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Lecture Notes

Tools for use in Integrated Natural Resources Management (INRM) and Payment for Environmental Services in Vietnam (TUL-Viet)

Volume 1

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FOREWORD

Integrated Natural Resources Management (INRM) aims to identify land-use practices that increase production while maintaining natural capital and continuing to provide ecosystem services at local and global scales (Izac and Sanchez 2001). The overall objective of INRM research and development activities is to help managers at various levels do a better job of managing natural resources. Natural resource management problems that relate local stakeholder decisions are usually different at different scales. The challenge is how should the opportunities for adaptive response among diverse interest groups, at a number of hierarchical levels, be included in the assessment of impacts on the livelihoods of rural people.

Payment for Environmental Services (PES) is recognized as one of the successful market-based instruments of NRM. Over the last ten years, the PES concept and its application have gained increasing attention, not only among environmentalists and scientists, but also policy makers across Southeast Asia, including Vietnam. In Vietnam, Payment for Forest Environmental Services (PFES) was tested in Lâm Đồng and Sơn La provinces from 2008 to 2010, following government decision number 380[1]. From January 2011, a new government policy called Decree 99[2] took effect. However, itt is planned that payment at the local level will start from 2012. In connection with this plan, the government is developing an action plan to implement the decree and neccessary guidances. Currently, there is only a guidebook for implementing PFES published in Vietnamese and English by Vietnamese-German Forestry Programme (GTZ/FP).

This TUL-Viet booklet is produced to directly support the implementation of PES in the Vietnamese context. It is one of the products of the TUL–SEA[3] project in Vietnam which is funded by the Federal Ministry of Economic Cooperation and Development (BMZ) and Deutsche Gesellschaft fürTechnische Zusammenarbeit (GTZ), and is coordinated by ICRAF Southeast Asia program. The project started in 2007, with project activities in six Southest Asian countries, including Vietnam and China. Most of the case studies, provided in the TUL-Viet booklet resulted from tests of tools by ICRAF Vietnam and its national partners in the upland north (Bac Kan, Thai Nguyen), midland north (Hoa Binh), and central coast (Ha tinh) of Vietnam.

Four key tools for designing PES projects are introduced in this booklet including:

1. Participatory Landscape Analysis (PaLA) at landscape[4], community and household levels. PaLA helps identify a basis for decision-making in land use and land use changes. This is key for designing PES.
2. Participatory analysis of Poverty, Livelihoods and Environment Dynamics (PaPOLD) at community level: PaPOLD helps identify target groups and payment mechanisms that are fair and sustainable.
3. Reverse Auction for Payment of Environmental Services (RA): RA is a new tool, which has been been tested in Africa and Southeast Asia, and is planned to be applied for PES negotiation in Bac Kan in 2011.

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[1] Decision No:380/TTg. The Policy on Pilot Payment for. Forest Environment Services. Dated 10 April 2008.

[2] On 29 April 2010, the government issued Decree 99/2010/ND-CP policy for Payment for Environmental Services, which took effect 1 Jan 2011

[3] Project "Trees in Multi-Use Landscapes in Southeast Asia (TUL-SEA)"

[4] A Landscape is a defined area of specific interest, with clear administrative and ecological boundaries.

4. Rapid Carbon Stock Appraisal (RaCSA): RaCSA is a tool used to identify carbon Environmental Services, and the potential for communities to participate in reporting and monitoring contracts in payment for carbon ES.

Four tools and case studies from ongoing PES projects in Vietnam, as well as lessons from the RUPES[5] project in Africa, are presented to highlight these concepts and methods. The booklet is aimed at professionals working with INRM and PES. This TUL-Viet lecture notes, volume 1, introduces the first five among a series of lecture notes in the fields of natural resources management, PES and REDD+[6] that are under development by ICRAF Vietnam together with our national partners to meet the increased demand of the action research and development works in the fields of Vietnam.

The authors hope that these lecture notes will be useful for local professionals in their works of sustainable natural resources management. Thereafter, it contributes to the poverty reduction of Vietnam.

ICRAF Vietnam representative

Dr. Hoang Minh Ha

[6] Reduce Emissions from Deforestation and forest Degradation

ACKNOWLEDGEMENT

The theory section of RACSA, PaLA and PaPOLD was taken from the TULSEA book that is under development by ICRAF SEA. Most of the case studies are from recent findings from RUPES project in Bac Kan. Besides, there are two case studies conducted by ICRAF but in other locations, including:

(1) The PaLA case study applied in Ha Tinh province (in lecture note 2) was adapted from the scientific manuscript: Nguyễn, H.Q., Hoàng, M.H., Oborn, I., van Noordwijk. (2011), with the tittle ‘ *Multi-fuctional agroforestry systems as option for agriculture production in the climate change context – A case study on climate change adaptation in Vietnam'*.
(2) The PaLA case study adapted in Dien Bien province for a scoping survey in early 2011 by ICRAF and its national partners, aimed at studying role of agroforestry in improving household economy and farm environment.

(3) The RA case study (in lecture note 4) is adapted from the scientific paper: Jindal, R., J. Kerr, P. Ferraro, and B. Swallow. (2011). *Allocating contracts for payment for environmental services using field auctions in the Uluguru Mountains, Tanzania*.

The authors are grateful for the crucial support of local partners in Vietnam, particularly in Bac Kan province. We extend thanks for support provided from Bac Kan province leaders, especially the management team at 3PAD[7], and the households and individuals that participated in our research activities. We are grateful to staff and local people in Dien Bien, Hoa Binh, Ha Tinh provinces in Vietnam and Uluguru in Tanzania, who’s case studies are presented in this book.

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[7] Project “Pro-Poor Partnership for Agro-Forestry Development in Bac Kan” funded by IFAD and Vietnamese government ((http://www.baobackan.org.vn/channel/1021/2008/12/3959/)

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PART I. CONCEPTS AND ABBREVIATIONS

1. CONCEPTS

The common definitions used in PES:

The common environmental services are watershed fuction, carbon sequestration, landscape beauty and biodiversity.

Payment for Environmental Services (PES) is undertood as 'a voluntary agreement to enter into a legally binding contract under which one or more buyers purchase a well-defined ecosystem service[8] by providing a financial or other incentive to one or more seller who undertakes to carry out a particular land use on a continuous basis, which will generate the agreed upon ecosystem service' (Wunder et al., 2005).

This definition combines what a payment *is* with what the payment is for, and alludes to mechanisms. A better approach would be to first say *what* it is, *who* is involved, and then to explain *how* it works.

The key concepts for *what PES is*:

- Payments for ecosystem services are compensation for providing ecosystem services.
- Compensation and/or incentives can take many forms (e.g. cash, in-kind assistance, exemption from taxes, tenure security).

The key concepts for *who* is involved with PES:

- Sellers who are willing (or obliged) to produce the ecosystem goods and services by managing the ecosystem.
- Buyers who are willing (or obliged) to pay for the benefit of receiving the ecosystem goods and services.

The key concepts for the *how* PES works:

- An ecosystem service is defined.
- A contract/agreement for maintaining or changing the specified land use is established.

Important concepts and tools used in the lecture notes:

- Participatory rural appraisal (PRA): a family of approaches and methods enabling rural people to share, enhance, and analyse their knowledge of life and conditions, to plan and to act. What distinguishes PRA more than any of its techniques is its emphasis on participation (Chambers, 1992).

- Geographic Information System (GIS) is a computer based information system used to digitally represent and analyse the geographic features present on the earth's surface and the events (non-spatial attributes linked to the geography under study) that take place on it.

[8] 'Ecosystem services' as commonly understood includes both goods (provisioning services) and environmental services

- The Sustainable Livelihoods Approach (SLA) as developed by the UK Department for International Development (DFID) has become as the most prominent framework among various concepts developed by other agencies. Basically, DFID subscribes to a system approach that attempts to capture the many factors that influence people's livelihoods and helps to identify priorities for action based on the needs and interests of poor people by reflecting their perceptions of poverty and well-being (http://www.poverty-wellbeing.net/media/sla/docs/introduction.htm)

- Participatory Analysis of Poverty, Livelihoods and Environment Dynamics (PAPOLD) (Hoang, et al., 2007) was developed to capture local specific issues of inter-linkages between poverty, people's livelihood strategies, and the natural environment. It is a refinement of the Stages of Progress (SoP) developed by Anirudh Krishna of Duke University in the USA (Krisma et al.) and adapted by Hoang, et al. (2007) in Vietnam condition.

- Participatory Landscape Appraisal (PaLA) (Fagerstrom et al., 2005): was designed through packaging appropriate Rapid Rural Appraisal/ Participatory Rural Appraisal (RRA/PRA) tools/methods with an approach of agro-ecological analysis, and GIS, in order to capture local knowledge at relevant temporal and spatial scales. PaLA can be used in scoping studies to identify environmental issues at landscape and farm levels and for awareness-raising among community members on problems and issues connected within an ecological and administrative boundary.

- Rapid Carbon Stock Appraisal (RACSA): an appraisal tool designed to measure carbon stock at landscape level by quantifying carbon at plot level, which represent different land use types in a landscape and extrapolate the results using satelite images (van Noordwijk, 2007).

- Auction and Reverse Auction (RA): Auctions are a potential solution for estimating the payment level and the selection of participants, in which farmers who wish to be enrolled in a PES project, offer bids of how much money they are willing to accept in return for implementing the recommended land use in order to supply a certain level of environmental service (Giampietro and Emiliani, 2007; Cason and Gangadharan, 2004).

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Environment Focus, United Nation Development Program and Ministry of Natural Resources and Environment of Vietnam, Hanoi.

Krishna and colleagues have produced a training manual for the method as well as a number of journal articles summarizing the results. His work is gathered on the web site: http://www.pubpol.duke.edu/krishna/. This includes a training manual and results from India, Kenya, Uganda and Peru.

