposal is to pilot test this process in the Ngao Demonstration Forest in Lampang province. The subsequent Phase II shall be the development of national carbon equations for all the major tree species groups in Thailand.

1.2 Relevance

1.2.1 Conformity with ITTO's objectives and priorities

Conformity with ITTA 2006 Objectives

This project conforms to the ITTA 2006 objectives as shown in Table 1.

[1] Proceedings of the final workshop of ITTO Project PD 195/03 Rev. 2 (F), June 2007. Department of National Parks, Wildlife and Plant Conservation (DNP), Bangkok, Thailand; Recommendation #16, page 10.

[2] Pochai, B. and T. Nanakorn. 1992. Volume tables constructed by the Spiegel Relascocpe. Forest Management Division, Forest Research Office, Royal Forest Department, 61 Phaholyothin Road, Chatuchak, Bangkok, 10900, Thailand.

Table 1. Explanation of the contribution of the proposed project to ITTA 2006 Objectives

Article 1 Paragraph No.	Description of Paragraph, and explanation of the contribution of the proposed project to ITTA Objectives
f)	*Promoting and supporting research and development with a view to improving forest management and efficiency of wood utilization as well as increasing capacity to conserve and enhance other forest values in timber producing tropical forests:* • The Project shall encourage reporting of carbon stocks in national and private forests. This will raise the profile of the importance of carbon sequestration by forests.
q)	*Promoting better understanding of the contribution of non-timber forest products and environmental services to the sustainable management of tropical forests with the aim of enhancing the capacity of members to develop strategies to strengthen such contributions in the context of sustainable forest management, and cooperating with relevant institutions and processes to this end:* • The Project shall reduce uncertainty on carbon stock statistics, thus, providing better knowledge of the contribution of environmental services of tropical forests.
s)	*Identifying and addressing relevant new and emerging issues:* • This project shall contribute to balanced discussion on the emerging issue of climate change mitigation through carbon sequestration by trees.

Conformity with ITTO Action Plan
This project conforms to the priorities and activities set out in the current ITTO Action Plan 2008-2011 as shown in Table 2.

Table 2. Relationship of the proposed project to the priority actions of ITTO (ITTO Action Plan 2008-2011).

Expected Outcome (ITTO Action) No.	Action by members, and explanation of the contribution of the proposed project to the ITTO priorities
1 (G)	*g. Formulate and implement strategies and pilot projects that test potential schemes for services such as forest-based carbon, hydrological functions, biodiversity conservation, and ecotourism:* • The proposed Project shall improve tools to estimate carbon stocks; the improved carbon statistics can be used to support development of national strategic plans for climate change mitigation and adaptation.
5 (D)	*d. Develop pilot and full-scale activities that test carbon sink and carbon sequestration measures and capture new and additional financial resources to support this:* • The proposed Project shall improve tools to estimate carbon stocks; the improved carbon statistics can be used to support tests of carbon sink and sequestration measures.
5 (E)	*e. Identify opportunities for and implement activities to capitalizes on non-timber forest products and environmental services that further the security of the tropical timber resource base, taking into account the needs of forest-dwelling indigenous and local communities:* • The proposed Project shall improve tools to estimate carbon stocks; the improved carbon statistics can be used to support balanced public debate and forest policy development on sustainable forest management.

Conformity with the REDDES Programme Deliverables and Monitoring Protocol

This proposed project conforms to Activity (i) of the Call for Proposals (First Cycle 2011): *Monitoring, Assessment, Reporting and Evaluation of the carbon and other environmental services* (Chapter 6 A of the ITTO REDDES Thematic Programme Document). It aims to enhance the accuracy of the tools for the assessment and monitoring of carbon stocks in Thailand's forests. Elaboration of the conformity of this proposal with the REDDES deliverables, and the association with the REDDES Monitoring Protocol, are outlined in Table 3.

Table 3. Conformity of proposed project with REDDES Programme deliverables and monitoring protocol.

Deliverables (from Table 1, REDDES Thematic Program Document)	**Outputs (from REDDES Monitoring Protocol)**	**Output Indicators (from REDDES Monitoring Protocol)**	**Means of Verification (from REDDES Monitoring Protocol)**
Clear demonstration using biodiversity surveys or other ecosystem assessment tools to monitor changes in biological and physical characteristics of forests:	*Quantification of carbon stocks performed using reliable monitoring and assessment technologies and/or valuation techniques:*	*National forest carbon and assessment and monitoring systems.*	*National forest carbon inventory reports. National forest monitoring systems.*
This project deliverables shall be improved methodology, and an action plan, to develop equations and tools to support the assessment and monitoring of carbon stocks in Thailand's forests. .	This project shall improve the reliability the existing carbon stock assessment, monitoring and reporting systems in various government and private agencies responsible for estimating carbon stocks in forests and TROF.	Monitoring information systems developed by DNP, RFD, FIO, MRCD and other government and private agencies.	Carbon stocks reports by the DNP, RFD, FIO, MRCD and other agencies. National monitoring information systems documentation.

1.2.2 Relevance to the submitting country's policies

Climate change threatens the agriculture, tourism and trade sectors of the Thailand economy. Yet, most of Thailand's population of 65 million live in rural areas and rely on these three sectors of the economy. 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 would be achieved by developing new national standard tree carbon equations and tools to estimate carbon stock. This, in turn, would improve the quality and coverage of carbon stocks reporting in Thailand's forests and trees outside forest (TROF).[3]

The Government of Thailand is committed to climate change mitigation and adaptation. Thailand's policy situation on climate change is described in the national strategic plan on climate change 2008-2012, as well as an annual plan for its implementation, prepared by the Ministry of Natural Resources and Environment (MONRE). The six key areas in this strategic plan are:

- Capacity building to respond to climate change adaptation

[3] The TROF, which are an important carbon sink, include trees in agricultural areas, roadsides, riversides, urban parks, and private lands. The existing area and amount of TROF in Thailand today are not known precisely. However, the potential TROF area has been estimated to be about 240,000 km^2, or approximately 47% of the country. Source: ITTO Project 375/05 Rev. 2 (F,M) Project Document, page 5.

