

# Community-based forest biomass monitoring

Action research in PNG, Cambodia,  
Indonesia, Lao PDR and Vietnam

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Editor

Henry Scheyvens

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Logos of CCA Action Research Project core implementing organisations and funding support



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## Foreword

From about the 1970s, the paradigm of forest management in developing countries began to shift away from top-down “fences and fines” approaches towards participatory approaches that open up spaces for communities in forest management. This has been a challenging and difficult experience from a number of perspectives, including the reluctance of governments to hand over rich forest resources to communities and the challenge of reorientating forestry away from looking just at trees, towards looking at the rights and well-being of the millions of people living in and around forests. Progress has been made however, and this is reflected in the emergence of multi-stakeholder approaches and public consultations to formulate forestry policies and national community-based forest management programmes. Globally, the importance of community participation in natural resource management is reflected in multilateral environmental agreements, especially the Convention on Biological Diversity (CBD), and is increasingly being discussed under the United Nations Framework Convention on Climate Change (UNFCCC) processes with respect to REDD+ (Reducing Emissions from Deforestation and forest Degradation and enhancing forest carbon stocks).

The Institute for Global Environmental Strategies (IGES), together with some of our key partners and local communities, launched an action research project in five countries – Papua New Guinea, Cambodia, Indonesia, Lao PDR and Vietnam – beginning in 2010 to develop and test approaches to engage local communities in forest biomass monitoring. This report reflects some of the knowledge acquired during the action research and describes how the action research evolved in each country. This work is generally based upon outputs produced through a REDD+-related project funded by the Ministry of Environment of Japan and a three-year project funded by the Asia Pacific Network for Global Change Research (APN) titled “Participatory Approaches to Forest Carbon Accounting to Mitigate Climate Change, Conserve Biodiversity, and Promote Sustainable Development.”

I would like to thank the authors for succeeding in bringing together this report, which I anticipate will be useful for organisations and governments aiming to incorporate monitoring into community-based forest management systems to ensure they are fully sustainable and generate maximum benefits, as well as interested in supporting community involvement in the monitoring of forest biomass and other forest values in and outside community forests. I believe this report will also be an important reference for ensuring that REDD+ safeguards agreed by the UNFCCC Conference of the Parties are respected and for the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) in providing guidance on how local communities and indigenous peoples can work together with scientists on knowledge co-production.

Hideyuki Mori

IGES President

March 2014



## Dedication

We dedicate this report to the late Mr Yati A. Bun who unexpectedly and sadly passed away shortly before it was published. Yati was the Executive Director of the Foundation for People and Community Development (FPCD), a key partner for IGES in the action research on community-based forest biomass monitoring. He was a Papua New Guinean professional forester of high national and international standing who dedicated much of his career to developing a model of forestry in Papua New Guinea that aimed first-and-foremost at community self-reliance. He consistently and courageously stressed that this model was needed to challenge the “status quo” of forestry in his country that left the local communities as spectators to, rather than actors in, development. Yati was a close friend of IGES researchers and will be fondly remembered by many.

Yati explaining the importance of forest monitoring to Malas community, 2012





## Executive summary

- Community Based Forest Biomass Monitoring (CBFBM) is the monitoring of forest biomass by communities. It is a form of monitoring that ultimately aims to be “driven” and “owned” by the local communities and “guided” and “facilitated” by outside experts. The information that is generated from the monitoring aids the communities in making wise decisions about their forest management.
- Together with a number of partners, the Institute for Global Environmental Strategies (IGES) launched a regional programme on CBFBM in 2010 covering five countries – Papua New Guinea (PNG), Cambodia, Indonesia, Lao PDR and Vietnam – with funding from the Ministry of Environment of Japan and the Asia Pacific Network for Global Change Research. The main objectives of the regional Community Carbon Accounting (CCA) Action Research Project are to:
  - develop, test and implement approaches to engage local communities in monitoring forest biomass, and
  - use the information generated to assess the feasibility of alternative forest management options, including REDD+.
- Action research is a cumulative learning process in which cycles of planning, action, observation and reflection build on each other in the process of problem solving. For the CBFBM, the action research involved community facilitators working together with local communities in designing, testing, reflecting on and adapting community-based forest monitoring systems.
- In this report, IGES and its project partners describe the approach to the action research taken in each country, progress that has been made and challenges faced, as well as lessons learned and plans for moving the research forward. The first chapter provides an explanation of the concept of community carbon accounting, or what we have to come to refer to more precisely as *community-based forest biomass monitoring*, its rationale, how it differs from conventional forest monitoring, key features of the action research as it evolved in each country, and what we have learnt about the design and implementation of CBFBM systems from the action research. Chapters 2 to 6 each provide a description of the action research undertaken in one of the study countries.
- Through action research conducted over the past four years we have learnt that not every CBFBM system will be the same. The system must reflect clear objectives defined by the communities themselves as well as contextual factors (e.g. community institutions and forest conditions). The action research in each country under the CCA Project has evolved according to location-specific contexts, challenges and opportunities.
- The action research in PNG is being conducted through the Community-based Forest Monitoring Project (CFMP), which is a joint initiative of IGES and the Foundation for People and Community Development (FPCD), a national NGO with core expertise in community forestry. The research is being implemented with six clans (extended families) that hold areas of natural forest under customary tenure arrangements. The



CFMP has built the capacity of the FPCD foresters to work with the participating clans on forest biomass monitoring, and the foresters in turn have provided training to the clans on forest monitoring and guidance on establishing permanent sample plots (PSPs) in their forests. The data generated from the PSPs provides for better planning of timber harvesting by the clans and has enabled the estimation of forest carbon stocks.

- CBFBM was introduced in 2010 as a collaborative effort of RECOFTC – The Centre for People and Forests and the Wildlife Conservation Society (WCS), with participation of the Forestry Administration (FA), into the Community-based Production Forestry Project (CBPF), which lies in the buffer zone of Seima Protection Forest in Cambodia. The entire CBPF area holds about 10,000 ha of forest and the action research focused on two trial areas for inventory within this; one for deciduous forest and one for evergreen forest. A training of trainers was followed by full implementation of the trial inventory, with the three ethnic Bunong communities in the project area participating.
- The CCA Action Research Project-Indonesia is being implemented by DKN (the National Forestry Council of Indonesia), ARuPA (a national NGO supporting community forestry), and two villages in Yogyakarta province – Semoyo and Terong – with analytical support from IGES. Households in Semoyo and Terong have private ownership of trees in their home gardens and in dryland areas where they have established woodlots and planted trees on the land boundaries. A unique approach taken by the Indonesian partners was to include key village persons in the training of trainers at Semoyo. The action research has evolved to support the communities in the development of a project design document (PDD) for community-based REDD+ using the Climate, Community and Biodiversity (CCB) Standards.
- The Faculty of Forestry, National University of Laos (NUoL), with support from IGES, launched action research on CBFBM in a hilly part of Sangthong District with four villages that hold a total of 9,788.40 ha of forest. The main research activities have included training of trainers to build the capacity of the researchers in the Faculty of Forestry to work on CBFBM, wide consultations to agree on the research villages, a socio-economic baseline survey, a training workshop for the district staff and the community members, setting up of community forest biomass inventory teams, forest sampling and initial data processing, mapping of land cover, and demarcation of forest strata.
- The CBFBM action research was launched in Vietnam by IGES and the Faculty of Forestry, Vietnam Forestry University (VFU) in 2012. The research is being implemented with several ethnic minority communities in Cao Phong district, Hoa Binh province who established *Acacia mangium* plantations under a small-scale Afforestation/Reforestation Clean Development Mechanism (A/R CDM) project. A key challenge for the action research was to build a research/facilitation team that had the competency to facilitate rather than direct communities on forest monitoring. The VFU team developed a field manual for guiding facilitators and the communities in their future monitoring, tested the manual with one community, and produced a second draft. The action research has evolved to look into the possibility of



introducing community-based forest monitoring into Vietnam's Payment for Forest Ecosystem Services system.

- The action research in the five countries has generated knowledge on the key elements and steps for designing a CBFBM system. The key elements of the CBFBM development process are:
  - ✓ Element 1 (E1): Feasibility assessment and stakeholder engagement
  - ✓ Element 2 (E2): Agreeing on the objectives, technical parameters and building a community based forest biomass monitoring design
  - ✓ Element 3 (E3): Designing and delivering community level training whilst testing the forest biomass assessment design
  - ✓ Element 4 (E4): Reflecting on the testing, and adapting the design of the forest biomass assessment and the community training
  - ✓ Element 5 (E5): Agreeing on next steps.
- The need to maximise the links between community based forest monitoring initiatives and local livelihoods/well-being has been emphasised by all the communities/villages participating in the action research. This has led to further action research cycles to use the data generated to explore other forest management options, especially REDD+, and improving the existing forest management.
- The research findings have implications for the implementation of several multilateral environmental agreements. For the UNFCCC, it shows how communities can be engaged in measurement processes to ensure that payments for REDD+ activities lead to real, long-term reductions in greenhouse gas emissions, while for the Convention on Biological Diversity (CBD), it indicates ways in which local communities and indigenous peoples can work together with scientists on knowledge co-production for the assessment and sustainable management and use of biodiversity and ecosystems services.
- CBFBM is highly relevant to addressing and respecting safeguards that the UNFCCC COP have agreed for REDD+ actions, and that countries are now building into their national REDD+ strategies. The safeguards cover governance, the participation and rights of indigenous peoples and local communities, biodiversity and ecosystems services, as well as the permanence of avoided emissions and the displacement of emissions through REDD+ actions. Through CBFBM, communities can participate in a meaningful way in REDD+ by providing information on carbon stocks and drivers of forest change, and their knowledge on biomass will put them in a better position to participate in national REDD+ dialogues and policy development through consultations and public submissions. Respect for the knowledge and rights of indigenous peoples and local communities is another REDD+ safeguard that is clearly promoted through CBFBM. In CBFBM, full use is made of local and traditional forest knowledge, including on species, ecosystem types and drivers of land cover change. CBFBM is also relevant to the safeguards on permanence and emissions displacement. CBFBM increases local understanding of how carbon revenues are generated and calculated, which in turn increases understanding of why permanence must be ensured and why leakage must be prevented. CBFBM systems could include a



component that engages communities in monitoring and reporting on leakage activities, which, because of their close proximity to forests, they could make an important contribution to.



## List of acronyms

AGLB	above ground living biomass
APN	Asia-Pacific Network for Global Change Research
A/R CDM	Afforestation/Reforestation Clean Development Mechanism
asl	above sea level
BGLB	below ground living biomass
C	carbon
CBPF	Community-based Production Forestry
CCA	Community Carbon Accounting
CCB	Climate, Community and Biodiversity (Standards)
CDM	Clean Development Mechanism
CFMP	Community-based Forest Monitoring Project
CFO	Community Forestry Office
CI	confidence interval
COP	Conference of the Parties (to the UNFCCC)
CV	coefficient of variation
DBH	diameter at breast height
DF	degrees of freedom (chapter 2)
DF	deciduous forest (chapter 3)
DHR	diameter / height relationship
DKN	National Forestry Council of Indonesia
DPA	Development and Partnership in Action
EF	evergreen/semi-evergreen forest
FA	Forestry Administration
FCA	Forest Cover Assessment
FDF	Forest Development Fund
FoF	Faculty of Forestry (National University of Laos)
FPCD	Foundation for People and Community Development
FSC	Forest Stewardship Council
FY	(Japan) fiscal year (April – March)
GIS	geographical information systems
GTZ	German Organisation for Technical Cooperation
ha	hectares
IDR	Indonesian rupiah
IGES	Institute for Global Environmental Strategies
IPCC	Intergovernmental Panel on Climate Change



JICA	Japan International Co-operation Agency
KPH	Forest Management Unit (Indonesia)
K:TGAL	Kyoto – Think Global Act Local
LC	land cover
LLG	local level government
LU	land use
MAFF	Ministry of Agriculture, Forestry and Fisheries
MRV	measurement, reporting and verification
NGO	non-governmental organisation
NTFP	non-timber forest product
NUoL	National University of Laos
PAR	participatory action research
PDD	project design document
PNG	Papua New Guinea
PSP	permanent sample plot
RECOFTC	The Centre for People and Forests
REDD	Reducing Emissions from Deforestation and forest Degradation
REDD+	Reducing Emissions from Deforestation and forest Degradation in developing countries, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks
SBCP	Seima Biodiversity Conservation Project
SD	standard deviation
SE	standard error
SESA	Strategic Environmental and Social Assessment
SPF	Seima Protection Forest
t	tonne
TMF	Training Model Forest
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples
UNFCCC	United Nations Framework Convention on Climate Change
USD	US dollars
VFU	Vietnam Forestry University
WCS	Wildlife Conservation Society



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# 1 INTRODUCTION

Henry Scheyvens (IGES)

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## 1.1 Background

Community Based Forest Biomass Monitoring (CBFBM) is the monitoring of forest biomass by communities. It is a form of monitoring that ultimately aims to be “driven” and “owned” by the local communities and “guided” and “facilitated” by outside experts. The information that is generated from the monitoring aids the communities in making wise decisions about their forest management.

Together with a number of partners, the Institute for Global Environmental Strategies (IGES) launched a regional programme on CBFBM as an outcome of national level awareness-raising and training workshops in FY2009 on Reducing Emissions from Deforestation and forest Degradation (REDD) for key stakeholders from government and civil society in Cambodia, Indonesia and Vietnam. IGES secured funding for the workshops from the Ministry of Environment of Japan and engaged The Centre for People and Forests (RECOFTC) in organising the workshops. The workshops included a participant-led capacity building needs assessment exercise for REDD, during which the development of local-level skills for monitoring of forest carbon was identified as a priority. IGES and RECOFTC therefore proposed an action research project on community carbon accounting

(CCA) as part of a proposal to Japan’s Ministry of Environment in May 2010. In the same year, IGES secured three-year funding from the Asia Pacific Network for Global Change Research (APN) for the project.

The main objectives of the regional CCA Action Research Project are to:

- develop, test and implement approaches to engage local communities in monitoring forest biomass, and
- use the information generated to assess the feasibility of alternative forest management options, including REDD+ (REDD activities plus activities to increase carbon stocks in standing forests).

In addition, it is anticipated that through their understanding of forest carbon dynamics that the project aims to generate, communities will be in a more informed position to participate in REDD+ policy dialogues.

A number of partners have joined IGES in implementing the CCA Action Research Project in five countries – Papua New Guinea (PNG), Cambodia, Indonesia, Lao PDR and Vietnam (Fig. 1.1). In addition to the action research with the participating communities, project activities have included workshops from district to national levels as well as presentations at various forums by researchers, facilitators



and leaders from the participating communities. Each year a regional reflection workshop that brings partners together to share their experiences, report on progress and to strategise has been held. A variety of products have been generated by the project, including research papers, a website, videos, and

forest inventory manuals, amongst others. A comprehensive training of trainers manual that deals with all aspects of building capacity to design and implement community-based forest biomass monitoring systems is one the major outputs.

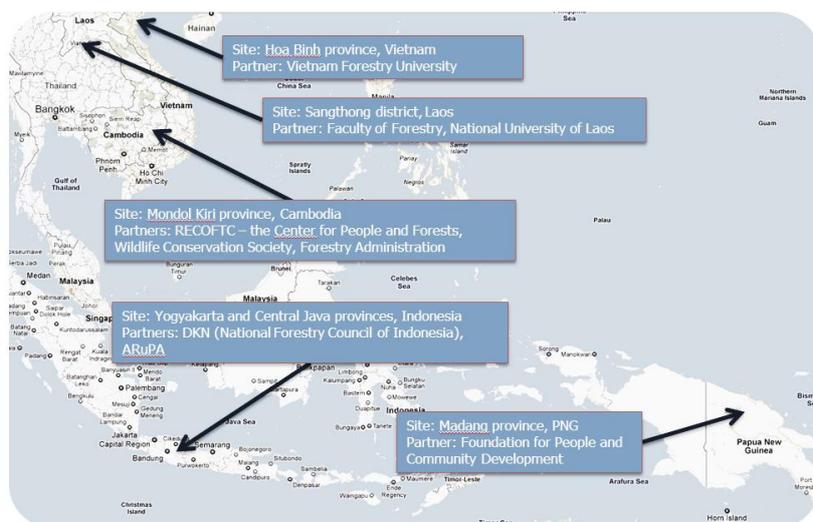


Figure 1.1: CCA Project sites

In this report, IGES and its project partners describe the approach to the action research taken in each country, progress that has been made and challenges faced, as well as lessons learned and plans for moving the research forward. Chapters 2 to 6 each provide a description of the action research undertaken in one of the study countries. This first chapter provides an explanation of the concept of community carbon accounting, or what we have to come to refer to more precisely as *community-based forest biomass monitoring*, its rationale, how it differs from conventional forest monitoring, key features of the action research as it evolved with partners in each country, and what we have learnt about the design and implementation of CFBM systems from the action research.

## 1.2 Concept and rationale

It is normally assumed that forest measurement can only be done by people who specialise in forestry. It is easy to understand why. Sampling is necessary as it is impractical to measure all trees in a forest, so knowledge on sampling design is required. Expertise is needed to determine statistically efficient sample plot dimensions, how to locate plots to avoid bias, how to map and stratify a forest according to management types and carbon densities, which carbon pools to focus on, what measurement instruments can be used, and how to minimise errors and present uncertainties as part of the results.



Given this complexity, usually little thought is given to involving local people in forest assessments beyond the menial tasks of carrying equipment, cutting tracks, etc. However, communities who for many generations have relied upon forests for part of their subsistence, cultural, financial and other needs, self-regulate their use of forest resources and, to do so, are constantly assessing and monitoring them. They observe who enters their forests and for what purposes, even if they are not always able to control this. The concept of forest monitoring is thus not something new to these communities. It is part of their traditional systems of knowledge generation and natural resource management.

Table 1.1 lists the major differences between conventional forest monitoring by professionals and CBFM. CBFM aims to generate knowledge that the communities themselves can use when deciding on forest management options, whereas professional surveys are normally carried out to produce data for outside organisations. Professional surveys are likely to use some expensive and sophisticated equipment, whereas CBFM prefers basic but nevertheless reliable equipment and methods. Common forest mensuration instruments such as diameter tape and clinometers are used in CBFM systems, while the more expensive instruments such as laser distance finders usually are not.

Table 1.1: Major differences between conventional forest monitoring by professionals and CBFM

	<b>Conventional forest monitoring by professionals</b>	<b>CBFBM</b>
<b>Aim</b>	*Generates data for research, government departments, companies, etc.	*Generates data for communities to strengthen their forest management and consider alternative forest management options *Can also contribute to district/provincial/ national forest monitoring
<b>Capacity</b>	*Already exists	*Must be built, but utilises local knowledge and skills
<b>Methods/ Equipment</b>	*Some are “high-tech (e.g. laser distance measuring tools)	*Simplified methods and equipment that provide reliable measurements preferred *Ideally, equipment is held by the communities
<b>Awareness</b>	*Professionals understand the purpose of the monitoring, but it remains largely a mystery to local people	*Communities have identified the need and make a choice to develop CBFM, and have strong ownership of the system, the process and the results
<b>Participants</b>	*Professionals conduct monitoring; local people may be recruited for menial tasks, such as track clearing and carrying equipment	*Community monitoring teams are self-organised and competent to generate and record data *Facilitators train communities and assist in building and coaching community institutions for forest monitoring *Professionals provide technical inputs, such as setting up spreadsheets for data processing, development of allometric equations, etc.



CBFBM can have a range of benefits for communities.

- **CBFBM generates information that the communities themselves can act on**

Through the generation of scientifically verifiable data, communities can strengthen their existing forest management as well as consider alternative forest management options, and will be better informed in their internal discussions and in dealings with outsiders.

- **CBFBM is timely as REDD+ could provide new revenue streams for forest management**

CBFBM is particularly timely as Parties to the United Nations Framework Convention on Climate Change (UNFCCC) agreed that developing countries could receive payments for their efforts to protect and enhance carbon stocks in standing forests, or REDD+. REDD+ could present opportunities for communities to receive payments for undertaking management activities to protect and/or enhance the carbon stocks in their forests, but these payments are to be “performance-based”, which means estimation and monitoring of forest carbon stocks are required. CBFBM provides the necessary estimates and a sound framework for ongoing monitoring.

- **CBFBM contributes to addressing and respecting REDD+ safeguards**

CBFBM is highly relevant to addressing and respecting safeguards that the UNFCCC COP have agreed for REDD+ actions, and that countries are now building into their national REDD+ strategies (Box 1.1). The safeguards cover governance, the participation and rights of

indigenous peoples and local communities, biodiversity and ecosystems services, as well as the permanence of avoided emissions and the displacement of emissions through REDD+ actions. In terms of participation, through CBFBM communities can participate in a meaningful way in REDD+ by providing information on carbon stocks and drivers of forest change, and their knowledge on biomass will put them in a better position to participate in national REDD+ dialogues and policy development. Respect for the knowledge and rights of indigenous peoples and local communities is another REDD+ safeguard that is clearly promoted through CBFBM. In CBFBM, full use is made of local and traditional forest knowledge, including on species, ecosystem types and drivers of land cover change. CBFBM is also relevant to the safeguards on permanence and emissions displacement. CBFBM increases local understanding of how carbon revenues are generated and calculated, which in turn increases understanding of why permanence must be ensured and why leakage must be prevented. CBFBM systems could include a component that engages communities in monitoring and reporting on leakage activities, which, because of their close proximity to forests, they could make an important contribution to.

- **CBFBM as part of a broader movement on community-based environmental monitoring**

CBFBM should be understood as one of a group of approaches that support community-based monitoring of natural resources and ecosystems services. The Global Workshop on Community-Based Monitoring and Information Systems, held on 26-28 April 2013 in Bonn, Germany,



noted that governments and international bodies have begun to recognise the importance both of indigenous peoples' traditional knowledge and of the information generated through community-based monitoring. The workshop concluded that international

agreements whose implementation could benefit from community monitoring include the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), the Convention on Biological Diversity (CBD) and the UNFCCC.

#### Box 1.1: REDD+ safeguards development in the action research countries

##### **PNG**

In PNG, the issue of REDD+ safeguards has been taken up in the development of National REDD+ Project Guidelines, which are intended to be a template for all project proponents who wish to develop a "Government supported REDD+ project". The Guidelines aim to (i) ensure that Government-supported REDD+ projects produce real net emissions reductions, meet high environmental and fiduciary standards, and are assessed in a transparent manner by criteria available to all stakeholders, and (ii) provide safeguard criteria to determine which REDD+ pilot projects and demonstration activities receive Government support.

##### **Cambodia**

Cambodia is still at an early stage in developing a REDD+ safeguards system. The proposed Consultation and Safeguards Technical Team under the REDD+ Taskforce will be responsible for elaborating a consultation plan. The Team is also expected to develop a strategic environmental and social assessment framework, and a system for monitoring and reporting social, environmental, governance-related and other impacts of REDD+. The REDD+ Roadmap states that this assessment and monitoring system will be built on the Strategic Environmental and Social Assessment (SESA) framework used by the World Bank.

##### **Indonesia**

The REDD+ Task Force has introduced safeguards principles in the REDD+ National Strategy, while the Department of Standardisation, Ministry of Forestry is working on the development of a REDD+ Safeguards Information System (SIS-REDD+). A two track approach is being taken to developing the SIS-REDD+ that involves (1) stakeholder communications to develop the institutional structure and to develop verifiers to evaluate conformity with principles, criteria and indicators, and (2) hiring consultants to develop principles, criteria and indicators for the safeguards, and to develop a database and web-based information system. Seven principles, 17 criteria and 31 indicators were identified for the safeguards.

##### **Lao PDR**

The Government of Laos has made a commitment to develop a range of safeguards based on consultations with major stakeholders. The Government aims to develop relevant safeguard instruments in line with: (1) the country's laws and regulations; (2) the policies and procedures of financing agencies such as the World Bank's Forest Carbon Partnership Facility; (3) the requirements of the UN system, and (4) REDD+ safeguards agreed under the UNFCCC negotiations.

##### **Vietnam**

The Government has undertaken several activities related to REDD+ safeguards, including piloting the concept of free prior informed consent (FPIC) at a UN-REDD Programme project site; designing a REDD-compliant benefit distribution system (BDS); and drafting the Measurement, Reporting and



Verification Framework Document, which illustrates the linkage to the safeguards information system. The Sub-Technical Working Group on Safeguards was established in 2012 under the REDD+ Network to deliver coordinated technical assistance to these efforts. The Working Group is a multi-stakeholder platform open to all interested entities including public, private and civil society sectors. In 2013, the Vietnam REDD+ Office released the draft Roadmap for Environmental and Social Safeguards for the National REDD+ Action Programme.

### 1.3 Key features of the action research

Through action research conducted over the past four years we have learnt that not every CBFM system will be the same. They must reflect clear objectives defined by the communities themselves as well as contextual factors (e.g. community institutions and forest conditions). The action research in each country under the CCA Project has evolved according to location-specific contexts, challenges and opportunities. Below we provide a brief description of the action research approach and progress in the five countries.

#### 1.3.1 PNG

The action research in PNG is being conducted through the Community-based Forest Monitoring Project (CFMP), which is a joint initiative of IGES and the Foundation for People and Community Development (FPCD), a national NGO with core expertise in community forestry. The research is being implemented with six clans (extended families) that hold areas of natural forest under customary tenure arrangements. Each of these clans is being supported by FPCD to manage their forests according to Forest Stewardship Council (FSC) principles and to harvest and market timber from their forests. The

CFMP has built the capacity of the FPCD foresters to work with the participating clans on forest biomass monitoring, and the foresters in turn have provided training to the clans on forest monitoring and guidance on establishing permanent sample plots (PSPs) in their forests. The data generated from the PSPs provides for better planning of timber harvesting by the clans and has enabled the estimation of forest carbon stocks. The data on carbon stocks is being combined with the results of work to map land cover using remote sensing and a study of deforestation and degradation drivers to assess the feasibility of REDD+ at some of the project sites. A field manual and several videos of the project have been produced. The progress of the action research was reported at several national workshops related to natural resource management and ecosystems services organised by IGES and the PNG Institute of National Affairs.

Photo 1.1: Forest sampling, Yate clan, Brahman, PNG



© Henry Scheyvens



### 1.3.2 Cambodia

CBFBM was introduced in 2010 as a collaborative effort of RECOFTC and the Wildlife Conservation Society (WCS), with participation of the Forestry Administration (FA), into the Community-based Production Forestry Project (CBPF), which lies in the buffer zone of Seima Protection Forest in Cambodia. The CBPF is a new model of forestry for Cambodia that establishes community institutions to manage forest on a sustainable production basis. The CBFBM action research looked into the potential of training community-based teams to undertake the inventory work for commercial timber harvesting as well as to gather additional data that would allow calculation of carbon stocks and through this consideration of the feasibility of REDD+ for the project area. The situation at the action research site in Cambodia was thus similar to the sites in PNG in that inventory and monitoring is required for the planning of sustainable timber harvesting, and CBFBM was viewed as one approach that could generate the data required as well as generate additional data to investigate REDD+ feasibility.

The entire CBPF area holds about 10,000 ha of forest and the action research focused on two trial areas for inventory within this; one for deciduous forest and one for evergreen forest. A training of trainers was followed by full implementation of the trial inventory, with the three ethnic Bunong communities in the project area participating. Other features of the action research project included: experimentation with low cost, simple devices using locally available materials to measure trees; experimentation with different sample

plot designs to understand their “statistical efficiency”; destructive sampling to develop species-specific allometric equations; use of three dimensional photogrammetric techniques to estimate tree volume; study of tree rings to model tree growth; land cover / land use mapping using remotely sensed data; and study of emissions scenarios under different forest management options.

Photo 1.2: Testing of simple method to estimate tree bole diameter, Seima, Cambodia



© Kimihiko Hyakumura

### 1.3.3 Indonesia

The CCA Action Research Project-Indonesia is being implemented by DKN (the National Forestry Council of Indonesia) and ARuPA (a national NGO supporting community forestry) with analytical support from IGES. Through an extensive process of consultation and feasibility assessment, DKN and ARuPA considered the potential of introducing CBFBM in a total of five villages, including



two in Sumatra that have rights to natural forest, but settled on two villages in Yogyakarta province – Semoyo and Terong – which have strong institutions for forest management and where ARuPA and DKN have strong stakeholder networks.

Households in Semoyo and Terong have private ownership of trees in their home gardens and in dryland areas where they have established woodlots and planted trees on the land boundaries. The planting and harvesting of trees is supported by forest farmer groups that have been established in each village and the small-scale forestry provides an important source of household income and brings a significant amount of money into the local economy.

A unique approach taken by the Indonesian partners was to include key village persons in the training of trainers at Semoyo, and then to have these persons, together with the field facilitators, train the community on forest measurement. This approach proved particularly useful when the trainers from Semoyo Village supported the training of trainers in Terong Village, as they were able to explain concepts using local idioms and analogies. The participating communities were also given the responsibility of data entry into MS Excel spreadsheets. Local enthusiasm for the action research can be seen in the initiative taken by Semoyo leaders to share their experiences with the forest monitoring through the public radio service.

The action research has evolved to support the communities in the development of a project design document (PDD) for community-based REDD+ using the Climate, Community and Biodiversity (CCB) Standards. The action

research has also been promoted widely through national forums, and the potential to include the approach to CBFBM developed at Semoyo and Terong into the permanent forest management units (KPH) that will eventually be responsible for managing all of Indonesia's state forests is being studied. The project's outputs include a video in Bahasa Indonesia and a module that provides guidance on implementing the CBFBM approach developed by the project.