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2. ABBREVIATIONS

GIS	Geographic Information System
INRM	Integrated Natural Resource Management
ICRAF	World Agroforestry Centre
PaLA	Participatory Landscape Appraisal
PAPOLD	Participatory Analysis of Poverty, Livelihoods and Environment Dynamics
PES	Payment for Environmental Services
PFES	Payment for Forest Environmental Services
PRA	Participatory Rural Appraisal
RACSA	Rapid Carbon Stock Appraisal
RA	Auction and Reverse Auction
RES	Reward for Environmental Services
RRA	Rapid Rural Appraisal
RUPES	Rewarding Upland Poor for Environmental Services
TULSEA	Trees in Multi-Use Landscapes in Southeast Asia (TUL-SEA)

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PART 2. LECTURE NOTES

LECTURE NOTE 1: Participatory Rural Appraisal (PRA) method

From ICRAF-Carlbro Tender to UNDP, 2002[9]

The Participatory Rural Appraisal (PRA) method is used commonly in action research and development projects. In this volume of lecture notes, PRA method is adapted in two method packages named (i) Participatory Analysis of Poverty, Livelihoods and Einvironment Dynamics (PaPOLD, lecture note 2); and (ii) Participatory Landscape Analysis (PaLA, lecture note 3). The introduction of PRA tools in this lecture note as well as lecture notes 2 and 3 is only understandable if the lecturers combine it with practicing the tools. This lecture note 1 provides the basic knowledge of PRA, before bringing readers into how to adap the tools in PaPOLD and PaLA, particularly in case studies in Bac Kan and other provinces in Vietnam.

1. The Evolution of PRA

Since mid 80s of the 20th Century, the Rapid Rural Appraisal method (RRA) has been widely applied in rural development programs and projects. This is a rapid survey method, by which researchers apply social survey tools to collect and analyze information from the community. RRA has advantages over traditional survey tools in that comprehensive, systemic, and oriented information can be collected within a short period of time, attention is paid to the community, their voice is listened to and their participation is encouraged. However, RRA also has several disadvantages such as: with the attitude of "bringing knowledge to a community", researchers can not fully understand the community and identify their principle issues; information is collected from questions and short interviews without careful analysis with participation from the community; data collected is analyzed by experts/specialists who make conclusions, solutions, plans and actions that reflect interference from outsiders.

The transition from RRA to Participatory Rural Appraisal (PRA) is the process of changing attitude and behaviors of researchers from an oriented approach 'towards' people to a learning approach 'from' people in order to collect and analyse information then collaboratively create a development plan together with participation from local people.

Robert Chamber (1994) defined PRA as "a method to approach and learn together with people and from people, based on their own lives and community activities". The advance of this definition is reflected by the word "learn" and "based on".

Participatory Rural Appraisal (PRA) is a short-cut method of data collection. It is a methodology for action research and utilizes a range of techniques, involving local people and outsiders from different sectors and disciplines. Outsiders facilitate local people in analyzing information, practising critical self-awareness, taking responsibility and sharing their knowledge of life and conditions to plan and to act.

PRA grew out of biases of rural development tourism—the phenomenon of the brief rural visit by the urban-based professional—and the problems of the costs, inaccuracies and delays of large scale questionnaire surveys.

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[9] The method description was taken from the bidding document produced by ICRAF-Calbro to UNDP in 2002.

PRA provides the middle path of greater cost effectiveness between rural development tourism research (quick and dirty) and the tradition of academic research (lengthy and boring).

2. Principles of PRA

1. Selective ignoring: this refers to the importance of knowing what it is not worth knowing. It avoids unnecessary details and irrelevant data. It does not measure more precisely than is needed. It optimizes the trade off between quality, relevance, accuracy and timeliness.
2. Offsetting biases: especially those of rural development tourism, by being relaxed and not rushing, listening not lecturing, probing instead of passing on to the next topic, being unimposing instead of self important, and seeking out the poor and their concerns.
3. Triangulation: using more than one, and often three, sources of information to cross-check answers.
4. Learning from and with rural people: directly, on-site and face-to-face, gaining from indigenous physical, technical and social knowledge.
5. Learning rapidly and progressively with: conscious exploration, flexible use of methods, opportunism, improvisation, iteration and crosschecking, not following a blueprint program but adapting through a learning process.

3. Positive features of PRA

PRA has the following unique features:

- *Iterative*: goals and objectives are modified as the team realizes what is or is not relevant. The newly generated information helps to set the agenda for the later stages of the analysis. This is the "learning-as-you-go" principle.
- *Innovative*: techniques are developed for particular situations depending on the skills and knowledge available.
- *Interactive*: the team and disciplines combine together in a way that fosters innovation and an interdisciplinary approach. A system perspective helps make communication easy.
- *Informal*: focuses on partly structured and informal interviews and discussions.
- *In the community*: learning takes place largely in the field, or immediately afterwards, or in intensive workshops.

4. The menu of methods

There are seven major techniques used in PRA:

1. Secondary data reviews: books, files, reports, news articles, maps and so on.
2. Observation: direct and participant observation, wandering, DIY (do-it-yourself) activities.
3. Semi-structured interviews: this is an informal, guided interview session, where only some of the questions are pre-determined and new questions arise during the interview, in response to answers from those interviewed. The interviewees may be (1)

individual farmers or households, (2) key informants, (3) groups, (4) participants of a community meeting or (5) people participating in chains (sequences) of interviews. The interview is conducted by a multi-disciplinary team of two to four persons and the discussion is lead by different people on different occasions. Questions used for *digging* in semi-structured interviews are *what, how, by whom, when* and *why*.

4. Analytical game: this is a quick game to find out a group's priorities and performance on aspects such as involvement in poverty reduction, ranking, scoring or stratification. The common PRA technique for this purpose is named 'Brainstorming'. More details on brainstorming techniques are described in both PaPOLD and PaLA packages in the following lecture notes.
5. Stories and portraits: colorful descriptions of situations, local history, trend analysis etc.
6. Diagrams: maps, aerial photos, transects, seasonal calendars, Venn diagrams, flow diagrams, historical profiles, ethno-histories, time linesetc. Detailed examples of these tools are presented in lecture notes 2,3 and Annexes 1 and 2).
7. Workshops: Local people and outsiders are brought together to discuss information and ideas intensively.

5. Analysis and preparation of the report

(i) Analyzing data

In PRA qualitative and quantitative methods are used, therefore the analysis of data is complex. Each technique has its own method of analysis. The analysis should be kept simple; it should be related to the purpose and scope of the study. If complex data is to be used, every effort should be made to present findings in non-technical language. Data and information should be arranged according to category, issue, topic, sub-topic or question.

For qualitative methods

Categorization (grouping) of data should be done. Data should be analyzed according to category. The category should be inclusive and mutually exclusive. Data could be coded according to inductive categories (for open-ended questions) and deductive categories (such as farmer, farm worker, non-farmer, etc).

For quantitative methods

Simple statistical techniques such as mean, mode and median (measures of central tendency) range, variance and standard deviation (measures of dispersion), frequencies and percentage can be used. Also, Pearson's coefficient of correlation, square, multivariate regression and t-test can be employed.

(ii) Presenting the report

- Include some products of field activities such as the output of an analytical game, box for good examples, pictures or graphs where necessary.
- Follow this sequence; Field Note - Fine Note - Final Note.
- At the end of the day, all team members sit together and consolidate the field notes into a fine note (detailed, clearly written and consolidated field note). The fine note should be the basis for further discussion, analysis and report preparation.

- The fine notes could be structured in chronological order (if detail is needed), or according to the topic (if time is limited) or according to the question.
- The report should consist of the following:
    - the problem statement (including the conceptual framework)
    - purpose and scope
    - methodology
    - data and findings
    - implications of findings
    - summary
    - reference and appendices.

6. **Discusion questions**

1. Why has PRA become a popular method in action research and development projects?
2. What tools in PRA are most commonly used in this TUL-Viet booklet?
3. Which types of research activities and development projects is PRA the most appropriate choice of approach? Why?
4. What major principles need to be followed to apply PRA successfully?
5. What are the conditions for successfully applying PRA?

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Bidding document produced by ICRAF-Calbro to UNDP in 2002 with Dr Ann Elizabeth Killen, Carlbro consultant was the first author.

LECTURE NOTE 2. PARTICIPATORY ANALYSIS OF POVERTY, LIVELIHOODS AND ENVIRONMENT DYNAMICS (PAPOLD)

Kira de Groot and Minh Ha Hoang

1. Background and Objectives

Poverty, people's livelihood strategies, and the natural environment are inter-linked in both space and time. Some of those inter-linkages are distinctly spatial phenomena, which can be measured using household surveys and remote sensing technologies and mapped using geographic information systems, while other inter-linkages are more context-specific and difficult to observe. The method of Participatory Analysis of Poverty, Livelihoods and Environment Dynamics (PAPOLD) was developed to capture the local specific issues of these inter-linkages. The method is asserted to be more comparative than other methods because it is participatory, dynamic and comparable (Hoang, et al., 2007).

It is a refinement of the Stages of Progress (SoP) developed by Anirudh Krishna of Duke University in the USA (Krishma et al., 2007). In Vietnam, it was modified by the ICRAF team in collaboration with Ministry of Labour, Invalids and Social Affairs and Vietnam Institute of Economics in 2007 to better address links between poverty and the environment in Vietnam. Furthermore, the method was applied in Ba Be, Bac Kan in 2010-2011 (see case study below). In principle, PAPOLD was developed on the basis of PRA and the DFID Sustainable Livelihoods Approach.

2. Case Study: Application of PaPOLD in Ba Be, Bac Kan province, Vietnam

2.1. Objectives

Apply PaPOLD to identify target groups and payment methods for landscape beauty, ensuring fairness and sustainability. Research questions are the basis for selecting PaPOLD method: Understanding the local livelihood context and identifying the poverty-environment dynamics is crucial for PES as it aims at changing livelihood strategies.

The research questions are:

- How does poverty levels influence exploitation of forest resources?
- What capacity and (access to) livelihood assets does the village have, that are relevant for participation of the poor in PES arrangements?

2.2. Research site

Bac Kan is a mountainous province located approximately 170 km north of Ha Noi, famous for Ba Be National Park established around Viet Nam´s largest natural fresh water lake. There are five communes partly or fully managed under the National Park core and buffer zones. The strictly protected ecological rehabilitation zone, 10 048 ha, is the home of about 3200 inhabitants (most belonging to ethnic minorities) in thirteen villages surrounding the lake (Figure 01). In addition, the park hosts about 30 000 visitors every year. Environmental degradation, such as deforestation, unsustainable agricultural land-use and water pollution, is a severe problem and local people struggle for livelihood options as they are restricted in their use of forest resources due to national park protection. The national decree on PES (Decree 99), which took effect in January 2011 opened the opportunity for income from hydropower, water and tourism to be paid to ES-providers i.e. land owners and forest protectors. This is a promising solution to resolve conflict between the livelihood development of people living near the forest and forest protection by the national park.