- Reducing emissions of and increasing absorption of GHG
- Support research and development on the impact of climate change
- Increase awareness and participation in dealing with climate change
- Capacity building for institutions and personnel
- Support international collaboration.

Forests play a significant role in the implementation of this strategic plan. The government has several stringent laws towards the protection and conservation of forest areas, including the Forest Act (1941), National Park Act (1961), National Reserved Forest Act (1964), Wildlife for Reservation and Protection Act (1992), and Plantation Act (1992).

The RFD is responsible for community forests and other forests outside protected areas, which are the responsibility of the DNP. The 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 and other coastal forests. All these departments are under the supervision of MONRE. Several other agencies also deal with forests, including the Forest Industry Organization of Thailand (FIO), which is a state enterprise also within MONRE.

1.3 Target Area

The target area for the pilot project is the Ngao Demonstration Forest (NDF), Lampang province. The NDF covers an area of approximately175,159 hectares, including several forest types (Table 4). 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 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 (perhaps in Phase II) to the development of carbon equations for other tree species occurring in TROF areas, such as fruit trees.

Table 4. Land use types in the Ngao Demonstration Forest (NDF) pilot project area

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

1.4 Outcomes at project completion

The intended immediate effects of this pilot project (Phase I) are three-fold:

1. Methodology that can be used by stakeholders to construct new tree carbon equations is available. There is currently no methodology available.
2. Accurate new tree carbon equations for the major species groups in the pilot project area are available, including an evaluation of the level of uncertainty in the carbon stocks estimates based on the existing equations. These new equations would replace the current biased volume equations.
3. An action plan for the development of new national tree carbon equations is available, and endorsed by all the stakeholders. This plan shall be the basis of the Phase II project – construction of national tree carbon equations.

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

PART 2. PROJECT RATIONALE AND OBJECTIVES

2.1 Stakeholders analysis

The list of stakeholders is shown in Table 5 below. The primary stakeholders are the DNP and RFD who manage the largest natural forest areas with the most carbon stocks in the country. The secondary stakeholders include the MCRD, FIO, private TROF land owners, and KUFF and other universities and research institutions (mainly Maejo University, Chiangmai University and the Thailand Environment Institute or TEI). The MCRD, TROF land owners and FIO control relatively small natural forest or TROF areas with relatively less carbon stocks. The KUFF and the other universities and research institutions are primarily interested in information to support research and teaching; they are not directly involved in managing of any large forest areas. This project focuses on developing and testing methodology for constructing tree carbon equations; thus, there is no community involvement, except by the TROF land owners.

Table 5. Stakeholder analysis table

Stakeholder group	Characteristics	Problems, needs, interests	Potentials	Involvement in the Project
Primary stakeholders				
Department of National Park, Wildlife and Plant Conservation (DNP)	Government department responsible for protected forests.	Limited capacity to estimate carbon and demonstrate environemntal benefits of protected forests.	Improved estimates of carbon stocks**.** A cost benefit analysis of protecting forests for carbon sequestration.	Primary project beneficiary; shall provide input on tree species priorities and groupings; and participate in field data collection.
Royal Forest Department (RFD)	Government department responsible for production, other reserve forests; ITTO focal point.	Limted capacity to estimate carbon and provide accurate extension information to the public about reserve and community forests.	Improved estimates of carbon stocks. Provide the public accurate information on climate change mitigation efforts through reserve and community forests.	Primary project beneficiary; shall provide input on tree species priorities and groupings; and participate in field data collection.
Secondary stakeholders				
Marine and Coastal Resources Department (MCRD)	Government department responsible for mangrove and other coastal 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.
Private TROF owners	Owners of trees in agricultural area and private	Limited capacity to estimate carbon in	Improved estimates of carbon stocks. May	Secondary project beneficiary; shall

Stakeholder group	Characteristics	Problems, needs, interests	Potentials	Involvement in the Project
	lands	TROF areas.	benefit from accurate trading in carbon credits in international markets and inter-trade among private land owners.	provide input on tree species priorities and groupings.
Kasetsart University Faculty of Forestry (KUFF) and other universities and research insititions (Maejo University, Chiangami University and Thailand Environmental Institute or TEI)	KUFF is the main institution of forestry education in the country. Maejo University has an agroforestry program; Chiangmail University has a Plant Science and Natural Resources program, and TEI is an NGO that aims to achieve sustainable development and a better quality of life through partnership.	Limited information to support research and teaching.	Information to support research and teaching.	KUFF is the Project implementing agency; and shall also provide the national expetrise needed to develop the tree carbon equations.

2.2 Problem analysis

The key problem to be addressed is that the national estimates of carbon in Thailand's natural forests and TROF areas are inaccurate and incomplete (Figure 2). This is mainly because the forest government agencies, industry and private TROF land owners have limited capacity to estimate carbon stocks.