Photo 1.3: Community using GPS and filling field sheets, Terong



© Taiji Fujisaki

### 1.3.4 Lao PDR

The Faculty of Forestry, National University of Laos (NUoL), with support from IGES, launched action research on CBFBM in a hilly part of Sangthong District with four villages that hold a total of 9,788.40 ha of forest. The main research activities have included training of trainers to build the capacity of the researchers in the Faculty of Forestry to work on CBFBM, wide consultations to agree on the research villages, a socio-economic baseline survey, a training workshop for the district staff and the community members, setting up of community forest biomass inventory teams, forest sampling and initial data processing, mapping of



land cover, and demarcation of forest strata. The project has produced training materials for introducing CBFBM as well as a field guide in the local language.

The action research observed that community teams are very active in the training programmes and after the training are able to establish and measure the sample plots with some guidance from the trainers, but that a strategy needs to be devised to ensure women are also involved in the monitoring. Women have been involved in the forest monitoring in all the other countries under the regional CCA Action Research Project.

Photo 1.4: Training of trainers, NUoL



© Saykham Bouttavong

### 1.3.5 Vietnam

The CBFBM action research was launched in Vietnam by IGES and the Faculty of Forestry, Vietnam Forestry University (VFU) in 2012. The research is being implemented with several ethnic minority communities in Cao Phong district, Hoa Binh province who established *Acacia mangium* plantations under a small-scale Afforestation/Reforestation Clean Development Mechanism (A/R CDM) project. As the site is a registered A/R CDM project, training of the communities on CBFBM will contribute to the monitoring and reporting necessary for the issuance

of carbon credits. However, whether the communities are actually interested in managing the planted forests from a long-term perspective was not entirely clear as their initial motivation to participate in the tree planting was to harvest the trees as quickly as possible. A survey undertaken in 2013 as part of the CBFBM action research has found that villagers' perceptions towards the forests is changing as they are noting a number of benefits from the forests, such as higher, more stable and less turbid water supplies, less erosion, fuel wood and return of birdlife.

A key challenge for the action research was to build a research/facilitation team that had the competency to facilitate rather than direct communities on forest monitoring. Two workshops were conducted by trainers from RECOFTC to build the understanding of the VFU team on participatory action research and to build their competency as facilitators.

Photo 1.5: Testing the manual



©Makino Yamanoshita

IGES organised a five-day training of trainers for the VFU team to produce an initial design for the CBFBM. The VFU team then went ahead and developed a field manual to provide guidance to the facilitators and to the community forest monitoring teams for their future monitoring. VFU facilitators conducted a two-day training for community members



on the manual's use, observed responses, reflected on the problems identified and lessons learned, and incorporated these into a second draft of the manual. The action research has evolved to look into the possibility of introducing community forest monitoring into Vietnam's Payment for Forest Ecosystem Services system.

#### 1.4 Steps in designing a CBFBM system

Action research is a cumulative learning process in which cycles of planning, action, observation and reflection build on each other in the process of problem solving. For the CBFBM, the action research involved community facilitators working together with local communities in designing, testing, reflecting on and adapting a monitoring system that aims to assist the communities in managing their forests wisely. CBFBM is in fact the first cycle of action research that builds community institutions and generates data for exploring the feasibility of alternative forest management options as well as data to improve existing forest management planning. Together with the participating communities, project partners at some of the action research sites have moved on to subsequent action

research cycles, for example, the preparation of a PDD for community-based REDD+ in the two participating villages in Indonesia, and the study of emissions scenarios under different forest management options for the sites in PNG and Cambodia.

The action research in the five countries has generated knowledge on the key steps for designing a CBFBM system. These are shown in Fig. 1.1. Some were understood when the action research was launched, though others became clear as the action research progressed. The key elements of the CBFBM development process are:

- ✓ Element 1 (E1): Feasibility assessment and stakeholder engagement
- ✓ Element 2 (E2): Agreeing on the objectives, technical parameters and building a community based forest biomass monitoring design
- ✓ Element 3 (E3): Designing and delivering community level training whilst testing the forest biomass assessment design
- ✓ Element 4 (E4): Reflecting on the testing, and adapting the design of the forest biomass assessment and the community training
- ✓ Element 5 (E5): Agreeing on next steps.

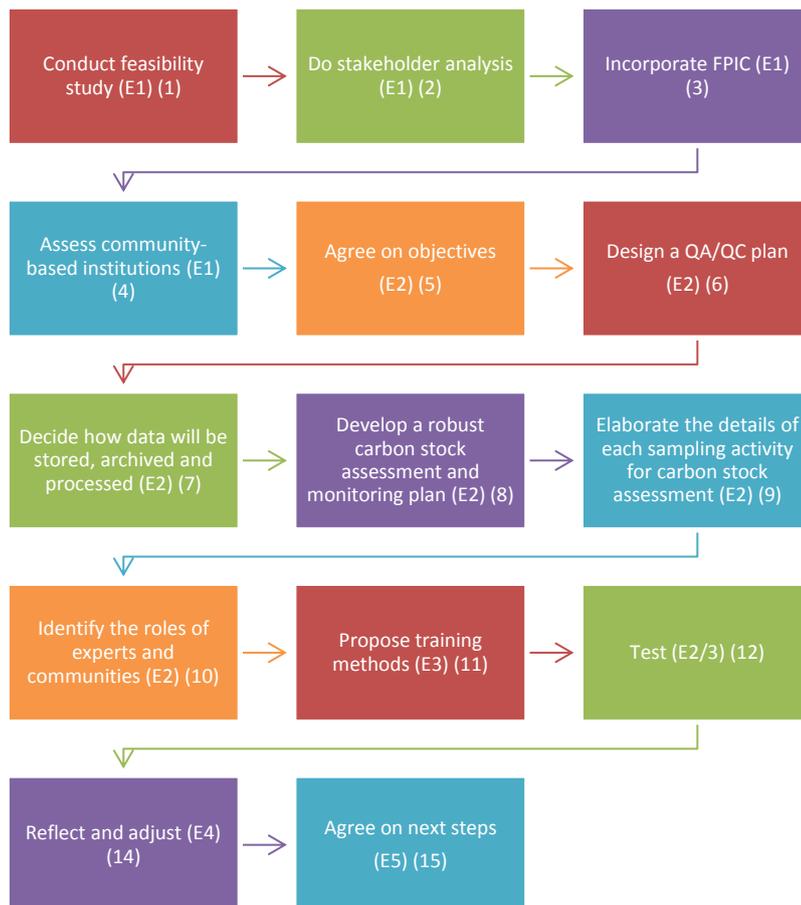


Figure 1.2: Key elements and steps of the CBFM development process  
Figure designed by Karen Edwards and Henry Scheyvens

### 1.4.1 Feasibility assessment and stakeholder engagement

#### *Feasibility assessment*

Action research can pose risks to communities or risks for other organisations who hope to work with the participating communities in the future. It can raise expectations that cannot be met as factors out of the control of the researchers change over time. These risks can be minimised by a thorough feasibility assessment.

As part of the feasibility assessment, the potential relationship between CBFM and livelihoods and community well-being in general must be studied. The feasibility assessment should also consider whether local communities have a commitment to long-term forest management and some of the basic institutions, e.g. strong leadership, required to achieve this.

#### *Stakeholder analysis and engagement*

The key stakeholder groups in CBFM have been found to include:

- ✓ Community leaders
- ✓ Community members, including specific interest groups, such as



women, men, youth, ethnic minorities, etc.

- ✓ Implementing organisations
- ✓ District/municipal/province/state governments
- ✓ Forestry departments
- ✓ Local civil society groups
- ✓ Local NGOs
- ✓ Surrounding communities

A stakeholder engagement plan helps in identifying who the key stakeholders are and analysing their rights, responsibilities, revenues/returns, as well as the nature of their relationships (referred to as the 4 Rs).<sup>1</sup> The importance of investing in regular consultations and information-sharing events with stakeholders through workshops and other forums is highlighted in the CBFBM action research in all five countries.

### ***Free, prior, and informed consent***

Free, prior and informed consent (FPIC) can be described as the establishment of conditions under which people exercise their fundamental right to negotiate the terms of externally imposed policies and activities that directly affect their livelihoods or well-being, and give or withhold their consent. CBFBM action research approaches should incorporate FPIC principles, though, by definition, action research cannot exist without FPIC because action research requires communities to be involved as key research partners.

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<sup>1</sup> The 4Rs framework was developed as part of the Capacity Development for Sustainable Development in Africa Project carried out by the International Institute for Environment and Development and collaborating partners in six African countries, supported by the Danish International Development Agency. (<http://pubs.iied.org/7537IIED.html>)

Community-based monitoring provides the communities with information on their forest resources, which enables them to make informed decisions about the management of these resources. In this sense, CBFBM provides the communities with the information for FPIC (it is the “I” in FPIC) in relation to their decisions on forest management.<sup>2</sup> At the same time, FPIC principles also apply to the design and implementation of the CBFBM itself. When facilitators and communities are working together to develop any community-based monitoring system, efforts are required to ensure that the communities fully understand all elements of the system. Some elements will be highly technical and unfamiliar to the community members, and without a proper understanding of the reasons for these elements, the communities cannot participate in the design process and the monitoring in a fully informed manner.

## **1.4.2 Agreeing on the objectives, technical parameters and building a community based forest biomass monitoring design**

### ***Objectives***

Objectives for the CBFBM must be agreed with participating communities, which requires the use of local forums for discussion that they are comfortable and familiar with, as well as opportunities for the objectives to be extended as the action research progresses. The activities

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<sup>2</sup> Source: Toon De Bruyn, pers. comms.



conducted as part of the action research do not have to solely focus on biomass. For example, photographs and video of traditional songs and dances were captured at points of historical and cultural significance to the participating clan at Bangapala, PNG, when foresters and the community conducted the week-long land boundary demarcation. These photos and videos are not needed for biomass assessment, but are nevertheless important for the community as they provide a record of some of its traditional knowledge and culture for future generations.

### *Designing the monitoring system and teaching approach*

To introduce CFBM in any community requires a team of people who hold expertise in forestry inventory as well as community facilitation. Finding both sets of skills in any one person is uncommon, though some of the action research partners, for example, FPCD in PNG and DKN/ARuPA in Indonesia, were fortunate in having such people in the form of professional foresters who have worked closely with communities. Even in these cases, further capacity building of the CFBM facilitation teams was desirable.

- *Training of trainers*

The action research has found that a well-organised training of trainers (ToT) is essential for successful support and facilitation for CFBM. The “core” ToT aims to guide the facilitation team in producing the initial design of the CFBM system, setting out appropriate teaching methods, testing key elements of the design and teaching methods with one or more communities, and reflecting on the testing (Fig. 1.2). One ToT is unlikely to be

sufficient and ToTs on facilitation skills (Vietnam), technical issues such as geographic information systems (PNG, Lao PDR and Vietnam) and other needs identified may be necessary.

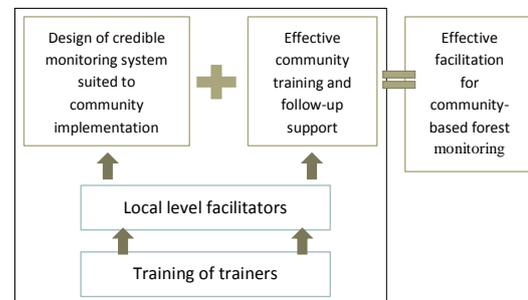


Fig. 1.2: Role of training of trainers in effective facilitation for CFBM

- *Quality assurance and quality control*

Quality assurance refers to the collection and recording of data, whereas quality control refers to checks to ensure the data recorded is accurate or (based on good judgment) appears reasonable. Showing that quality assurance and quality control measures (QA/QC) are in place and are put into practice is particularly important for CFBM because there are always likely to be some people, especially those from a purely technical background, who will question the ability of local community teams to conduct forest sampling. A procedural document that describes the quality assurance and quality control steps can be developed.

Keys to QA for CFBM identified from the action research are (i) well-structured training programmes for the communities, (ii) supervision of the community teams when they first begin to do the sampling, and (iii) the establishment of procedures to ensure that data is correctly entered into field sheets, and again into computer software. Other practical measures include



having a trainer/s as a member of each community forest monitoring team to provide guidance (this is the common approach taken for the CBFBM action research in several of the countries), assigning two people to the technically more difficult tasks and putting in place systems for double-checking each measurement, confirming measurements prior to entry into field sheets, and checking data prior to departing from plots.

In some situations communities may have sufficient starting capacity to take responsibility for entering the field data into prepared MS Excel spreadsheets (as in the research villages in Indonesia), but training must be provided on quality assurance during data entry.

### **1.4.3 Training of community monitoring teams**

Effective training of communities on CBFBM requires proper preparation. Though must be given to understanding the current knowledge and skills of communities relevant to forest monitoring, an appropriate location for the training, teaching aids and inventory equipment, a well-designed training programme that covers the concepts, protocols and skills needed, and methods of teaching built on adult-learning principles. The experience of the action research is that topics such as climate change and concepts such as REDD+ and carbon can be difficult for local communities to grasp, and finding local analogies or other ways of making these topics/concepts understandable through relating them to existing community knowledge and experiences is essential. For teaching inventory techniques, such as

locating PSPs using handheld GPS (global positioning system) devices, setting out the PSPs, and using measurement tools such as distance and diameter tape, compasses and clinometers, experiential teaching methods have been found to be effective. In practice, this means that “classroom” teaching is kept short and broken up by longer periods in the forest where the community members acquire skills through guided practice. With these methods, the action research has found that communities can produce measurements comparable with those of professional foresters (comparisons between measurements by communities and experts are provided in the action research reports from Cambodia and Vietnam) and they retain the knowledge learnt (see action research report from Cambodia). One observation common to the action research in all countries is that where individuals first find it difficult to grasp the complexity and meaning of the concepts, protocols and techniques associated with CBFBM, their understanding and competency grows as their experiences under the action research accumulates.

### **1.4.4 Reflecting and adapting**

The CBFBM system will be developed based on expert knowledge on forest inventory and on experience with community facilitation. However, no matter how good this knowledge and experience is, the first design of a CBFBM system is unlikely to be perfect. The design must be tested, the experiences reflected on, and adjustments made. The testing has two objectives (Fig. 1.3):



- ✓ To test some of the major proposed elements of the CBFBM design;
- ✓ To test some of the proposed community training activities.



Figure 1.3: CBFBM testing objectives

With respect to the first objective, the testing is to confirm the feasibility of the proposed measurement elements of the CBFBM design. It is an opportunity to test not only whether community members can be taught the proposed protocols and measurement techniques, but also to test various monitoring options (e.g. testing of square vs. dimensionless plots in Cambodia) and to experiment with simplified, yet nevertheless rigorous, measurement techniques (e.g. use of Christen hypsometers in Indonesia and variable wedges / transparent rulers to estimate tree diameter in Cambodia).

### 1.4.5 Agreeing on next steps

After reaching Element 5: Agreeing on Next Steps, the local level facilitators and communities embark on a second cycle of action research, e.g. full roll-out of the CBFBM system, and this will be followed by further cycles, e.g. decision to protect or enhance forest carbon stocks, etc.

## 1.5 Roles of communities and experts/facilitators in CBFBM

As these key steps in CBFBM design indicate, both communities and facilitators/experts have important roles to play in the design and implementation of CBFBM systems. Table 1 provides an example of the roles that communities and facilitators/experts might play for the major components of a CBFBM system, drawing on the action research experience in the five countries. In this case we are assuming that the CBFBM system is part of a REDD+ project, so we have included land cover and land use mapping and the analysis of future carbon scenarios as additional activities.



Table 1.2: Possible roles of experts/local level facilitators and communities in CBFBM systems

	<b>Experts</b>	<b>Communities</b>
<b>Agreeing on CBFBM sites</b>	*Responsible for analysing feasibility of CBFBM at sites, and for ensuring FPIC principles are fully implemented	*Decides whether to participate or not
<b>Design of CBFBM system</b>	* Facilitates a participatory design process	*Provides local knowledge on forest and planning of system that may be relevant to design
<b>Land cover / land use mapping and stratification</b>	*Encourages communities to share their ideas for the mapping *Decides on technical issues and responsible for mapping using remote sensing and GIS *Provides training on GPS and map reading *Maps boundaries with communities	*Shares expectations for the mapping *Provides sketches *Assists with interpreting features in satellite images *Participates in ground-truthing *Demarcates boundaries using GPS *Can be involved in GIS when participatory GIS tools are used
<b>Position, set up and measure sample plots</b>	*Provides training on concepts and techniques, guidance and on-going support	*Plays main role (when competency is sufficiently built)
<b>Additional technical work: destructive sampling, etc.</b>	*Leads – explains purpose to communities	*Participates in field activities
<b>Spread sheet design</b>	*Leads	-
<b>Data entry and storage</b>	*Usually responsible for data entry (If communities are responsible for data entry, experts must provide instruction on quality assurance, i.e. checking whether measurements recorded in the field are reasonable) *Determines system for data storage and archiving	*May be responsible (can do data entry if some members have computer skills)
<b>Quality assurance and quality control (QA/QC)</b>	*Integrates into all aspects of CBFBM system *Builds community awareness on importance of QA/QC	*Responsible for careful plot positioning and layout, measurement and recording
<b>Analysis of future carbon scenarios (baseline vs alternative management options)</b>	*Leads	*Provides local information for modelling scenarios (e.g. on extraction of fuel wood)
<b>Interpreting results</b>	*Leads – Explains results to communities	*May be able to assist with interpretation using local knowledge on forest conditions (e.g. spatial



		variation in biomass)
<b>Deciding actions</b>	*Agrees with communities on any actions	*Agrees with experts on any actions *Can choose to withdraw consent for actions at any time
<b>Future monitoring</b>	*Proposes monitoring frequency and plays supporting role, including refresher trainings, if needed	*Conducts future monitoring *Ideally, data generated is consolidated within a community-based information system for forest management

## 1.6 Conclusion

The Community Carbon Accounting Action Research Project implemented by IGES and its partners in five countries in the Asia-Pacific region has shown that communities can be engaged in assessing and monitoring biomass in their forests. The action research has pointed to the key elements and steps that need to be followed in the design and implementation of any CFBM system. The need to maximise the links between community-based forest monitoring initiatives and local livelihoods/well-being has been emphasised by all the communities/villages participating in the action research. This has led to further action research cycles to use the data generated in exploring new forest management options and improving existing forest management.

The research findings have implications for the implementation of several multilateral environmental agreements. For the UNFCCC, it shows how communities can be engaged in measurement processes to ensure that payments for REDD+ activities lead to real, long-term reductions in

greenhouse gas emissions, while for the CBD, it indicates ways in which local communities and indigenous peoples can work together with scientists on knowledge co-production.

The following chapters provide a more detailed account of the action research undertaken in each country and illustrate the generic messages presented in this chapter through their field experiences.

### Acknowledgements

The author is grateful to all IGES colleagues and all IGES partners involved in the regional Community Carbon Accounting Action Research Project, as well as co-authors of the generic CFBM training of trainers manual that has provided some of the ideas discussed in this chapter.





## 2 FPCD–IGES Community–based Forest Monitoring Project

Henry Scheyvens (IGES), Ram Avtar (UNU-ISP), Taiji Fujisaki (IGES), Yati A. Bun (FPCD), Mark Winai (FPCD), and Lavinia Poruschi (Consultant)

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### 2.1 Introduction and backdrop

Approximately 60% of Papua New Guinea (PNG) is covered by natural forests, making it one of the most significant areas of largely intact tropical forest in the world. Almost all of PNG's forest is owned by local clans according to their customs.

The customary land owners face a fundamental set of problems. Their cultural systems and traditional livelihoods are closely tied to forests, but they also desire the benefits that they anticipate “development” will bring. However, their knowledge, skills and institutions to develop their resources for cash income is limited.

Rather than aiming to build the capacity of the customary owners to manage their forest resources, PNG's forest policies mostly focus on alienating timber rights from the customary owners and making these rights available to logging companies. For as long as the logging takes place, this form of forestry generates some benefits for some of the local people through royalties, employment and the construction of infrastructure. However, it mostly does not generate sustainable benefits over the longer term and, due to inadequate monitoring and enforcement, can result in

widespread environmental damage (ITTO, 2007).

With this backdrop, the Foundation for People and Community Development (FPCD), a Papua New Guinean non-governmental, not-for-profit organisation, is developing an alternative community-based forestry model. In this model, communities who request assistance from FPCD are trained to manage their forest resources in accordance with Forest Stewardship Council (FSC) principles, and on timber milling and marketing, and business management.

FPCD's vision is “improved livelihoods and greater self-reliance for Papua New Guineans through community development initiatives and sustainable resource use.” Through its Certified Community Forestry Programme, FPCD is supporting six clans in Madang Province – Gniat, Namokanam (Urinite), Dalomes (Dawen), Awane, Yate and Ugalingu (Fig. 2.1) – in managing their forests. A seventh community, the Gendo Mavi clan at Tingari, initially requested FPCD support for their forest management, but their participation in the project is currently uncertain.





assessment and the results. The approach to mapping is explained and illustrated through the work at Bangapala in 2013. The report then provides a rough costing of the CFMP approach and of a conventional biomass survey. The report concludes with a number of observations on how PNG can move forward with community-based forest assessment and monitoring.

## 2.2 CFMP objectives

IGES and FPCD launched the CFMP to complement FPCD's Certified Community Forestry Programme. FSC forest management principles require monitoring of the forest management areas set aside by each clan for sustainable timber harvesting to record how the forests respond to the community-based forestry operations. There is thus a need to establish permanent sample plots (PSPs) in these areas. In addition to monitoring the impacts of small-scale and occasional logging by the clans, the PSPs can also generate data that allows FPCD and the participating communities to explore further options for forest management.

One potential option that could provide additional financial incentives for community-based forest management in PNG is REDD+ (Reducing Emissions from Deforestation and forest Degradation in developing countries, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks). Under REDD+, communities could receive financial rewards for maintaining or enhancing the carbon stocks of their forests. In principle, REDD+ does not deny clans the right to harvest their forests; rather, it would require that community management maintains higher carbon

stocks than the most likely alternative forest management/use scenario (e.g. logging by companies or clearance under agricultural leases).

REDD+ must be approached cautiously, however. Securing results-based payments for REDD+ activities requires long-term commitment and investment. Without sufficient awareness and capacity building, communities could become disappointed with the inability of REDD+ to generate easy financial returns.

Based on these contextual factors and considerations, the objectives of the CFMP are to:

- ✓ Develop and implement an approach to community-based forest monitoring;
- ✓ Analyse the data generated by the communities and assist the communities in interpreting the results;
- ✓ Assess the feasibility of REDD+ to provide an additional incentive for community-based forest management at the project sites.

## 2.3 Overview of the participating clans

The participating clans mostly live a traditional lifestyle based around subsistence gardening, supplemented by hunting, fishing and gathering, which they further supplement with income from the sale of garden produce, fish, cash crops, etc. A few clan members may operate small local businesses, usually trade stores or transportation services (PMVs), or engage in wage employment. Literacy is low. Securing sufficient protein is a major issue and an inadequate diet, together with a lack of government services,



inadequate hygiene practices and the tough living conditions, may be responsible for the low life expectancy reported.

The relationship the clans have with their forests is characterised by:

- Extraction of timber and non-timber forest products for consumption, medicines, structural materials and “customs work” (ceremonies, etc.);
- Dependence on forests for other ecosystems services, such as water and soil conservation;
- Clearance of patches of forest as part of shifting agriculture and cash cropping systems;
- Harvesting of timber in line with management plans based on FSC principles;
- Controls placed on forest access and use through customary institutions;
- Controls placed on forests through land use planning facilitated by FPCD.

The participating clans are motivated to manage their forests well and hand them on to their future generations, but they are also interested in increasing their cash income. Some are able to generate income from timber milling, but the work is hard and some may still be vulnerable to approaches from logging companies and agriculture developers (though some clan leaders report having “chased logging companies away”). Logging companies have sought entry to some of the forests (reported by the Gnait and Ugalingu clans). Some of forests under the CFMP would thus likely meet the requirements of additionality for a REDD+ project.

The participating clans hold between 270 and 13,000 ha of land, most of which is

forested. Most of the forest has previously been mapped as low altitude natural tropical rainforest (Hm class), though some has been disturbed by human activities, e.g. shifting cultivation, commercial logging, and natural events such as storms. The forests have high species diversity, with over 60 species identified in the CFMP sampling. Large variations in stem counts, stand density and basal area are recorded in the CFMP surveys. Climate is similar across the area (annual rainfall, 3-4,000 mm; temperature range, 21-33 degrees Celsius), while there are some differences in soils and topography. Much of the remaining forest is on steeply sloping land, though Bangapala is distinctive in that it is low lying and has a high water table that supports swamp forests.

All of the land is under customary ownership and use rights are retained by the clans (i.e. they have not been transferred to the state or private interests). In Madang Province, society is patrilineal, meaning that traditional chieftainship and landownership is passed on from father to son. The clans are usually associated with a larger community that comprises a village.

The clan populations vary considerably and in some cases are small (e.g. the Yate clan has only 11 adult members and the Namokanam clan has only 8 adult members). As adult clan members have a variety of obligations (social and livelihood related), in the smaller clans the amount of time that adults can contribute to forest monitoring is limited.



## 2.4 Building community capacity for forest monitoring

The approach of the CFMP has been to engage fully with the participating communities in all aspects of forest monitoring with the aim of building largely self-reliant community-based forest monitoring teams. We use the term “monitoring” very broadly to include (i) mapping, (ii) measurement (forest assessment) and (iii) continuous observation and periodic re-measurement of the forest.

The key capacity building activity under the CFMP is the implementation of a training programme on forest monitoring in each community. The communities select between about six and ten of their members for the forest monitoring training. The training programme runs over three days. Day 1 is spent in and around the villages and involves training on (i) the purpose and principles of forest monitoring, (ii) the monitoring parameters, methods and equipment, (iii) data recording and (iv) team management. Days 2 and 3 are spent in the forest, where the trainers guide the teams in locating, setting up, measuring and recording data from PSPs. A community-friendly field manual has been drafted as a resource for the training and to guide the monitoring.

The community forest monitoring teams are trained on how to locate and set out nested square plots; tree marking and tagging; and on the use of GPS, survey tapes, diameter tapes, compasses and clinometers. In addition to tree measurement, the community teams take measurements for estimating biomass in lying dead wood and they record site conditions, such as altitude, slope, aspect,

and disturbance (natural and human causes). The teams also record tree species in their local languages.

Photo 2.2: Classroom training - Dawen



Photo 2.3: GPS training - Bangapala



Photo 2.4: Clinometer training - Dawen





Photo 2.5: Diameter measurement training - Bangapala



Photo 2.6: Forest sampling, Awane



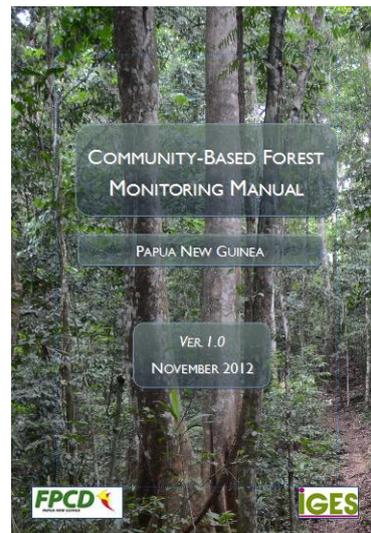
Photo 2.7: Forest sampling – Brahman



Photo 2.8: Forest sampling, Sogeram



Photo 2.9: Field manual



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## 2.5 Land use planning

FPCD has conducted participatory land use mapping with all communities for them to plan and place controls on their land use. The CFMP has supported the participatory land use mapping by building the capacity of FPCD foresters on GIS. Table 2.1 provides information on the areas the clans have allocated for different land uses through community-based land use planning processes and Figure 2.2 provides an example of the land use maps.



Table 2.1: Land-use zoning of 5 of the participating clans

Clan	Reserve forest (ha)	Production forest (ha)	Agriculture area (ha)	Protection forest	Reforestation	Resettlement	Total
Gnait	3245	500	600	2020			6365
Namokanam	40.1	153.8	77.9				271.8
Dawen	305.3	144.4	115.1		59.7		624.5
Awane	198.01	416	106.24	573			1293.25
Yate		409	35.5	72		3.5	520
<b>Totals (ha)</b>	<b>3788.41</b>	<b>1623.2</b>	<b>934.74</b>	<b>2665</b>	<b>59.7</b>	<b>3.5</b>	<b>9074.55</b>
<b>Totals (% of total area)</b>	<b>41.75</b>	<b>17.89</b>	<b>10.3</b>	<b>29.37</b>	<b>0.66</b>	<b>0.04</b>	<b>100</b>

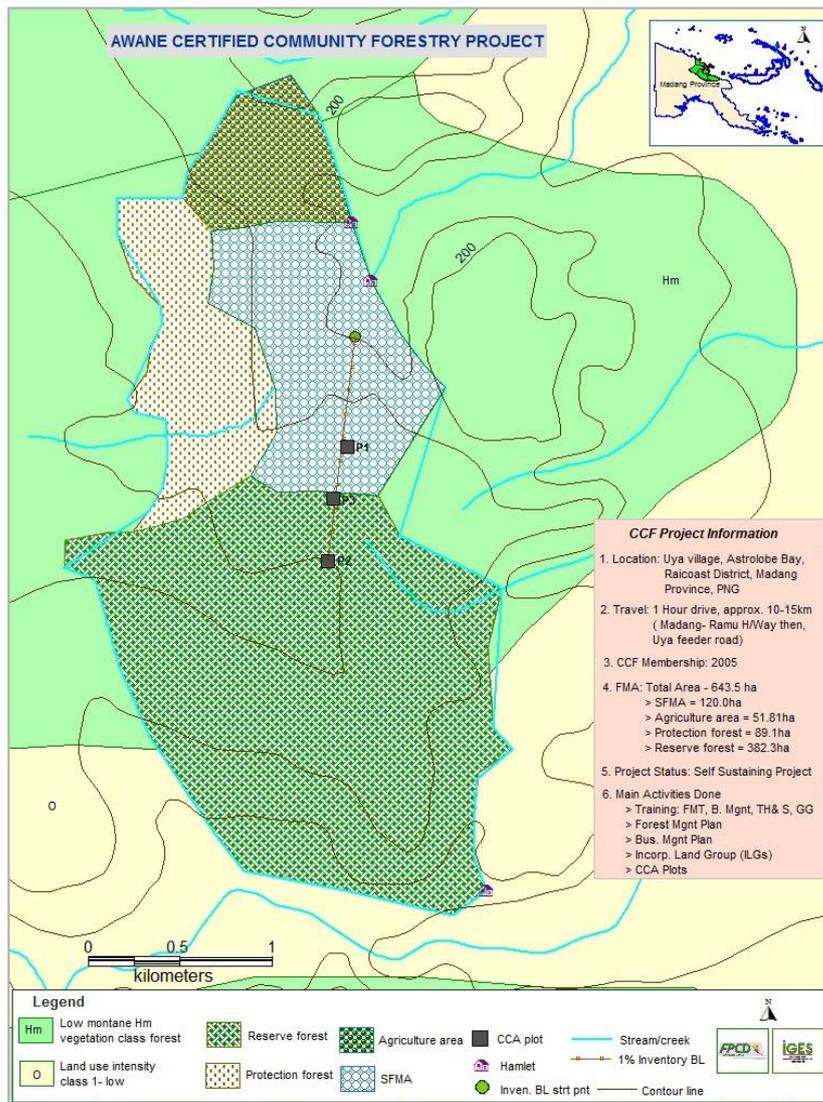


Figure 2.2: Awane land use map



## 2.6 Biomass assessment

### 2.6.1 Defining project boundaries

The boundaries of all the sites under the CFMP were surveyed by the FPCD foresters working together with the communities. One purpose of the boundary surveys is to enable the communities to register themselves as land groups and thus have their customary ownership formally recognised. Boundary demarcation is also required for estimation of forest biomass.