The villages Bo Lu, Pak Ngoi (Nam Mau Commune) and Leo Keo (Quang Khe Commune) were selected for this pilot. Bo Lu and Pak Ngoi were chosen due to their location in the core zone next to the lake where villagers are permitted to offer homestays and other tourism services. Leo Keo is located upstream at the border of the core and buffer zone along the Leng River that passes through Nam Mau commune; as this river nurtures both the fields in Nam Mau Commune as well as the lake, behaviour and practices of upstream Leo Keo villagers directly affect a functioning environment in Nam Mau. In each village a focus group discussion with eight to ten participants was carried out.

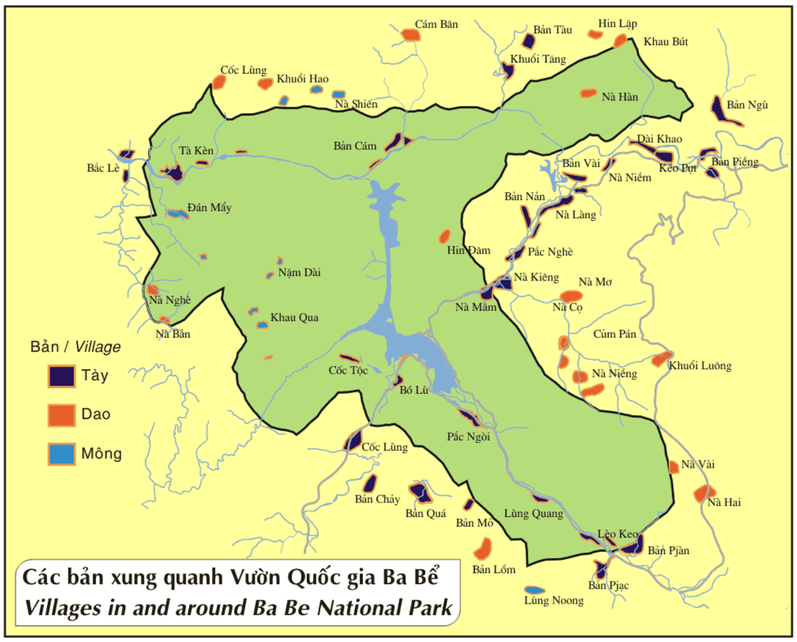

Figure 01. Villages and ethnicity around Ba Be National Park (Ba Be National Park, 2009).

2.3. Methods

2.3.1. Focus group discussion

In each village, a focus group discussion of eight to ten participants was held. Participants were selected after consultation with village and commune leaders according to criteria on gender, income activities, and ages. For example:

- 50% female, 50% male
- generational spread
- Spread of poverty status according to classification
- (Certain income activities, i.e. involement in tourism)

2.3.2. Process

In this study, the PaPOLD process included seven steps. Details for each step and PRA tools were presented in Table 01 and Annex 1.

Table 01. Seven steps for PaPOLD and results.

Item	Objective	PRA tool[10]	Results obtained
1	To identify key markers that provoked changes in natural resource use and economic development	Village Time Line Local secondary data (e.g. Socio-Economic development reports)	1. Changes in infrastructure (roads, electricity) - *physical assets* 2. Occurrence of severe natural disasters (flood, disease) - *natural assets* 3. Arrival of the first tourists, starting the involvement in tourism - *financial, social assets* 4. Regulations and governmental programs - *social, financial assets*
2	To understand local perspectives on wealth and indicators for poverty	Wealth Ranking Poverty Indicators	1. Evaluation of the official governmental poverty criteria/indicators - *social assets (institutional and political aspects)* 2. Importance of the use of natural resources for different wealth groups- *financial, natural assets*
3	To understand livelihood options and strategies for poverty reduction	Stages of progress Livelihood ranking Individual HH progress over time	1. Role of tourism as an alternative livelihood option (those living inside NP) - *physical, human assets* 2. Desired livelihood activities for the future - *human* assets 3. Sustainable ways out of poverty- *financial, natural assets*
4	To identify interrelations between villager´s use of environmental resources and the involvement in tourism	Village Time Line Individual HH progress over time In-depth interviews	1. Changing environmental awareness - *human, natural assets* 2. Appreciation of landscape beauty - *natural assets* 3. Links between economic welfare and use of forest resources - *natural, financial assets* 4. Waste treatment - *natural, human assets*
5	To link governmental changes in NRM to local livelihoods	Village Time Line Individual HH progress over time In-depth interviews	1. Effect of establishing National Park and tightening laws on poverty issues - *institutional and political aspects* 2. Change in laws/regulations and how it affects local livelihood options - *human assets, institutional and political aspects*
6	To assess	Venn Diagram	1. Perspectives on the functioning of

[10] For PRA example, see Annex 1

	organizational and institutional conditions of villagers to become involved in PES schemes		governmental programs 2. Involvement of NGOs – *institutional and political aspects*
7	To understand local perceptions of institutions and organisations	Venn Diagram In-depth interviews	1. Identify organisations and the level of trust that local stakeholders have in them 2. Existing tensions, relationships amongst local organisations 3. Information about relevant actors within NRM and tourism 4. Identify members for Ba Be Watershed Management Board – *social assets, institutional and political aspects*

2.3.3. Data analyses and synthesis

After the focus group meetings, data analyses and synthesis was carried out by the research team in two steps:

Step 1: Team interaction and discussion on findings:
This is held in the afternoon of the same day of the focal group meetings. The flipchart papers that were produced in the morning were put on the wall for all team members to see. The Vietnamese facilitators explained for each exercise how they perceived the discussions and together with the notes that were made during the exercises, the team identified key issues. Documents or earlier interview notes were consulted to clarify some issues.

Step 2: Final data analysis and synthesis:
After PaPOLD meetings were done in all three villages, a second step of data analysis began, whereby the key issues that were identified in each village were looked at by means of the sustainable livelihood framework. Using this lens means the raw data (in form of rankings, tables etc.) and discussion notes were analyzed in terms of social-political, financial, natural, human and physical assets. Dividing data into these different dimensions minimizes the risk of overlooking important issues. Once this was done, the existing or non-existing assets were weighed against their importance for PES participation; e.g. higher human assets in terms of higher environmental awareness of homestay owners indicates higher acceptance of PES schemes among homestay owners. Findings on the different assets were put into an Excel file in order to enable other researchers to quickly find and look up information (See Annex 1). However, as with all conclusions from qualitative data it´s important not to generalize findings and to recognize that validity is limited to the specific context.

2.4. Findings from PaPOLD

Table 02. Local poverty-environment dynamics.

Outcome/findings	Implication for PES design
• Inadequate amount of cultivation land is the main reason for poverty; poverty is the key driver for forest exploitation • However (1) "if someone is rich, he wants to get richer. So even if the government gives them money, they still go to the forest to earn more" • (2) Homestays have gas cookers but don´t use it because forest wood is a cheaper option	PES rationale confirmed • Need for a direct conservation approach like PES • strong conditionality criteria (as opposed to indirectly propagating alternative livelihoods)
• Upstream/land people exploit core zone forest • Some recognize importance of upstream villages for tourism • The poor have been paid by the better-off (e.g. homestays) to take the risk and go to the forest for them	**Up/downstream relations** • Not easy to identify who is responsible for illegal forest exploitation • Difficult provider/user relations

Table 03. Village's capacity & assets for PES participation.

Asset	Outcome/findings	Implication for PES design
Human	• See connection between actions and environment: "increase of slash and burn→led to many floods, lake was consolidated, became narrower" and "since using petrol boats many fish have died" • Environmental awareness through involvement in tourism	**Environmental awareness** • Good starting point • Emphasized the idea <u>behind</u> PES: benefits to humans from environmental services
Natural	• Unclear land rights	**PES allocation** • To villages instead of individuals
Natural Social	• Community forest was allocated in Bo Lu in 2000 • - So-called 'Village Forest Protection Teams' were established. However, not effective due to little/no	**Conditionality/monitoring** • Such exisiting protection teams need to be taken into accont, as PES design should built on exisiting structures. Not parallel. Avoid confusion

	payment and social relations with neighbours	
Social Political	• Villagers don´t always agree on official poverty classifications, but hesitate to speak their own opinion • Hiarachical social-political context in Vietnam	**Institutional design** • Extra effort to make sure local people are represented in PES institutions
Financial Physical	• Homestay often mentioned as a step to lift HH out of poverty • However, no guests means no secure income	**Payment mechanism** • Be aware not to generally think that all those involved in tourism are rich and can easily pay 2% of their income
Social	Earlier governmental programs focused on Pac Ngoi: • Disappointment & jealousy in other villages • Pac Ngoi villagers seemed less interested than other villagers in PES	**Acceptance of PES** • People in Leo Keo seem more cooperative and open to negotiations for projects • Be aware: some HS might be reluctant as PES requires stricter monitoring of their income

2.5. Discussion on findings from PRA tools used in PaPOLD

PRA tools used in PaPOLD are flexible enough to be adapted to suit different research objectives and examples from Vietnam show the high adaptability of this method.

The **Village Time Line** is a useful ice-breaker and support tool for the participants to remember crucial events and changes, not a comprehensive village history. It is easy to participate and avoids sensitive or difficult topics. Some key findings include dates for major changes in the natural resource management, such as when the national park tightened their control over the land, which then enabled further discussions about the impacts on livelihoods. The arrival of tourists had an overall positive effect on the villagers' environmental awareness, while a contradictory state grant for building traditional stilt houses confused farmers as to where they could take timber.

A contextual **Wealth Ranking** tool is valuable as some villagers may disagree with the official poverty classifications. In Bac Kan villagers are used to the government´s terminology "poor", "near poverty" and "non-poor" or having "escaped poverty", but not always agree on the criteria applied by the government. Each participant is asked to put a paper with another participants name under the appropriate wealth category displayed on the flipchart paper, whereby it is emphasized to give reasons for the choice and everybody to speak out if they disagree. This indicated that although poverty is a key driver to land degradation and deforestation, people classified as non-poor continue to rely on forest resources. For example, those who own a gas cooker, see firewood from the forest as the cheaper alternative. Occasionally, the poor have been paid by the better-off to take the risk and go to the forest for them. Those that have escaped poverty (the non-poor) are said to use as many forest resources as those of the poor and near poverty group.