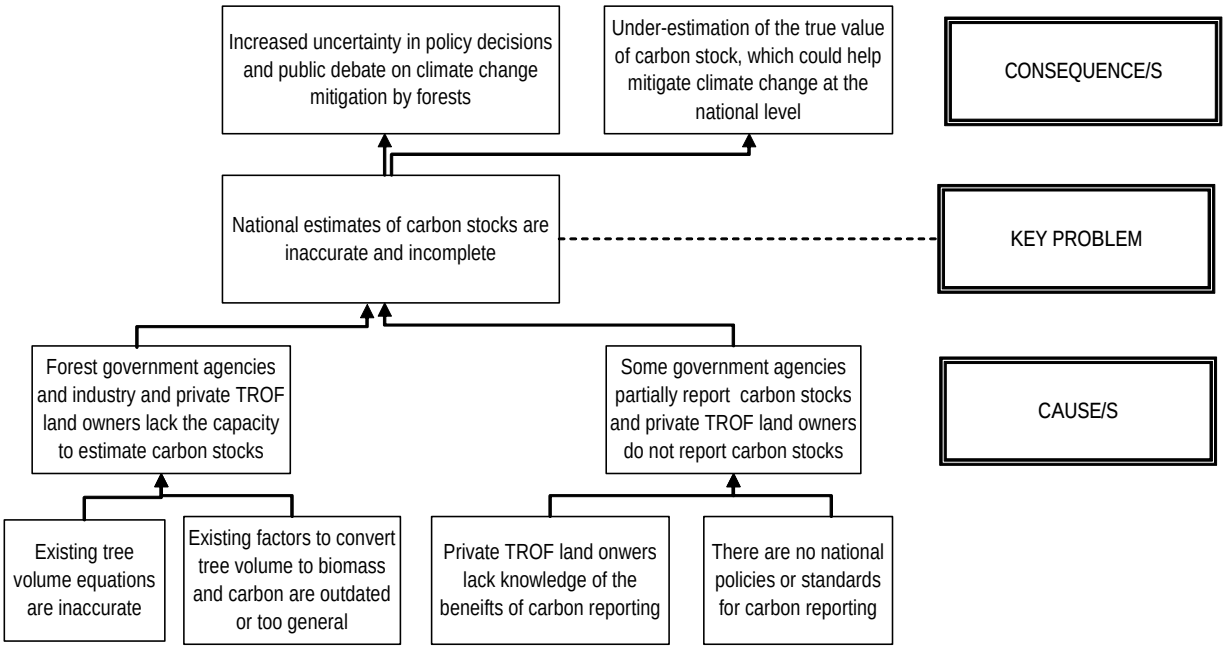

Figure 2. Problem-tree.

2.3 Objectives

The development and specific objectives are formulated as follows (Figure 3):

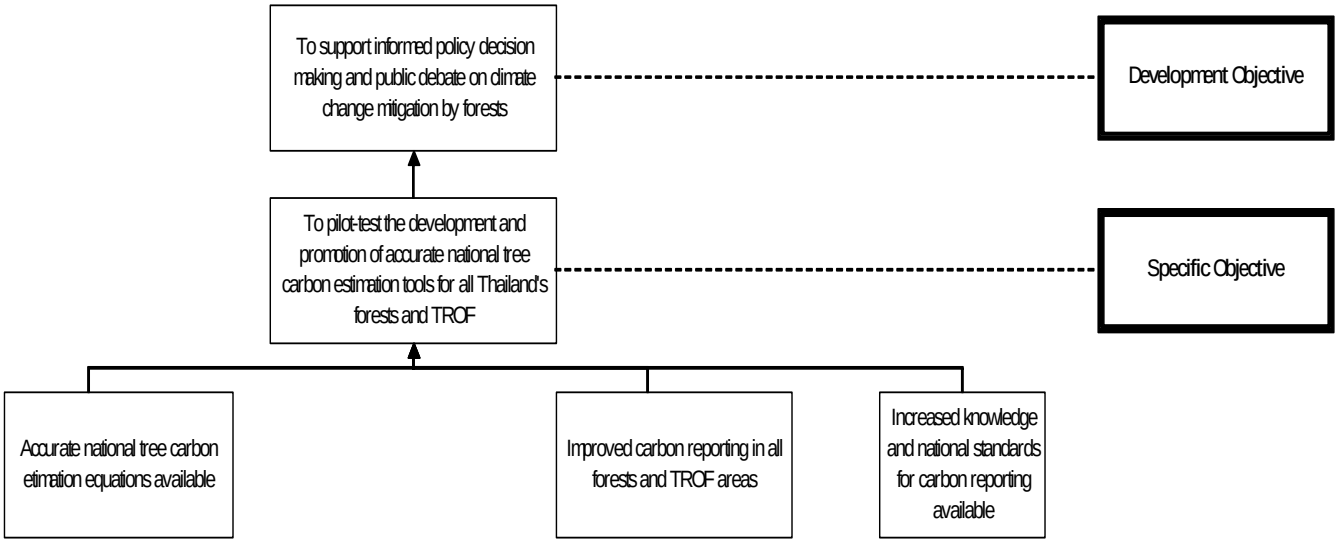

Figure 3. Objectives-tree.

2.3.1 Development objective and impact indicators

To support informed policy decision making and balanced public debate on climate change mitigation by forests.

The impact indicators are:

1. By 2018 (when the national tree carbon equations have been developed), DNP, RFD, MRCD and FIO and private landowners (30%) have adopted and are reporting on producing carbon stocks using the new national tree carbon equations and tools.
2. The carbon stock estimates are incorporated into the next national strategic plan on climate change, after the one for the period 2008-2012 expires, by the Ministry of Natural Resources and Environment. Preparation of this plan normally involves extensive public consultation. As well, the carbon stock estimates are included in the RFD and DNP “Flagship” climate change project.

2.3.2 Specific objective and outcome indicators

To pilot-test the development and promotion of accurate national tree carbon estimation equations for all Thailand's natural forests and TROF.

The outcome indicators are:

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

PART 3. DESCRIPTION OF PROJECT INTERVENTIONS

3.1 Outputs

Output 1: Methodology to construct new tree carbon equations developed.
The methodology shall be outlined in a technical report, which shall be submitted to a scientific journal for possible publication. This report shall describe the methodology to collect the sample tree data, to form tree species groups from the sample data, and to fit regression equations relating above-ground bole tree carbon to standing tree attributes such as total height and DBH by species group. As well, the tree carbon equations in the pilot project area shall be presented. Note that estimation of carbon stocks below ground, in the forest litter, and in tree branches and leaves are not considered because the methodology to be pilot-tested here is not suitable for the estimation of these carbon stock components.