The FPCD foresters facilitated a process in which the participating clans agreed with neighbouring clans on the land boundaries. The CFMP built on the previous boundary survey work conducted by FPCD by ensuring all boundaries were demarcated using handheld GPS devices. The CFMP also supported a one week boundary survey at Bangapala.

### 2.6.2 Stratification

When forest areas within the forest boundaries clearly have different biomass densities, then stratifying the forest can increase the efficiency of sampling. By dividing the forest into relatively homogenous areas, the number of sample plots required can be reduced. This is possible when there is smaller variation in carbon stocks in identifiable strata than there is in the whole area. However, while large variation in forest biomass occurs across the project area, mapping this variation would be highly complex as the differences are due to growing conditions

and disturbances, which can vary significantly even across a small area. Post-sampling stratification using sample plot data was attempted but was found not to increase sampling efficiency.

### 2.6.3 Carbon pools sampled

The Intergovernmental Panel on Climate Change (IPCC) identifies the following forest carbon pools: living biomass (above ground, below ground), dead organic matter (litter, dead wood) and soils (IPCC, 2006, 3.15). In tropical rainforest, most carbon is stored in above ground biomass; hence, measurements focus on this pool. Initially, trees with a diameter at breast height (DBH)  $\geq 10$  cm were measured, but in the initial sample plots it was observed that significant biomass also likely exists in the 5-10 cm DBH class. Therefore, the measurements of above ground living biomass (AGLB) are for all trees  $\geq 5$  cm DBH (AGLB <sub>$\geq 5$ cm</sub>).

The litter and soil layer observed at the project sites is thin, so these pools were excluded from the sampling. Below ground living biomass in roots was incorporated into the total biomass estimate by using a suitable root-to-shoot default ratio.

Initially, both standing and lying dead wood were measured. Standing dead wood was later found to be insignificant so was dropped from the monitoring, whereas lying dead wood was found to comprise about 5% of the aboveground biomass and was retained in the monitoring.



## 2.6.4 Type, number and location of PSPs

Nineteen nested 35 m<sup>2</sup> PSPs have been located systematically across six of the community forests. As the natural diameter class distribution in a natural forest has an inverse J shaped curve, and as most of the stand basal area is contained in the few large trees, the nested sample design has a wider sampling area to cover the few large trees with decreasing sample areas for the lower diameter class ranges (Fig. 2.3).

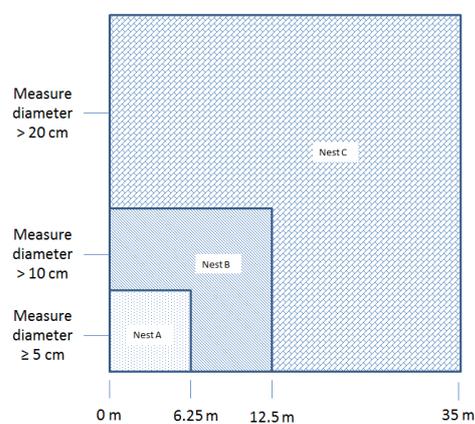


Figure 2.3: Sample plot shape and dimensions

## 2.6.5 Results of forest biomass monitoring

Five of the clans established and measured three 35 X 35 m<sup>2</sup> plots in their forests and one established four plots, bringing the total to 19 plots. A template was drafted for the field sheets and was used for data recording in the field. The data was later entered into a MS Excel spreadsheet with inbuilt functionality for estimating AGLB<sub>>5cm</sub> and tonnes carbon per hectare (tC/ha). Wood density was linked to species codes. AGLB was calculated using

the following equation developed by Chave et al. (2005) for wet tropical forests:

$$AGLB = 0.0776[pD^2TH]^{0.940}$$

Where p = specific gravity, D = DBH, TH = total height.

AGLB<sub>>5cm</sub> was divided by 2 to estimate tonnes carbon in the AGLB of each tree, and this value was expanded to 1 ha. The 1 ha values for each tree were totalled to give an estimate of tonnes carbon per hectare in AGLB<sub>>5cm</sub>.

The amount of biomass in lying dead wood was estimated using the line intersect method, following Walker et al. (2012).

Table 2.2 presents the results of the analysis of carbon stock estimates from the 19 PSPs. The average carbon stock in ABLB<sub>≥5cm</sub> and lying dead wood combined is 129.1 ± 43 tC/ha. Trees<sub>≥5cm</sub> DBH account for 95% of the measured biomass and lying dead wood accounts for 5%. Belowground living biomass (BGLB) is estimated in Table 2.2 using  $BGLB = \exp(-1.0587 + 0.8836 \times \ln ABD)$  (Cairns, Brown, Helmer, & Baumgardner, 1997). Carbon is converted to CO<sub>2</sub>e by the factor 44/12 to give an average of 561.8 (±186) tCO<sub>2</sub>e/ha.



Table 2.2: Summary of carbon stock estimates

Carbon Pool Totals	Mean	SD
Trees $\geq 5$ cm (tC/ha)	122.6	44.3
Lying Dead Wood (tC/ha)	6.5	7.1
Total above ground (tC/ha)	129.1	43.0
Below ground living biomass (tC/ha)	24.2	7.7
Grand total above and below ground (tC/ha)	153.2	50.6
Total carbon stock (tCO <sub>2e</sub> /ha)	561.8	186

Table 2.3 compares these results with those of other studies. The most relevant of these is the estimate provided by Fox et al. (2010) from 1 ha sample plots in Madang province, PNG. There is no significant difference between the estimates from the community measurements under the CFMP and the estimate in Fox et al. (2010). We can thus say that the measurements provided by the CFMP appear reasonable.

Table 2.3: Comparison of carbon stock estimates for tropical forest

Source	Unit of measurement	Estimate
CFMP	Trees <sub><math>\geq 5</math>cm</sub> + lying dead wood	129.1 $\pm$ 43.0 tC/ha
CFMP	AGLB + BGLB	153.2 $\pm$ 50.6 tC/ha
IPCC default	Lowland tropical forest	180 tC/ha
Gibbs & Brown (2007)	Tropical forest	164 tC/ha
Lewis (2009)	Tropical forest	202 tC/ha
Fox et al. (2010)	Trees <sub><math>\geq 10</math>cm</sub>	106.3 $\pm$ 22.7 tC/ha
Abe (2007)	Litter + understory + lianas <sub><math>\geq 5</math>cm</sub> + standing dead wood + trees <sub><math>\geq 5</math>cm</sub>	251.8 $\pm$ 62.6 tC/ha

One purpose of the 19 PSPs is to estimate the variation in carbon stocks across the forests and then to use this to determine the total number of sample plots required for an acceptable precision and accuracy of the mean carbon stock estimate. We specified the estimate of mean carbon stock per hectare with (2-tailed) 90% confidence and 10% error. The formula used to calculate the total number of sample plots required is:

$$n = \frac{CV^2 t^2}{E^2}$$

Where:  $n$  = number of samples,  $CV$  = coefficient of variation,  $t$  = student's  $t$  value for a 90% confidence interval at a specified degree of freedom,  $E$  = acceptable level of error (10%) of the true mean

The initial plot size was set to 25 m<sup>2</sup>. From 16 25 m<sup>2</sup> PSPs the total number of sample plots required was estimated at 105 (Table 2.4). This number reflects the large variation in biomass across the forests.

To increase the efficiency of the sampling, the plot size was extended from 25 m<sup>2</sup> (area = 625 m<sup>2</sup>) to 35 m<sup>2</sup> (area = 1,225 m<sup>2</sup>). For 35 m<sup>2</sup> plots, for the same precision and accuracy of the average per hectare carbon stock estimate, the total number of plots required drops to 40, which is less than half the number of 25 m<sup>2</sup> plots required. As increasing the plot size adds no travel time to and from the plots, and as the 35 m<sup>2</sup> plots require less than double the time of the 25 m<sup>2</sup> plots to measure, using 35 m<sup>2</sup> plots clearly increases sampling efficiency.

Using the full 19 PSPs as a pilot survey of variance, the total number of sample plots required is 33. If this number was spread



equally across the six participating clans, each would have to establish and maintain between five and six 35 m<sup>2</sup> PSPs in their forests. With well-structured training and support, this is certainly within their capacity.

Table 2.4: Estimated of no. of plots required for 90% CI

Plot size	35 m <sup>2</sup>	35 m <sup>2</sup>	25 m <sup>2</sup>
No. of plots	19	16	16
Mean	129.1	127.7	129.5
SD	43.0	46.0	75.8
CV	0.3	0.4	0.6
DF	18	15	15
t-value (90% CI)	1.734	1.753	1.8
Required no. sample plots (90% CI)	33	40	105

## 2.7 Land cover mapping

Remotely sensing data has been used to provide accurate mapping of land cover and to contribute to the projection of emissions scenarios. Comparing several potential sources for satellite data based on spatial and spectral resolution, period of image capture, availability of satellite images for the project areas and price indicates that only a few options are suitable. Cloud cover is a problem for much of the year when using optical imagery.

The potential of PALSAR application to distinguish between dense and sparse forest was tested for the Brahman site. The Brahman forest starts on alluvial river flats then climbs very steeply. This high relief proved to be an obstacle to the use of PALSAR data as regardless of vegetation cover, steeply sloping land tended to be mapped as sparse forest. This suggests that it is not appropriate to

use radar sensed images for mapping of most of the project sites.

RapidEye data were found to be a better option. As the images are optical they are affected by cloud cover, but they are available year round and their cost was considered reasonable for the scale of application.

Table 2.5 provides a summary of observations of land cover / land use at Bangapala, one of the project sites where RapidEye data was used for mapping. Bangapala lies adjacent to the Ramu River, one of PNG's longest rivers, is mostly flat lying and has a high water table that sustains areas of swamps and swamp forest.

The land cover classes used were forest, swamp forest, grasslands, water bodies, and settled and cultivated areas. The accuracy of the land cover classification map is 80% and most of the misclassification is between the swamp forests and settled and cultivated areas. A small part of the forest has recently been selectively logged by a company invited in by one of the local clans. This area could not be mapped through processing of the RapidEye data. The RapidEye data could also not be used to map "planted trees and palms", which was suggested as one important land use class, and the processing could not distinguish between planted trees and palms and swamp forest (where sago palms are dominant). Previous studies (e.g. see Eitel et al., 2011) show that RapidEye-based various vegetation indices can be useful to monitor vegetation conditions, but in our study vegetation indices were not useful parameters to distinguish between gardens, swamp forest, intact forest and planted trees and palms.



The use of RapidEye data was supported by an extensive ground survey. The survey was conducted by two teams of researchers/foresters and members of the community. Each team carried handheld Gamin GPS, digital cameras and prepared field sheets. Community involvement was essential to the success of this exercise. Errors in the initial land cover map created using RapidEye data were corrected using local knowledge.

Classification can occur through an “unsupervised” process which is based purely on a mathematical algorithm, or a “supervised” process, where “training areas” for each of the classes are selected in the scene to “educate” the software on

the types of classes and how to recognise them. A supervised process was used, taking advantage of the extensive knowledge on land cover at Bangapala. The final map is presented below (Fig. 2.4).

Photo 2.10: Gnait clan assisting with interpretation of RapidEye image



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Table 2.5: Observations of land cover / land use at Bangapala during 1 week ground survey

Class name	Observations	Images
Bare land	<p>Bare land mostly occurs as sandbanks on the edges of the Ramu River and patches newly cleared for gardens. Bare land is also found as very small patches in settlements.</p> <p>Recommendation: Include in “settled and cultivated area” class</p>	 <p>Bare land in settlement</p>  <p>Bare land as sandbar</p>



		 <p>Bare land as area prepared for new garden</p>
Planted trees and palms	<p>Planted trees and palms are mostly found in patches and bands along the Ramu River and around the oxbow lakes. The main varieties are betel nut, coconut, and cacao. The trees/palms are often interplanted, e.g. cacao planted below coconuts. Ferns and grasses occur as ground cover.          Recommendation: Include in “settled and cultivated area” class</p>	 <p>Planted trees and palms</p>
Gardens	<p>Gardens are mostly found in patches along the Ramu River and around oxbow lakes. There are basically 2 types of gardens. Type 1 gardens are sweet potato grown in small patches on sand close to the Ramu River. Type 2 are gardens of mixed vegetables, nuts and palms grown in patches of cleared forest under shifting cultivation cycles.          Recommendation: Include in “settled and cultivated area” class</p>	 <p>Sweet potato planted along Ramu River</p>  <p>Area of bush recently cleared for garden</p>  <p>Well established garden</p>



<p>Grassland</p>	<p>Grassland occurs in various forms. Pitpit grass (<i>Miscanthus floridulus</i>) grows along the sides of the Ramu River in long bands that can extend over 500 metres. Kunai grass (<i>Imperata cylindrica</i>) can be found in one large area around the school building, in the abandoned log pond, and in small patches in the gardening areas near settlements. Smaller grasses can be found within and around settled areas. The logging tracks are now grassed over. Recommendation: Map as distinct class</p>	 <p>Pitpit along Ramu River</p>  <p>Grassed over logging track</p>  <p>Large grassed area surrounding school building</p>
<p>Logged over forest</p>	<p>Some of the clans in Bangapala have allowed a logging company to selectively log part of the forest. The visible impacts of this operation are the clearance of an area of several ha for the camp and log pond, the clearance of the forest for logging tracks and skid trails, removal of biomass through logging and residual damage, including opening of the canopy, where trees have been felled. Recommendation: Trace area using concession boundaries</p>	 <p>Opening in canopy at felling sites and revegetation by shrubs, etc.</p>
<p>Swamps</p>	<p>Swamps are found across much of the area. Swamps may be covered entirely in grasses, or included sago palms. Swamps with sago palms and other vegetation with crowns appear mottled in satellite images. Map as distinct class</p>	 <p>Swamp covered in grasses</p>  <p>Areas dominated by sago palms</p>

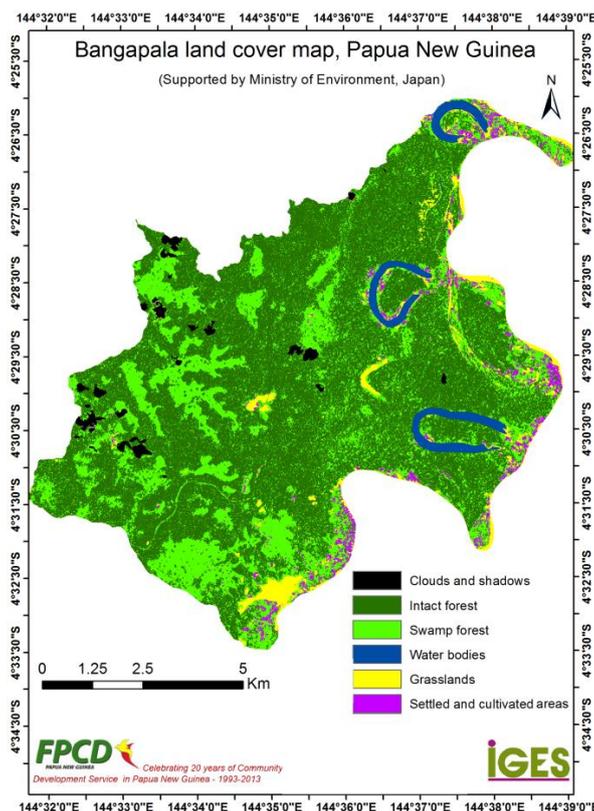


Figure 2.4: Land cover map of Bangapala (based on Support Vector Machine SVM classification)

## 2.8 Costing of CFMP approach

Table 2.6 presents a costing of CFMP inputs and compares this with the anticipated costs for a forest survey by a team of foresters from the PNG Forestry Authority. The costs are for establishing three 35 m x 35 m sample plots in a forest. The CFMP costs include training the community on forest mensuration and guiding the measurement, but exclude training-of-trainer costs and opportunity costs associated with the time spent by the community on the training and monitoring.

The calculations show that the CFMP approach costs roughly half that of sending a team of foresters to do the measurement by themselves. The figures in the table are based on various assumptions and should be viewed as a rough first attempt at comparing costs of community-based versus conventional approaches to forest biomass assessment. Nevertheless, this finding is generally supported by the existing literature (e.g. see Skutsch et al., 2011).



Table 2.6: Comparing CFMP costs with costs of conventional approach to biomass assessment

CFMP costs					
Item	Unit	Amount per unit (PGK)	Total (PGK)	Details	Notes
Costs for travel	1	2,000	2,000	2 full tanks fuel; vehicle depreciation	
Camping equipment and food	1	1,000	1,000		
Accommodation (in town)	1	1,000	1,000		
Venue for 1 meeting in town	1	500	500		
Stipends	25	50	1,250	4 foresters/trainers (plus one driver) X 5 days	50 PGK
Contribution to community	1	200	200		
<b>Grand total</b>			<b>5,950</b>		
<b>Assumptions:</b>					
1. 2 days travel + 1 day classroom training + 2 days training to set up 3 35mX35m PSPs = Total 5 days					
2. Have own vehicle; will pay stipend to driver					
3. Foresters competent in community facilitation					
4. 4 foresters will act as trainers; will break into two teams on day's 2 and 3.					
5. Stipend of 50 PGK per day					
Team from Forestry Authority costs					
	Unit	Amount per unit (PGK)	Total (PGK)	Details	Notes
Stipend (includes food)	20	200	4,000		200 PGK per day for forester in the field
Vehicle hire	4	800	3,200		
Fuel	1	500	500	2 full tanks fuel	
Camping equipment	1	1,000	1,000		
Porters	8	50	400		
Accommodation in town	4	250	1,000		
<b>Grand total</b>			<b>10,100</b>		
<b>Assumptions:</b>					
1. 2 days travel + 1 day discussion with community + 2 days to set up and measure 3 35mX35m PSPs = Total 5 days					
2. Will prefer to hire vehicle rather than use one in car pool					
3. Will spend one night in hotel in the town					
4. 4 foresters will participate.					
5. Stipend of 200 PGK per day (food costs will come out of this)					
6. Will use 4 porters at 50 PGK X 2 ways each					



## 2.9 Conclusion

The IGES-FPCD Community-based Forest Monitoring Project has been successful in generating an approach to engage local communities in assessing and monitoring biomass in their forests. Observations from the action research include:

- The participating communities understand the importance of managing their forests well. Facilitators must explain the value of forest monitoring, including biomass assessment, from this perspective, rather than from the narrower perspective of REDD+. The community-based forest monitoring aims to ensure that community harvesting of timber from their forests is fully sustainable, while at the same time providing data that can be used to explore the feasibility of a REDD+ initiative.
- The community-based forest monitoring approach, combined with other community-centred strategies, such as community-

based land use planning, would contribute to the foundations of a REDD+ model appropriate to PNG that is built on and used to strengthen customary institutions, rather than one which, in a similar vein to the dominant forestry and agriculture paradigms, is based on the alienation of rights from communities and leaves them as spectators to the changes taken place around them.

## *Acknowledgements*

FPCD and IGES are grateful to the Ministry of Environment of Japan for its funding of the Community-based Forest Monitoring Project. FPCD appreciates the support shown by the Madang Provincial Forestry Office for its certified community forestry work. We are especially grateful to the Gniat, Namokanam (Urinite), Dalomes (Dawen), Awane, Ugalingu and Yate clans for their enthusiastic participation in the CFMP and their hospitality during field activities.

## References

- Abe, H. (2007). *Forest management impacts on growth, diversity and nutrient cycling of lowland tropical rainforest and plantations, Papua New Guinea*. University of Western Australia.
- Cairns, M. A., Brown, S., Helmer, E. H., & Baumgardner, G. A. (1997). Root biomass allocation in the world's upland forests. *Oecologia*, 111(1), 1-11.
- Chave, J., Andalo, C., Brown, S., Cairns, M. A., Chambers, J. Q., Eamus, D., . . . Yamakura, T. (2005). Tree allometry and improved estimation of carbon stocks and balance in tropical forests. *Oecologia*, 145, 87-99.



- Fox, J. C., Cossey, K. Y., Nimiago, P., Oavika, F., Pokana, J. N., Lavong, K., & Keenan, R. D. (2010). Assessment of aboveground carbon in primary and selectively harvested tropical forest in Papua New Guinea. *BIOTROPICA*, 42(4), 410–419.
- Gibbs, H. K., & Brown, S. (2007). *Geographic distribution of woody biomass carbon stocks in tropical southeast Asian forests: An updated database for 2000*. Carbon Dioxide Information Centre, : Oak Ridge National Laboratory, Oak Ridge, TN.
- IPCC. (2006). *2006 IPCC guidelines for National Greenhouse Gas Inventories*.
- ITTO. (2007). *Achieving the ITTO objective 2000 and sustainable forest management in Papua New Guinea. Report submitted to the International Tropical Timber Council by the Diagnostic Mission established pursuant to Decision 2(XXIX)*. Yokohama: ITTO.
- Lewis, S. L. et al. (2009). Increasing Carbon Storage in Intact African Forests. *Nature*, 457, 1003-1006.
- Walker, S. M., Pearson, T. R. H., Felipe, M. C., Harris, N., Petrova, S., Grais, A., . . . Brown, S. (2012). *Standard Operating Procedures for Terrestrial Carbon Measurement*: Winrock International.



## 3 Action learning for community carbon accounting in Seima Protection Forest, Cambodia

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### *Editors: Note*

*With support from IGES and funding from the Ministry of Environment of Japan and the Asia-Pacific Network for Global Change Research (APN), RECOFTC – The Centre for People and Forests and the Wildlife Conservation Society (WCS) engaged stakeholders in an action learning process to design and test an approach to community-based forest monitoring as part of the Community-based Production Forestry project in the buffer area of the Seima Protection Forest, Cambodia. The action learning process was undertaken in FY2010, and in FY2011 and FY2012 activities focused more on technical procedures, such as destructive sampling to development allometric equations, testing of three dimensional photogrammetric analysis to estimate commercial timber volume, estimation of annual tree growth through the analysis of tree rings, and emissions scenario analysis. This report focuses on the action learning processes in FY2010, though also discusses community involvement in a later mapping exercise and observations of community ability to establish and measure both rectangular and k-tree plots a year after they had conducted an initial trial inventory.*

### 3.1 Background

The Community-based Production Forestry Project (CBPF) operates in the buffer area

of the Seima Protection Forest. It has been in development since 2006 and in 2010 it was incorporated into the National Forestry Programme, giving a green light for full implementation of the model. The project is a joint activity of the Forestry Administration (FA), the Wildlife Conservation Society (WCS) and local communities, with The Centre for People and Forests (RECOFTC) joining as a partner from the end of 2010.

For the period November 2010 to March 2011 the project received funding from the Institute for Global Environmental Strategies (IGES), through RECOFTC, to develop methods that enable local communities to estimate and measure carbon stocks during community forest management activities. In addition to the benefits to the IGES/RECOFTC international research programme, this was expected to provide on-site benefits including training of community members in inventory techniques, testing the practicality of legally mandated inventory methods, preliminary information on forest stocking and preliminary numbers to assess the REDD+ potential of the CBPF site. REDD+ project development is underway in the SPF Core Area, but not currently in the CBPF area.



RECOFTC has been involved in the development of capacity building tools and awareness-raising exercises on REDD+ for local-level (grassroots) stakeholders since October 2008. Since June 2009, under the Norad-funded project 'Grassroots Capacity Building Programme for REDD+ in the Asia-Pacific Region', RECOFTC has been adapting and refining these tools for national-level capacity building programmes in Indonesia, Lao PDR and Nepal.

IGES approached RECOFTC in November 2009 with a proposal to conduct one-off national level awareness-raising and training workshops on REDD+ for key stakeholders from government and civil society in Cambodia, Indonesia and Vietnam. The basis for these workshops was the training materials developed through the Norad-funded project. The Cambodia workshop was conducted in February 2010, in collaboration with the Cambodia REDD+ focal point and other members of the FA and the Ministry of Environment. The workshop included a participant-led capacity building needs assessment exercise for REDD+, during which the development of local-level skills for monitoring of forest carbon was identified as a priority. IGES and RECOFTC therefore proposed an action research programme on Community Carbon Accounting (CCA) as part of a project proposal to Japan's Ministry of Environment in May 2010.

The Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) has recognised the need for safeguards in REDD+ to protect the rights and wellbeing of communities and indigenous people. Moreover, in Decision 4/CP.15 "Methodological guidance for activities

relating to reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries", the Conference of the Parties "encourages, as appropriate, the development of guidance for effective engagement of indigenous peoples and local communities in monitoring and reporting."

This action research drew on the experience of the Kyoto - Think Global Act Local (K:TGAL) project, which has been implemented in eight countries worldwide, including three in the Asia-Pacific region (India, Nepal and Papua New Guinea), by the University of Twente (Netherlands) and partners. The K:TGAL project piloted community forest monitoring methodologies which demonstrated that community forestry based approaches can deliver results in terms of increased forest carbon stocks over time and that community-based monitoring of forest carbon stocks produced results of comparable quality to conventional scientific analysis at reduced unit costs.

RECOFTC signed a four-year project on Forest Information Generation and Ownership by Local People (ForInfo) with Finland's Ministry of Foreign Affairs. This project links several sites in the Lower Mekong countries (Cambodia, Lao PDR, Thailand and Viet Nam) to exchange, adapt and scale up best practices for the generation of forest-related information by local people and communities in ways that secure and maximise the benefits they accrue from forest resources. One of the categories of information generation under this project is forest carbon, in the context of REDD+, the Clean Development



Mechanism (CDM) of the Kyoto Protocol or voluntary carbon market projects. The action learning project described here serves as an important test case for ForInfo's approach in Cambodia as well as the wider region.

Based on IGES and RECOFTC's combined experience and knowledge of Cambodia's forestry sector and community forestry programmes, the Seima Protection Forest (SPF) was suggested as the site for this action learning project. WCS has been implementing the CBPF model in the SPF buffer zone since 2007 and in 2008 initiated a pilot sub-national REDD+ project in the core protection zone, in association with Winrock International and the FA. These two initiatives are distinct, but the areas are adjacent and involve many of the same communities.

## **3.2 Action learning preparations**

### **3.2.1 Consultations**

The CBPF has been the subject of extensive consultations with the three key communities, local government stakeholders and the FA (e.g. Grimm et al (2007), Pollard et al. (2010)). The proposed activities fitted well with existing work plans and hence did not require extensive consultations, although the National REDD Focal Point was consulted to ensure that the activity was not in conflict with development of the national REDD+ framework. The research activities do not imply that a REDD+ project will be conducted at the site and so there was no need for additional formal consent from participating communities beyond their enthusiasm for the overall CBPF project.

### **3.2.2 Organisation of facilitation team**

The non-community team members were drawn from the Seima Biodiversity Conservation Project (a collaborative project between WCS and FA), from FA's Community Forestry Office (CFO) and from the Bangkok office of RECOFTC.

### **3.2.3 Field location**

The study site is quite accessible. SPF HQ lies about 4.5 hours from Phnom Penh on an all-weather road. The nearest of the three communities, Pu Char, is about 30 minutes away on a rough laterite road, and the two study blocks chosen for the CCA work lie another 15-20 minutes away along smaller laterite roads. Access by car is more difficult in the rainy season. Transportation to study blocks was done largely on 110 CC motorbikes.

## **3.3 Overview of research sites**

The site has been described in detail by Grimm et al. (2007) and Pollard et al. (2010). The following is taken mainly from those two sources.

### **3.3.1 Forest type, condition and extent**

The CBPF Phase 1 target forest area is around 12,750 hectares of logged evergreen, semi-evergreen and mixed-deciduous forest, with a high percentage of trees from the genus *Lagerstroemia*. The site includes smaller areas of wetlands, natural grassland, and riparian vegetation. The area is generally flat, at an altitude of 100 - 200 m asl.



### 3.3.2 History of forest tenure and management

Today the CBPF area forms a part of the SPF, which is Permanent Forest Estate under the jurisdiction of the FA. Indigenous Bunong villages have been resident in the area, at or near their current locations, for many decades, possibly much longer, and have the legal right to claim certain areas in the SPF, such as residential and farm land, under community land titles. This titling process is underway.