The discussion for identifying **Poverty Indicators** demonstrated certain prejudices about what causes poverty. For example, the better-off (non-poor) believed that people are poor because they do not understand how to do business, while the poor believed that they know how to carry out business but they do not have money to do this. More importantly, participants agreed that, "if someone is rich, he wants to get richer. So even if the government gives them money, they still go to the forest to earn more." Concerns were also expressed about poor households becoming passive, lazy and dependent when receiving unconditional subsidies. Such comments can lead into a discussion on conditionality for PES scheme.

The **Stages of Progress** follows up the poverty indicators in-depth. For example, a homestay could not be seen as a poverty indicator, because when there are no tourists, they have to rely on other income sources. However, in the stages of progress - where participants were asked "what does a poor household do first (then second, third) to gradually improve their livelihood?" Having a homestay was seen as the first step to get above the poverty line. There may be interesting differences between the villages and spatial interactions, such as in order to climb up the ladder, people in Leo Keo buy farmland in other villages. It sheds light on dynamic processes through which people move up and down the ladder; for example, the National Park bought local handicraft during the PARC project but some of the small businesses ended with the project.

The **individual household's progress over time** links the Stages of Progress and the village time line to the personal life of each participant. This gives an idea about the time it takes to move up and down the stages and helps identify households for follow-up interviews. Individual success may depend on changes in access to farmland due to National Park regulations, or how investments turn out.

The **livelihood ranking** asks for people´s most important current and desired future livelihood activities. This showed that external projects have had little importance for reducing poverty levels. Specifically, the rewards paid from national governmental programs for forest protection give little incentive for changing cultivation practices or use less forest products. In all three villages expanding poultry and tourism services are seen as important desired future activities.

The **Venn diagrams** show power distribution and relations among stakeholders. It showed that local people generally had trust in their village leader, the Bank for Social Policies and certain mass organizations, while they expressed lower trust in National Park authorities, who restricted farmers' land use despite their legal rights. The tool revealed local organisations that were perceived as ineffective in preventing illegal forest exploitation. Inhabitants of the villages around the lake, where tourism is apparent, accuse upstream and upland villagers of coming to their forest in the core zone to exploit. In addition the tool helped pinpoint different levels of trust of homestay owners among villages.

2.6. Discussion questions

1. What is the PaPOLD method?
2. Which purposes is the method is useful for?

3. What do the processes look like?
4. Who should be involved?
5. How are the findings from the fieldwork analysed?
6. What are the implications of the findings?

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Hoang M.H., Pham T.T., Brent, S., Nguyen, T.L.H., Thai, P.T., Nguyen, V.H. and Dao N. N.. 2007. Understanding the Voice of the Poor- Participatory Poverty Analysis with Environment Focus, United Nation Development Program and Ministry of Natural Resources and Environment of Vietnam, Hanoi.

Krishna and colleagues have produced a training manual for the method as well as a number of journal articles summarizing the results. His work is gathered on the web site: http://www.pubpol.duke.edu/krishna/. This includes a training manual and results from India, Kenya, Uganda and Peru.

World Agroforestry Centre. 2003. Carrying_out_a_stakeholder_analysis. http://www.cglrc.cgiar.org/icraf/toolkit/Carrying_out_a_stakeholder_analysis.htm

LECTURE NOTE 3. MULTI-SCALE PARTICIPATORY LANDSCAPE ANALYSIS (PaLA)

Hoang Minh Ha, Nguyen Hoang Quan, Ann Degrande, Nguyen thi Hoa

1. Why Multi-scale Participatory Landscape Analysis (PaLA)?

Global population growth, local migration and increasing wealth exert pressure to convert forests to agricultural, industrial or residential land. The diversity in physical and socio-economic conditions in the uplands requires new sustainable land use options for obtaining food security and environmental protection. Involving multiple stakeholders in the analysis of the tradeoffs between short and long-term benefits and drawing upon their perspectives and knowledge is considered essential in the development of sustainable land use. Furthermore, farmers' knowledge of landscape relationships and their perceptions of an underlying logic play an important role in their management decisions. Development of sustainable land use practices at farm and landscape levels depend on bridging the various perceptions and communication gaps.

Land use at plot level is linked to land ownership or tenure, and is the primary source of harvested goods and income. What happens in one plot, however, also influences the flows of water, moist air, sediment, organisms (beneficial, detrimental and 'neutral'), fire and smoke/haze. The spatial pattern of land use and its relation to the underlying structure of the landscape determine the overall outcome for 'goods and services'. Land use planning is normally the basis for local regulation of who is allowed to do what where, but implementation usually falls short of expectations and the plans may not sufficiently reflect local concerns and knowledge.

PaLA was designed as an option to combine multi-stakeholders knowledge and perspectives for the development of sustainable land use from plot to farm and community level, mainly to be used in the upland context. With an interdisciplinary and system approach in mind, the authors brought both biophysical and socio-economic aspects into the method.

At the community level: PaLA, through packaging some appropriate Rapid Rural Appraisal/ Participatory Rural Appraisal (RRA/PRA) tools/methods, in combination with an approach of agro-ecological analysis and GIS, captures local knowledge at relevant temporal and spatial scales.

At the household level: Through a well-structured questionnaire, PaLA helps to link ‘goods and services’ issues found at community and landscape level with household income and land use concerns.

This multi-scale PaLA method can be used in scoping studies and for awareness-raising among community members on problems and issues connected with ecological and administrative boundaries.

Specifically, the objectives of PaLA are:

- To articulate and study farmers' perception of the relationship between land use and landscape functioning.
- To understand farmers’ management options and actual choices made.

- To understand the flows of water, sediment, nutrients and organisms and internal filter functions that determine landscape functioning on the basis of the mosaic of land use practices and interactions between landscape units.
- To understand links between ‘goods and services’ outcomes of each land use decision made and to be made.

Together with PaPOLD (see Lecture note 2) PaLA has shown to be useful in designing PES/RES (Payment for Environmental Services/Rewarding for Environmental Services) mechanisms, appropriate for the local context in Bac Kan. While PaPOLD is efficient in defining social, human, physical and financial aspects of livelihood, PaLA is relevant in providing an in-depth understanding of natural assets in a dynamic way, both in time and space.

2. PaLA at community level

2.1. Steps to apply PaLA at community level

PaLA at community level consists of eight steps, containing five indoor and three outdoor activities (Table 04).

Table 04. Steps to carry out PaLA.

Steps	Activities	PRA tools and GIS	Output
In-door preparation activities			
1	Identification of ecological and administrative domains with clear boundaries (indoor and observation activity)	Reviewing secondary relevant reports (bio-physical, ecological, socio-economics, prevailing and future policies) and maps. Relevant maps include topographical maps, land use maps, soil maps, administration maps and GIS.	Boundaries for PaLA research presented as a map or data in excel
2	Sampling of stakeholders to be interviewed	Questionnaire and/or ranking methods (in-door and observation activities)	A list of selected stakeholders representative in terms of several criteria such as spatial location of their fields (in upper, middle or down slope areas), wealth and/or gender, social, ages, experience, education
3	Formulation of the survey, interdisciplinary group, planning and designing checklist and matching PRA tools (indoor and observation activities)	Brainstorming technique	Concepts and steps of PaLA are agreed upon by the team
Field activities			

4	Making village sketch/model (fieldwork activities) in order to identify the land use patterns and focus points in the landscape	Semi-structured interviews with male and female groups	Village sketch/ model, showing local names of different areas, distribution of land use plots, and main features such as rivers, streams, mountains, roads, etc.
5	Transect walk (fieldwork activities) in order to get an understanding of the soil/plant/water interactions in a landscape	The methods used are simultaneous transect walks and semi-structured interviews	Representative transects and sketches of the areas, locations of transects entered on a map
6	Making timeline (fieldwork activity)	The methods used are semi-structured interviews and timeline drawing	Time line for each land use type along transects and/or the fields situated in the representative areas of the study catchment or village, in order to study land use changes over time
In-door activities			
7	Feedback meeting (in-door activity)	The methods used are posters with visualised tools and group meetings	Findings are reported to the farmers/ stakeholders and obtain their feedbacks
8	Data analysis (indoor activity)	Team work	Qualitative data of each PRA tool such as sketch transect, timeline, and secondary data is analysed separately by different team members All findings are compared and cross-checked using a matrix in order to identify landscape patterns and issues

2.2. Case study 1 - Apply PaLA for studying watershed fuction service at Leng river catchment, Ba Be district, Bac Kan province

Objective: PaLA was applied in this study for rapidly assessing water related issues affected by land use, the upstream and downstream relationship, at two levels: watershed (commune) and sub-watershed (village) levels in order to catch the overall pattern.

Study site: The study was conducted in three communes within the Leng River watershed area. They are Dong Phuc, Quang Khe and Nam Mau of Ba Be district, Bac Kan province. These are watershed areas of Leng river, starting at Dong Phuc commune and ending at Ba Be lake of Nam Mau commune (Figure 02).

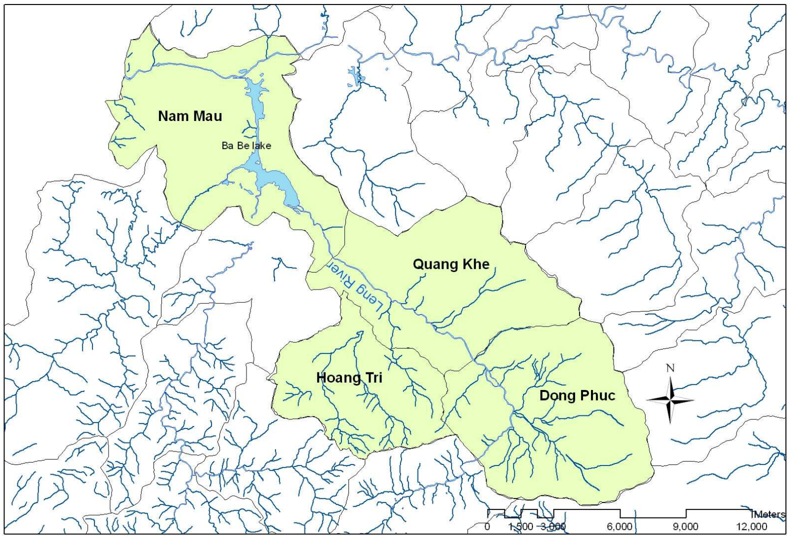

Figure 02. Location of Leng River watershed.