Output 2: Action plan to construct and promote national tree carbon equations prepared.
The Phase II action plan will be a road map for constructing national tree carbon equations, and shall be developed through a national workshop. It shall include an action plan for tree data collection and analysis and tree carbon equation dissemination and promotion, institutional set-up for maintaining and updating the equations, capacity building, resource requirements, and priority actions.

3.2 Activities and inputs

For Output 1:

1. Collect sample tree field data: The number of sample trees and species groups sampled shall be determined depending on a pre-survey of the variability of carbon stocks among trees and the available budget. However, a preliminary estimate is approximately a minimum total of 300 trees (20 major species and 15 trees per major species.
2. Measure and analyze wood core samples in the laboratory: Measure the core green volume and weight, and determine the oven-dry carbon content of core samples.
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.
4. Prepare technical report: The report shall describe the proposed methodology to construct tree biomass equations, including sampling design, data collection and processing, and fitting of the equations.

For Output 2:

1. Prepare national workshop materials: This will involve consultation with the stakeholders, since the workshop is intended to develop the Phase II action plan and review the methodology to construct equations.
2. Conduct national workshop: This shall involve about 40 participants (stakeholders) from the relevant agencies, who shall provide inputs to the new equation development methodology and the Phase II action plan.
3. Prepare Phase II action plan

The project inputs are provided in Table 6.

3.3 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[4] measurements of tree attributes, including volume, DBH, upper stem diameters, and total height on a sample of standing trees. The tree carbon content shall be estimated based on sample cores taken at 1.3 m height, which is a new approach. This pilot project will focus on the major species groups in the pilot area (Table 4). Stakeholder representatives shall be invited to participate in the field data collection.

[4] 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.

Then, a national workshop involving 40 participants from the relevant government and private agencies shall be held to develop a Phase II action plan and promote the carbon estimation methodology. The workshop shall review the pilot project results, and develop an action plan for the Phase II project.

The following steps shall be used in Phase I:

Output 1. Methodology to construct new tree carbon equations developed

1. Construct a sample tree selection matrix (tree species x DBH class), and select sample trees using purposive stratified sampling.
2. Estimate the whole-bole volume, V, of each sample tree based on tree bole upper-stem diameters measured with Wheeler Prentaprism Calliper by 2.5-metre sections up to the first major branch, and Newton's formula. Tree DBH, total height, merchantable height, and bark thickness shall also be recorded. The V excludes wood volume in branches and twigs and leaves.
3. Collect two wood sample cores (or cubic pieces) using an Increment Borer at 1.3 m height for each sample tree, and measure the wet volume and weight of the sample cores.
4. 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.
5. Fit the carbon equations: C = *f* (Total Height, DBH) for each major species group in the pilot project area.
6. Compare the new equations with the existing equations, to assess the level of uncertainty (bias and precision) of carbon estimates and to determine the improvements that have been made in the new equations compared to the old in carbon assessment in the pilot area.

Output 2: Action plan to construct and promote national tree carbon equations prepared

A two-day national workshop shall be conducted. It shall involve about 40 participants from the stakeholder agencies - RFD, DNP, MRCD, FIO, KUFF, Maeyo University, Chiangmai University and TEI. The objectives of the workshop are to review the pilot project results and to develop an action plan for the Phase II project – to develop and promote tree carbon equations for all major tree species groups in Thailand. The expected workshop outputs are the stakeholder input into the equation development methodology and the preparation of an action plan.

3.4 Work plan

A project work plan has been prepared by activity and is presented below (Figure 4). The project outputs are 1) a methodology to construct tree carbon equations and to develop an action plan for Phase II project, and 2) an action plan for the development of national tree carbon equations for all the major tree species groups in Thailand is available. The output 1 activities include field data collection, laboratory analysis and constructing the equations. The output 2 activities include a national workshop involving stakeholders who will provide input to the new methodology for carbon equation development and develop an action plan for Phase II project.

The project covers a period of 18 months. The Project Manager is the responsible party for all the project activities. The human resources, materials and financial inputs needed to realize the activities in Figure 3, as well as the unit costs, are given in Table 6.

OUTPUT/ACTIVITIES	MONTH																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Output 1.0: Methodology to construct new tree carbon equations developed																		
Activity 1.1: Collect sample tree field data																		
Activity 1.2: Measure core samples in the lab																		
Activity 1.3: Construct tree carbon equations																		
Activity 1.4: Prepare technical reports																		
Output 2.0: Action plan to construct and promote national tree carbon equations prepared																		
Activity 2.1: Prepare workshop materials																		
Activity 2.2: Conduct workshop																		
Activity 2.3: Prepare action plan																		

Figure 4. Project work plan

Table 6. Project human resources, materials and financial inputs, and respective unit costs.

Budget Item & Resource	Unit cost (US$)	
	ITTO	GOT
Project Personnel (Salary)		
11. National Experts:		
11.1 Project Manager (1 for 18 months)	1,000	600
11.2 Data Analyst (1 for 30 days)	250	50
11.3 Tree ID expert (1 for 13 days)	250	50
11.4 Office Assistant (1 for 18 months)	500	
11.5 Stakeholder representatives (15 for 5 days)		50
12. Other Personnel:		
12.1 Inventory Assistants (6 for 10 days)	25	
12.2 Local labor (6 for 10 days)	15	
13.3 Drivers (2 for 11 days)	25	
13.4 Crew Chief (1 for 10 days)	50	
Sub-contracts		
21 Sub-contract (workshop facilitator) (1 for 3 days)	1,000	
Duty Travel		
31. Daily Subsistence Allowance (DSA):		
31.1 National Experts (2 for 12 days)	65	
31.2 Project Manager (1 for 12 days)	65	
31.3 Crew Chief (1 for 10 days)	65	
31.4 Workshop participants (40 for 2 days)	65	
31.5 Inventory Assistants (6 for 10 days)	50	
31.6 Stakeholder representatives (15 for 5 days)	65	