The inhabitants were moved out of the area in the early 1970s by the Khmer Rouge and families gradually returned 10-20 years later as the area became safe again. The CBPF area experienced significant logging of high-value species during the 1980s and early 1990s, which continued after it was placed within a Samling International logging concession in 1994. This logging harmed local communities, especially through the loss of resin trees. In 2000, a logging concession moratorium was put in place nationwide and Samling's operations ceased. In 2002, much of the concession was declared as the Seima Biodiversity Conservation Area by Ministerial Decree and began to benefit from a conservation project. The CBPF project formally began in 2008 after feasibility studies in 2006-7. In 2009, the Council of Ministers upgraded the legal status of the whole reserve to Protection Forest. The CBPF project area was given 'Buffer Protection Forest' status, which allows the activities to continue as long as they are consistent with the conservation goals of the area.

### 3.3.3 Local communities

#### *Community institutions*

The three target villages are small, relatively traditional ethnic Bunong communities. There are three main kinds of community institution.

1. Government structures: village chiefs are appointed by the government; the Commune Council is elected every five years.
2. Traditional community structures: Bunong villages traditionally recognise village elders as sources of wisdom and, at times, decision-making. There are also many kin relationships through extended families.
3. Modern community-based organisations: with NGO and government support the villages have been assisted to form a number of institutions to help build self-reliance or enable the village to advocate for its rights, etc. The most relevant to the CBPF project are the elected Community Forestry Management Groups, which will form the basic structure for managing the forest.

Several NGOs are active in the three target villages. In addition to WCS, the most significant is Development and Partnership in Action (DPA), which conducts integrated rural development projects.

#### *Socio-economic profile*

The village populations in 2008 were as follows:

- Pu Char, 72 families, about 360 people



- Ou Char, 28 families, about 140 people
- Pu Kong, 62 families, about 310 people

The combined population grew from 127 families in 2002 to 162 in 2008, a rate of about 4.5% per year, due to a combination of natural growth and in-migration.

The great majority of these people follow a mixed livelihood strategy based on two key activities - farming and collection of liquid resin from wild *Dipterocarpus* trees. Rainfed lowland rice is the predominant farming system, with some upland agriculture, partly fixed and partly rotational. Livelihood surveys consistently show that resin-tapping is of crucial importance, conducted by more than 80% of families and forming 30-50% of total livelihood value for many of them. Poverty rates are high and literacy generally very low.

### *Relationship with the forest*

Residents of villages around the target site utilise the area for the collection of many forest products as well as for spiritual reasons. Resin trees are found throughout the area and are owned by individual families. People fish extensively in the rivers and pools of the site. A wide diversity of non-timber forest products (NTFPs) are also collected, both for subsistence and for sale. The villages recognise parts of the site as spirit forest.

## **3.4 Awareness raising and capacity building**

Action learning was identified as the approach for capacity building because of its potential to generate specific and

relevant knowledge that could inform future forest management decisions and predict the impacts of different forest uses on livelihoods and carbon stocks. Action learning is a means of development, intellectual, emotional or physical, that requires its subjects, through responsible involvement in some real, complex and stressful problem, to achieve intended change sufficient to improve his/her observable behaviour henceforth in the problem field (Revens, 1974). The action learning in the CCA project involves developing, testing and reflecting on the outcomes of participatory approaches to forest carbon stock estimation measurements and monitoring. Specifically, action learning here involved a process of engaging with the communities through training and planning for carbon stock measuring, data collection and processing, reflection and sharing.

### **3.4.1 Who has been involved and what are their roles?**

Different levels of stakeholders were involved in the project's development. Their roles and responsibilities can be seen against a series of competences needed for REDD+ and sustainable forest management (Table 3.1).



Table 3.1: Project stakeholders

Stakeholder Level	Stakeholders	Roles
4	Partners / Regional Level officers (IGES, WCS, FA, RECOFTC)	*project design and management *training and capacity building (focused on technical inputs) and supervision of implementation *data-analysis, presentation and communication *coordinating efforts, advising, communicating and coaching of CBPF development
4	National Level officers (CFO, FA, WCS, RECOFTC)	*supervision and institutional support *training and capacity building for provincial level officers *communication and advising CBPF development
3	Sub-national officers (CBPF team, Cantonment)	*supervision of ground work, data-input *training and capacity building of community members *presentation and communication of results *recommendations on inventory methods for SPF *coaching and advising on CBPF development
1	Community members	*data collection *sharing of information within and between villages on project and CCA *different roles and involvement in CBPF development *development, implementation and administration

### 3.4.2 Overview: Activities

After institutional arrangements between FA, WCS and RECOFTC were clarified, including the roles and responsibilities of the different parties involved, a work plan was developed that included the following

training and awareness raising activities as integrated activities in the project:

- ✓ REDD+ awareness raising meetings at village level
- ✓ Cantonment launch meeting
- ✓ Community launch meeting
- ✓ Training of trainers on principles of survey methodologies from FA and k-tree method, technical training, and try out
- ✓ Follow up training and coaching on inventory methodologies
- ✓ Supervised community level implementation

### *Awareness raising*

With the objective to increase awareness on REDD+, a cascading process was initiated. For this, national level trainers, who also participated in the initial awareness raising workshop in February 2010, trained provincial level trainers, whom in turn reached out to the communities. Through this approach, community members in the participating villages, including key committee members, have increased awareness of REDD+ concepts, and also on the plans for SPF.

### *Community capacity building*

Capacity building focused on skills training to address technical aspects of forest inventory, in view of having a full inventory of the forest and of the CO<sub>2</sub> sequestered in the forest. Also, it aimed to test the FA requirements for the inventory and compare alternative forest inventory techniques. Further, it aimed to identify the best technology for this type of set up.



### Training of trainers

A training of trainers (ToT) on inventory techniques was conducted during 17-21 January 2011 at SPF HQ. The training was led by Thong Sokunthea from CFO, who is a specialist in the techniques mandated under the CF Guidelines. Mr Bernhard Mohns (RECOFTC Bangkok Forestry Specialist) provided inputs on alternative inventory techniques and the WCS/FA team provided inputs on supplementary techniques for measuring carbon pools not covered by the CF Guidelines. The trainees were from the WCS/FA team on site (3), local branches of FA (3), CFO (1) and the Ratanakiri branch of the local NGO DPA (4).

Photo 3.1: Training of trainers



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Photo 3.2: Certification of completion of training



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### Coached fieldwork

The ToT was followed by coached field work in early February 2011. During the fieldwork, participants of the January training were guided in their role of managing the community-based inventory work. They were guided on what data should be collected, how they should be collected and recorded, and how to organise the sampling. Whereas originally Thong Sokunthea (CFO) trained the ToT participants, the participants (Mr. Em Tray and Mr. Hing Mesa working with FA/WCS) were now working with the villagers directly. After being part of a seven person team in early February, and increasingly playing a coordinating role in the team, they took charge of two teams collecting data. Full data collection took place between February 14 and March 11 2011. Members from the Community Forestry User Groups were selected and applied themselves to collecting the data and completing the inventory.

### 3.4.3 General Observations

The following observations were made on the implementation of the approach outlined above.

#### Observations from a community perspective:

- Improved livelihoods and alternative livelihood strategies are the key drivers for community members to engage in structured forest monitoring.
- Community members can acquire the necessary skills and knowledge to collect data, with minimal technical supervision, but with high investments needed in the



design, initial training, and technical support / backstopping.

- Communities cannot process the data and discuss the implications for different management options without substantial technical support.
- Motivation to work and contribute to the project comes from the incentives provided, but also from exploring the potential for forest production.

**Observations from the advisors' perspective:**

- A high amount of technical support is needed to analyse data and interpret information.
- Community-based forest monitoring is promising for different stages of the REDD+ process, including for the baseline and MRV (measurement, reporting and verification) processes, but it should be approached cautiously and within a context of different forest management options.

**Observations from community level facilitators' perspective:**

- The community level facilitators find themselves in a difficult position when facing government-approved inventory processes and methods that may be less appropriate and the pragmatic approaches being proposed as an outcome of the testing of protocols/methods under the project (discussed below).
- Both experience with the methodology and community level facilitation skills are critical for their role in the project.

### 3.5 Boundary demarcation

During the community launch meeting half a day was spent identifying two potential trial blocks (one deciduous, one evergreen/semi-evergreen) to be used as training areas for all forest management techniques including inventory, harvesting and silviculture. A set of criteria were suggested (e.g. target sizes, presence of harvestable timber species, accessibility, overlap between village territories where possible to promote collaboration) and participants added others (e.g. avoidance of overlap with proposed shifting cultivation areas). After initial discussions, large scale laminated maps based on the 2005 aerial photos and 2010 Landsat imagery were laid out and provisional areas were marked with pens. It was agreed for a subset of the group to inspect the areas and select suitable natural boundaries.

The boundaries of the proposed areas were inspected by motorbike and on foot by the WCS team. A demarcation team (three people from each village) then walked the entire boundaries, recording waypoints on handheld GPS devices and placing wooden signboards at key points. The blocks are almost entirely defined by natural boundaries, mainly in the form of established trails. The sites are shown in Fig. 3.1.

The deciduous block (east) covers 68.9 ha, of which almost all is deciduous. It contains good stocks of locally important timber species. It is bisected by a small seasonal stream that has been buffered according to FA guidelines and removed from the inventory area by GIS.

The evergreen/semi evergreen block (west) covers 264.6 ha. It contains patches



of good commercial timber, most notably stands of the Grade I species *Lagerstroemia calyculata* (*sralao* in Khmer) but has evidently been quite heavily logged in the past, so it is expected to have lower stocks than some remoter parts of the CBPF area. It was selected because it is accessible, suitable for training purposes and was proposed by the communities.

Table 3.2 shows the composition of each block according to a JICA national forest cover assessment. The JICA assessment indicates some parts of the evergreen/semi evergreen training block are 'Bamboo and secondary forest'. Observations during this survey show that this category corresponds quite well on the ground with *heavily degraded patches smothered in vines and with a very low stock of trees* (most presumably non-commercial). It is recommended that these patches be excluded from the proposed trial inventory as they are of low potential (unless there is great investment in silviculture) and very great logistical difficulty for inventory. The small area of deciduous forest should also be excluded, leaving 189 ha of area to be inventoried.

Table 3.2: Forest type according to the JICA national land-use cover map (2002)

Land Use Type (JICA 2002)	CBPF Deciduous Forest Training Area	CBPF Evergreen Forest Training Area
Deciduous forest	68.9	14.8
Evergreen broad leaved forest	0.00	189.5
Bamboo and Secondary forests	0.00	60.3
Grand Total	68.9	264.6

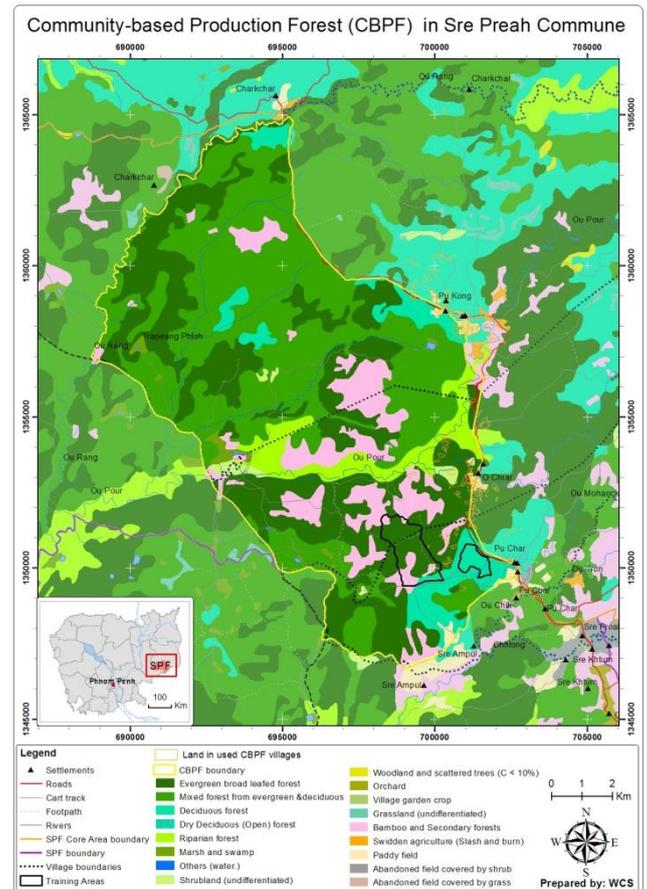


Figure 3.1: Location of the two training areas in relation to the JICA 2002 land-use interpretation

### 3.6 Sampling design

#### 3.6.1 Basic approach

The basic approach for determining carbon stocks in the project area is to derive carbon estimates from regular forest inventory data as prescribed under the FA Community Forestry (CF) Guidelines (which are an annex to MAFF Prakas 219). Two kinds of modifications were considered by the project - protocols for measuring additional carbon pools/sub-pools and efficiency improvements.



### *Protocols for additional pools*

The CF Guidelines do not require the measurement of dead wood, and do not specify exact protocols for bamboo, which was felt to be the only NTFP sub-pool with a potentially significant carbon stock. These additions are discussed in the Carbon Pools section below.

### *Efficiency improvements*

The CF Guidelines, while statistically correct, are unlikely to provide optimal statistical efficiency (that is, optimal level of precision for a given price). An inventory following the guidelines will be prohibitively expensive across the whole 10,000-plus ha of the CBPF forest area, whether for carbon alone or for all forest values. This issue has been raised a number of times in recent years (e.g. Brofeldt (2009), Blomley et al. (2010)). It is also recognised as an issue by FA (E Payuan and Sok Srun, pers. comm.). It was therefore considered timely to test alternative methods.

Brofeldt (2009) gives a systematic account of the main issues and many smaller points of technique. In the current trials we chose to focus on the two major issues: plot size/number and estimation of tree heights. Plot design is discussed here and tree heights in a later section.

The FA regulations foresee 50 x 100 m sample plots in evergreen forest (EF) and 50 x 50m plots in deciduous forest (DF). While such plots may be appropriate in situations where the primary aim is to visually demonstrate the impact of CF operations over periods of five to 10 years, such large plots are not the ideal choice for covering larger areas as in the case of the Seima project area.

It was therefore decided to explore alternatives for the management planning inventory, a forest resources assessment that is intended to cover all operable areas within the 13,000 ha CBPF project area - perhaps 10,000 ha in total.

Clusters of fixed circular plots of smaller size had been applied for the earlier carbon stock assessment in the SPF Core Area and were found quite efficient, especially as digital measuring equipment was used, meaning no demarcation was required. As this approach has already been tested, it was decided to test a further potential enhancement, the 6-tree method. Also called k-tree sampling, this approach was suggested due to its two major advantages of (1) allowing an automatic adjustment to tree spacing and (2) being far less time consuming since the outer perimeter of the plots do not have to be marked. This was considered a further major advantage in situations with dense understory vegetation.

K-tree sampling designs have an inherent bias by overestimating (up to 15%) plot volume since the  $k^{\text{th}}$  tree is always located on the plot perimeter. The degree of bias depends on the pattern of spacing of the trees, which varies between sites. Various methods for partially correcting this bias have been suggested in the literature, but none is universally effective. Given the expected sampling efficiency of the method, and the fact that it is recommended by many authors in cases where a small bias is considered acceptable, it was decided to conduct a trial.

The value of  $k$  can be chosen by the inventory designer; 6 is often found to be an optimal number and was chosen here. The design for 6 trees is shown in Fig. 3.2.



In the EF, teams also recorded distance and diameter at breast height (DBH) for the 7th tree, to allow us to test one of the methods proposed for correcting bias.

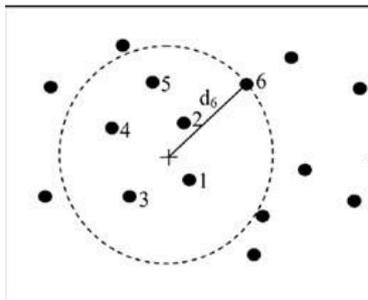


Figure 3.2. Plot lay-out of k-tree sampling

### 3.6.2 Number of sample plots

Based on the size of the training blocks, the CF Guidelines required us to place four plots in the DF and 10 in the EF.

For the 6-tree plots it was decided to aim for the sample fraction in the CF Guidelines. Plot sizes cannot be predicted exactly, but the expected average size of the 6-tree plots was estimated from small pilot studies as follows: DF 700-750m<sup>2</sup>, EF 1000-1300m<sup>2</sup>. To be conservative the smaller plot size was assumed, and a target number of plots calculated - 10 in the DF and 60 in the EF.

### 3.6.3 Locating sample plots

The CF Guidelines call for a systematic sample within each block, with a random or quasi-random start point. This was followed in the present study. The same approach was taken for the centres of the 6-tree plots.

The CF Guidelines call for the physical marking of access lines to all plots. In consultation with the FA trainer, Mr

Sokunthea, it was agreed that this was unnecessary if GPSs were available. All plot centers were uploaded to a GPS and the FIND function was used to navigate to the centre. This is only accurate to within a few metres, and the operator will be biased towards more open areas, so an additional step was added to counteract this. Each plot was centred 5 paces north of the point indicated by the GPS, irrespective of the vegetation density at that point.

The following maps for the inventory in the DF illustrate the comparison between the rectangular FA plots and the 6-tree sample plots, both having the same total percentage area coverage. Similar maps were produced for the EF.

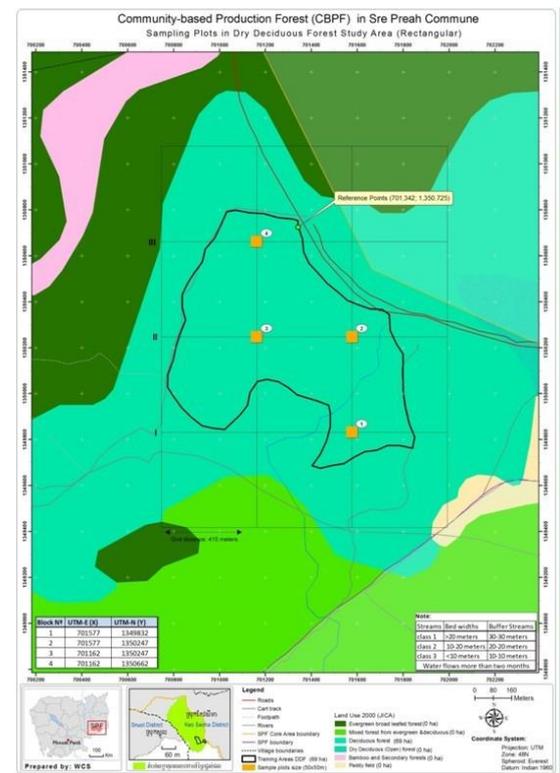


Figure 3.3: Distribution of plots in DF following CF Guidelines

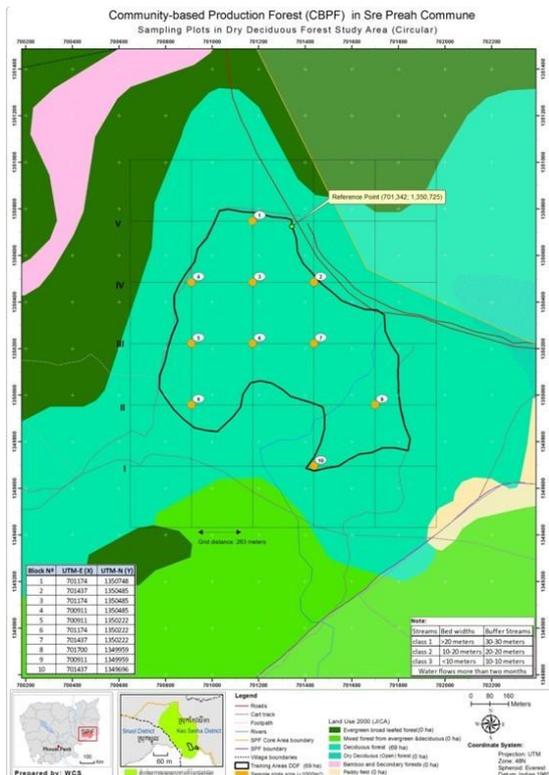


Figure 3.4: Distribution of plots in DF following k-tree method

### 3.6.4 Plot shape and dimension

Fig. 3.5 illustrates the plot lay out recommended under the FA CF Guidelines. According to the FA regulations, trees above 30 cm DBH are to be measured in 50 x 100 m plots in EF and 50 x 50 m plots in DF. Smaller size trees between 10 and 30 cm DBH are to be measured in plots of 50 x 50 m and 25 x 50 m and NTFP and regeneration in 50 x 25 m and 25 x 25 m plots, respectively.

Standing dead wood was measured on the same plots, the same as for living trees of similar size (e.g. dead trees >30 cm DBH were measured across the whole plot, etc.). Lying dead wood was measured using a line intersect method of 50 m lines in two perpendicular 25 m legs starting

from a corner point of the rectangular plots.

The 6-tree method applied a similar principle of nested plots whereby an outer plot of 6 trees was measured for trees >30 cm DBH with a second, smaller plot for trees between 10 and 30 cm DBH using the same plot centre but defined by a different outer tree. Any dead trees of appropriate size were measured on the relevant plots, but were not counted amongst the six trees that defined a plot. Seedlings and NTFPs were counted in 5 m radius plots and lying dead wood in the same transect line layout starting at the plot edge.

Table 7.8 : Plot lay out in Dry Dipterocarp forest

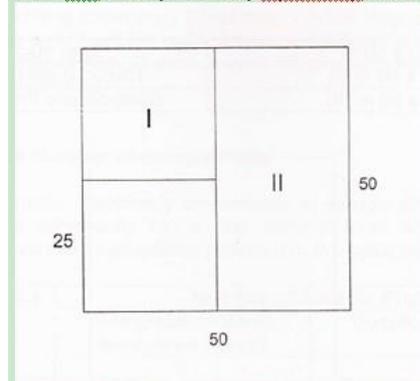


Table 7.9 : Plot lay out in Dry Evergreen forest

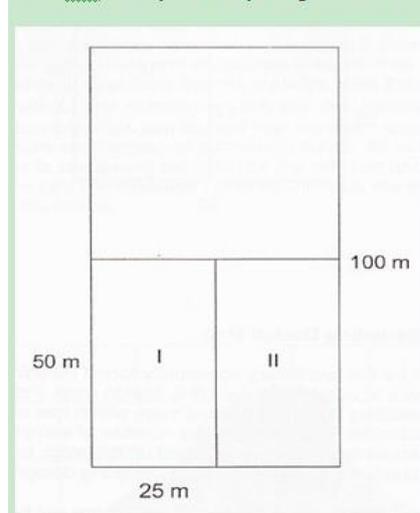


Figure 3.5: Plot layout in CF guideline



### 3.6.5 Carbon pools measured and reason for inclusion / exclusion

Aboveground woody biomass for trees >10 cm, saplings (regeneration), bamboo and standing plus lying dead wood were the carbon pools/sub-pools measured. Regeneration was measured mainly in order to assess options for restoring the forest further, since the carbon pool in this fraction is negligible. No attempts were made to measure litter, herbs or soil carbon. The soil carbon pool was assumed not to undergo significant changes as compared to any possible baseline, following generic guidance from the Verified Carbon Standard.

### 3.6.6 Variables measured / information gathered (e.g. DBH, species, physical characteristics of plots, etc.)

In addition to DBH, height was measured on all plots that followed the CF guidelines. For the 6-tree plots, the project attempted to establish diameter-height relationships (DHRs) to allow a more precise estimation of aboveground biomass, and also to enable the estimation of timber volumes, without having to laboriously measure every individual tree. For NTFPs, estimates were made of quantities using locally chosen units - kg, m, stems etc. - as appropriate to the growth form of the plant. Standard equipment including compasses, 1 m

calipers and SUUNTO clinometers were applied in the inventory work.

### 3.6.7 Challenges faced

#### *Establishing plot corners*

Plot layout work encountered problems in the rectangular plots in establishing right angles at outer and inner plot corner points particularly if visibility was poor. A simple method of laying out plot corners by measuring triangles with 3, 4 and 5 m side lengths, based on the principle  $a^2 + b^2 = c^2$  was introduced to help overcome this issue.

#### *Estimating tree height*

Height measurements were found to be a key problem due to the lack of understanding of the basic principles involved as well as issues with the visibility and estimation of crown midpoints and confusion of baseline scales in the SUUNTO clinometers. It is thus recommended that height measurements should only be done only by one or two specially trained inventory crews, and limited to the creation of DHRs as noted above. The recommended method of estimating tree heights against 5 m poles placed close to the sample trees was found to be erroneous in comparison to SUUNTO measurements, particularly when applied in evergreen forests where trees exceed 30 m heights.

The testing of other equipment aiming at methods that can be understood easier by community target groups, are less prone to measurement errors and are less costly, is desirable considering that eventually some 200 to 300 CF user groups will have

to carry out inventory work and have to be equipped accordingly.

Photo 3.3: Using SUUNTO to estimate tree height



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### *Measuring DBH of buttressed trees*

In order to measure buttressed trees estimations from variable wedges (either small calipers or transparent rulers with fixed distance to the observer's eye (50 cm) at tape-measured distances to the sample trees was introduced. This was found useful for estimating diameters at up to 6 m high measurement points above the buttress. The method reduced estimation errors considerably.

Photo 3.4: Measuring diameter on a tree free of buttressing using calipers



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Photo 3.5: Experimenting with a can top as an optical aid to estimate tree diameter



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### *Assessing biomass of dense bamboo culms*

In order to assess biomass of dense bamboo culms the idea of measuring either diameter or circumference of culms was introduced. These parameters can be used to estimate stem numbers via regressions between these parameters and stem numbers measured in sample plots. This approach had proven successful in similar measurements in northern Lao PDR. However, in the end no considerable numbers of clumps of bamboo were found in the compartments studied and thus just stems were counted. The approach may however be applicable in the remaining inventory areas.

## 3.7 Carbon stock calculations

### 3.7.1 Data recording and entry

Six data sheets were used for each plot - large and small living trees, saplings, NTFPs, standing dead wood and lying dead wood. Copies of the sheets were lodged with the Seima Biodiversity Conservation



Project and with the community committees. Data entry was conducted off-site by WCS staff and thoroughly checked by advisory staff to minimise entry errors and identify likely data recording errors for review. Data were handled using an Excel spreadsheet, designed for this project by modifying the sheet used in the SPF Core Area surveys. The original sheet was developed by Winrock International and remains their intellectual property.

Photo 3.6: Data recording



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### 3.7.2 Calculations

#### *Plot area*

The CF Guidelines plots are of fixed area. The minimum radius estimate for the 6-tree plots is the distance to the centre of tree 6 (i.e. distance to the tree plus half of its DBH). However this value underestimates effective plot size so a correction factor must be applied. In this study we used the correction proposed by Eberhardt (1967) for k-tree plots - multiplying the plot area by  $k/(k-1)$  or, in this case,  $6/5 = 1.2$ . Other corrections are possible and will give slightly differing results.

#### *Height*

Diameter-height relationships curves were developed for three dominant species in DF and are being developed for six dominant species in EF.

#### *Carbon stock*

In each sub-pool, standard equations are used to estimate biomass from other parameters. Timber density is assumed to be  $0.57 \text{ g/cm}^3$  ( $=0.57 \text{ t/m}^3$ ), the average for tropical Asia (Reyes, Brown, Chapman, & Lugo, 1992). The carbon content of the biomass in all six classes is assumed to be 0.50, following IPCC (2003). The spreadsheets estimate the biomass of each plant, culm or piece of wood then apply an expansion factor, depending on the sub-plot used, to convert to per-hectare values which can be summed. Below ground biomass can be estimated using the equations of Cairns, Brown, Helmer, & Baumgardner (1997).

- *Carbon stock of large and small trees (>10 cm DBH)*

Several alternative equations exist to link DBH (and sometimes height) to tree biomass. Destructive sampling of trees in the SPF Core Area to validate biomass equations for the REDD+ project there (Evans, Kelly, & Hor, 2011) found that the DBH-only moist forest equation developed by Chave et al. (2005) had acceptable performance, giving small underestimates for a selection of large and small trees from DF (-6%) and EF (-10.8%). Therefore this is the main equation used in this report. The moist forest equation developed by Chave et al. (2005) using both DBH and height performed less well for the SPF sample (Evans et al., 2011) and is not considered further here.



- *Carbon stock of standing dead wood*

The few Type 1 dead trees, which still have their twigs, are calculated in the same way as living trees. For Type 2 dead trees, those missing their smaller limbs, we followed a formula that treats the trees as truncated cones (Walker et al., 2012). If necessary the top diameter is estimated from a simple taper equation. Timber density uses the default for live trees.

- *Carbon stock of lying dead wood*

This is calculated using the line intersect method described by Winrock International (Walker et al., 2012). The only parameters required are the length of the transect, the diameter of each intersected piece of wood and the soundness class (which indicates the choice of wood density value).

- *Carbon stock of saplings and bamboo*

Saplings are counted and multiplied by 0.248 kg, the average dry weight of saplings derived from studies in the SPF Core Area (WCS/FA unpublished data). Bamboo culms are counted separately in three classes (large, medium and small) and the counts are multiplied by 10.929, 1.742 and 0.0012 kg respectively. These are the average dry culm weights derived from studies in the SPF Core Area (WCS/FA unpublished data).

### *Timber stock*

The CF Guidelines present standard equations for the wood volume of Cambodian forest species based on USAID (1962), a source that we have not seen directly. Trees below 30 cm DBH are

considered to be 'poles' and the top height of the tree is used. For trees >30 cm the height to the last branch >20 cm diameter is used. This measure of wood volume is not the same as the legally harvestable volume or recoverable volume. Legal minimum harvest diameters for timber concessions are set by MAFF Prakas 089 (2005) and are typically 35-45 cm for most species. Furthermore, tree selection rules further limit the volume that may be cut at a given time, although the rules for timber trees in CF sites have not yet been developed for Cambodia (Samreth Vanna pers. comm.). Recovery rates are largely unstudied for Cambodian species, although Blackett (2009) provides estimates from the CBPF area based on village interviews.