Method: In this study PaLA was applied during group meetings (including group discussion and fieldtrips) at district, commune, and village level. At district level, one meeting was organized in Be Be district. The participants were head of district people's committee, district cadastral officer, agriculture officer, meteorology and hydrology officers, head of three communal people's committees (Quang Khe, Dong Phuc and Nam Mau), cadastral and agriculture officers of each commune, At communal level participants included: head of communal people's committee, cadastral officers, agriculture officers, communal party leader, head of all villages. At village level twelve to fourteen people were selected in each village based on the following criteria: (i) diversified land use types, plot spread in different landscape units; (ii) experience in cultivation; (iii) representative of age: six people over fifty years old and six people below fifty years old (The age of long cultivation experience); (iv) representative for gender: six male and six female; (v) representative of living standard: four rich households, four average households and four poor households. Specific PRA tools used in this study were: time line for 'hotspots' in a landscape, village history, seasonal calendar, village sketch, problem-solution trees, transect walks within villages and inter-vilages using GIS.

Results:

- Hotspots/important sub-catchments in Đong Phuc, Quang Khe and Nam Mau and the relationship between upstream and downstream were identified *(kết quả từ công cụ: phác họa thôn bản, đi lát cắt).*
- Water plays a very important role in agricultural cultivation and domestic use of all villages. Water relationships including quality and quantity changes. Water related issues founded in study sites include: lack of water especially in dry season, river bank erosion, floods, water pollution *(results from PRA tools: seasonal calendar, village sketch, problem-solution trees, timeline and village history).*
- Local people recognized the strong relationship between forest cover in upstream and water availability in downstream area and agreed that forest plantation and protection

are the major solutions *(results from PRA tools: timeline, village history, village sketch and problem-solution trees).*

- Within sub-watershed, water availability in downstream is dependent on forest cover in upstream and areas of terraced rice fields. The larger the area of terraced fields in upstream the less water downstream *(results from PRA tools: transect walk, seasonal calendar, time line and problem-solution trees)*.
- Water conflicts: agriculture land area is limited, especially when slash and burn is reduced, leading to the need to intensify which puts greater demand on water *(results from PRA tools: village history and time line)*.
- Downstream villages use more fertilizer than upstream villages in cultivation practice. Livelihoods of upstream villagers are more dependent on income from rice cultivation activities than downstream villagers. Meanwhile, rice productivity in the study sites are dependent on water availability. This means that water plays an important factor in the livelihoods of local people *(results from PRA tools: seasonal calendar, timeline and problem-solution trees)*.
- Upstream areas have more forest. People both up and down stream realize their cause/effect relationship and agree on main solutions such as long-term forest protection and conservation and building irrigation channels in the short-term for better water distribution *(results from PRA tools: GIS, village sketch, timeline and problem-solution trees)*.

The results identify service providers (people to receive payment) and service users (potential payers) for water service, as well as land use options to ensure supply of this service, thereby providing important information for RES/PES design in this watershed area.

Discussion on PaLA methods:

- **In term of temporal scale**

Village history, timeline for hotspots, seasonal calendar tools are important for finding trends especially factors influencing water.

- Village history: help participants to review and the PaLA team to identify local and national events people feel were important in their history and collect information related to water issues, land use and other related events. Often, many of the villagers will be hearing of important past events for the first time so this is a good chance for them to understand their village history. However, facilitators need to cross check information between participants to avoid individual opinions biasing the results.
- Timeline discovers the time from the past to the present which had changes in water availability and forest cover. This tool can help us see the trend of water and forest change overtime and the relationship between them.
- Seasonal calendar give us the picture about schedules of crop cultivation activities. The results of this tool help us get rainfall and water availability during twelve months of the year. Comparing that information with the crop cultivation schedule, we can see clearly when lack of water happened. Based on this, we can find answers for water dependence and the link between upstream and downstream.

- **In term of spatial scale**

Village sketch and transect walk are important tools for selecting hotspots of village and going through hotspots of that villages and inter villages.

- Village sketch is a tool that can make all focus group discussion participants feel highly enthusiastic and confident to talk, discuss and draw out detailed information about their village with mountains, stream systems, rice fields, roads, the location of their house and other places they are very familiar with in the real world but have never seen on a map. Furthermore, the villagers feel happy when they identify the village boundary by themselves. Based on a village sketch, villagers could easy find the hotspots and identify the owners of those places if there are any.

- Transect walk shows the link between upstream and downstream and in-depth detail about water issues related to land use and other practices. By combining GPS in transect wall, spatial analyses by PRA tools have been improved

- Problem solution tree is a good tool for summing up the overall picture. Based on the results of other tools, this tool digs deeper into the main issues of the study site in order to find the direct and underlying cause of the issues, how the issues affect the livelihoods of local people and their environment, and potential solutions. However, in cases where villages don't have issues like Na Le, the problem solution tree tool is not useful.

- Participatory GIS identifies sub-catchment, basal map to help participatory identification of water and land use systems and transect walk with key informants to get local information.

2.3. Case study 2: Vulnerability assessment and climate change adaptation strategies using landscape analysis

Objectives: This study applied PaLA to evaluate vulnerability to climate variability and investigate local adaptation measures in two selected study villages in central Vietnam—a very vulnerable area to extreme droughts and floods.

Study site: Cam My commune is located in the upstream area of Cam Xuyen district, part of the low coastal area of Ha Tinh province. Cam My commune is characterized by a high poverty rate (40% compared with the national poverty rate of 13% in 2007 according to Ministry of Labor, Invalids and Social Affairs), rich forest, and a high dependence on agriculture. The main agricultural activities in the commune include the cultivation of rice and rain-fed crops (cassava, sweet potato, peanut and soya bean), forest plantations, agroforestry in the form of home gardens and forest gardens, and livestock such as buffalo, cattle, pigs and poultry. The local people belong to the Viet (also known as Kinh) ethnic group.

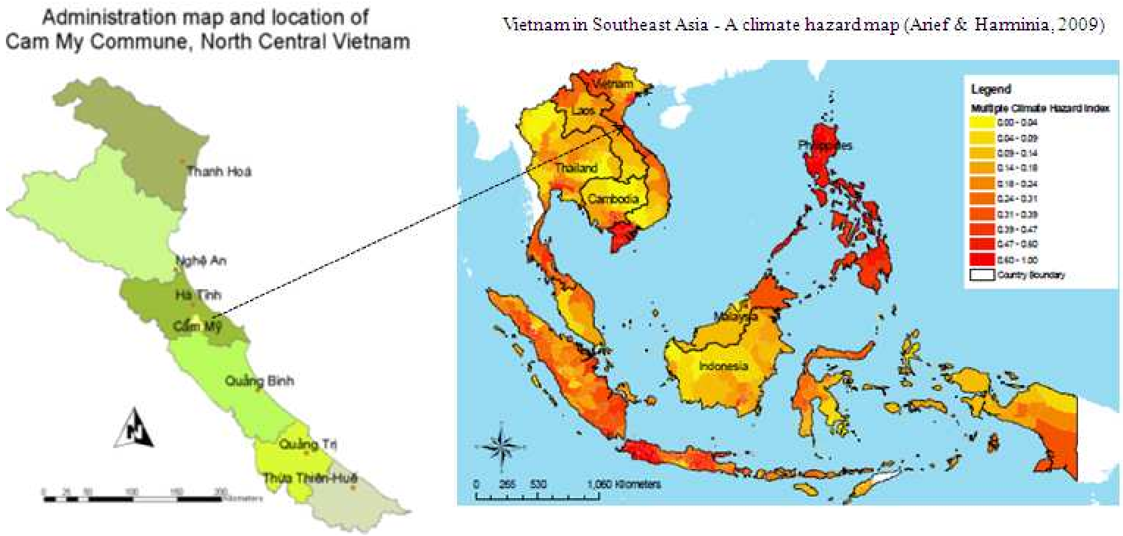

Figure 03. Cam My commune, Ha Tinh province is one of the most vulnerable areas to climate change in Vietnam and Southeast Asia.

Methods: Analysis was carried out at landscape level using Participatory Rural Appraisal/Rapid Rural Appraisal (PRA/RRA) tools (including Village sketches, transect walks, problem and solution trees, timelines and seasonal calendars) (Chambers, 1994; Pretty, 1995) and GIS techniques. In each village, key informant group meetings with village leaders (including one communal representative, the two village leaders, two farmers' association representatives and one knowledgeable farmer) and farmers' group meetings with 18 households were held to collect information on diverse adaptation strategies. Participants were selected to represent different genders, social and geographical locations.

A participatory GIS mapping method was used to define village boundaries and access to physical and natural resources, especially access to water resources, road and irrigation systems, market and hotspots vulnerable to climate hazards. This was carried out with key informants including the head of the village farmers' association, the commune cadastral officer and the two village leaders in combination with village sketch and transect walk. The transect walk mapped geometric points, features and local important names along main roads, main streams, markets, forest, residential area, and paddy fields. During the village sketch activity, a simple map was drawn with participation of local people using the communal administrative map as a guide. After combining this information, a digital map with important information about hotspots, village boundaries, and local names was built (using ArcGIS 9.0). This map shows differences in land use and access to natural resources and physical assets.

Results:

Secondary data analysis (meterological data on temperature and rainfall during 40 years) together with information collected from timeline and seasonal calendar show that the two villages studied were affected strongly by climate variability and severe weather conditions. Importantly, the intensive paddy cultivation pattern used for maximum exploitation of the limited cultivation area leads to highly vulnerable agriculture production if abnormally hard weather occurs (Figure 04).