Budget Item & Resource	Unit cost (US$)	
	ITTO	GOT
33. Local transport costs		
33.1 National experts (6 economy air tickets)	200	
Capital Items		
41. Project Office (1 for 18 months)		200
44. Capital equipment		
44.2 Printer	250	
44.2 Computer	1,000	
44.3 Increment borer (4)	700	
Consumable Items		
51. Raw materials:		
51.1 Car rental (2 vans for 11 days)	70	
51.2 Forest equipment rental (10 days)	200	200
51.2 Carbon analysis of cores (300 trees)	35	
51.3 Core measurement (600 cores)	10	
52. Spares (truck maintenance/truck/day)	15	
53. Fuel (2 vans for 11 days)	15	
54. Office supplies (18 months)	200	
Miscellaneous		
62. Auditing (one time)		2,000
63.1 Publications & brochures (3 technical reports)	1,000	
63.2 Workshop room rental	2,000	

3.5 Budget

The ITTO project budget by activity, the master budget, the ITTO yearly budget, and the GOT yearly budget tables are shown in Tables 7, 8, 9 and 10, respectively, below.

Table 7. ITTO project budget by activity

OUTPUTS/ACTIVITIES + Non-Activity based Expenses	BUDGET COMPONENTS							
	10. Project Personnel	20. Sub-contract	30. Duty Travel	40. Capital Items	50. Consumable Items	60. Miscellaneous	Quarter/ Year (Q/Y)	GRAND TOTAL
OUTPUT 1: Methodology to construct new tree carbon equations developed								
Activity 1.1:	8,900		11,675	0	7,900	0	Q1/YR1	**27,975**
Activity 1.2:	0		0	0	16,500	0	Q2/YR1	**16,500**
Activity 1.3:	2,500		0	0	0	0	Q3/YR1	**2,500**
Activity 1.4:	1,250		0	0	0	1,000	Q4/YR1	**2,250**
Subtotal 1	**12,650**		**6,800**	**0**	**24,400**	**1,000**		**49,725**
OUTPUT 2: Action plan to construct and promote national tree carbon equations prepared								
Activity 2.1	0	1,000	0		0	1,000	Q1/YR2	**2,000**
Activity 2.2:	1,000	1,000	5,590		310	2,000	Q1/YR2	**9,900**
Activity 2.3:	500	1,000	0		0	1,000	Q2/YR2	**2,500**
Subtotal 2	**1,500**	**3,000**	**5,590**		**310**	**4,000**		**14,400**
NON-ACTIVITY BASED EXPENSES:								
(1) Project Office (Project Manager; Office Assist.; Office computers)	27,000	0	0	2,250	3,600	0		**32,850**
Subtotal 3	**27,000**	**0**	**0**	**2,250**	**3,600**	**0**		**32,850**
TOTAL (ITTO)	**41,150**	**3,000**	**12,390**	**2,250**	**28,310**	**5,000**		**96,975**

(This page is blank)

Table 8. Master Budget (a consolidation of Budget Tables 6 and 7)

Outputs and Activities	Inputs		Unit Costs	Source (I or E)	Year	Budget Component	TOTAL
	Units and Quantity	No.					
Output 1: Methodology to construct tree carbon equations developed							
Activity 1.1: Collect sample tree field data							
	Data Analyst, md	12	250	(I)	Y1	11	$3,000.00
	Data analyst, md	10	50	(E)	Y1	11	$500
	Tree ID expert, md	10	250	(I)	Y1	11	$2,500.00
	Tree ID expert, md	10	250	(E)	Y1	11	$500
	Stakeholders, md	75	50	(E)	Y1	11	$$3,750
	Crew Chief, md	10	50	(I)	Y1	11	$500.00
	Inventory Assistants, md	60	25	(I)	Y1	11	$1,500.00
	Labor, md	60	15	(I)	Y1	11	$900.00
	Driver, md	20	25	(I)	Y1	11	$500.00
	driver, mm	4	500	(I)	Y1	11	$2,000.00
	Air tickets	6	200	(I)	Y1	33	$1,200.00
	DSA (PM, experts), md	115	65	(I)	Y1	31	$7,475.00
	DSA (Inv. Assistants), md	60	50	(I)	Y1	31	$3,000.00
	car rent, md	20	70	(I)	Y1	52	$1,400.00
	Equipment rent	10	200	(I)	Y1	52	$2,000.00
	Equipment	1	200	(E)	Y1	52	$2,000
	Fuel, md	20	85	(I)	Y1	53	$1,700.00
	Increment borer	4	700	(I)	Y1	53	$2,800.00
Activity 1.2: Measure and analyse wood core samples in the laboratory							
	Core measurement in lab	600	10	(I)	Y1	52	$6,000.00
	Carbon analysis lab	300	35	(I)	Y1	52	$10,500.00
Activity 1.3: Construct tree carbon equations							
	Data Analyst, md	10	250	(I)	Y1	11	$2,500.00
Activity 1.4: Prepare report							
	Data Analyst, md	5	250	(I)	Y1	11	$1,250.00
	Publication	1	1,000	(I)	Y1	61	$1,000.00
Output 2: Action plan to construct and promote national tree carbon equations prepared							
Activity 2.1: Prepare workshop materials							
	Sub 1	1	1,000	(I)	Y1	21	$1,000.00
Activity 2.2: Conduct national workshop							
	Data Analyst, md	2	250	(I)	Y2	11	$500.00
	Data Analyst, md	2	50	(E)	Y2	11	$100
	Tree Id expert, md	2	50	(E)	Y2	11	$100
	Tree ID expert, md	2	250	(I)	Y2	11	$500.00
	Stakeholders, md	30	50	(E)	Y2	11	$1,500
	Project Manager DSA, md	2	65	(I)	Y2	31	$130.00
	Experts DSA, md	4	65	(I)	Y2	31	$260.00
	Fuel, md	2	85	(I)	Y2	53	$170.00
	car rent, md	2	70	(I)	Y2	53	$140.00
	Workshop participants DSA, md	80	65	(I)	Y2	31	$5,200.00
	Sub 1	1	1,000	(I)	Y2	21	$1,000.00
	Publication	1	1,,000	(I)	Y2	63	1,000.00
Activity 2.3: Prepare Phase II action plan							
	Data Analyst, md	1	250	(I)	Y2	11	$250.00
	Data Analyst, md	1	50	(E)	Y2	11	$50
	Tree ID expert, md	1	50	(E)	Y2	11	$50
	Stakeholders, md	15	50	(E)	Y2	11	$750
	Tree ID expert, md	1	250	(I)	Y2	11	$250.00
	Sub 1	1	1,000	(I)	Y2	21	$1,000
	Publication	1	1,000	(I)	Y2	21	$1,000.00
	Publications	1	500	(E)	Y2	61	$500
Non-Activity Based	Project Manager, mm	18	1,000	(I)	Y1/Y2	11	$18,000.00
	Project Manager, md	220	50	(E)	Y1/Y2	11	$11,000
	Office Assistant	18	500	(I)	Y1/Y2	11	$9,000.00