### 3.7.3 Results – Deciduous forest block

Data from the plots in the 69 ha DF study block are summarised in Table 3.3. Carbon values are based on DBH-only biomass equations, but the timber stocks are based on height measurements too. For the CF Guideline plots these were measured for every stem and for the 6-tree method these are derived from the local DHRs.

Table 3.3: Summary of results from the two sampling methods

Parameter	CF Guidelines	6-tree method
Number of plots	4	10
Average plot size (ha)	0.25	0.15
Sample fraction for trees >30 cm	1.4%	2.2%
Team size	17 people	8 people
Enumeration time per plot (mins)	53.8	14.0



Enumeration time per plot (person-mins)	914 (+/- 32%)	112 (+/- 21%)
<b>Total enumeration time (person-mins)</b>	<b>3655</b>	<b>1120</b>
Approx plot-plot travel times (minutes)	20	10
<b>Total travel time (person-mins)</b>	<b>1360</b>	<b>800</b>
<b>Time to collect DHR data (person-mins)</b>	<b>0</b>	<b>960</b>
<b>Grand total survey time</b>	<b>5015</b>	<b>2880</b>
<b>General information</b>		
Trees/ha	304	387
Basal area (m <sup>2</sup> /ha)	14.1	15.2
<b>Carbon stock (tC/ha)</b>		
Trees >10 cm	69.7	68.7
Saplings	0.2	0.1
Bamboo	0.0	0.0
Standing Dead Wood	0.2	0.7
Lying Dead Wood	2.1	5.6
<b>Total above ground carbon</b>	<b>75.5</b>	<b>72.2</b>
Precision for total carbon (95% conf. int.)	+/-26%	+/-23%
<b>Timber stock (&gt;30 cm DBH)</b>		
<b>m<sup>3</sup>/ha</b>	<b>54.6</b>	<b>39.4</b>
Precision for total stock (95% conf. int.)	+/- 31%	+/-46%
<b>Timber stock (10-29 cm DBH)</b>		
<b>m<sup>3</sup>/ha</b>	<b>36.7</b>	<b>54.7</b>
Precision for total stock (95% conf. int.)	+/- 31%	+/- 26%
<b>Timber stock (all trees)</b>		
<b>m<sup>3</sup>/ha</b>	<b>91.3</b>	<b>94.1</b>
Precision for total stock (95% conf. int.)	+/- 28%	+/- 23%

## Sampling efficiency

Approximately the same sample fraction was obtained by each method, although in this case the 6-tree plots gave a slightly higher sample fraction than was targeted, since the average plot size was somewhat larger than expected. The 6-tree plots give a better distribution of samples across the study area. The CF Guidelines, by only sampling a few plots, risk missing significant variation within the block.

In both cases the total sample size is small and so the precision is quite limited, ranging from 23-50% for the three main parameters analysed here. These levels of precision may be insufficient for management planning - they certainly seem rather low for setting the level of timber harvest. They would also be too low for estimating carbon stocks in a REDD+ project as they currently stand, and further plots would be needed.

Given a similar sample fraction, the precision of the results from the two methods was essentially the same. The precision was almost equal for carbon stocks, while slightly higher precision was obtained from the Guidelines method for timber volume above 30 cm DBH and slightly higher precision from the 6-tree plots for timber volume of trees 10-29 cm DBH. The higher individual variation between the smaller k-tree plots is balanced by the greater number of degrees of freedom, which has a strong effect on the standard error.

The key finding was that the level of effort (and hence cost) required to reach this comparable sample fraction/level of precision was markedly different. Total survey time for the 6-tree plots in this example was 57% of the time for plots



following the Guidelines, which implies that the field activity costs would be around 40% lower as well. As discussed below, the time savings would be proportionately higher over larger forest areas.

The 6-tree plot sampling has similar travel costs and requires additional fieldwork to estimate DHRs, but is still faster overall due to much lower plot enumeration times. The main time savings are:

- The 6-tree plots do not need to be demarcated - selection of the target trees takes only a few minutes for an experienced team whereas the laborious demarcation process under the CF Guidelines is hard to avoid and will always lead to high fixed time costs on each plot.
- The decision to use DHRs: These reduce time spent on each plot and replace it with a smaller amount of targeted data collection after the plots are completed. This additional cost is more or less independent of forest size, so the savings become much more significant for larger study areas than for the small area studied here.<sup>3</sup>

The time savings of the 6-tree approach need to be weighed against the theoretical objections to their use. The literature suggests that the biases in k-tree methods are often small, but tend to be unpredictable. K-tree methods are used successfully in at least one national forest inventory (Germany). Ultimately a case-by-case decision must be taken as to whether

the potential biases are serious compared to other inaccuracies in the inventory method, and whether they outweigh the efficiency benefits. For strategic-level inventories in a CF setting, where many other inaccuracies are likely to creep in and where cost is such a crucial issue, we would argue that there is a strong case for considering k-tree methods.

### *Additional cost of CCA activities*

Measurement of standing and lying dead wood is additional to the CF guidelines requirements, and so has an additional cost. Table 3.4 shows the way the field teams were organised and shows that the additional cost of the dead wood surveys is about 20% of the enumeration and travel time.

In the current example standing dead wood is a negligible proportion of the total above ground carbon stock (<1%). This class also represented less than 1% of carbon stocks across the SPF Core Area. It could arguably be dropped from the surveys to save costs and reduce complexity. This decision would have to be taken in the light of guidelines in the REDD+ methodology that was to be followed to measure credits. One key factor to consider is that the level and proportion of standing dead wood might well increase in a forest subject to increased harvesting.

Lying dead wood makes up 3.0-7.4% of the above ground carbon stock, even in this fire prone habitat type, and so it is clearly an important part of any carbon accounting process.

Measurement of tree heights is not required for carbon calculations using the equations we chose, and so if timber

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<sup>3</sup> Note that DHRs could also readily be used on the large CF Guidelines plots, reducing their time costs too.



estimates were not required, this aspect of the inventory could be dropped.

Table 3.4: Approximate time costs of the various inventory tasks

	CF Guidelines		6-tree plots	
	Members assigned	% of staff time	Members assigned	% of staff time
Team leader	1	8%	1	12%
Large trees	4	23%	2	25%
Small trees	4	23%	2	25%
NTPP/Saplings	4	23%	1.5	19%
Dead wood	4	23%	1.5	19%
Total	17		8	

### *Accuracy of results*

Apart from the risk of sampling bias with the k-tree plots (see above) accuracy also depends on the quality of data collection and the assumptions made during data analysis. Both present challenges for community-based forest assessments.

Data collection quality was generally felt to be good. Team leaders were attentive and team members produced consistent results that were subject to spot-checks by the team leaders. Very few implausible values or extreme outliers were detected during data analysis. The biggest challenges for data collection were:

- Plot demarcation under the CF Guidelines. We encountered the same difficulties listed by Blofeldt (2009) in setting up exactly rectangular plots in dense vegetation. This is likely to introduce unavoidable errors into the data, although it is hoped

these are random rather than biasing the results.

- Estimation of tree heights. This was reasonably easy in the DF, although there was variation between team members. It was very much harder in the EF due to the combination of taller trees and dense mid-story vegetation. This leads to inevitable errors, and this is an additional reason why using DHRs is preferable.
- Estimation of diameter on buttressed trees. This had previously been challenging as it required climbing and it was not always possible to reach above the buttresses. The notched ruler estimation method introduced during this survey was felt to be more reliable.

### *Assumptions during data analysis*

The conversion from DBH to biomass has been done on the basis of a biome-wide equation which is inevitably going to be imprecise when applied at a specific location. We used an equation validated for the general area and range of forest types according to the requirements of the draft Frontier Deforestation REDD Methodology ([www.v-c-s.org](http://www.v-c-s.org)) but even so the fit is not exact and it is suspected to lead to a systematic under-estimates of carbon stock (which is conservative, and so acceptable, but not ideal). The applicability of the equation for the particular narrow stand type studied for the community-based forest monitoring purposes has not been tested, although Khun Vathana (2010) has conducted some destructive sampling of relevant species in



the same forest patch and his results will be useful.

The total above-ground carbon stocks and stocks per pool as estimated by the two sampling approaches were remarkably similar at around 72-75 tC/ha above ground. Live trees >10 cm DBH dominate, contributing 91-96% of total biomass, with lying dead wood making up most of the remainder. This provides some reassurance that the two sampling approaches give consistent results. However, the timber calculations give rather differing results - 278 m<sup>3</sup>/ha for the CF Guidelines and 398.3 m<sup>3</sup>/ha for the k-tree plots. Given the low precision of the components of each estimate (Table 3.3) and the small number of plots being compared, this is likely due mainly to sampling variation. This is supported by the fact that while some classes appear over-estimated, others appear under-estimated, so there is not a consistent bias.

### *Comparison with existing estimates*

Table 3.5 compares carbon stock estimates from this study with results from some other studies in deciduous forests. The results are evidently consistent with other datasets, which reinforces our confidence in the results. The higher values for deciduous forest in the SPF Core Area are due to the inclusion of other, richer sub-types of deciduous forest. The lower results from Oddar Meanchey may be because of the markedly drier climate there, and perhaps also forest degradation.

Table 3.5: Comparison with carbon stocks in other deciduous forests

Source	Location	Above ground C stocks (tC/ha)	Notes
Current study	SPF Buffer Zone	72-75	khlong, chhlik & pchek dominant
Khun Vathana (2010)	SPF Buffer Zone	73.8+/- 8.6 (SE)	Same forest patch
IPCC (2003)	Tier 1 Default values, tropical dry DF	65 (range 50-80)	
WCS/FA unpublis hed data	SPF Core Area (all DF)	115.3 +/- 10.0 (SE)	DF types include many taller stands with species on richer soils other than current study
FA <i>et al.</i> (2009)	Oddar Meanchey REDD Project, DF & mixed forest class	c. 50	Estimated by converting biomass to carbon & subtracting 20% for below ground portion

### 3.8 Land cover / land use mapping

A land use / land cover (LU/LC) study of the CBPF area was carried out during June-August 2011. A LU/LC map was obtained by means of visual interpretation of satellite images and aerial photos, using as reference data existing forest maps and ground truthing information obtained in the field. The objective of the study was to determine the relevance of the existing national forest cover maps to this site and to provide updated LU/LC data, as a necessary preliminary step for the management of the CBPF.

For the photo interpretation process satellite images from Landsat 7 ETM+ were analysed. Since the sensor of Landsat 7 ETM+ has experienced a failure from March 2003, images taken afterward have a lower quality. To discriminate between different vegetation types an image





province, Cambodia. One day was devoted to a field visit of the CBPF site. During the visit the CBPF Management Committee and other communities members joined the workshop participants in measuring some trial sample plots. The objectives were to test and review the various carbon inventory methodologies used during the action learning activities carried out in Feb-March 2011. These included layout, demarcation and measurement of a rectangular plot, layout and measurement of a 6-tree circular plot, height estimation, use of optical wedges to estimate DBH of buttressed trees, and methodologies for standing and lying dead wood.

During the field activities the workshop participants shared technical advice and tested various methodologies, while the CBPF members from the Bunong communities shown their skills and commitment in the forest inventory. The community members were able to establish the plots and carry out precise measurements with only a little guidance from the facilitator, a promising result considering almost one year had passed since they had conducted the trial inventory. This can be taken as evidence that well-trained and supported local communities can conduct inventory of their forests. As discussed during the workshop, an important next step in order to improve the ownership of the data would be to provide technical assistance to have the communities involved in processing the data.

Photo 3.7: Community members demonstrate how they set out rectangular plots



Photo 3.8: Community members demonstrate how they set out k-tree plots



© Henry Scheyvens (photo 8 & 9)

### 3.10 Conclusion

From an action learning perspective, the project has achieved its objective: the project demonstrated approaches to engage communities in forest carbon stock estimations and monitoring. Capacity building in this context is a process, and community understanding will increase as the project develops and as people gain more experience in participating in different aspects of the work. Where individuals find it difficult to grasp the complexity and meaning of biomass assessment at the beginning of the project because carbon is a new commodity, their understanding



grows as they become more familiar with the project and with the potential value-added of biomass assessment and monitoring for the development of their livelihoods.

To reduce costs and promote local decision-making, it is important that community members have a greater role than simply participating in the enumeration of plots. Once data analysis is completed, review sessions with the CBPF communities are essential to continue the gradual process of building technical understanding of the biomass data. This increased understanding will enable community members to participate to a greater degree in REDD+ policy dialogue and the design and implementation of REDD+ activities at the site they will manage.

Notwithstanding these opportunities, biomass monitoring and assessment faces great challenges from a capacity building perspective, originating in the highly complicated, abstract and technical nature of the underlying calculations, the large volume of data involved and the consequent need to draw on technical support. This is especially true of existing voluntary carbon market methodologies, which tend to be very data intensive. Given complex certification requirements there is limited flexibility to simplify methods of data collection and analysis.

As carbon accounting systems (project-based and national-level) expand and diversify, it is hoped that alternative, more community-friendly systems can be designed. One potentially promising approach may be to develop tools that provide simpler approximations of C stock - for example it may be possible to develop lookup tables that combine dominant

species information with simple DBH data (or relascope results) to indicate the approximate standing tree carbon stock of an area (e.g. in broad classes, rather than exact figures). This might be enough to monitor management outcomes, and may possibly even be sufficient for accounting purposes if nested within a more rigorous national framework.

Community-based forest biomass assessment and monitoring should inform an integrated forest management strategy, in which C-stocks are considered in relation to other products or services derived from the forests. For example, in the case of the CBPF project area in SPF, C-stocks and consequently REDD+ as a management option should be seen against the potential for timber production, and the costs and benefits of alternatives need to be carefully considered alongside their technical feasibility.

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## References

- Blackett, H. (2009). *A study of the Cambodia timber trade: Market analysis for the commercial community forestry project*. Phnom Penh: Wildlife Conservation Society and Forestry Administration.
- Blomley, T., Tola, P., Kosal, M., Dyna, E., & Dubois, M. (2010). *Review of Community Forestry and Community Fisheries in Cambodia*. Phnom Penh: Natural Resource Management and Livelihoods Programme, Multi-Donor Livelihood Facility.
- Brofeldt, S. (2009). *Inventory in Community Forestry in Cambodia*. Phnom Penh: RECOFTC.
- Cairns, M. A., Brown, S., Helmer, E. H., & Baumgardner, G. A. (1997). Root biomass allocation in the world's upland forests. *Oecologia*, 111(1), 1-11.
- Chave, J., Andalo, C., Brown, S., Cairns, M. A., Chambers, J. Q., Eamus, D., . . . Yamakura, T. (2005). Tree allometry and improved estimation of carbon stocks and balance in tropical forests. *Oecologia*, 145, 87-99.
- Eberhardt, L. L. (1967). Some developments in distance sampling. *Biometrics*, 23, 207-216.
- Evans, T., Kelly, H. O., & Hor, N. M. (2011). *Validation of the biomass equation used for the Seima REDD Project, Cambodia*. . Phnom Penh: WCS Cambodia Program and Forestry Administration.
- Grimm, J., Evans, T. D., Mesa, H., & Ratanakoma, L. (2007). *Commercial Community Forestry in Cambodia: Development of a pilot project in the Seima Biodiversity Conservation Area*. . Phnom Penh: Wildlife Conservation Society, Tropical Forest Trust & Forestry Administration.
- IPCC. (2003). *Good Practice Guidance for Land Use, Land-Use Change and Forestry* (J. Penman, M. Gytarsky, T. Hiraishi, T. Krug, D. Kruger, R. Pipatti, L. Buendia, K. Miwa, T. Ngara, K. Tanabe & F. Wagner Eds.). Hayama: Institute for Global Environmental Strategies.
- Pollard, E., Mesa, H., Thannarak, C., Evans, T., & Pheaktra, P. (2010). *Implementation model for the Commercial Community Forestry Project*. Phnom Penh: Wildlife Conservation Society and Forestry Administration.
- Revans, R. W. (1974). The Project Method: Learning by doing. In S. Mailick (Ed.), *The Making of the Manager: A world view* (pp. 132-161). Garden City, NY: The United Nations Institute for Training and Research (UNITAR) and Anchor Press/Doubleday.
- Reyes, G., Brown, S., Chapman, J., & Lugo, A. E. (1992). *Wood densities of tropical tree specie: United States Department of Agriculture*, 98. Forest Service Southern Forest Experimental Station, New Orleans, Louisiana. General Technical Report SO-88.
- USAID. (1962). *Forest inventory manual (techniques and procedures for Cambodia)*.



Vathana, K. (2010, 9-10 August 2010). *Carbon storage of tropical deciduous forests in Mondulkiri Province Cambodia*. Paper presented at the International Conference on Managing Forest Resources for Multiple Ecosystem Services under Robust and Fragile Environments, Phnom Penh.

Walker, S. M., Pearson, T. R. H., Felipe, M. C., Harris, N., Petrova, S., Grais, A., . . . Brown, S. (2012). *Standard Operating Procedures for Terrestrial Carbon Measurement*: Winrock International.





## 4 Community Carbon Accounting Action Research Project, Indonesia

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### 4.1 Background

The Community Carbon Accounting Action Research Project – Indonesia is based on the premise that activities to reduce emissions from deforestation and forest degradation and enhance forest carbon stocks (REDD+) will not be sustainable unless communities and indigenous people are provided the opportunity and capacity to participate in a fully informed manner in the design of REDD+ strategies and the design and implementation of REDD+ activities.

This action research project takes up this challenge by exploring approaches to involve local communities in the measurement and monitoring of forest biomass using sample plots. It builds on previous work conducted on this subject by developing an approach tailored to Indonesia's conditions.

The Community Carbon Accounting (CCA) Action Research Project – Indonesia was launched with funding from the Ministry of Environment of Japan and the Asia-Pacific Network for Global Change Research (APN) in 2010 by the National Forestry Council of Indonesia (DKN) and ARuPA, a national NGO that specialises in

supporting community forestry. ARuPA and DKN have strong stakeholder networks in and around Yogyakarta, including in the villages participating in the research, i.e. Semoyo and Terong. The village communities have been important partners in the design and implementation of the Action Research Project.

### 4.2 Evolution of the action research

The developmental phases of the action research have been:

- a. Feasibility analysis and development of approach and methodology for community-based biomass monitoring – 2010
- b. Designing and conducting capacity building for CCA – 2011
- c. Internalising CCA lessons learned into 5-year Forestry Development Plan – endorsement by Indonesia Forestry Congress – 2011
- d. Deepening the institutional setting for CCA at the village level – 2011-2012



- e. Exploring the business case for, and promoting, community-level REDD+ – 2012-2013.

In the first year, the main project activities were (i) identifying suitable sites for the action research, (ii) conducting consultations with key stakeholders, (iii) designing the initial CCA process, (iv) conducting training of trainers and training of communities, and (v) processing the data. For the first year of the project the action research team was organised according to Table 4.1 and this basic structure has been maintained for the course of the action research.

Table 4.1: Action Research Team, FY2010

Position	Person/s	Roles
Principal Researcher	Agus Setyarso (DKN)	*Design, planning, management, supervision, control, decision making and reporting of the research *Liaison with IGES and external partners *Organising and participating in workshops/forums to share research lessons
Assistant Researchers	Ardian, Anik Sulistyowati, and Krisnawati (DKN)	*Preparing fieldwork plan *Preparing manuals for training *Facilitating capacity building / coaching communities *Managing data generated from the research *Maintaining meeting records
Field Facilitators	Suryanto, Dwi Nugroho for Central Java	*Liaison with community at research sites *Organising

	and Yogyakarta; Krisnawati and Dadan for South Sumatra (only 2010 activity)	community level meetings/forums *Contributing to the preparation of training manuals *Coaching communities
Community Level Trainers	Assistant Researchers, Field Facilitators, and Community Leaders	*Assist in coaching communities

The activities conducted in Year 2 of the Project were (i) further capacity building and remeasurement at Semoyo Village, (ii) continuation of activities at Burat Village, (iii) introducing the Project to Terong Village, (iv) a CCA workshop in Gunung Kidul district and (v) introducing the Project to Telang Tembago Village, Jambi.

In Year 3, the major activities undertaken were (i) remeasurement of sample plots, (ii) integrating CCA into the villages' institutional setting, (iii) adaptation of inventory tools to be more practical for community members, (iv) a socio-economic household survey, (v) preparation of a community-based REDD+ project design document (PDD), and (vi) a regional workshop.

In Year 4, the key objectives of the action research were to maximise the value of the CCA activities undertaken thus far and to transform the CCA into readiness for REDD+. The main activities were (i) remeasurement of forest carbon stock in Semoyo Village and Terong Village, (ii) preparation of publication of lessons learned from CCA-Indonesia and a module for organising CCA programmes, (iii) bringing CCA into national policy dialogues, (iv) completion of the socio-



economic survey and (v) further work on the PDD.

Action research involves cycles of planning, action, monitoring/evaluation and revision in fully iterative processes, while recording and documenting. As the phases above suggest, action research does not follow a linear path, but rather winds its way forward as researchers and participating communities learn together through collaboration on problem identification, solution proposal, solution testing, reflection and onward planning.

### 4.3 Determination of research communities

#### 4.3.1 Villages initially considered

The determination of research sites was not straight forward and was part of the action research process. The initial determination was carried out by considering forest types, types of communities and the possibility of securing support from the local authorities. Two forest types were initially considered: (1) private forest consisting of plantations with some agricultural crops, (2) state-owned forestland consisting of natural forest. Both local and indigenous communities were considered in the research. The potential commitment of local authorities was indicated by their previous support towards improving forest governance and/or forest management.

These considerations directed the CCA Research Team to initially select the districts of Gunung Kidul in the province of

Yogyakarta, Wonosobo in the province of Central Java, and Musi Banyuasin in the province of South Sumatra. In the case of Gunung Kidul and Wonosobo, the commitment of local authorities was indicated by their strong past and present support for community forest programmes. Wonosobo had issued a special District Regulation on community forests and Gunung Kidul had been declared a community forest district. Community forestry is performing well in both districts. Forests have been established through planting trees on individually-owned private land. Gunung Kidul is characterised by teak forest and Wonosobo is more represented by *Paraserienthes* forest plantations.

In the case of Musi Banyuasin, strong commitment from local authorities was indicated by their decision to establish a Forest Management Unit (KPH) and their decision to agree to a demonstration activity for a REDD+ project supported by GIZ (German Organisation for Technical Cooperation). The KPH is composed of a mixture of natural and plantation forests on peatland and dryland areas, and the location is home to an indigenous community.

#### *Initial consultations*

- *With local governments*

Consultations with local authorities were conducted through a series of meetings with the Heads of the Forestry Offices of Gunung Kidul, Wonosobo, and Musi Banyuasin. The consultation at Musi Banyuasin also included meetings with the Head of KPH Lalan of South Sumatra.

In Gunung Kidul, the issues of climate change and REDD+ were not well



understood by the local authorities. The current policy focus of the local government is to promote timber production from community forests for economic benefit. It was reported that at least 48,000 m<sup>3</sup> of timber has been harvested annually from these forests and that approximately 80% of the villages are involved. In monetary terms, this is equivalent to a contribution of IDR 150 billion or USD 168 million per annum to the district economy. Other benefits of community forests mentioned during the consultation were water and soil conservation and the formation of limestone. Carbon sequestration and storage were viewed as additional to the main function of the forests perceived by the district authority, i.e. timber production for income generation. Nevertheless, the district authority welcomed the idea of studying how forest carbon could be managed to benefit the communities.

The Head of the Forestry Office in Wonosobo District explained that the production of *Paraserienthes falcataria* (local name: sengon) has yielded in excess of 150,000 m<sup>3</sup> annually, and that more than 120 small scale timber industries are listed as active in sengon timber businesses. These activities may be contributing more than IDR 200 billion or USD 224 million per annum to the district economy. Sengon has been planted in about half of the villages, while the other villages are maintaining tobacco plantations. The income per capita of the people in the district is considered higher than that of Gunung Kidul. The Wonosobo District authority welcomes any effort involving forestry. Forestry is considered good for community livelihoods and for water and soil conservation. The district

authority stressed that conservation of water regimes is becoming more important because of a downward trend in water supply in the district. As in Gunung Kidul, Wonosobo District considers that maintaining quality forests is good for the local economy and has made this its main priority for the community forests.

Meetings with the Head of the Forestry Office and Head of KPH Lalan in Musi Banyuasin District, South Sumatra, revealed strong support for the action research initiative. There was no real need to introduce climate change/REDD+ issues as these issues have been repeatedly brought up and explained by the GIZ REDD+ demonstration activity. It was noted that there are some areas that have been proposed as Village Forests under the KPH; a “Village Forest” (*Hutan Desa*) is a special license from the Government to the Village Authority to manage a piece of forestland, without changing the status of the land, i.e. it remains state forestland.

Consultations were also carried out to secure collaboration and support from the GIZ funded project.

- *With communities*

#### **Gunung Kidul, Yogyakarta**

Consultations with the District Forestry Office, DKN’s local partner ARuPA and the community led to the selection of Semoyo Village as one of the action research sites. ARuPA and the Semoyo community have a close relationship and the village has been earmarked as having potential for forest certification. Consultations related to tree measurement had thus been conducted prior to the introduction of the action research.



Photo 4.1: Consultation at Semoyo Village



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Informal consultations were held with key persons in the village. Finding these key persons was critical to having the messages and information transmitted effectively. Explanation of REDD+ and the purpose of the CCA action research took place later at the village hall. Recommendations on follow-up activities were recorded. Informal discussions, as a follow up to the recommendations, covered several topics – the institutional setting for further consultations, the organisational arrangements for capacity building/training, and the institutional setting for the community-based forest monitoring. Informal discussion on data management also took place.

#### **Wonosobo, Central Java**

Consultations were conducted at Bogoran Village, Wonosobo District. The Head of the village is an activist who has been promoting community forestry for the last ten years. Bogoran village has three sub-villages and two of them already manage their sengon forests on a sustainable production basis. Follow up consultations/meetings with Bogoran villagers were conducted twice. The consultations concluded that a high priority issue is fungus that is affecting the sengon trees. The villagers felt that they were not ready to undertake biomass

assessment and monitoring as their efforts were directed to addressing the health of the sengon trees. Consequently, effort was made to identify another village in Wonosobo for the action research and Burat Village was suggested.

#### **Musi Banyuasin, South Sumatra**

The action research team visited a sub-village of Kepayang Village that is a partner of the GIZ REDD+ Project, and then called for a meeting with village leaders including the Head of the village and two leaders of farmer groups. A series of consultations and visits to Kepayang Village found that more than 90% of Kepayang residents are relatively new migrants and their rights to land have not been legalised. As a consequence, the buying and selling of land is common and the relationship between people and land is somewhat loose. Connections between the community and the forests cannot be directly observed during the community's daily activities.

A second round of community consultations was carried out at Muara Merang Village, which had been awarded a Village Forest by the Central Government. The management of the Village Forest was still evolving and knowledge and skill in forest management was yet to be built.

### **4.3.2 Addition of Terong Village**

CCA action research was launched in Terong Village, which is next to Semoyo, in Year 2 of the project after consultations with the Village Head and several village leaders. The consultations used forums that are active in the Village. The villagers were interested in acquiring forest



management certificates for their forests. When they found out that the adjacent village was involved in the CCA action research, they began exploring the possibility of conducting CCA activities.

### **4.3.3 Engagement with Talang Tembago Village, Jambi**

Talang Tembago Village was also selected for the action research in Year 2 of the project. Out of 23 villages in Merang District, Jambi Province, Talang Tembago was considered to be the most capable for the management of Village Forest. Consultations were held with the District Forestry Office and the Ministry of Forestry, in particular the Directorate General of Forestry Planning, which is in charge of establishing Forest Management Units, and with the community.

### **4.3.4 Final agreement on research villages**

As the above discussion indicates, the selection of villages for the action research involved consultations with various levels of government, the communities and feasibility assessment. The feasibility of CCA was explored with five villages and CCA activities were initiated in four villages. However, by Year 4 the project was concentrating its resources on two villages – Semoyo and Terong.

The action research team concluded that the community at Muara Merang were not sufficiently organised to be involved in a community-based forest monitoring initiative. In Muara Merang, the village institutions were facing difficulties and

community members were mostly interested in harvesting timber from the forest to earn cash. Since they extract the timber from the state forest, they had little concern for how to regenerate or sustain the forest.

The action research in Talang Tembago was concluded in 2012 in order to focus the project's resources on Semoyo and Terong.

## **4.4 Overview of research villages**

During the Dutch colonial period, Gunung Kidul was rich in teak forests. However, it was over-exploited and became totally deforested during the Japanese occupation. Most of the area in Gunung Kidul became bare land and limestone. Thereafter, Gunung Kidul became known as one of the poorest areas. In the 1970s, the government launched a reforestation and afforestation programme. Slowly, Gunung Kidul restored its green landscape. This process of recovery received a strong incentive during the “reformation period” that began in 1999. The process of decentralisation enabled multi-stakeholder approaches as well as local institutions to recover degraded – and even barren – state enterprise plantations as agroforestry systems (Adi et al., 2004).

In the past, most of the land was owned by the Sultan and was known as Sultan ground. However, the area of Sultan ground has been decreasing and most of the land is now owned by individuals.

Agriculture and forestry is mostly a mixture of traditional food crops, pasture and trees (teak, mahogany, acacia). All land is owned by individuals in the community. Two types of land ownership were observed, namely dryland farming



and home gardens. The composition of private forest can be classified as:

- a) Clustered
- b) Linear, i.e. trees planted along the border of the land

Agroforestry techniques with multilayer cropping are implemented by communities on their land. Sengon, suren (*toona sureni*), mahogany, jackfruit (*artocarpus*), jengkol (*Pithecellobium jiringa* or *Archidendron pauciflorum*), kelapa (*Cocos nucifera*), petai (*Parkia speciosa*), aren (*Arenga pinata*), and rambutan (*Nephelium lappaceum*), comprise the top layer. On the second layer one may find coffee, snakefruit/salacca, kaliandra (*Calliandra calothyrsus*), cacao, banana, clove, and papaya. On the forest ground layer, yellowroot/kunir and other medicinal plants can be found.