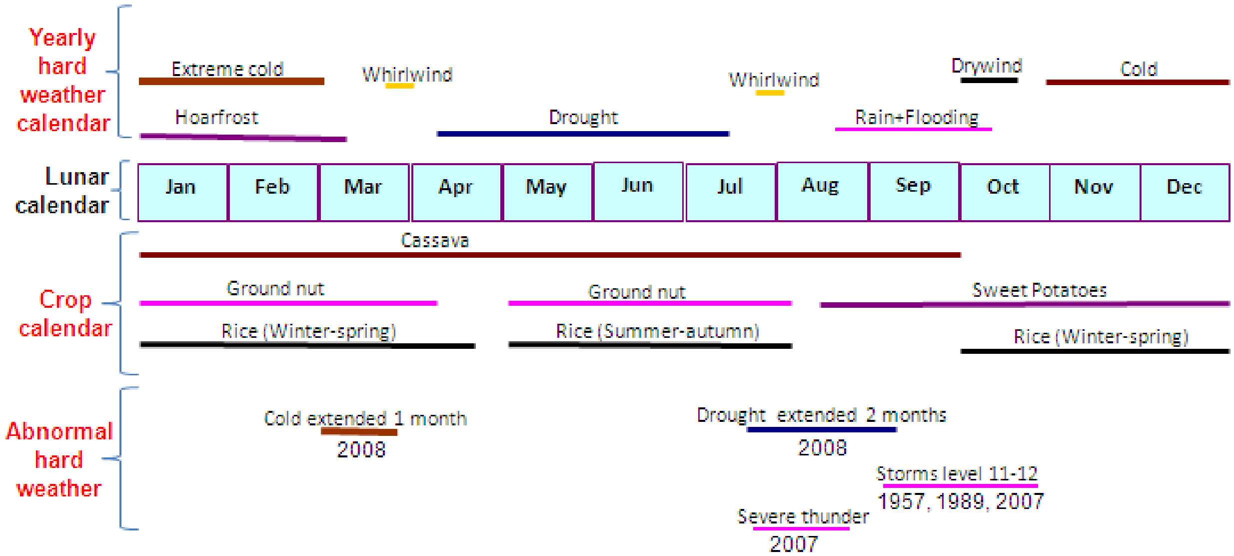

Figure 04. Seasonal calendar showing crops timed to fit in annual hard weather events and the vulnerability to abnormal hard weather.

This study points out that adaptation options depend on access to physical and social assets (Figure 05). Village four has more access to forest (59 ha already allocated and part of the State Forestry Enterprise) and irrigation water (the main water channel from Ke Go reservoir passes through village four before it reaches village eight). Village eight is closer to a communal market, only one kilometre away, while village four is fourteen kilometers away. A main road for the district, which is large and convenient for transport, runs through village eight but not village four. However, agriculture in village eight has limited access to arable land (94 households rely on a total of only 22 ha for rice and crop cultivation). Therefore, local adaptation strategies in village four differ from those in village eight. Village four uses forest land to create forest gardens for fast-growing timber trees, fruit trees, industrial plants and even vegetables. In difficult times caused by extreme weather, the farmers in village four go to the forest to earn extra money legally or illegally. The poor households in village four would like to plant perennial trees but do not have any land (only 0.33 ha in a home garden; in-depth interview) or sufficient financial backup, because forest trees require a long time for harvesting. On the other hand, with little agricultural land but convenient access to the main road and market, village eight focuses more on raising livestock and on trading for fodder and agricultural materials such as fertilizers and pesticides. Six households reported that they trade for fertilizers, commercial livestock feed and chemical pesticides. Therefore village eight employs more technological measures to improve soil conditions and pest management to increase crop yield. In-depth interviews with a medium-wealth household found that 'using more fertilizers could help reduce damage caused by the cold weather'.

Both villages obtain backup products from trees in the home garden or forest garden when rice and rain-fed crops fail due to weather or pests and diseases. This research provides more evidence on the important roles of homegardens and forest gardens as potential systems that can increase adaptation capacity and reduce risks from climate changes.

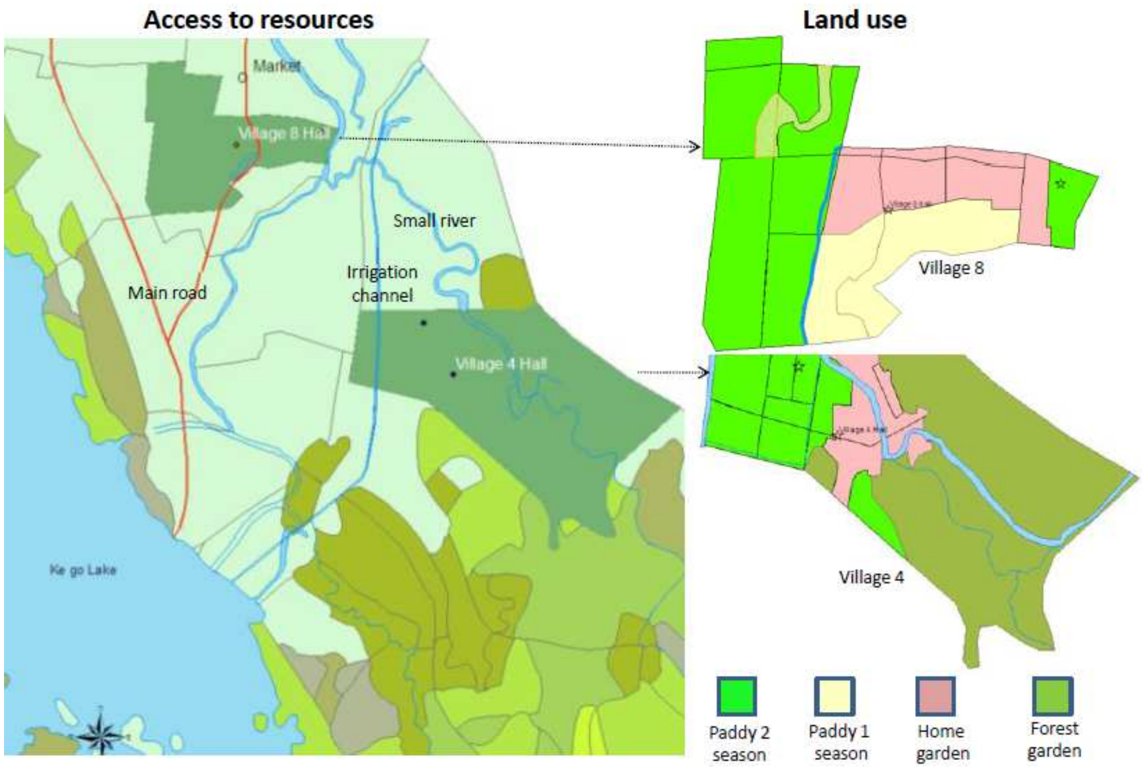

Figure 05. Access to physical and social assets in the two villages studied.

Discussion on PaLA methods used in this study:

This research shows that climate change vulnerability of communities can be assessed rapidly using PRA tools to determine local perceptions on climate changes, identify impacts of different climate hazards on life and cultivation, and assess adaptive capacity based on awareness and physical and social assets.

Diverse adaptaion options can be collected using problem and solution trees during indepth interviews on direct impacts of climate variability and climate changes.

GIS helps assess access to natural resources such as water and cultivation land, as well as social and physical conditions, such as distance to markers, road system, irrigation system, and land use types at landscape level.

Timeline help peple recall major weather events that occurred in their area as well as the measures they used to overcome.

Seasonal calendar helps analyse impacts of climate change on agriculture cultivation.

3. PaLA at household level

3.1. What is PaLA at household level

PaLA at household level was developed to study more in depth after PaLA at community level. In the household level, the landscape analysis of each area belonging to each household will be combined with land use impacts on household productivity and economy. Monthly income of each household is assessed for each land use in the farm. From there, the importance of land use change on household will be evaluated both in time and space.

The households selected to be involved usually are the households involved in the transect walk in PaLA at the community level. By doing so, links between issues found from the community with household levels. PaLA at household level can also carry out alone (see example of Keo Lom below). In that case, the households involved are selected using other criteria (depending on the specific objectives of each study). Usually, wealth criteria are used. The wealth ranking tool to be carried out with village leader is very useful for this purpose.

3.2 Case study of PaLA at household level in Keo Lom commune, Dien Bien Dong district, Dien Bien province

In Dien Bien, the PaLA at household level was carried out to study the potential impacts of an Agroforestry project on livehoods under development. In this scoping study, PaLA was not carried out at the community level before we did the PaLA at household level. Instead we carried out a rapid rural appraisal (RRA) with key informants (communal and village leaders) before carrying out the household survey. The households were selected to participate in the survey in relation to their wealth assertained by asking key informants. A structure questionnaire is prepared in advance to be used for interviews (see section 2.2.2 in Annex 2).

Steps, methods and outputs are given in Table 05.

Table 05. Research steps and corresponding results in PaLA at household level.

Steps	**Time (working days)**	**Aims/activities**	**Methods**	**Results**
Overview issues at the community level				
1	0.5	Collect existing secondary documents at the study site	Review related documents and reports	Statistics on socio-economic and physical characteristics at the study site, including those at village level
2	0.5	Meeting with commune leaders: indepth-interviews on economic development, difficulties and advantages, development priorities, and existing agroforestry project in the commune	Focus group discussion	General reports provided by the commune, plan for agroforestry Selection of two representative villages for household survey
3	0.5	Meeting with village leaders: interview village leaders about general information in the villages (number of households, difficulties and advantages in cultivation, wishes to change in the future, opportunities for land use changes ect.)	Focus group discussion	General situation in the village: village sketches with local names of important areas. Selection of three representative households for three groups (rich, poor, middle) to survey
Survey at household level (three households):				

4	1.5	Household interview: characteristics of that household, main income sources, what trees/crops/animals create main income, cultivation activities, where to sell products, who transfers cultivation technology, existing difficulties and advantages	Interview by questionnaires (an example of a filled questionnaire is in Annex 2)	Filled questionnaires Farm sketches with numbers for each land area and land use type
5	1.5	Visit and interview each area with different land use types as shown in the farm sketch, use questionnaires for each land area	Walk to the fields and interview by questionnaires (Annex 2)	Filled questionnaires for each paddy field/upland field of each household
6	2	Data analysis and report writing	Quantitative data analysis using comparative method (Annex 2)	Report includes survey results, findings and recommendations

Study site: The above approach was tested in the survey to identify the potential for ACIAR project in two villages Tia Ghenh C and Huoi Mua A, Keo Lom commune (103^0 4'-$103^0$15' North, $21^0$10'-$21^0$18' East), Đien Bien Đong district, Đien Bien commune. Main charaters of two studied villages are listed in Table 2.