Office space, mm	18	200	(E)	Y1/Y2	41	$3,600
Audit	1	2,000	(E)	Y2	62	$2,000
Computers	2	1,000	(I)	Y1/Y2	41	$2,000.00
Printer	1	250	(I)	Y1/Y2	41	$250.00

Table 9. ITTO yearly project budget

Budget Components	Total	Annual Disbursements	
		Year 1	*Year 2*
10. Project Personnel			
11. National Experts:			
11.1 Project Manager	18,000		
11.2 Data Analyst	7,500		
11.3 Tree ID Expert	3,250		
11.4 Office Assistant	9,000		
11.5 Crew Chief	500		
11.6 Inventory Assistants	1,500		
12. Other Labor:			
12.1 Local labor	900		
12.2 Drivers	500		
19. Component Total	**41,500**	**30,650**	**10,500**
20. Sub-contracts			
21. Sub1: Workshop facilitator	3,000		
29. Component Total	**3,000**	**0**	**3,000**
30. Duty Travel			
31. Daily Subsistence Allowance (DSA):			
31.1 Project Manager	780		
31.2 Tree ID Expert	780		
31.3 Data Analyst	780		
31.4 Stakeholders	4,875		
31.5 Workshop participants	5,200		
31.6 Crew Chief	650		
31.7 Inventory Assistants	3,000		
32. Transport costs:			
32.1 Domestic air tickets	1,200		
39. Component Total	**17,265**	**10,000**	**7,265**
40. Capital Items			
41. Computer & printer	2,250		
49. Component Total	**2,250**	**2,250**	**0**
50. Consumable Items			
51. Raw materials:			
51.1 Increment borers	2,800		
52.Spares:			
52.1 Car rental	1,540		
52.2 Equipment rental	2,000		
52.3 Carbon analysis	10,500		
52.4 Increment core measurements	6,000		
53. Fuel & utilities	1,870		
54. Office Supplies	3,600		

Budget Components	Total	Annual Disbursements	
		Year 1	*Year 2*
59. Component Total	**28,310**	**28,000**	**310**
60. Miscellaneous			
61. Sundry (publications & wrkshp room rental	5,000		
69. Component Total	**5,000**	**1,000**	**4,000**
SUB-TOTAL 1	**96,975**	**71,900**	**25,075**
80. ITTO Monitor., Evaluat. and Administ. Costs 81. Monitoring and Review Costs 82. Ex-Post Evaluation Costs	 **8,000** **0**		
SUB-TOTAL 2	**8,000**		
83. Programme Support Costs (8% of Subtotals 1 and 2)	**8,398**		
90. Refund of Pre-Project Costs	**0**		
ITTO TOTAL	**113,373**		

Table 10. Government of Thailand (GOT) yearly project budget

Budget Components	Total	Annual Disbursements	
		Year 1	*Year 2*
10. Project Personnel			
11. National Experts:			
11.1 Project Manager	11,000		
11.2 Data Analyst	650		
11.3 Tree ID Expert	650		
11.4 Stakeholders	6,000		
19. Component Total	**18,300**	**16,000**	**2,300**
20. Sub-contracts			
29. Component Total	**0**		
30. Duty Travel			
39. Component Total	**0**		
40. Capital Items			
41. Office space	3,600		
49. Component Total	**3,600**	**3,600**	
50. Consumable Items			
52.Spares:			
52.2 Field equipment	2,000		
59. Component Total	**2,000**	**2,000**	
60. Miscellaneous			
61. Sundry (brochures)	500		
62. Auditing	2,000		
69. Component Total	**2,500**		**2,500**
SUB-TOTAL 1	**26,400**	**21,600**	**4,800**
70. Executing Agency Management Costs (15% of Total *Overall Project Budget* from ITTO and GOT: $123,375)	**18,506**		
GOT TOTAL	**44,906**		

PART 4. IMPLEMENTATION ARRANGEMENTS

4.1 Executing agency and oganization structure

The Project organizational chart is shown in Figure 5 below.