The formal village institutions in Semoyo and Terong are legitimate and effective. The institutional structure is hierarchical: village – sub-village – group/compound – household. Strong and effective community groups exist in Semoyo and Terong. Agriculture farmer groups were initiated to promote the production of cash and food crops, and forest farmer groups were established in the process of developing the agriculture farmer groups. At Semoyo, women and community radio groups are also functioning.

Photo 4.2: Forests and livelihoods, Semoyo



© Agus Setyarso

Currently, both villages are under process to be awarded with timber legality certificates (SVLK) from an independent legality verification body, which makes forest monitoring even more pertinent to their forest management and selling of timber. The locations of Semoyo and Terong are shown in Fig. 4.1.

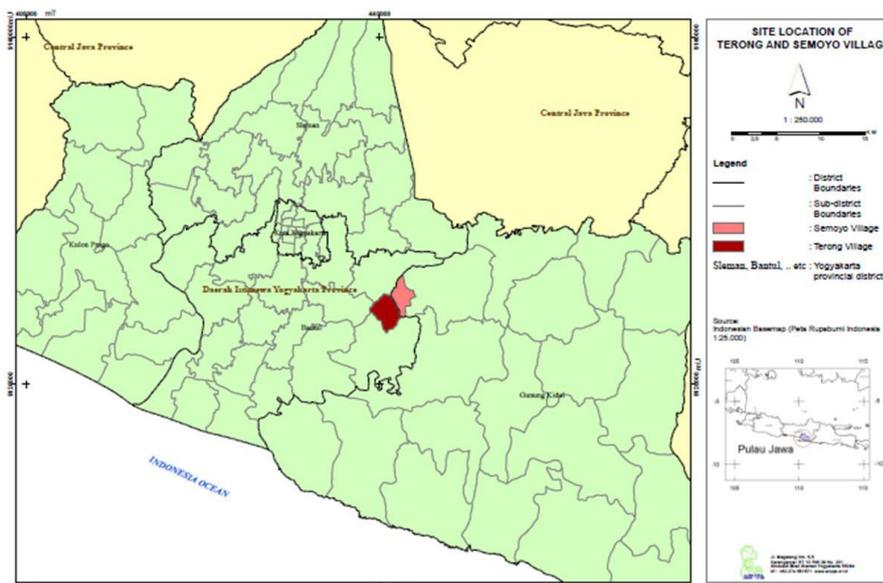


Figure 4.1: Location of Semoyo and Terong Villages, Yogyakarta

## 4.5 Training of trainers

Training of trainers (ToT) have been conducted at different points in time, both because the original trainings have been followed up with further trainings and because different villagers were brought into the action research at different points in time.

### 4.5.1 ToT at Semoyo and Burat, 2010

The design and implementation of the ToT incorporated the fact that biomass assessment and monitoring was totally new to everyone at the research sites and that the relationship between CCA and community livelihoods was not so clear. The objective of the ToT was to enable the training participants to (i) understand the importance of climate change, REDD+ and community-based forest monitoring, (ii) build their capacity to undertake biomass monitoring and (iii) develop methods for effectively introducing information on

biomass monitoring to community members. The participants were selected from key persons in the villages who were active in the series of discussion/consultations with the research team. The subject matter of the ToT is outline in Table 4.2.

Table 4.2: ToT programme

Subjects	Contents
Group dynamics	ice breaking, setting a good training atmosphere, internal rules in participating in the training, agreement on schedule
Concepts and awareness	climate change phenomena, how community forest may contribute to mitigation, rights to carbon, distribution of benefits, need for CCA
Forest sampling	sampling framework, plot shape and dimension, dynamics in applying sampling on the ground
Measurement	team work, setting plot boundaries, introduction to measurement equipment, using measurement equipment, finding best techniques on the ground



Data recording	introduction to tally sheets, adjustment of tally sheets, practice filling tally sheets, data entry and storage on computer
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### *Implementation and observations*

Training was carried out in the village and the entire programme was completed. The need for a flexible training schedule was observed. Training could not be conducted daily, but depended on the availability of the participants. With the intermittent schedule, the entire programme required three weeks to complete.

#### **4.5.2 Further training at Semoyo**

A follow-up training workshop to consolidate the activities undertaken was held in Semoyo Village. The workshop emphasised the importance of carbon monitoring, provided a refresher on biomass assessment, and improved training materials and the field sheet filing system. Training was also provided to 21 community members to build their skills in using MS Excel.

#### **4.5.3 ToT at Talang Tembago**

Talang Tembago Village probably represents the final evolution of village establishment at Sumatra. It originated from the Sungai Tenang ethnic group and it was slowly established from old settlements such as the Koto Mutut, Sungai Seluang, Sijori and Durian Malai compounds. In the past, these compounds were mobile as they practiced shifting cultivation. The last settlement was established in 1982.

Talang Tembago has natural mixed Dipterocarp production and protection forests. Some areas have been logged by forest concessionaires. Currently, the villages treat some of the surrounding forests as a source of fertile land for their livelihoods and protect the remainder for water supply and electricity generation.

Six people from different villages that had secured the status of Village Forests participated in the ToT at Talang Tembago. However, it was difficult for the participants to understand the concepts of climate change, carbon and greenhouse gasses. These are completely new concepts for them. Two days were not sufficient to cover these concepts. A number of terms on climate change and REDD+ need to be transformed into local expressions. The training facilitator and resource persons were not sufficiently prepared for this. As the villagers benefit from their protection of water for consumption and hydropower generation, this could be one entry point to explain protection of carbon stocks for climate change mitigation.

Another difficulty was introducing the participants to the use of maps, GPS and other measurement tools. The concept of measuring tree diameter and height took a lot of time for the participants to understand. Introduction to the use of measurement tools may be best conducted in the field, and even home gardens can be used for practising measurement.

#### **4.5.4 ToT at Terong**

The Terong village leaders agreed to invite villagers from Semoyo to learn more about climate change and CCA. The Semoyo CCA



“trainers” contributed to an awareness raising programme for Terong, which included:

- A field visit from Terong to Semoyo to raise awareness on how forest measurement can be conducted by local people. Sixteen people from Terong and four trainers from Semoyo participated in the training.
- A dialogue on the importance of CCA training for Terong, which was attended by 15 people from Terong and two trainers from Semoyo.
- A shared learning forum where village leaders from Terong and Semoyo discussed how CCA can be implemented. The forum was attended by 15 people from Terong and 15 people from Semoyo.

After these meetings, Terong Village decided to proceed with a CCA ToT. Ten Terong Village leaders participated in the ToT and conducted CCA training for 45 villagers representing nine sub-villages.

Photo 4.3: Checking plot corners have right angles, Terong



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## 4.6 Community capacity building

The design and implementation of the training of community members was based on the knowledge that climate change, REDD+ and biomass assessment are entirely new to them and that they are not so familiar with quantitative measurements. The content of the training was similar to that of the ToT in that it covered group dynamics, concepts and awareness, forest sampling, measurement and data recording. The participants were the land owners where the sample plots were to be measured and other community members who were interested in the initiative. The trainers were the research assistants and field facilitators and the key village persons who had participated in the ToT.

### *Implementation and observations*

Training was carried out in the villages. One session was conducted indoors, while others were conducted in the forest. Coaching was carried out by setting up a sample plot for training purposes. Other sessions were carried out sequentially, moving from one sample plot to the next. In other words, measurement sessions of the training were organised for every plot. Coaching on measurement was given at every plot and then the actual field measurement was conducted. This approach was considered the most effective and acceptable by the training participants.

In Year 2 of the project refresher training on carbon assessment was conducted in Burat, and a shared learning forum was facilitated where 10 people from Burat Village and 10 people from Semoyo Village



discussed their biomass monitoring activities.

## 4.7 Forest sampling

The sampling design was formulated by researchers and field facilitators through the following steps:

- ✓ Determination of sampling frame
- ✓ Stratification of sampling units
- ✓ Determination of variables to be measured
- ✓ Determination of sample plot shape
- ✓ Determination of number of sample plots
- ✓ Packaging the protocols and methods into a field manual (in Indonesian).

This design was then introduced and discussed with key community persons to obtain their input. The input from the community leaders increased the practicality of sampling on the ground. This was considered important as they are to be in charge of the measurement.

### 4.7.1 Number of sample plots

The sampling unit was determined as a unit of land owned by community members. This was found effective since the sampling frame can be easily mapped from the statistical data at the Village Office. Through a series of discussions the number of the total sample units in Semoyo Village was determined as 100.

### 4.7.2 Locating sample plots

In Semoyo, there are five sub-villages with 20 sampling units for every sub-village (Fig.

4.2). The units for sampling were determined by random numbers. The randomisation needed to be clearly explained to the community since there are questions on why their land is or is not selected for the sampling.

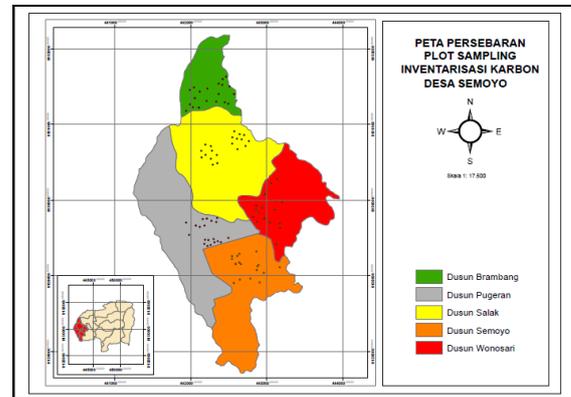


Figure 4.2: Location of permanent sample plots in Semoyo Village

### 4.7.3 Plot shape and dimension

There are four sub-types of tree spatial patterns according to land use and the dispersion of trees: dryland with trees in clusters, dryland with trees at boundaries, home gardens with trees in clusters, and home gardens with trees at borders.

For the clustered tree distribution type, the plot is square with dimensions of 20 x 20 m for both dryland forests and home gardens, while for trees that are spatially distributed along the border of land units, trees are selected and measured across alternate 10 metre intervals (Fig. 4.3).

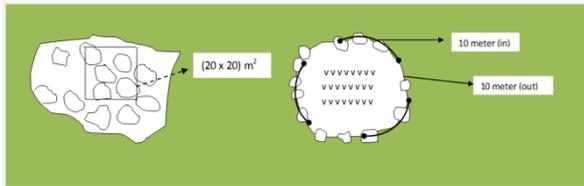


Figure 4.3: Plot dimensions and sampling strategy for trees planted in clusters (left) and along property borders (right).

#### 4.7.4 Carbon pools measured and reason for inclusion / exclusion

During early consultations it was agreed that the following carbon pools would be measured: trees (above ground woody biomass), litter, and above ground non-woody biomass (banana, grass, other herbal plants, food crops). During the training it was found that the complexity of measuring the non-woody carbon pool would not be understood by the community within the first year of the action research. It was thus decided that the measurement of the non-tree carbon pools would be left until a later date.

The parameters measured are diameter at breast height (DBH), total tree height and thickness of the litter. The measurement, demarcation and recording equipment used are: tape measure, Haga Meter, plastic line, wooden stick for plot border marking, GPS, tally sheet and notepad.

Every year since they joined the action research, Semoyo and Terong have conducted maintenance on the plots, including re-marking of plot boundaries, and remeasured the trees.

#### 4.7.5 Carbon stock calculations

##### *Data recording and entry*

Field measurements are recorded in pre-designed tally sheets. Research assistants are assigned to supervise the filling of the tally sheets by the community members. Field data are then entered into an MS Excel spreadsheet. A computer with MS Excel is available at the community secretariat Semoyo, so data entry is conducted at the farmer group leader's house. The research assistants copy and back up the electronic data, carry out mathematical transformation to convert field measurement to carbon stock, and compile the results of the measurement.

##### *Calculations / Results*

- *FY2010*

In FY2010, carbon estimates were derived by applying regressions produced by Brawijaya University from home gardens and community dryland forests. Carbon was estimated for the main stem, branches and leaves using the following equations:

- Main stem/trunk  $(C_b) = 0.4078 * D^{1.6847}$
- Branches  $(C_c) = 0.1086 * D^{1.8273}$
- Leaves  $(C_d) = 0.0305 * D^{1.5843}$

The results of the initial biomass assessment from 50 plots for each forest type are presented in Table 4.3.



Table 4.3: Summary of biomass assessment results

	C for the main stem (Kg)	C for branches (Kg)	C for leaves (Kg)	C Total
<b>Home garden</b>	46722.36	19043.81	2598.35	68364.51
	Mean average	$68.36451/50 = 1.3672902 \text{ ton}/0.04 \text{ Ha}$ <b>=32.5 ton/ha</b>		
<b>Dryland farm</b>	43950.57	17805.94	2452.85	64209.35
	Mean average	$64.20935/50 = 1.284187 \text{ ton}/0.04 \text{ Ha}$ <b>=32.104675 ton/ha</b>		

• **FY2013**

The species specific allometric equations listed in Table 4.4 are now being used. These are the research result of the Ministry of Forestry and the Forestry Faculty of Gadjah Mada University. They were selected because they were derived from research conducted in community forests in Java that have similar characteristics to those at the CCA action research sites.

Table 4.4: Formulas used for forest carbon estimation

Tree Species	Total biomass (including stem, branch, and leaf)	Number of trees sampled (n)	Determination Coefficient (R <sup>2</sup> )	Remarks
Mahogany ( <i>Switenia mahagony</i> )	$BT=0.9029 (D^2H)^{0.6840}$	10	0.9857	Community forest (non-irrigated field and home garden) of Jatimulyo Village, Jatipuro Sub-District, Karanganyar District, Central Java
Sonokeling ( <i>Dalbegialatiolia</i> )	$BT=0.7458 (D^2H)^{0.6894}$	10	0.8852	Community forest (non-irrigated field and home garden) of Nglanggeran Village, Pathuk Sub-District, Gunung Kidul District, Special Region of Yogyakarta
Teak ( <i>Tectona grandis</i> )	$BT=0.0149 (D^2H)^{0.9296}$	10	0.9813	Community forest (non-irrigated field and home garden) of Jatimulyo Village, Jatipuro Sub-District, Karanganyar District, Central Java
Sengon ( <i>Parasenianthers falcatania</i> )	$BT=0.0199 (D^2H)^{0.9296}$	18	0.9921	Community forest (non-irrigated field and home garden) of Bateh Village, Candimulyo Sub-District, Magelang District, Central Java
Acacia auri ( <i>Acacia aurialifamis</i> )	$BT=0.0775 (D^2H)^{0.9018}$	10	0.9578	Community forest (non-irrigated field and home garden) of Nglanggeran Village, Pathuk Sub-District, Gunung Kidul District, Special Region of Yogyakarta
Others	$BT=0.0219 (D^2H)^{1.0102}$	58	0.8407	Combination of main 5 species listed above

**Semoyo**

In Semoyo, most of the trees measured are teak, mahogany, acacia, sonokeling, and sengon. These are the dominant tree species in the region. Results of the

estimation for biomass stocks of the community forest are shown in Table 4.5.



Table 4.5: Biomass stocks of the Community Forest in Semoyo Village, 2013

	Home garden (kg)	Dryland (kg)
teak	49,687.8	42,554.5
mahogany	52,275.9	46,493.8
acacia	3,386.8	6,553.2
sonokeling	22,459.5	34,250.3
sengon	1,400.1	3,516.0
Biomass	<b>129,210.1</b>	<b>133,367.9</b>

The estimated forest carbon stocks in Semoyo Village in 2013 for trees in home gardens is 32.302 tC/ha and for dryland fields is 33.342 tC/ha.

Figure 4.4 shows that the carbon stocks in the home gardens and dryland (non-irrigated fields) have increased year-by-year since the monitoring began in 2010. Tree carbon stocks in home gardens increased by 3.331 tC/ha and for dryland fields by 4.256 tC/ha from 2010 – 2013.

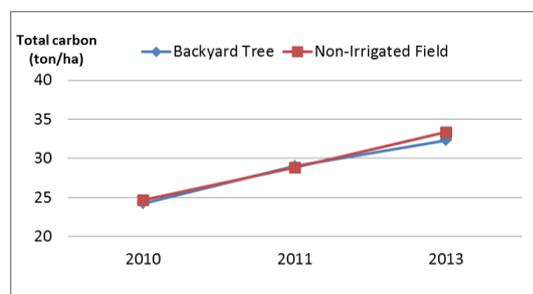


Figure 4.4: Carbon stocks of the Community Forest in Semoyo Village, 2010-2013

### Terong

The first measurements were undertaken in Terong in 2012, and in 2013 the 180 plots were remeasured using the same procedures. The results for 2013 are provided in Table 4.6.

Table 4.6: Carbon stocks of the Community Forest in Terong Village, 2013

Land use	Total Biomass (ton)	Biomass per ha (ton)	Carbon/ha (ton)
Home garden	361.47	132.41	<b>66.20</b>
Dryland	266.76	89.52	<b>44.76</b>

### 4.7.6 Innovations in measurement

Christen hypsometers were introduced to estimate tree height as an initiative to ensure that measurement tools best suited to community-based forest biomass assessment are used. These are produced locally at an affordable price of USD 2.50 per unit. By the end of 2012, Semoyo Village had produced 200 Christen hypsometers, some of which may be distributed to adjacent villages.

Photo 4.4: Facilitator (left) instructing on use of Christen hypsometer, Semoyo



© Taiji Fujisaki



Photo 4.5: Local production of Christen hypsometers



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### 4.8 Community REDD+ PDD

A ToT for the development of a community-based REDD+ project design document (PDD) was conducted in October 2012. This ToT aimed to (i) enable participants to understand in detail what a REDD+ project is and become owners and managers of future REDD+ activities, (ii) build knowledge on PDD elements and (iii) build competencies in understanding application of a carbon standard (the

Climate, Community and Biodiversity (CCB) Standards were selected). Most of the participants were local leaders and forestry extension agents.

The ToT was followed up by support to each village to prepare the PDD. Two ToT participants from each village were then assigned to inform their peers on the requirements for preparing the PDD, and they were instructed to start working on generating the necessary inputs for the CCB Standards components.

After the ToT, household surveys were conducted in Semoyo Village on the relative importance of different productive activities for the villagers in order to establish a socio-economic baseline for the PDD.

The support for community-based REDD+ PDD development and progress is summarised in Table 4.7. PDD preparation has turned out to be the most challenging activity under the action research for community members.

Table 4.7: Activities and progress on community-based REDD+ PDD

Activity	Location	Progress
Dissemination & internalisation	Semoyo	*Members of Semoyo & Terong acquired basic knowledge on PDDs & are actively contributing to work on the PDD.
Training on preparation	Semoyo	*Completed. Key persons in the community forest organisations contributed to preparation of the PDD.
Collection of data & information required	Relevant locations	*Required data for Semoyo collected & analysed.
		*Supporting data from neighbouring villages collected.
		*Some secondary data from district & province offices still to be collected.
Focus group discussions	Gunung Kidul District & Semoyo Village	*Focus group discussions carried out.
		*Another focus group discussion needed for completion of PDD.
Farmer group meetings	Semoyo	*Organised monthly.
Drafting	Semoyo	*Part I & Part II completed. *Two parts left to be written.
Monitoring on preparation	Semoyo	*5 meetings with ARuPA at Yogyakarta & Semarang. *6 meetings organised at Semoyo on progress of PDD preparation.



## 4.9 Dissemination, outreach and capacity building module

### 4.9.1 Initiatives of Semoyo leaders

Semoyo leaders prepared an extracurricular class on environment, with climate change as one of the main subjects. They are using radio to share lessons from their biomass monitoring activities. Monthly meetings of women’s groups are also being used to raise awareness on climate change and encourage more women to be involved in the CCA.

Photo 4.6: Village radio raising awareness on climate change and community-based forest monitoring, Semoyo



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### 4.9.2 Video production

The CCA experience has been presented as a video to demonstrate how local communities can be engaged in monitoring their forests. The video footage was prepared with the assistance of ARuPA and provides an explanation of carbon and the role of trees in the carbon cycle, the why and how of community monitoring of forest carbon stocks,

including the sampling design and measurement protocols, the importance of facilitation, and the expectations of the communities involved.

### 4.9.3 Capacity building module

A module for capacity development for CCA implementation has been prepared in Indonesian (Bahasa Indonesia) (Fig. 4.5). The aim of the module is to provide an effective and systematic training course for villagers who wish to participate in CCA actions in Indonesia in order to manage their forest resources and land in a sustainable manner. The module is based on the CCA experiences in Semoyo and Terong. The module covers the concept of community-based forest monitoring, community forest composition, biomass measurement, and data processing and analysis.

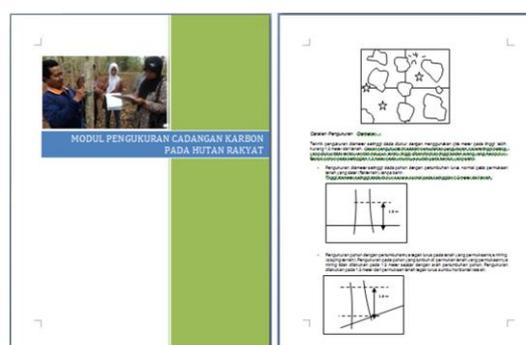


Figure 4.5: Module for organising CCA programmes (top page and 1 technical page shown)

## 4.10 Workshops

Local workshops with the project communities have been held every year as part of the action research. Workshops have also been organised at district level to ensure government departments are



engaged, the CCA approach is disseminated widely, and opinions are shared.

#### 4.10.1 Participatory carbon assessment workshops in Gunung Kidul District

##### 2011

The workshop was a 1-day event held on 07 December 2011 and was attended by the leaders of each village, the district government (heads of forestry and environment) as well as IGES, DKN and ARuPA. The district government of Gunung Kidul has shown strong interest in the action research, and both heads of forestry and environment stated that activities such as this have high priority for the district.

Photo 4.7: Presentation on community-based forest monitoring to Gunung Kidul forestry office, Java, Indonesia



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The Semoyo villagers presented on the forest assessment and monitoring they had undertaken in their village including on the establishment of 100 permanent sample plots. They also showed a locally produced video (Indonesian with English

subtitles) explaining their CCA activities and the importance for the community of forest environmental services. It was also noted that CCA has generated new information on village resources and has encouraged villagers to strengthen their local institutions.

##### 2012

The workshop was organised at the District Government Auditorium and was attended by more than 50 participants. The first day was used to report on CCA activities that have been implemented in three villages representing three districts, namely Semoyo Village and Terong Village, which are under the CCA Action Research Project, and Caturhari of Pacitan District, East Java. Caturhari conducted forest measurement through its own initiative and resources, and invited the Semoyo trainers as coaches.

On the second day, the workshop moved to Semoyo Village hall where participants discussed progress in preparing the community-based REDD+ PDD. Preparing the PDDs has involved a lot of self-learning by the communities, but they still require a lot of assistance to understand the substantial elements of the CCB Standards.

#### 4.11 Strengthening village institutions for CCA

Collectively, the community members need guidance for the continuous development of their land and local economy, particularly for administering resources and regulating land treatment (for example, the use of fertilizer and irrigation). There is a pattern of regularity on these issues that calls for improving the communities' institutional frameworks. In



2013, the institutional setting activities included (i) the establishment of a legal deed on the statute of the community groups, and (ii) formulation of standard operating procedures for the technical treatment of forest land.

#### 4.12 Bringing CCA into National Policy Dialogues

Generally, the concept of community participation in forest monitoring has not been addressed in Indonesia's forest policy. While there have been a number of national dialogues on climate change and REDD+, the potential roles of communities in biomass monitoring have not been seriously discussed. The approach of the Action Research Project is to channel the CCA experience into agendas that are being set up by other initiatives.

At the National Meeting for DKN-Academician Chamber and KPH Coaches in 2013, one 3-hour session was allocated to discussion on CCA. The Chairperson of Semoyo Farmer Groups was the sole speaker for this session.

The CCA Action Research Project was also discussed at the 2013 annual meeting of DKN. The meeting spent considerable time evaluating the performance of the forestry system in Indonesia, including policies on REDD+ and forest carbon. Recommendations were packaged into a "DKN White Book" (still draft). The White Book includes the importance of community roles in forest and carbon monitoring, within which CCA was considered an effective concept.

CCA was also discussed at a regional KPH event in 2013. At the regional KPH meeting in Padang, West Sumatra, it was learned

that all KPHs have community forestry programmes. Half of them decided to go for REDD+ initiatives as one of the core KPH businesses. A basic problem is that knowledge on REDD+ is quite limited, and therefore course of actions for bringing REDD+ under the next 10-year KPH management programmes are not clearly defined. The CCA experience at Semoyo was introduced as a possible approach that could be integrated into KPH programmes. The responses were positive and the idea was widely accepted.

#### 4.13 Conclusion

The following observations are taken from the action research project:

##### **Awareness and commitment**

- Strong commitment from local authorities and intensive consultations with community members is essential for community-based forest monitoring approaches. This requires significant resources and must be ongoing.
- Community institutions are still weak and ineffective in some parts of the country. CCA cannot be introduced unless communities have strong institutions, including institutions for forest management.
- Finding how forest management activities specifically to conserve forest carbon stocks can benefit local livelihoods is a challenge. This requires moving to the next cycle of action research, which in the case of the participating communities has been the decision to develop a community-based



REDD+ PDD. This is a new challenge that the Project is now taking up.

### **Research design**

- Action research was found to be suited to the evolution of CCA systems. Researchers and facilitators are required to adhere to the research cycle (plan – action – monitor/evaluate – revise) in fully iterative processes, while recording and documenting. Research design, sampling and measurement techniques have to be intensively discussed with the participating communities to realise their full engagement in the research process.

### **Capacity building**

- Training of trainers will only be successful (effective in producing “trainers”) if the selection of participants is proper in the sense of producing true leaders in the community.
- The combination of short classroom and longer outdoor/field exercises proved the best approach to training community members.
- Training sessions must be fitted to the daily activities of community members. As a result, the commitment from the researchers/trainers may exceed those of normal training programmes.
- Explaining climate change, REDD+, carbon and carbon accounting, including how carbon estimates are derived from biomass

measurements, is challenging. Local illustrations are needed. The ToT at Terong was quite effective as the “trainers” provided by Semoyo Village were able to support the facilitators by explaining concepts to the participants using local idioms and analogies.

- Community members initially find it difficult to use the measurement instruments, but become increasingly competent through supervised repeated use. Measurement instruments suited to community-based forest sampling, such as Christen hypsometers, should be tested in terms of ease-of-use, availability, costs, and measurement accuracy.
- When computers are available in the villages, communities can potentially take on the role of transferring the data they have recorded on field sheets to MS Excel spreadsheets. Training was provided on MS Excel use, but ongoing support and further training is required. This must lead towards the building of an information system for CCA that would be handled by the community members for their forest management and livelihood activities.

### **Outreach**

- It is important to explore possible linkages through which CCA can inform existing forest information systems and be integrated into other forest initiatives. The Indonesia CCA Action Research



Project presented the CCA experience in Semoyo and Terong at two national events and one regional event in 2013.

- Effective ways of sharing action research experiences with a wide range of stakeholders requires looking beyond the usual project report formats. Under the CCA Action Research Project-Indonesia, community experiences with CCA have been shared through public radio and video.

#### Acknowledgements

The authors are grateful to the Head of Gunung Kidul District and Head of Pacitan District, as well as the Office of Forestry at Gunung Kidul, Pacitan and Bantul.

#### References

- Adi, N. J., Arganata, F., Chehafudin, M., Fuad, F. H., Nugraheni, S. C. A., Sanyoto, R., . . . Walpole, P. (2004). Communities transforming forestlands. Java, Indonesia. In M. Poffenberger & K. Smith-Hansen (Eds.), *Community forest management trends in Southeast Asia*. Bohol. Philippines: Asia Forest Network.



## 5 Community Carbon Accounting Action

### Research in Lao PDR

Saykham Boutthavong (NUoL), Douangta Bouaphavong (NUoL) and Kimihiko Hyakumura (Kyushu University / IGES)

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#### 5.1 Introduction

The Faculty of Forestry (FoF), National University of Lao PDR (NUoL) and the Institute for Global Environmental Strategies (IGES) are jointly implementing the Community Carbon Accounting (CCA) Action Research Project in Sangthong District, Vientiane, Lao PDR with financial support from the Asia-Pacific Network for Global Change Research (APN) and the Ministry of Environment of Japan. This action research project aims to explore approaches to involve local communities in forest carbon accounting. Another objective of this project is to enhance the capacity of NUoL researchers on forest biomass measurement and monitoring.

#### 5.2 Research sites

The CCA-Lao PDR project was launched in 2011 in four villages – Ban. Napor, Ban. Kouay, Ban. Xor and Ban. Nongbua – in Sangthong District. The site is near the Training Model Forest (TMF) of the Faculty of Forestry, which is located along the Mekong plain about 80 km northwest of Vientiane (Fig. 5.1). The site is characterised by mainly hilly topography with altitudes varying between 200 and 400 metres asl, and a typical monsoon climate with a distinct rainy and dry season.

The major land use systems in the area are unstocked forestland, forests and various agricultural land uses such as rice paddy, pasture, upland cultivation and agroforestry. Mixed deciduous forest is the dominant forest type, and is now characterised by the rampant occurrence of bamboo in the understory and a low abundance of the high-value commercial tree species, such as *Azalia sp.*, *Dalbergia sp.* and *Pterocarpus sp.* Flora and fauna are diverse, especially in the less degraded areas.