Table 06. Main charaters of village Tia Ghenh C and Huoi Mua A.

Parameters	Tia Ghenh C	Huoi Mua A
Population	174 (38 households)	167 (38 hộ)
Ethnicity	H'mong: 82%, Kinh: 18%	Thai: 47%, Kho mu: 26%, H'mong: 21% and Xa: 6%
Poverty rate (%)	37	50
Main income sources	Upland rice, low land rice, maize, cassava; livestocks: buffalo, cows, goats, pigs, chicken	
Total land area (ha)	247,5	172,71
Agriculture land (%)	25	28,37
• Low land paddy field (%)	7,68	8,11
• Upland field (%)	17,37	20,27
Forest land area (%)	72,32	70,70
• Natural forest (%)	72,32	55,01
• Plantation forest (%)	0	9,84
Main issues	Limited livelihoods options, forest plantation receiving	Limited land for cultivation, livestock disease, drought,

	little attention, land available for cultivation is reducing due to water shortage and soil degradation	soil degradation

Source: Tia Ghenh C and Huoi Mua A village leaders, February 2011; Report from scoping survey by JICA project in Dien Bien, 2010

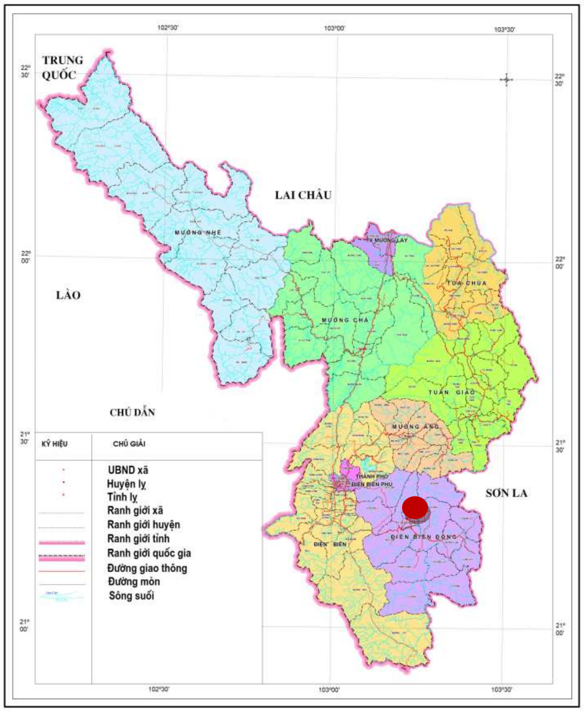

Figure 06. Geographical map for Dien Bien province, Đien Bien Đong district, which includes study sites**.** *Sources: http://doitacaav.vn/sonla/thongtincoban/dktunhien/149/*

Research results:

Cultivation landscape from the village sketch shows that most cultivation activites are on sloping land. Data analysis also points out that household economics mainly depend on sloping land cultivation. Five out of six households under survey have more than 70% income from agriculture activities. Only one household has 14% income from agriculture activities due to small cultivation area (1500m^2).

Poor households in the commune are normally young families, newly separated from bigger families, inexperienced in cultivation, limited in labor and land, especially limited in sloping land cultivation.

Middle and better-off households have large cultivation land area. They apply more effective and diverse livelihood options such as raising livestock (buffalo, cows, fish ect.) and grow crops that allow harvest after a short period such as cassava, maize together with traditional paddy crops, namly wet rice (low land) and dry rice (upland).

Application of agroforestry systems in order to diversify agriculture production has currently been almost absent in these villages. Climate change and inappropriate cultivation methods have been the cause of soil erosion and degradation, drought and water shortage. Crop productivity is reducing due to pests and diseases.

Solutions to improve household economics: due to limited cultivation land in the village, improvement of household economics needs to ensure sustainable and more effective land use practices. Potential solutions include planting and developing agroforestry systems to recover upstream forest, protect soil and diversifying livelihoods by farming livestock and fodders. Applying intensive cultivation technologies and sustainable cultivation to increase crop productivity and prevent soil erosion is important.

Details of the results of each tools and methods for data analysis are presented in *Annex 2*.

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LECTURE NOTE 4. AUCTIONS IN PES - METHOD AND CASE STUDY FROM TANZANIA[11]

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1. About the method:

1.1 Why auction in PES?

Estimating the payment level:

A key issue for implementing PES programs in the field is identifying a payment/reward level or contract price that reflects the value of conservation, while compensating land owners' opportunity costs. If the payment is too low, many potential suppliers may not participate because their cost of land use change is more than the payment they are offered. If the payment is too high, the conservation budget will exhaust quickly and the project will fail to deliver an adequate level of environmental services. Further, in long term projects such as forestry based carbon sequestration activities, a correct estimate of the payment is needed in the beginning as changing prices in the middle of the project can send wrong signals to community members. Moreover, it is difficult to directly transfer cost estimates from one project to another since the cost of implementing a new land use practice can be site and farmer specific, with differences that are unobservable to outsiders. Instead, a more reliable method is required to estimate payment that incorporates both the hidden variables as well as heterogeneity across the farmers and/or group of farmers.

Selecting PES participants:

Similarly, selection of project participants or distribution of PES contracts among potential suppliers is a critical issue, especially when there is excess demand for contracts or project managers have to balance environmental and social outcomes. When project managers offer fixed price 'take it or leave it' contracts, there is still a choice to be made about who is eligible for enrollment particularly when there are more suppliers than the number of contracts that can be given out. If the selection criteria is perceived to be as unfair and non-transparent by the participating farmers, it can jeopardize the success of the entire project. Therefore, estimating the payment level, and the process of selecting PES participants or suppliers, are both important concerns for PES projects.

Auction and Reverse Auction (RA) in PES:

Auctions are a potential solution to these issues. Farmers' who wish to be enrolled in a PES project, offer bids in terms of how much money they are willing to accept in return for implementing the recommended land use in order to supply a certain level of an environmental service. Competition among bidders ensures that these bids represent farmers' best estimates of their true opportunity costs while selection of the lowest cost providers helps to set both a price for the PES activity as well as to distribute the PES contracts in a transparent and objective way. In conventional auctions, bidders bid for the maximum amount of money they are willing to pay to buy an object on sale. So the winner is decided on how

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high a particular bid is. In reverse auctions, the role of the buyers and the sellers is reversed; it's the sellers or the farmers who provide the service buyer with an environmental service at a minimum price they are willing to accept. So the winners are selected on the basis of how low their bids are.

A good example of such reverse auctions is the US Conservation Reserve Program (CRP), which offers annual payments to farmers for protecting ecologically vulnerable land from soil erosion and for conserving other valuable natural resources. Farmers bid in an auction process where their bids are weighted on the basis of an environmental index that scores parcels of land for the environmental benefits they will provide. Parcels with the highest score are enrolled first, followed by parcels with a lower score and so on until the enrollment targets are met. Nationwide, several million hectares of land has been enrolled under CRP through auctions. Similarly, the Bush Tender program in Australia uses conservation auctions to promote native vegetation and biodiversity protection on private lands.

1.2. How to construct an RA?

Similar methods have been tried by ICRAF in Malawi and Indonesia. In case of the RUPES project in Indonesia, ICRAF used RA process to select participants for watershed payments in two villages. Each farmer bids the amount of money he/she needed for implementing conservation activities on his/her farm and the auction was used to estimate the level of payment as well as to select participants. The response from the farmers was very good and ICRAF is now monitoring the effect of conservation activities on reduction in soil erosion and improvement in water quality downstream.

Even though farmers may take the help of other people in formulating their bids, we assume that their final bids are not related to bids made by other farmers. This is because in PES context, the cost of adopting a conservation practice is often farmer and farm specific and farmers cannot resell the PES contracts to others once they receive them. In the RA process, farmers can be asked to either submit their bids orally or in writing (known as sealed bids). However, we advise written or sealed bids because in that case sensitive information about a farmer or farm is not shared amongst everyone and the project manager can also observe all the bids, as compared to oral bidding where only a small sample of the bids are observed.

For threshold benefits (e.g. a certain proportion of a watershed must be brought under conservation for any discernable downstream benefit), or in order to produce a marketable level of environmental service (e.g. a minimum number of carbon offsets that are needed to cover administrative costs of a project), PES projects will contract a large number of farmers in an area. In a simple auction design, each such farmer or service provider can be asked to bid for only a single contract, while the auctioneer can still allocate multiple contracts to all the bidders whose bids were equal to or below the highest accepted bid. This is also good from an equity perspective where PES contracts are distributed amongst a greater number of farmers rather than a few who have multiple contracts each. The payments to these winning farmers can either be discriminatory (each service provider receives a payment equal to her bid) or uniform (all winning bidders receiving the same level of payment). For PES settings in developing countries, uniform payment is better than discriminative payments, which may be politically infeasible or perceived as unfair by local landholders.

Among the different auction models, we have found Vickrey second-price auctions to be quite useful (see *Annex 3*).

2. Case Study: Auctions in the Uluguru Mountains, Tanzania

2. 1. Reason for applying RA in the Uluguru Mountains

The Uluguru Mountains are part of Eastern Arc Mountains in Tanzania and are considered as an important biodiversity hotspot. They provide many valuable environmental services, including being the main source for River Ruvuu, which provides water to Dar-es-Salaam, Tanzania's largest city. However, rapid deforestation in many parts of the mountains threatens these environmental services. One potential way to revitalize the local ecosystem is by growing trees on agricultural fields, which would reduce soil erosion and produce carbon offsets that could be sold in international markets.

Therefore, the Ulugurus were selected by ICRAF as one of the sites for its project on pro-poor rewards for environmental services in Africa. Under this project, farmers receive incentives for conservation practices, such as planting multifunctional agroforestry trees on their farms. Within the Uluguru Mountains, the study was conducted in the Kinole sub-catchment, which lies in Morogoro district. The entire area is quite remote, with only one fair weather road that connects to the city of Morogoro and beyond. Agriculture is the main livelihood source in the area, with many households augmenting their income through casual labor or small businesses. Maize and cassava are the main food crops, and banana and pineapple are the main cash crops.