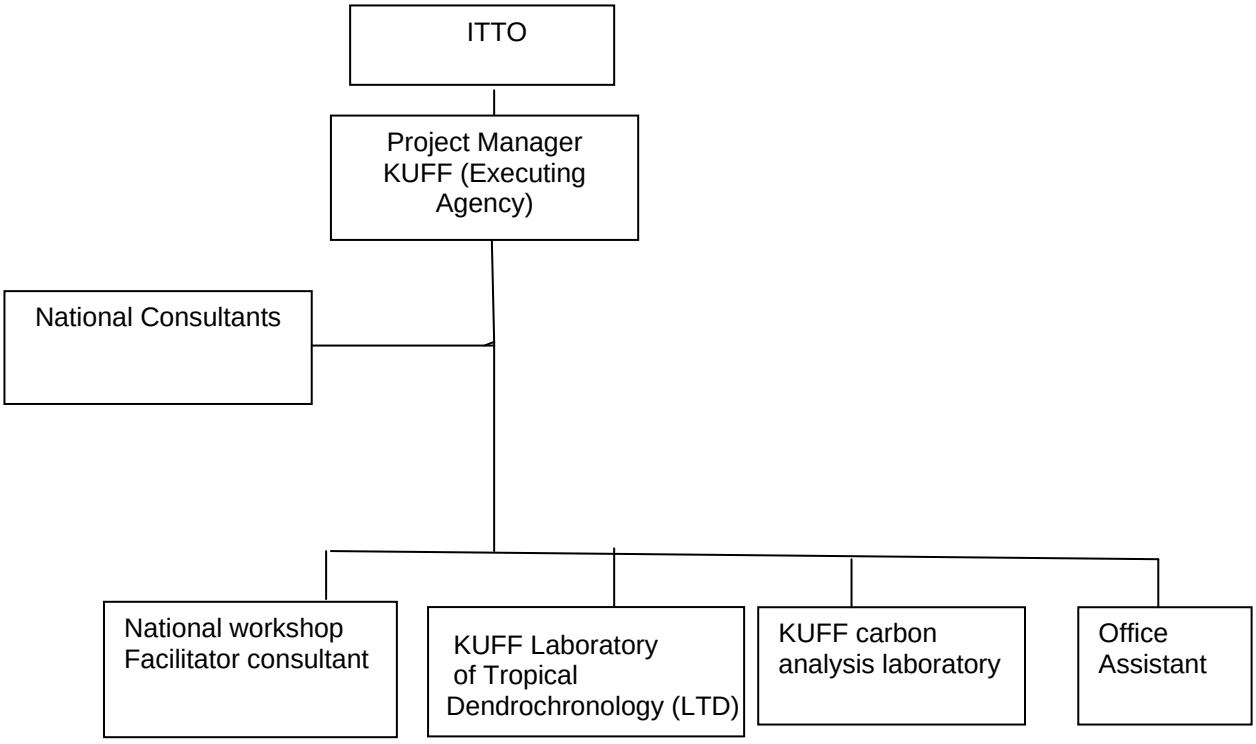

Figure 5. Project organizational chart.

The project executing agency is the KUFF (see Annex 1). The KUFF has the necessary forest inventory technical expertise to implement this project. The KUFF shall nominate the project manager and other team members. It shall also provide project office facilities. The RFD, DNP, MRCD, and FIO shall collaborate in the project implementation by providing support in terms of their respective relevant carbon policy and guidelines, and providing input to tree species priorities and groupings, and field implementation. The RFD is also the ITTO focal point in Thailand, and has also implemented several relevant ITTO 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.

4.2 Project management

The Executing Agency will set up a Project Management Team (PMT). This team shall include the Project Manager and other project national experts. The PMT will meet regularly to review project progress. The PMT members are: Dr. Khwanchai Duangsathaporn, Assistant Professor, Faculty of Forestry, Kasetsart University; Dr. Patsi Prasomsin; Associate Professor, Faculty of Forestry, Kasetsart University; Mr. Prasong Saguantam, Assistant Professor, Faculty of Forestry, Kasetsart University; and Mr. Kritsadapan Palakit, PhD Graduate Student, Faculty of Forestry, Kasetsart University.

There shall also be a Project Technical Committee (PTC), to provide technical guidance to the Project. The PTC members are: Dr. Khwanchai Duangsathaporn (forest measurements and dendrochronology), Dr. Patsi Prasomsin (biometrics and growth and yield), Mr. Prasong Saguantam (forest inventory, including tree species identification), and Dr. Roongriang Rollsiri (carbon laboratory measurements). Additional members shall be included as required.

4.3 Monitoring and reporting

(a) Project Progress Reports – Project progress reports will be prepared by the Executing Agency every 6 months. They will be submitted to the ITTO.

(b) Project Completion Report - Within 3 months of project completion the Executing Agency shall prepare and submit to the ITTO 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 PTC shall review the technical reports. These reports will be submitted to the ITTO.

ANNEX 1. PROFILES OF THE EXECUTING AND COLLABORATING AGENCIES

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

HISTORY

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

STRUCTURE AND FACILITIES

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

CURRICULA

Undergraduate Programs

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

Graduate Programs

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

Graduate students are required to complete a minimum of 36 credits (24

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

International Degree Programs

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

EXPERTISE IN DEVELOPOING MATHEMATICAL EQUATIONS

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

ANNEX 2. TASKS AND RESPONSIBILITIES OF KEY EXPERTS PROVIDED BY THE EXECUTING AGENCY

The KUFF shall provide the following experts (professors at the KUFF). They shall be recruited as short-term consultants as described in Annex 3. Use of the forest inventory and biometrics experts from KUFF increases the sustainability of the project.

Project Manager
The Project Manager shall be Dr. Khwanchai Duangsathaporn, Assistant Professor, Faculty of Forestry, Kasetsart University. He will liase with ITTO and will assume the general responsibility of overseeing project implementation.

Tree species ID expert (forest inventory expert from KUFF)
The Tree species ID expert shall assist the field crew in tree species identification.

Data Analyst (Biometrics expert from KUFF)
The data analyst shall conduct analysis of the data and construction of the carbon equations.