The total land area of the four participating communities is about 19,76.52 ha and the total area of forest is about 9,788.40 ha (Table 5.1). The total land area of Ban. Napor is 2,830 ha, of which about 1,521.55 ha is forestland. About two thirds of this is managed by NUoL as a training and model forest. In Ban. Kouay, the total land area is 6,537.56 ha, and of this 3,945.30 ha is forestland. About 2,274 ha is categorised as village conservation forest and this is proposed to be National Protection Forest (Phou Kha Ya- Pa Tae). In Ban. Nongbua, the total land area is about 1,343.29 ha, while the forest area is about 487.72 ha. About 80 ha of this forestland are managed by NUoL, and around 140 ha are proposed as a National Protection Forest. Ban. Xor is one of the largest villages in the project area,



with a total land area of about 9,051.67 ha, of which forestland accounts for around 3,833.83 ha. About 1,379 ha is village conservation forest which is being proposed as National Protection Forest. About 300 ha of forest holds large trees (*Azalia sp.* and *Pterocarpus sp.*) and has been categorised as mother tree seed network forest (Dong Pa Tae).

Ban. Xor is the only village that still has forest in good condition. The community forests are managed by the communities together with the local authorities.

### 5.3 Scheduling and location of project activities

#### *FY2011*

In 2011, project activities focused on capacity building of the research team, the local authority and community. A training workshop was conducted on forest carbon for NUoL researchers at the Faculty of Forestry. A socio-economic baseline survey was designed and information was collected on features of the research site, perceptions of the communities towards climate change and its impacts on their livelihoods, and forest resource management in the target communities. The NUoL research team conducted consultation meetings with the district and village authorities, and through this process the villages that would be participating in the action

research were decided. The NUoL research team carried out a training workshop for the district staff and the community members that covered a range of topics including the cause of deforestation and forest degradation in Lao PDR; the concept of REDD+; the current status of the REDD+ programme in Lao PDR; forest inventory techniques; understanding forest and land use cover types from satellite images and maps; designing of sample plot layout; and tree measurement techniques.

#### *FY2012*

The following activities were carried out in FY2012:

- ✓ Finalising the socio-economic baseline dataset for the research communities
- ✓ Developing training materials and a field guide for the communities
- ✓ Conducting community awareness and training
- ✓ Conducting a consultation and establishing the community forest biomass inventory team
- ✓ Enhancing the GIS capacity of the research team
- ✓ Conducting a ground survey
- ✓ Supporting the community team to establish sample plots and conduct measurement
- ✓ Field survey data management and analysis.

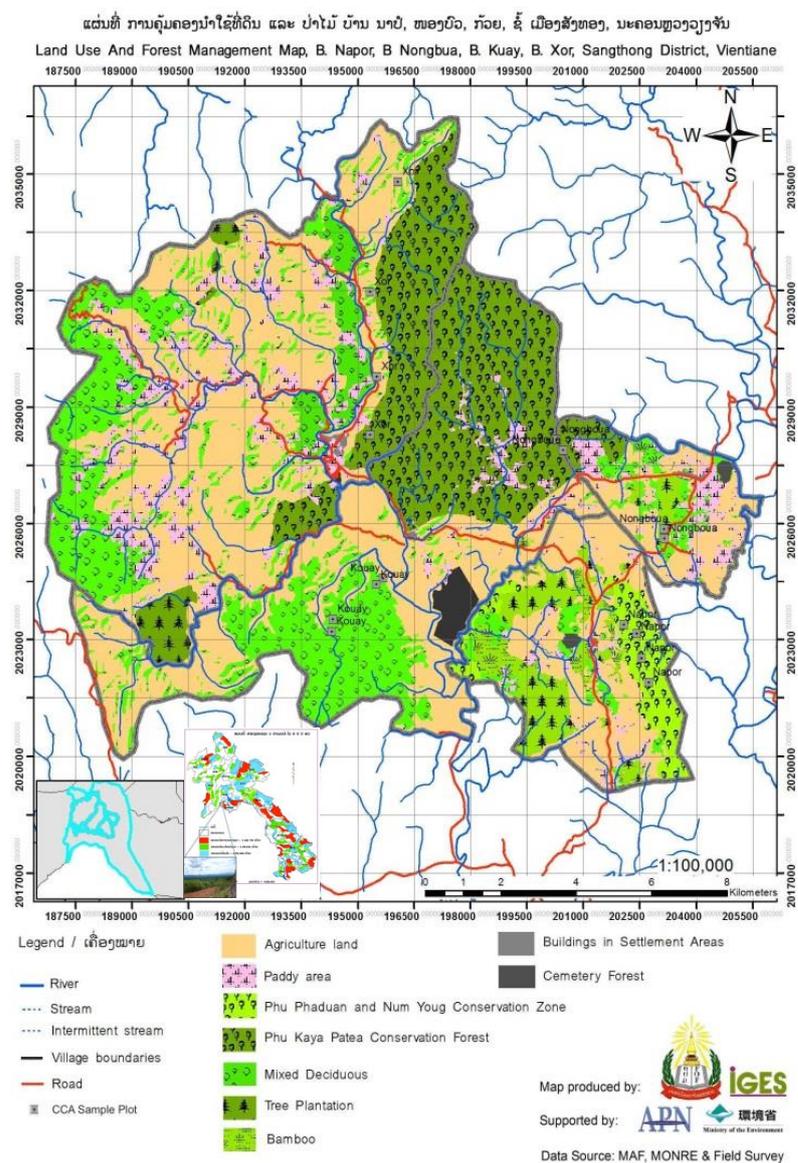


Figure 5.1: Location map of the four villages involved in the project

Table 5.1: Forestland in the participating communities

No	Village	Total land (ha)	Forest land (ha)	Percentage
1	Napor	2,830.00	1,521.55	53.77%
2	Kouay	6,537.56	3,945.30	60.35%
3	Nongbua	1,343.29	487.72	36.31%
4	Xor	9,051.67	3,833.83	42.35%
<b>Total</b>		<b>19,762.52</b>	<b>9,788.40</b>	<b>49.53%</b>

Remark: Source data is from GIS database (2014)



### **FY2013**

In 2013, the action research activities focused on land use mapping using remotely sensed data, GIS and ground surveys that involved the local communities.

### **5.4 Results of socio-economic baseline survey**

The socio-economic baseline survey began in 2011. The purpose of the survey was to understand local community and local authority perceptions on climate change and its impacts, land and forest resource management by the local people, as well their interest in community forest biomass monitoring. Household data and information of the survey was entered into an electronic database. The village populations and number of respondents is provided in Table 5.2.

Figure 5.2 shows that only 5% of the total households have general knowledge about climate change and can provide some explanation of it, while about 30% know a little about climate change. Figure 5.3 reveals the perceptions of the communities of the impact of climate change in the project area. Over 60% of the total households think that climate change has no impact on their lives. However, local people sense that there is change in their environment and that this has gradually impacted their livelihoods.

Table 5.2: Number of sampled households in the three villages

<b>Village</b>	<b>Total number of household</b>	<b>Total population (female)</b>	<b>Number of respondent households</b>	<b>Percentage of total households</b>
Napo	80	485 (240)	20	25%
Kouay	141	616 (296)	52	37%
Sor	402	1,909 (984)	118	29%
Nongbua	78	358 (165)	-	-

Figure 5.4 shows that the villagers in the target community have a strong relationship with their forest, especially in relation to harvesting bamboo and other non-timber forest products (NTFPs) for subsistence and also for selling at the local market. Figure 5.5 reveals that about one third of the sampled household had previous experience in tree measurement. The villages are located near the Training Model Forest and they have had the opportunity to participate in forest survey work with NUoL teachers and students.

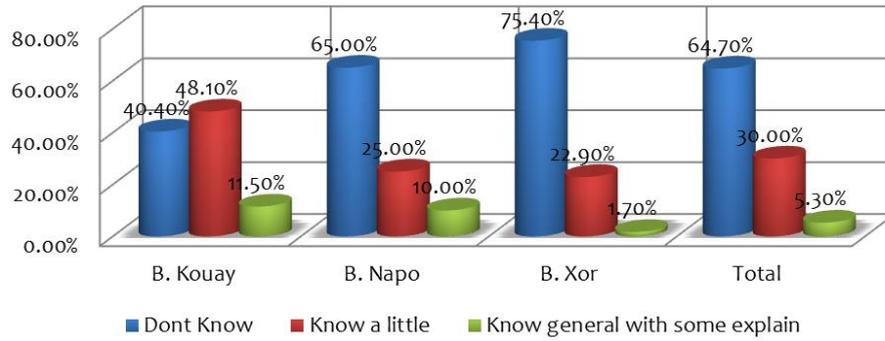


Figure 5.2: Level of understanding on climate change

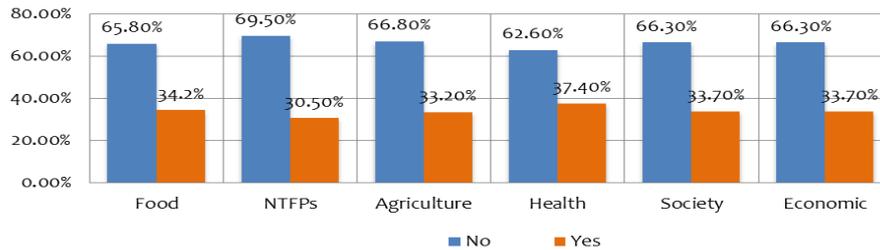


Figure 5.3: Perception on climate change impact

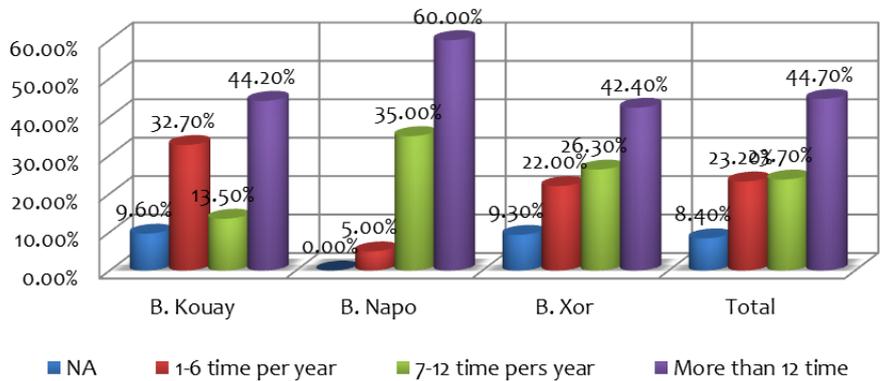


Figure 5.4: Frequency villages visit the forest

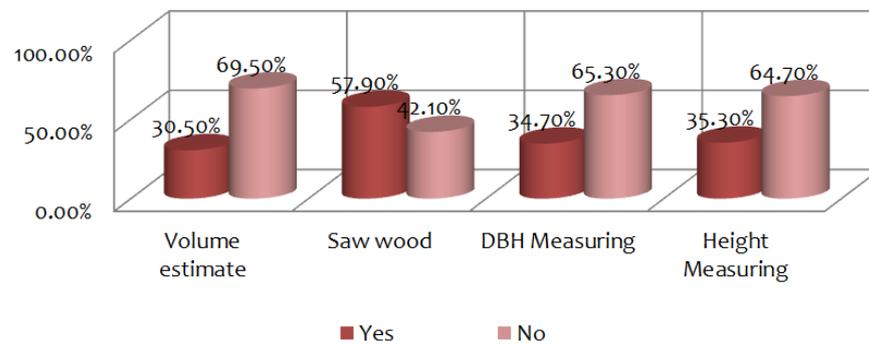


Figure 5.5: Experience of the communities in tree measurement



The tools include distance measurement tapes, compasses, SUNNTO clinometers, handheld GPS, satellite images, maps, etc.

## 5.5 Training materials and field guide development

The NUoL CCA facilitation team developed training materials in PowerPoint format in local languages and prepared the tools and equipment necessary for the field training programme and for forest inventory, including tree measurement.

The field guide covers sample plot establishment and tree measurement (Fig. 5.6). A guideline on GPS use was prepared in the local language. The technical steps outlined in the field guide were fully tested, adapted and then used in the sample plot establishment and measurement activities.

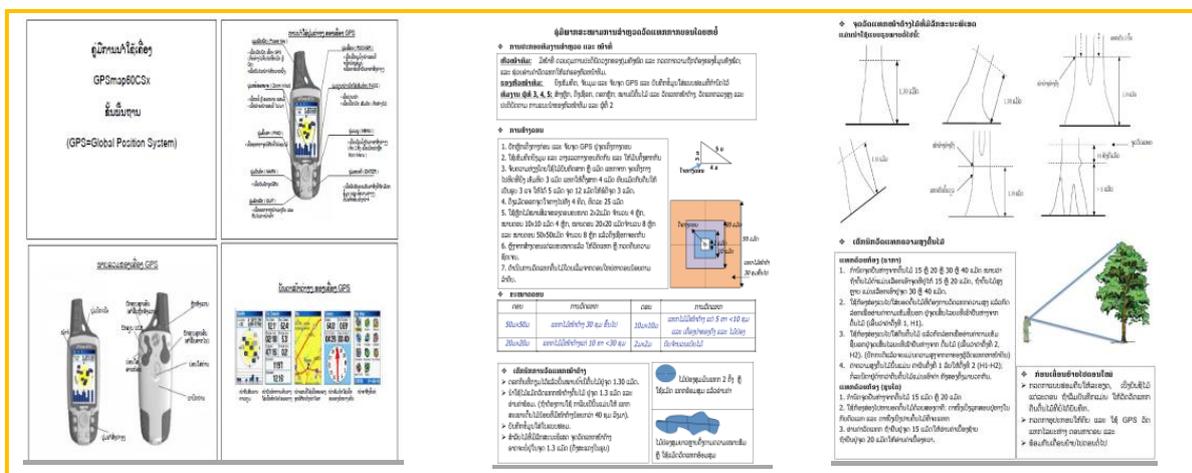


Figure 5.6: Field guide and GPS guidance booklet

## 5.6 Community team building

To prepare for the field data collection and the involvement of the community in CCA activities, especially sample plot establishment, tree measurement and data recording, a consultation meeting between the NUoL facilitation team and the village organisation committees was held. The village organisation committees nominated people from their villages to participate in the field activities. Each

village formed a survey team of 10 people (all male) (Fig. 5.7). The village teams were trained by the NUoL researchers. The training began with concepts, followed by practical exercises on establishing trial sample plots in the field. With guidance from the NUoL researchers/facilitators, the community teams then established the forest biomass inventory sample plots. The task and responsibilities of each member of the community teams were discussed and agreed in a session of the training programme.



Figure 5.7: Community forest biomass monitoring teams of the four participating villages

## 5.7 Awareness and training workshops

At the awareness and training workshops, the NUoL resource persons provided information to the community team members on:

- ✓ Background of the CCA project, concept of REDD, and REDD+ status in Lao PDR
- ✓ The techniques of forest biomass inventory, (step-by-step training

- programme covering both concepts and practice)
- ✓ Use of the tools and equipment for tree measurement and data recording
- ✓ Understanding maps, satellite images, and GPS applications and identifying locations on the maps and satellite images
- ✓ Action planning for establishment of the sample plots and tree inventory (Fig. 5.8).



Figure 5.8: Activities in the training programme

## 5.8 GPS training and ground survey

Community team members were introduced to basic use and applications of GPS, such as marking waypoints and tracks and note taking into a form. Training was also provided on map sketching and on satellite image use. High resolution

satellite images of each village were printed out and were used to find the different land use and natural boundaries. A survey of the forest boundary and ground-truthing was then conducted with the participants. Due to time constraints, the research team could not mark and survey all the village boundaries and delineate all the different types of forest. Images of the training and ground survey are presented in Fig. 5.9.



Figure 5.9: Introducing basic GPS use and forest boundary sketch mapping

### 5.9 Demarcation of forest strata and sample plots design

Prior to the forest measurement, the boundaries of forest strata were surveyed by the NUoL research/facilitation team,

together with the communities, using the land cover map produced by the NUoL team. The sampling for tree measurement was based on the results of the forest strata mapping. Images of the demarcation survey and project map are presented in Figure 5.10.

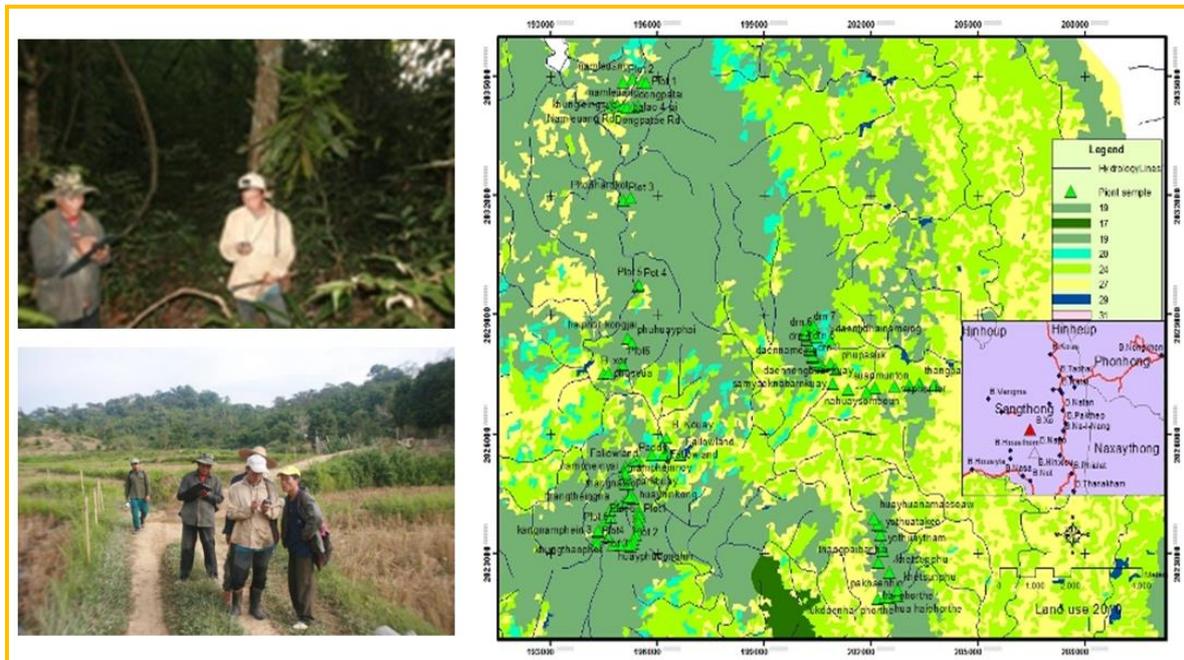


Figure 5.10: Forest strata survey and map of the project

### 5.10 GIS training and mapping

An informal GIS training programme was conducted at NUoL. The research/facilitation team and young researchers from NUoL participated in the training programme. Resource persons introduced basic use of Arc Map software.

The information from the ground truthing and the forest strata survey, the location of potential sample plots, the location of the 16 sample plots to be established, and land use information of the project area were uploaded and merged into the existing database. From these activities the research/facilitation team created a basic map of the project area.



### 5.1.1 Plot establishment and measurement

In total, 16 permanent sample plots were established by the local community teams. Each team established 4 samples plots in their community forest area. The sample plots were randomly distributed according to different forest types, accessibility, and terrain. Square 50 x 50 m nested plots, with sub-plots of 20 x 20 m, 10 x 10 m, and 2 x 2 m were used (Fig. 5.11). Plastic poles were placed in the centre of the plots and their location marked with GPS. Every

external and internal corner of the main and sub-plots were marked by bamboo and wooden pickets (Fig. 5.12). Team members measured distance with metre tapes and marked out all the internal and external boundary of sample plots with string tapes. Within the 50 x 50 m plots, trees with DBH (diameter at breast height)  $\geq 30$  cm are measured; in 20 x 20 m plots, trees with DBH 10-29 cm are measured; in 20 x 20 m plots, saplings (DBH 5-9 cm) and bamboo and NTFPs counted; and in 2 x 2 m plots, seedlings counted. All measured trees are tagged using metal labels with tree code numbers inscribed on them. On average, it took around three hours to establish and measure each sample plot.

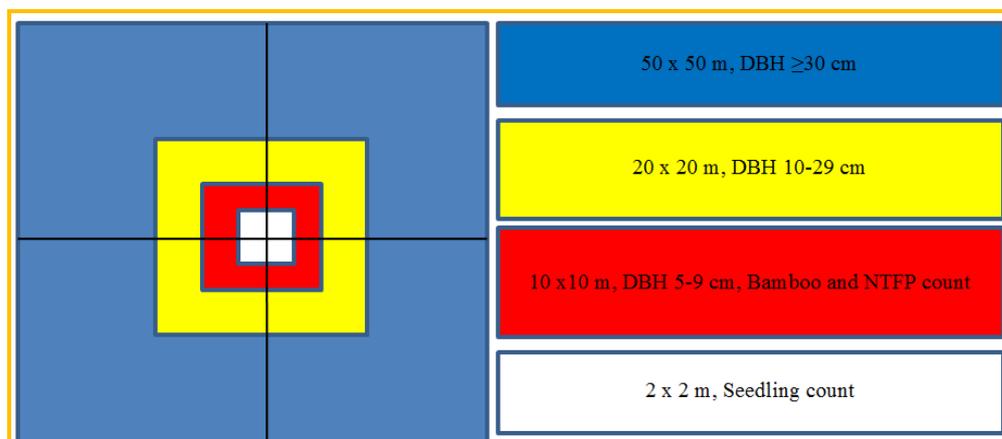


Figure 5.11: Design of square plot



Figure 5.12: Sample plot establishment by village teams



The local villagers were actively involved in the whole process of the sample plot establishment, tree measurement and data recording. The community teams identified all tree species in the inventory plots using their local names and these were later converted to their scientific names by the NUoL team. These could be the first community teams in Lao PDR to have been trained on and have carried out sample plot establishment, surveying, and data recording for forest biomass measurement.

## 5.12 Preliminary above ground

### biomass estimation

In the project area mixed deciduous forest is dominant. Of the 16 permanent sample plots established, 13 are located in primary mixed deciduous forest and three in secondary mixed deciduous forest. As this was the first experience of the community with biomass sampling, we did not carry out measurement of all the above ground carbon pools. Our measurement focused on above ground living woody biomass.

All data recorded by the community from the field measurement was transferred to a structured MS Excel spreadsheet. The data includes date, time, crew members, location of the plots, forest condition, species, tree height, DBH, etc.

A total of 490 trees were measured and among these trees, 80 species were identified with their local names. Only two species were not identified. The major tree species found were *Hopea ferrea*, *Ivingia sp.*, *Sandoricum sp.*, *Parashorea spp.*, *litchi chinensis*, *Gratexylon pruniferium*, *Diospyros sp.*, and *Walsura angulata Craib*. The tree crown cover ranges between 45 to 90%. The average height of trees with

DBH  $\geq 30$  cm is 28.17 m, for DBH 10-29 cm, 13.49 m, and for DBH 5-9 cm, 6.13 m (Table 5.3). The mean DBH in the different plot areas, from largest to smallest, was 51 cm, 16 cm, and 7 cm respectively.

The bole volume, total stem volume and form factor volume were applied to estimate the volume of the trees. The equations of each type of volume calculation used are from Savannakhet Province. These are:

#### Bole Volume

$$V_{\text{bole}} = -0.0527 + 0.00521D + 0.467X$$

$$X = D^2 BH / 10000$$

Where  $V_{\text{bole}}$  is bole volume ( $\text{m}^3$ ), D is DBH (cm) and BH is bole height (m).

#### Total Stem Volume

$$V = -0.0754 + 0.00737D + 0.328X$$

$$X = D^2 H / 10000$$

Where V is stem volume ( $\text{m}^3$ ), D is DBH (cm) and H is tree height (m)

#### Form factor Volume

Volume = Cross-sectional area at breast height  $\times$  Bole height  $\times$  Form factor

Where form factor has been assumed as 0.65



Table 5.3: Preliminary descriptive result of sampling

Description	Plot size		
	50x50m	20x20m	10x10m
Area of one plot (m <sup>2</sup> )	2,500	400	100
Total sampling area (16 plots) (m <sup>2</sup> )	40,000	6,400	1,600
No. trees	264	169	57
Average Height (m)	28.17	13.49	6.31
StdDev Height (m)	21.54	4.84	2.39
Average DBH (cm)	51.08	16.13	7.03
StdDev DBH (cm)	23.57	5.26	1.40
Bole volume (m <sup>3</sup> /ha)	318.44	60.80	-
Total stem volume (m <sup>3</sup> /ha)	233.64	48.38	4.40
StdDev total stem volume (m <sup>3</sup> /ha)	2.08	0.31	0.07
Total volume form factor (m <sup>3</sup> /ha)	332.71	57.42	6.25

The mean of the bole volume, total stem volume and form factor volume per hectare estimated from the full plots (50 x 50 m) is about 318 m<sup>3</sup>/ha, 234 m<sup>3</sup>/ha and 333 m<sup>3</sup>/ha, respectively.

We applied three types of allometric equations to estimate the forest biomass in the research area. The equation models are:

Equation 1:  $AG(kg) = 0.0288 * DBH^2.6948$

Equation 2:  $AGB = \exp(-1.996 + 2.23 * \ln(DBH))$

Equation 3:  $AGB = 10^{(-0.535 + \log_{10}(\text{basal area}))}$

Equation 1 was selected from the Asia Regional Biodiversity Conservation Programme Technical Training Workshop held by Winrock International in Vientiane in 2010. Equations 2 and 3 are from Brown

(1997) and are for tropical dry forest biomass estimation. The application of these equations to the project site needs to be considered further and other equations could be introduced and the results compared.

Table 5.4 presents the living tree biomass (t/ha), carbon (tC/ha) and carbon dioxide (tCO<sub>2</sub>/ha) for the different sized plots and the different equations used. When the three equations are applied, the living tree biomass ranges from 42 to 104 t/ha and the average forest carbon stock ranges from 77 to 190 tCO<sub>2</sub>/ha.

Table 5.4: Preliminary result of tree carbon estimation

Plot size	Equation 1	Equation 2	Equation 3
AG Tree Biomass (t/ha)			
10x10m	2.14	3.94	4.18
20x20m	17.15	20.32	17.41
50x50m	121.43	75.68	47.80
Average	103.55	65.91	42.29
StdDev	0.61	0.28	0.15
AG Tree Carbon (tC/ha)			
10x10m	1.07	1.97	2.09
20x20m	8.58	10.16	8.70
50x50m	60.72	37.84	23.90
Average	51.78	32.95	21.15
StdDev	0.31	0.14	0.08
AG Tree Carbon (tCO <sub>2</sub> /ha)			
10x10m	3.92	7.23	7.67
20x20m	31.45	37.25	31.91
50x50m	222.63	138.75	87.63
Average	189.85	120.83	77.54
StdDev	1.12	0.52	0.28

### 5.13 Land use mapping

Land use mapping was the focus of activities in FY2013. Land use categories were decided through inspection of high resolution satellite images. The boundaries of villages and other spatial data were added based on topographical and other maps, and information provided by members of village organisations. A ground-survey was conducted by a team



of researchers working and some of the village organisation members. GPS was used to mark locations, including the boundaries of land use classes.

Through this process, preliminary village land use maps of all four villages were produced. These were printed out and

then checked together with the heads of the villages and the village organisation members. The maps were then revised reflecting feedback from the community members. Figure 5.13 provides an example of one of the village land use maps.

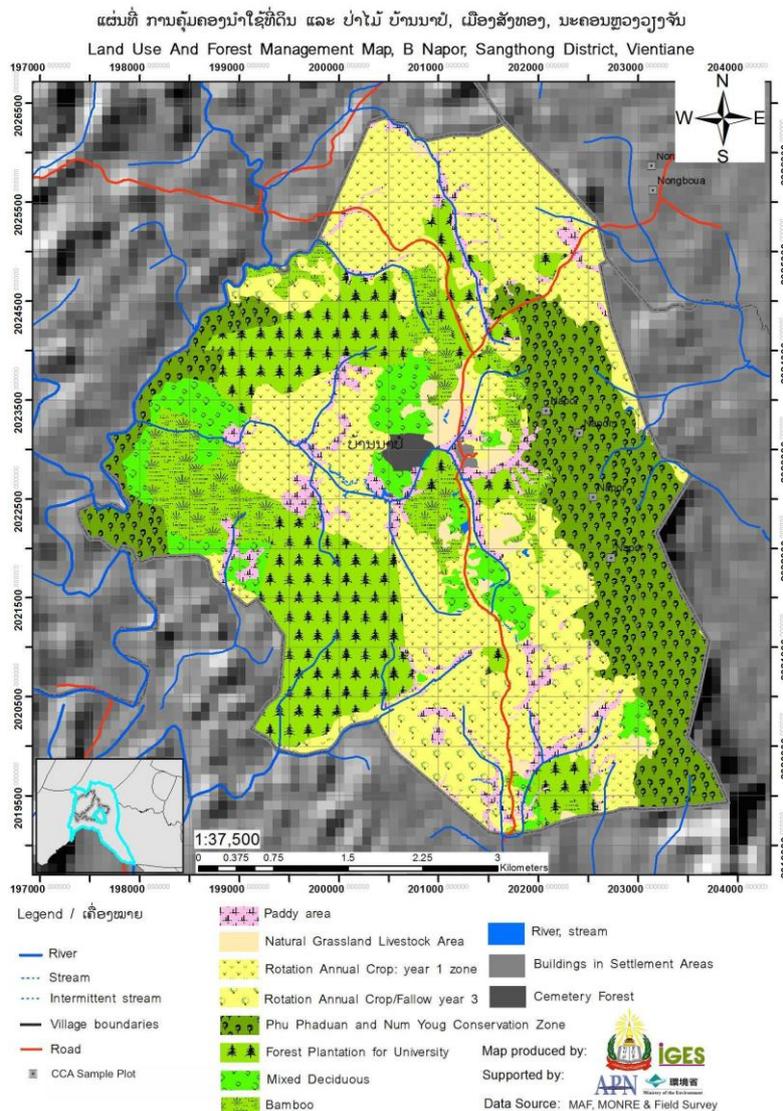


Figure 5.13: Napor Village land use map

### 5.14 Observations

The community team members have different backgrounds and experiences related to forest activities. Most of them can follow the training sessions and

understand the project, though it is important that instructions are clear and that simple guidelines are used. Field sheets also need to be carefully designed

There are some areas for potential improvement. Almost all the community



team members are male. Women could be encouraged to join the project activities by attending the training workshops, joining the consultation meetings, and participating in the forest inventory and measurement activities.