ANNEX 3. TERMS OF REFERENCE OF PERSONNEL AND CONSULTANTS AND SUB-CONTRACTS FUNDED BY ITTO

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

- Overall responsibility for the supervision, management and monitoring of the project;
- Supervise preparation of Yearly Plan of Operation and Project progress reports;
- Communicate with ITTO;
- Report Project progress to the Dean of KUFF;
- Establish the PMT.

Tree species ID expert (Consultant)
The Tree species ID expert shall assist the field crew in tree species identification.
Duration: 13 days at $250 per day
Start date: To be detailed once project has started (tied to the first instalment)
End date: As above
Duty place(s): Bangkok, Thailand

Data Analyst (Consultant)
The data analyst shall conduct analysis of the data and construction of the carbon equations.
Duration: 30 days at $250 per day
Start date: To be detailed once project has started (tied to the first instalment)
End date: As above
Duty place(s): Bangkok, Thailand

Workshop Facilitator (sub-contract)
The workshop facilitator shall prepare workshop materials, facilitate the workshop) and assist prepare the Phase II action plan and workshop proceedings.
Duration: 3 days at $1,000 per day
Start date: To be detailed once project has started (tied to the first instalment)
End date: As above
Duty place(s): Bangkok, Thailand

Crew Chief

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

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

Drivers

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

Local labor

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

Office Assistant

1. Word processing of Project documents, such as technical reports and progress reports.

2. Receiving and directing telephone calls to the Project Office.
3. Ensure the Project Office records and correspondences are properly maintained.

ANNEX 4: RESPONSES TO REVIEWER COMMENTS

Reviewer Comment	Amendment(s) made	Page #
1.1 The "origin" of the proposal is clearly written, quoting the reasons why such a follow-up effort is needed to make the existing equation for calculating tree volume and then carbon stock more representative at the national level. Some explanation is needed for the statement that the “equations” currently used is biased.	The reasons for the statement that the equations are biased have been provided.	*6*
1.3 Please provide a map of the project area. The extent/size of the area to be covered also needs to be stated in the proposal.	A map of the pilot project area has been provided as Figure 1, and extent/size of the pilot area involved described.	5, 9
2.1 Well presented overall; however problems, needs, interests and potentials of stakeholders almost identical; description on potentials is not satisfactory. Only KUFF mentioned as stakeholder, no other universities, research institutions included. As the proposal is intended to develop and promote a new equation for estimating carbon stocks, community involvement might not be needed, except by private owners of tree resources outside the forest area.	The problems, needs, interests and potential of stakeholders has been elaborated further. Two universities and one research institution have been added as secondary stakeholders.	11, 12
2.2 Well presented; however the effect (consequences) is not limited to just one. Inclusion of another effect would make the analysis better. Another suggestion with regard to the consequences of the key problem: Underestimation of the true value of carbon stock, which could help to mitigate climate change at the national level	One more consequence that was suggested by the reviewers has been added to the new Figure 2 (Problem Tree).	12
2.3.1 Indicator of improved policy decision making and public debates could be included. Quantification would be helpful - how many private landowners (all, half, 10%)	Examples of uses of the carbon estimates information for policy decisions and public debate have been added.	13
2.3.2 Please clarify what is the specific objective, to develop a tool or new equations under the project? In the project summary, the stated objective is to develop and promote new equations. Again - include quantification.	The Specific Objective has been clarified in the Summary as developing and pilot-testing a methodology to construct tree carbon equations, not to develop new equations per se. The number of forest types involved has been quantified.	13
3.1 Satisfactorily presented. However, the outputs are merely stated without any description and substantiated by indicators - please revise. In comparison with the previous section output "2. Accurate tree carbon equations for the major species groups in the pilot area available " is missing. In calculating carbon stock, is the project interested only in carbon stock above ground? What about carbon stock below ground? With regard to carbon stock above ground, does this refer only to carbon available in trees? What about carbon from forest litter?	The outputs have been elaborated further. A clarification has been made that interest is in only above-ground tree bole carbon. The proposed methodology would not work well for other carbon content components of the forest.	14
3.2 Is Output 2, i.e., a national workshop, meant for the preparation of an action plan? If it is, some	It has been clarified that the national workshop is to provide input to the methodology	14

Reviewer Comment	Amendment(s) made	Page #
details of the intended workshop should be highlighted in the proposal. More detail could be provided, such as how many tree samples will be collected, the species, etc.	developed for constructing tree carbon equations and to prepare an action plan to develop national equations.	
3.3 Some comparison of expected results based on the new and old equations should also be highlighted (i.e., what improvements are made in the new equations?).	The last task in the approach has been elaborated to include the comparison of the expected results in the old and new equations.	15
3.4 Inputs from stakeholders with regard to the new equations must be highlighted as outputs from the workshop.	This has been clarified in the text.	15
3.5 Budget well presented with realistic and reasonable estimates and unit costs. However, Tables 6 and 7 should also have been consolidated into a master budget table according to ITTO format. Tables 8 and 9 do not contain sub-categories. Budget for component 81 (ITTO monitoring and review costs) must be provided (~US$ 8000/year)	A master budget table (Table 8) has been created (a consolidation of budget Tables 6 and 7). Sub-categories have been added to the old Tables 8 and 9, now Tables 9 and 10, respectively. ITTO monitoring and review costs have been added to the project budget (see Table 9). The total ITTO budget increased from $104,733 to $113,373.The GOT budget did not change. (Note: According to the ITTO project formulation manual, a master budget is not normally required for small projects).	20, 21, 22
4.2 Please list all members of the project management team. A PTC is recommended.	A list of the project management team members has been provided. A PTC (project technical committee) has also been formed and the list included here.	23
4.3 Well presented. A PTC is recommended.	A PTC has also been formed and the list included in section 4.2.	23
Annex 1. Some statement about the expertise of KUFF in developing mathematical equations should be highlighted in the proposal	A section has been added to Annex 1, describing the relevant expertise of KUFF faculty in mathematical modelling.	26