The community teams are very active in the training programmes, and after the training are able to establish the sample plots with some guidance from the trainers. However, the accuracy of the inventory activities and working performance may need to be improved. Some of the community team members could become local trainers who train other members in their communities.

Despite the enthusiasm of the community teams that is observed, the CCA activity is not linked to community livelihoods. Therefore, an incentive scheme linked to community livelihood improvement needs to be tied into the CCA and any long-term monitoring systems.

The community teams were trained to identify their forest area in satellite images and on understanding maps. After participating in the training on using handheld GPS, they can mark the location of sample plots, and delineate forest boundaries using the GPS tracking function.

A preliminary analysis of the sample plot data was conducted, but further analysis on forest biomass and forest carbon is

required. The equations used need to be reviewed, and others may need to be considered.

Photo 5.1: Receiving feedback from communities on preliminary land use maps



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### Acknowledgements

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## References

Brown, S. (1997). *Estimating biomass and biomass change of tropical forests: A primer*. Rome  
FAO Forestry Paper 134.



## 6 Introducing community carbon accounting into plantation forest management, Cao Phong district, Hoa Binh province, Vietnam

Makino Yamanoshita (IGES), Do Thi Ngoc Bich (VFU), Hoang Ngoc Y (VFU), Nguyen The Dung (VFU), Nguyen Thi Phuong (VFU) and Mai Thanh Nhan (VFU)

### 6.1 Project background and area

The Institute for Global Environmental Strategies (IGES) and Vietnam Forestry University (VFU) launched the Community Carbon Accounting (CCA) Action Research Project in Vietnam in 2012 with funding from the Ministry of Environment of Japan and the Asia-Pacific Network for Global Change Research (APN). The IGES-VFU CCA Project is developing and testing an approach to engage local communities in forest monitoring and reporting, which are essential not only for the generation of performance-based carbon offset payments, but also for generating information that communities can use to manage their forests wisely. Under the CCA Project, IGES and VFU are supporting selected villages in Cao Phong district, Hoa Binh province by building their capacity to monitor carbon stocks in their planted forests. Hoa Binh province is about 100 km west of Hanoi (Fig. 6.1).

The CCA Project area is the plantations established under a small-scale Afforestation/Reforestation Clean Development Mechanism (A/R CDM) project. The A/R CDM project was registered under the United Nations

Framework Convention on Climate Change (UNFCCC) in 2009 and developed by VFU with support from the Japan International Cooperation Agency (JICA). The Cao Phong reforestation project is in fact the only registered A/R CDM project in Vietnam. The objective of the JICA project was capacity building of local organisations such as VFU on A/R CDM project development. The registered project was thus a test site of the JICA project.



Figure 6.1: Project location

The A/R CDM project works with Xuan Phong and Bac Phong communes. Ethnic



minority villages participate in the project and more than 200 households are involved. The site is separated into five areas (Fig. 6.2).

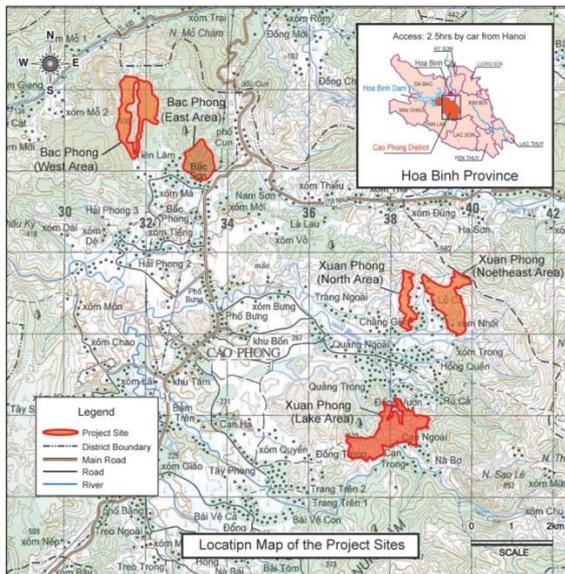


Figure 6.2: Map of project site

The local villages in the A/R CDM project area were not directly supported under the JICA project. The A/R CDM project is managed by a non-profitable organisation, the Forest Development Fund (FDF), and VFU is the lead project organisation. The project design document is available on the UNFCCC web site (<http://cdm.unfccc.int/Projects/DB/JACO1231473818.33/view>).

## 6.2 Rationale and objectives

Vietnam’s National REDD+ Strategy recognises the importance of community participation in REDD+. Community-based forest management is one of the core elements of the Strategy. To promote community engagement in REDD+ in Vietnam requires investment in human resources to build up the numbers of people who understand the concept of “community participation” and have the necessary skills to work with communities.

The IGES-VFU CCA Project compliments the National REDD+ Strategy by building the capacities of fieldworkers on community participation and on the technical requirements of forest biomass assessment and monitoring.

The proposed site was considered suitable for the CCA Action Research Project. As the site is a registered A/R CDM project, training of the local communities through the CCA action research will be directly applicable to the monitoring and reporting necessary for the issuance of carbon credits. Further, the local people will be able to understand more clearly the concept of carbon credits through the experience of measuring the carbon stock in the forest they planted. Before the A/R CDM project started, the mechanism was explained to them but it was difficult for them to understand the concept of carbon credits, because these are invisible commodities. Better understanding of carbon credits through CCA may motivate the local community to manage the forests. CCA at this site enables researchers to observe the processes through which the local people understand the concept of carbon credits and their decision making on land use, forest management and benefit sharing from the carbon credits.

The objectives of the CCA Project are to:

- Develop and test an approach to engage selected communities of the A/R CDM project in Vietnam in monitoring their forests, particularly carbon stock changes, with a view to building their capacity to manage their forests;
- Improve capacity of VFU researchers to be community facilitators and trainers on CCA and



to provide effective support to the community activities under the CCA Project.

### 6.3 Participating communities

Eleven villages are participating in the Cao Phong A/R CDM project. In FY2012, the CCA project was introduced to one of these, Ru 3 Village, which is located in the Xuan Phong Lake area (Fig 2). Ru 3 Village was selected because, according to the FDF, tree growth of their plantation is good and the village leader and the people in Ru 3 are interested in working with outsiders. Almost all villagers (42 out of 43 households) in Ru 3 Village joined the A/R CDM project (Table 6.1), which allows the CCA action research to be truly community-wide, rather than limited to just a few households who have planted trees.

A goal of the A/R CDM project was to plant *Acacia mangium* over 8.39 ha in Ru 3 Village; however, only 5.45 ha (65%) of the plantation was established. According to villagers, the reason for not planting some of the area was that the land was on steep slopes and too degraded to plant trees.

### 6.4 Mapping

Although the establishment of the tree plantations under the Cao Phong A/R CDM project has been completed, a map of the plantations was not prepared. Under the CCA Project, handheld GPS was used to map out the planted area in Ru 3 Village (Fig. 6.3).

Table 6.1: Villages participating to Cao Phong A/R CDM project

Commune / Village		Total no. house hold in the villages	Total house olds particip ating in project in 2009	Total house holds partici pating in the project in 2010	Total plan ed area (ha)
Xuân Phong	Rú 1	46	24		7.7
	Rú 2	31	27		11.8
	Rú 3	43	42		11.6
	Rú 4	59	10		4.6
	Rú 5	49	10		7.6
	Nhối 1	86	30		22.9
	Nhối 2	84	35		23.2
	Cạn 1	86	22	13	59.2
Bắc Phong	Má 1+ 2	190	14	13	25.1
	Bắc Sơn	130	2	47	48.8
<b>Total</b>		<b>804</b>	<b>216</b>	<b>73</b>	<b>222.5</b>

Source: FDF data.

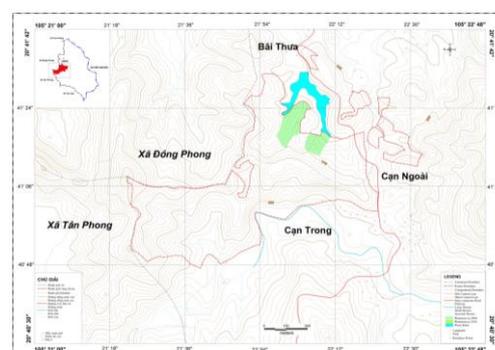
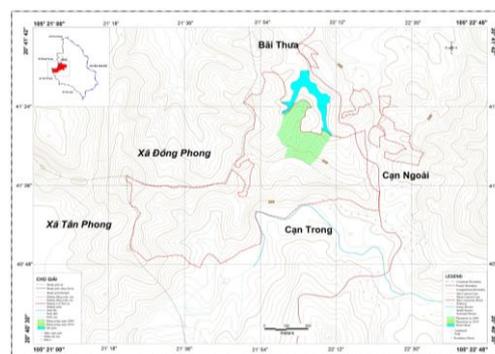


Figure 6.3: Map of planned (above) and actual (below) plantation area in Ru 3 Village



## 6.5 Training of trainers

Two workshops were held as a series of IGES-VFU-RECOFTC workshops on Community Participation in Forestry in Vietnam. These workshops were intentionally interactive and not the typical classroom lecture style of workshop. The participants were engaged through numerous experiential exercises. The first workshop, held in 2012, focused on the concept and value of participation. The second workshop, held a year later, focused on practical application of the concept of participation in social research and participatory action research (PAR).

A third workshop was held between the two workshops on community participation to support trainers/facilitators in designing and testing a forest biomass monitoring system. Further testing was conducted after the first draft of a field manual had been produced and this is described in section 6.6.

### 6.5.1 Training workshop on community participation in forestry

The “Training workshop on community participation in forestry” was held on July 23-27, 2012 at Vietnam Forestry University. Two trainers were provided by RECOFTC – The Centre for People and Forests, and in total 24 people from VFU and Cao Phong district local government participated. The purpose of this workshop was to build capacity to facilitate meaningful community participation in the design and implementation of community forest

management and to implement REDD+ through community forest management. The specific objectives were to:

- ✓ Increase participants’ understanding of community forest management, especially the importance of community participation, including participatory decision making;
- ✓ Develop/improve participants’ facilitation skills;
- ✓ Train researchers/fieldworkers of VFU to build capacity for community forest management;
- ✓ Provide participants with a field example of “meaningful” participation.

### *Observations*

The concept of participation was challenging for the participants as they are highly educated – most are teachers or government officers – and they have a strong sense of responsibility to lead and provide direction to the local communities. At the beginning of the workshop they equated facilitation with teaching. Through participatory exercises including games, role-plays and group discussions, the participants experienced what and how interactive and self-mobilised participation is. Comments from participants at the evaluation session on the last day of the workshop reflected their learning: e.g. “I thought I was a good facilitator but I realised during the field work that I was not”; “Currently, there is no ‘real participation’ in community forest in Vietnam.”

The participants indicated that there are few forestry projects in Vietnam that have adopted meaningful participatory processes. It was agreed that



opportunities should be sought for participants to put to practice their newly acquired facilitation skills.

### 6.5.2 Training on CCA

The training of trainers was held over five days from October 22-26, 2012 at Vietnam Forestry University. Training was provided by IGES researchers. Six VFU researchers/teachers and two officers from the local government in Cao Phong District participated.

On Day 1, the IGES researchers introduced the concept of community-based forest monitoring and existing standards and guidance for forest biomass assessment. The VFU CCA team presented on the national standard for forest monitoring in Vietnam. Days 2 and 3 were allocated to group work. The VFU facilitation team were given three questions to keep in mind:

- What are the technical requirements for biomass monitoring at the A/R CDM Project site?
- What roles can the communities play in the monitoring and what roles should the facilitators play?
- How can the measurement be kept simple to enable maximum community participation without compromising the scientific validity of the sampling?

Principles for teaching CCA to the community and designing a CCA training for them were also introduced on Day 3. The VFU team were then asked to design a one-day training schedule and methods to train the community on some of the key elements of their proposed monitoring design, namely sample plot setting, tree measurement including height and DBH

(diameter at breast height) and data recording.

The VFU team spent part of Day 3 preparing for the testing. This included preparing flip charts to explain concepts and protocols, field sheets and inventory equipment and tools (chalk, flagging tapes, callipers, distance measurement tape, DBH tape, Blume Leiss, compass, etc.). The VFU team agreed on the roles that each of them would play throughout the test training. While some would be providing the training, others would be making observations of the testing in notebooks. Ru 3 Village was proposed for the testing and the VFU team contacted the village leaders to agree on an appropriate place, time and programme for the test training, and on who should participate.

The test training was held on Day 4 of the workshop with about 15 participants from Ru 3. The VFU team played the role of trainers and facilitators. The testing began with discussion on the importance of good forest management. The VFU team explained how CBFBM could be applied to the reforestation project and the objectives of the test training. The remainder of the morning was spent testing teaching methods and options for DBH and tree height measurements.

After lunch, the testing moved into the plantation, where the community was divided into two groups, with one instructed on how to establish a circular plot and the other on how to establish a square plot. The facilitators provided guidance and observed both groups as they established the plots and measured trees. The facilitators also recorded the times taken for different plot types.



At the end of the day's testing, the facilitators called the community participants together to reflect on the proposed monitoring methods. Each participant was asked in turn what they found easy and what they found difficult about the training, and whether they had any suggestions for the monitoring or the training activities.

Photo 6.1: Local level facilitators explaining point of measure for DBH



Photo 6.2: VFU facilitator observing community member measuring DBH



© Photos 2 & 3, Henry Scheyvens

On Day 5 of the workshop, IGES researchers and the VFU team gathered at VFU to discuss the lessons learned and agree on how they could improve the forest biomass assessment design and the training of the communities.

### 6.5.3 Participatory Action Research for Community Based Natural Resource Management

The “Participatory Action Research for Community Based Natural Resource Management workshop” was held on 22-26 July, 2013 at Vietnam Forestry University. Two trainers were provided by RECOFTC, and 16 researchers and students of VFU and five local government forestry officers participated in the workshop.

On Day 1, the participants learned the fundamentals of action research through group work. On Day 2, participants were involved in an exercise to show that everyone has different ways of determining his/her values and they learned the importance of considering multiple perspectives. They also practiced some of the PAR tools, including participatory resource mapping, stakeholder analysis and problem trees, and examined advantages and disadvantages of each tool. On Day 3, participants prepared for the A/R CDM project field work. They were divided into four groups and each group prepared a research plan for the village. They started with identifying a problem to be addressed in the A/R CDM project and key information to be collected to resolve the problem. They then selected suitable PAR tools. The following day, each group carried out their research plan with a community involved in the A/R CDM project and tested the selected PAR tools. The last day of the workshop was used for field work reflection.



Photo 6.3: Testing a PAR tool with the villagers in Cao Phong



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### *Observations*

The workshop built participants' understanding of how social research and rural development can be merged by applying PAR. The participants were quick in learning the PAR concept as most of them are from academic backgrounds and are familiar with research. However, putting the PAR into practice was challenging for them. When applying PAR tools with the community, they tended to collect information in a conventional research way, i.e. the communication was essentially one way; the experts posed questions and they noted the answers from the community. This is not unexpected as the researchers are used to and comfortable with conventional survey approaches aimed at data gathering. It takes time and practice to become comfortable and competent with PAR, which requires a fundamental change in the mindset of researchers. No longer do they gather data from communities to then take away and conduct their analysis. Under PAR, the communities join in the research and together with the outside experts are involved in problem identification, solution proposal, solution testing and reflection.

It was agreed that follow-up will be conducted with the participants. Further

opportunities for the participants to apply PAR and implementation of the action research plans presented by them at the end of the workshop will be considered. IGES and VFU will discuss (i) whether the action research plans proposed by the workshop participants can be incorporated into the CCA Project to support villagers to improve the A/R CDM project and (ii) how to provide further training to the workshop participants on PAR.

## 6.6 Manual development, testing and results

The VFU team developed a manual for the CCA in Vietnamese (Fig. 6.4). The manual includes information for facilitators who will provide training to communities on CCA and instruction materials for the community to help them understand how to use the inventory tools such as GPS, Blume-Leiss and compasses. Step-by-step technical explanations are provided. The instruction materials can be used by the facilitators during community trainings as well as by the communities when they conduct future monitoring. The manual contents are:

- ✓ Introduction
- ✓ Method of identifying the project area boundaries
- ✓ Method of establishment and layout of sample plots
- ✓ Selection of carbon pools and appropriate equations for biomass estimation
- ✓ Method to describe field site conditions
- ✓ Measurement of sample plots
- ✓ Recording results of measurement
- ✓ Organisation of the monitoring team



✓ Quality check of the measurement

The CCA manual was tested in the field with community members involved in the Cao Phong A/R CDM project. The main purpose of this field test was to check applicability of the technical elements of the manual and the ability of communities to understand the manual. VFU facilitators conducted a 2-day training for community members on manual use, observed their responses, reflected on problems identified and lessons learned, and incorporated these into a second draft of the manual.

Preparation for the training involved discussion by the VFU team on effective facilitation methods for communities. Games were prepared by using the measurement tools and GPS so that the villagers would master the tools while having fun. The first day was spent on mastering the skills and the second day was set aside for forest measurement. The instruction materials in the manual were printed as hand-outs and sketched on Ao paper as training aids. Sketches to explain the concept of carbon credits were also prepared.

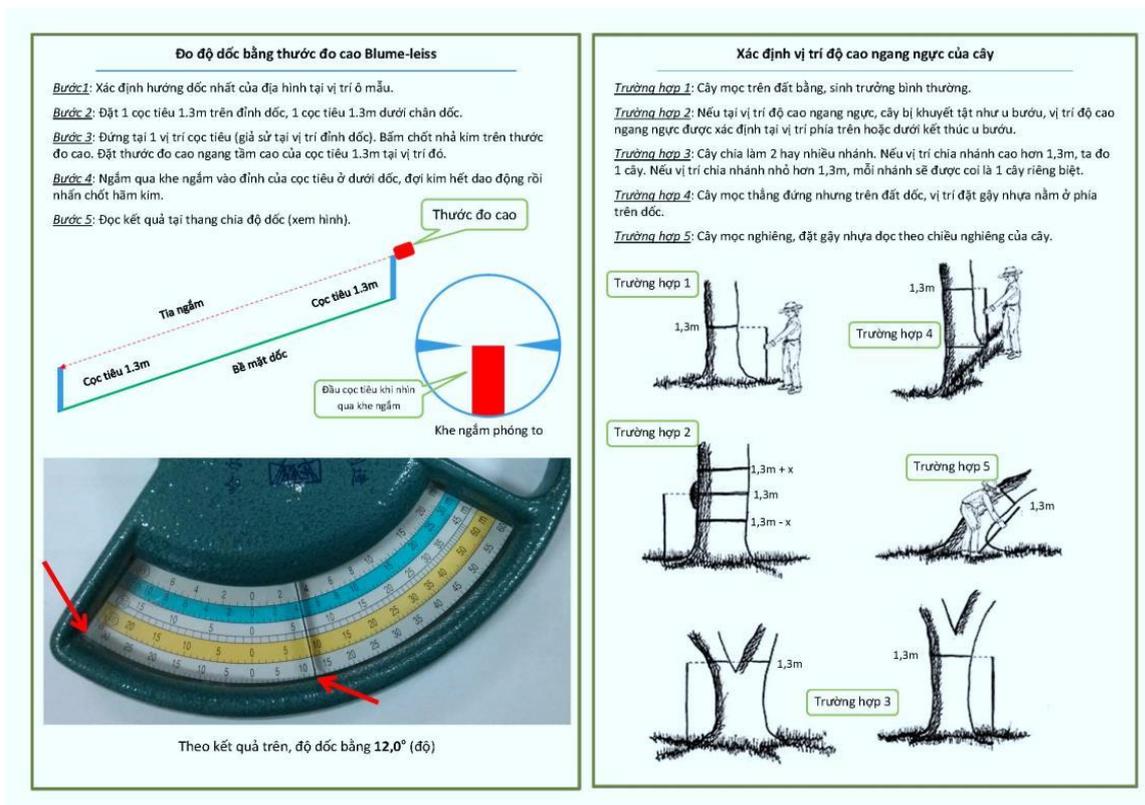


Figure 6.4: Example of instruction materials from the manual

VFU facilitators also measured the same sample plots established by the communities to check the accuracy of the tree and slope measurements.



Photo 6.4: VFU facilitator explains how to measure slope



Photo 6.5: Using GPS to correctly locate sample plots



Photo 6.6: Establishing a sample plot



© Photos 4 to 6, Makino Yamanoshita

### Observations

The community participants were able to conduct the monitoring by themselves on the second day. They had no problems locating sample plots using GPS and they used the measurement equipment correctly. There was no significant difference in the results of DBH measurement between the measurements recorded by the community members and the experts (Student's t test,  $p < 0.01$ ). The data recorded in the field test on the

second day was used by the VFU team to estimate forest biomass (Table 6.2).

Table 6.2: Results of measurement by community and experts/facilitators

	Community		Expert		Difference	
	Average DBH	Biomass	Average DBH	Biomass	Average DBH	Biomass
	cm	tC/ha	cm	tC/ha	cm	tC/ha
Ru3-01	8.84	7.18	8.81	7.20	0.03	-0.02
Ru3-02	11.09	13.11	11.17	13.55	-0.08	-0.43
Ru3-03	4.02	1.87	4.13	1.96	-0.11	-0.09
Ru4-02	8.75	15.44	8.66	15.16	0.10	0.27
Ru4-03	4.92	3.92	4.80	3.73	0.13	0.18
Ru4-05	5.84	3.96	5.80	3.91	0.05	0.05

The VFU experts observed some problems during the 2-day field test and suggested possible solutions (Table 6.3). The lessons learned from the testing included that preparation before the training is very important. Not only the schedule but also the contents of each session need to be carefully prepared, and thought must be given to effective training and facilitation techniques.

## 6.7 Evolving community perceptions on forest management

A field survey on the environmental benefits of the plantations in the Cao Phong A/R CDM project was conducted with the residents of Nhoi 2 village on February 26 and 27, 2014. The objectives of the field survey were (i) to identify the environmental benefits of the plantations from the perspective of villagers and (ii) to train the VFU researchers to apply the skills they had learned in the “Participatory Action Research for Community Based Natural Resource Management” workshop.

The villagers who took part in this survey were asked to select three sites in the



forest experiencing different growing conditions. A field note was prepared for the villagers to rate the site condition and take note of their observations during the site visit. The villagers were divided into pairs and asked to fill in the field note by discussing with their partner in the field. The villagers selected three sites in good, medium, and bad condition, then evaluated the site and recorded their

observations. A group discussion was organised after they returned from the field work. Each pair presented their observations and these were summarised in a table on A0 paper. Benefits of the plantations recognised in their everyday life were then discussed. Finally, the participants shared their ideas on how to manage the forest.

Table 6.3: Problems identified and solutions proposed by the experts

Problems identified	Proposed solution
*Participants did not fully understand the purpose and importance of measuring forest and taking care to ensure accurate measurements. *They also did not understand CO <sub>2</sub> and carbon.	*While the main purpose of the testing did not include explanation on CO <sub>2</sub> and importance of forest management, better explanations for local people on these points must be prepared.
*Not all participants understand and have mastered the tools and equipment, especially GPS and compass.	*Because some people have difficulty with GPS and compasses, everyone should first experience the tool, and then it is better to select a suitable person/s responsible for its use. The local team may be able to nominate one/some of their members for each tool.
*Some community participants had nothing to do during the sample plot measurement. The number of people in one team was too many.	*10 people in a team are too many. * Around 4-5 people (at least 3) is a good number.
*It was difficult for the community participants to decide whether a borderline tree was in or out of the plot.	*The manual must provide guidance for borderline trees, including remeasurement when the team is unsure. *Preparation for the training should include consideration of possible errors, mistakes and frequently asked questions by local people.

The survey was conducted separately with 10 men and 10 women because in the previous surveys we observed that women hesitated to present their opinion in front of men, and men and women had sometimes different points of view.

Photos 6.7 and 6.8. Men and women recording their observations on forest conditions





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## Results

In the bad sites, there were only a few surviving trees and these were of low height. More trees remained in the medium sites, but the trees were mostly small. In both types of sites, the forest canopy was still open so grass and shrubs were found in the understory. In the medium condition sites, some trees were growing well but some trees were dying. The villagers didn't know the reason for this but they assumed that the tree would die when it could not expand the root system because of the hard soil or rocks in the soil. Some yellow leaves were observed and this was associated with a lack of soil nutrients. There was some damage by insects, fungus and termites,

especially in the bad and medium sites. Some villagers mentioned that the cattle grazing damaged the trees as well. In the good sites, the crown was almost closed, less grass existed and the ground was covered by a lot of litter from the trees.

The environmental benefits from the plantations identified by the villagers are summarised in Table 6.4. The participants noted improvement in the quality of the drinking water which comes from the catchments where the plantations are located. They noted that the water was now less turbid after rainfall. The soil quality has also improved and erosion has been prevented. Even in the bad growth plantation sites, they consider that the quality of the soil has improved. The participants also explained that the number of birds has increased and wild fowl have appeared. They all agreed that the forest provided positive environmental impacts on their daily lives. They agreed it is better to manage the forest from a long-term perspective, rather than to clear-fell the forest for income. This is a significant change in villagers' perspectives on the plantations. At the time of establishing the plantations, the villagers hoped to harvest the trees as early as possible.

Table 6.4: Villagers perceptions of environmental benefits from their plantations

Environmental benefit	Observations
Drinking water	*Water became clearer *Water level of the stream became higher and stable
Irrigation water	*Water level became higher and stable *Irrigation water not much affected as water source is outside of the plantation
Soil	*Soil erosion decreased *Soil fertility increased *Soil moisture increased *Even in the bad condition sites, soil quality improved
Biodiversity	*More birds and insects in the plantation area than before *Wild fowl appeared
Others	*More fuel wood available *Provides shade; good when doing work outside * Air feels fresher * Psychological benefit from more attractive landscape than bare land



## 6.8 Workshop on “Seeking for possibility of applying Community Monitoring in Payment for Forest Ecosystem Services (PFES)”

The workshop on “Seeking for possibility of applying Community Monitoring in Payment for Forest Ecosystem Services (PFES)” was held on February 28, 2014 at the Department of Forestry (DOF), Hoa Binh province. Participants from IGES and VFU (including the members of the CCA Action Research Team, lecturers, researchers and students) and officers of Hoa Binh province attended the workshop. The purpose of the workshop was to (i) disseminate information on the CCA Action Research Project, (ii) understand the new policy on PFES in Vietnam and to introduce the research and activities that VFU has conducted related to PFES and (iii) consider the possibility of applying community monitoring in PFES.

There was general agreement that there is a need to apply community monitoring in PFES, but where and how questions must first be answered. Further surveys and dialogue to gather more detailed information and a clear understanding on the relevant issues were suggested for the near future. The surveys were proposed to be carried out by VFU and IGES in May or June 2014. Hoa Binh is one of the sites that will be included under the survey.

## 6.9 Conclusion

A feature of the CCA action research in Vietnam was that the project started by building the capacity of the VFU researchers to understand the concept of participation and to act as community facilitators. The training of trainers workshops were very effective and enabled the VFU researchers to consider the perspectives of the local villagers when developing the CCA training programme. In addition to the CCA training, participatory social surveys were conducted and problems related to land use and benefits from the plantations were identified.

Given the current situation of the carbon markets and the project institutional arrangement and its capacity, it seems that securing carbon credits for this A/R CDM project will be difficult. IGES and VFU researchers were concerned that this situation would discourage the community from managing the plantations, as under an earlier project the communities had been told that they would receive income from the sale of carbon offsets in return for managing the plantations without harvesting for a period of 15 years. The communities did not understand the payment mechanism associated with the trade in carbon offsets and their expectations are now no longer so high. Through the action research we found that five years after the trees were planted the communities are now realising several environmental benefits from the plantations in their daily lives, such as an improvement in the quality of drinking water. The perspective of the villagers has begun to change towards favouring long-



term forest management over short-term unsustainable gains.

These findings were identified through the social survey conducted by the VFU researchers using the facilitation skills they acquired in the capacity building workshops. Talking with outsiders during the survey was also a good opportunity for villagers to recognise and analyse their situation, to exchange views and to understand the views that existed within the communities. An appropriate next step would be organising a village meeting for the communities to commit to long-term management of their forests.

While local people are now seeing the benefits from their forests without having any carbon revenues, there may still be a role for carbon revenues in providing an additional incentive for long-term forest management. In Cao Phong, A/R CDM was too complicated for the local people to understand and did not encourage them in any way. To encourage the sequestration and storage of carbon in forests that are under community management, carbon crediting mechanisms will have to be redesigned or newly developed to be more community friendly.

Another concern is the tree species. *Acacia mangium* was planted in the project area and this appears a good choice for the degraded land, despite the fact that acacia monoculture plantation has often been criticised. *Acacia mangium* provides a primary greening, but its longevity is rather short at around 15-20 years. If the villagers want to manage their forests from a long-term perspective, supplemental planting or replanting dead trees with long-lived species will be required. It is not clear whether succession to local species would occur naturally in

acacia plantations. The villagers require further support on these issues.

The CCA project in Vietnam shows that long-term support is necessary for the communities to manage their forests. Initial support for planting trees by providing seedlings and technical training is not enough. The communities in Cao Phong faced many problems in managing the plantations after they had been established, but they had no one to turn to for support. The CCA action research also shows that outsiders can play various roles to support communities, not only through technical and financial support, but also as facilitators that enable communities to work towards solutions to some of their problems. An important function of CCA is building bridges between communities and outside experts through forest monitoring.

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