2.2. RA structure

Data for the study was collected in 2008-2009 through focus groups, a household questionnaire, and a set of reverse auctions conducted in March 2009. The survey was administered to randomly selected households in the area and included questions on the household profile, agricultural profile, and household's preference for trees. Respondents expressed a strong interest in tree planting, with many favoring timber trees over fruit trees because of the high costs of marketing fruit. Replacing agricultural crops with trees could however reduce farmers' incomes, requiring sufficient incentive (e.g. carbon payments) for them to voluntarily do so. So the local farmers were invited to a set of field auctions where they placed bids on the amount of money they needed to plant trees on their farms.

There were two auction rounds, each focusing on planting 80 trees on an area of 0.2 hectares with tree spacing of 5x5 m. In the first round, farmers bid for planting 40 trees of *Khaya anthoteca* (African mahogany) and 40 of *Tectona grandis* (Teak), while in the second and final round, farmers bid for planting 40 trees of *Khaya anthoteca* and 40 of *Faidherbia albida* (Winter Thorn)[12]. *Khaya anthoteca* is a timber tree that is popular in the area, *Tectona grandis* is a slow growing tree that provides valuable timber, and *Faidherbia albida* is a tree that provides rich organic matter to field crops when it sheds its leaves in the rainy season. In both rounds, farmers were told that they would receive free tree seedlings procured from a reputed nursery in Morogoro. At an average price of US$0.30 per seedling[13], the total value of tree seedlings per carbon contract was thus $25.20. Farmers were expected to protect their trees for at least three years, though they were free to grow crops in between the trees. In the

[12] These species were selected after consultations with the regional experts at Tanzania Forestry Research Institute, taking into account the local ecology.

[13] The exchange rate in March 2009 was US$1 = Tanzanian Shillings or TSH 1270.

absence of a local agency that could pay them every year, the entire payment was offered up front. The three-year payment period helped farmers to look after the trees until they became well established, while giving sufficient time to the ICRAF staff to look for potential buyers who could purchase carbon offsets from the area. Farmers were also told that they were free to decide how to use the trees if contracts were not extended after three years.

2.3. RA process

To inform the farmers on how the auction would operate, several rounds of mock auctions were conducted with familiar objects such as bananas and cell phone vouchers. Any questions from the participants were duly answered and the entire process was explained several times. Once the participants said they were comfortable with the auction process, two separate auction rounds were conducted inviting them to provide sealed bids for tree-planting contracts. The entire exercise took between five and six hours with a break for snacks and refreshments. The winners in both the auction rounds were selected using the uniform second price rule with the last rejected bid setting the equilibrium price. Price information was not shared between rounds and winning bids were announced only after both auction rounds had been completed. Each participant could bid in both rounds but could receive only one carbon contract covering half an acre. So in the event of a participant winning in both rounds, he/she had to choose between the two. Limiting each bidder to one contract covering a standard area was necessary to meet all the requirements for incentive compatibility in the auction model.

In all, 268 bids were received in each of the two rounds. 17 bids were disallowed either because they were illegible or outrageously high. Subsequent discussions with these farmers revealed that they had mistakenly added an extra zero to their bids. 69% of the participants were males, while almost 80% were born in the local area with the rest having migrated from elsewhere (*Table 26* see *Annex 3*). Average, demographic characteristics of participants were 43 years of age, 4.4 years of education, seven people per household including children, with five farm plots and 0.16 livestock units owned (one livestock unit equals ten goats or 100 chickens). In the previous year, local households had spent an average of $129 on agricultural expenses, out of which $53 was for hiring labor. 30% of all households ran a small business or had a household member with a regular job. The total cost of organizing the auction and payments for field assistants as well as for the contracted farmers was $5,000 which was provided by ICRAF. Survey data collection and monitoring contract outcomes required additional $10,000, excluding the cost of the lead scientist.

2.4. Auction results

Bids were similar in the two auction rounds (means of $108.70 and $112.60) with similar standard deviations ($75.70 vs. $73.30) (*Table 07*). However, there was notable heterogeneity across farmers as indicated by the large difference in minimum and maximum bids. The minimum and maximum bids in round one were $1.10 and $354.30 respectively, and $1.60 and $354.30 in round two. The distribution of bids in both rounds was skewed to the right with the mean bid in each round greater than the respective median bid. In round one the mean was $113.30, while the median was $102.30; while in round two the mean was $108.90 and the median was $99.20[14].

[14] At an average wage rate of $1.20 per day in the area, a mean bid of $113.30 represents 96 days of wage labor spread over three years, or about 32 days each year. In comparison, in 2008 the average per capita income in Tanzania was $440 (http://devdata.worldbank.org/AAG/tza_aag.pdf).

Table 07. Characteristics and summary statistics of conservation auctions.

Auction Details	Round 1	Round 2
Nature of contract	*K. anthoteca +T. grandis*	*K. anthoteca + F. albida*
Auction		
Format	Sealed bid	Sealed bid
Reservation price	No	No
Succeeding rounds		Sequential
Number of bids	251	247
Minimum bid	$1.10	$1.60
Maximum bid	$354.30	$354.30
Mean bid	$113.30	$108.90
Median bid	$102.30	$99.20
Standard deviation	$75.70	$73.30
Auction outcomes		
Number of winning bids	14	9
Payment per contract	$23.60	$15.80
Total Area contracted	2.8 ha	1.8 ha
Total trees planted	1,120	720

Note: All bidders were eligible to bid in both rounds. Winning bids for each round were announced only after the completion of both the rounds.

2.4.1. Price and selection of participants

Figure 12 (*Annex 3*) shows that the upward sloping supply curves with bids from the two rounds mostly overlap with each other. Starting from the lowest bidders, farmers were contracted until the conservation budget was exhausted (the budget was provided by ICRAF under its PES project). In all, the 23 lowest bidding farmers or households (fourteen in round one and nine in round two) received three-year carbon contracts at the end of the auction. Following the uniform pricing rule, each of the fourteen winning bidders in round one received a payment of $23.60, while the nine winning bidders in round two received $15.80 each. These payments were in addition to the free tree seedlings that were provided to each winning bidder. In all, 1,840 trees were planted as a result of the contracts allocated through the auction.

If we assume that the auction participants represent all the local households that are interested in PES activities, we can also use Figure 12 (*Annex 3*) to estimate the cost of providing carbon sequestration services through tree planting for the entire sub-catchment, inhabited by 1,227 households (*Table 26, column 2,* see *Annex 3*). For a low enrollment target of one third of the eligible area (16.4 ha out of the 50.2 ha included in the auction) using a uniform payment arrangement with each household eligible for one contract covering half an acre, a PES project would need to pay $78.70 per contract (or per 0.2 ha). For the catchment as a whole, this would lead to enrollment of about 73.6 ha (or 368 local households) at a total cost of $28,976.40. Similarly, for a high enrollment target of 80%, the project would need to pay $157.50 per contract[15], leading to enrollment of 196.4 ha of private land (982 households) at a total cost of $154,646.

[15] It is important to note that this excludes the cost of supplying tree seedlings and any other project administrative costs.

2.4.2. Participation of the poor

Participation of the poor is an important concern for PES projects in developing countries since many projects are either specifically taken up to augment rural incomes through conservation payments or are located in areas with widespread poverty. However, PES projects do not automatically include all the poor households on their own. Instead, managers need to (i) come up with pro-poor contracts, (ii) identify the extent to which poor households are able to enroll for these contracts, and (iii) further modify the PES design to make it even more appropriate for the poorer households to participate.

In case of the PES work in Tanzania, we structured the carbon contracts in a way that most poor households could participate. Each household had to enroll only 0.2 ha of land for tree planting (and even on this land intercropping was allowed), the choice of tree species was determined by local ecology and farmers' interests, and free tree seedlings were provided to each participating farmer. Further, the entire payment was offered upfront, which helped in taking care of the initial establishment costs. We then used a combination of auction (bids from farmers that indicated their opportunity cost) and survey data (to estimate the wealth status of a household on the basis of the market value of main assets owned) to identify the extent to which poor households were able to enroll for carbon contracts.

The plot of wealth status against farmers' bids in the auction shows that many poor households with assets less than $39.40 in value did have a low opportunity cost in terms of their bids and were therefore enrolled in carbon contracts (Figure 13, *Annex 3*). However, many other poor households submitted high bids and were therefore not contracted. These results show that some poor households were able to participate in the PES program, but not all. There are many possible reasons for high bids from poor households. They may own only a small land area, so diverting land from food and cash crops to trees would have a high opportunity cost. Similarly, poor households may attach higher risk to locking their land into a contract that requires maintaining tree cover for a minimum of three years.

2.4.3. Compliance and contract outcomes

When we revisited the project area in January 2011 almost two years after the auction and the planting of trees in March 2009, we found high rates of compliance. Of the 23 farmers who won the carbon contracts, we were able to contact 19 and visit their farms (the other four were unavailable at the time of the monitoring visit). 18 of these farmers had duly complied with the requirements of the carbon contracts, with 63% of the trees surviving on their farms almost two years after they were planted. The remaining farmer had sold her tree seedlings before marrying and moving off to another village. The contract outcomes were fairly similar across the two sets of carbon contracts, though the survival rates varied by tree species, (83% for *Khaya anthoteca*, 44% for *Tectona grandis*, and 36% for *Faidherbia albida*). This variation was due to higher familiarity with *Khaya anthoteca* than *Faidherbia albida*, and failure of the short rains which led to higher mortality of *Tectona grandis*. Local farmers also informed us that under a similar tree planting activity taken up in the area in 2002-04, fewer trees had survived due to lack of proper maintenance and care.

In a group discussion during the monitoring visit, many farmers said that they liked the transparent way in which the auction process had identified recipients of the carbon contracts. They expressed their satisfaction that unlike in other projects where prominent villagers had received contracts, the auction process selected people only on the basis of their bids. Farmers also expressed satisfaction with the payment they had received, which helped them cover the cost of labor and other inputs in planting the new trees.

2.5. Conclusion

This case study shows how to use auctions to identify an efficient price in distributing PES contracts among potential service providers in a developing country context. The auctions in the Uluguru Mountains in Tanzania were well received by local farmers, who appear to bid appropriately and received payments that covered their opportunity costs adequately. Similar auctions can therefore be used to estimate payment level and to select participants in other kinds of PES projects such as paying for watershed services. Our case study also shows that when poor households are not the low cost providers there may be strong tradeoffs involved between least-cost targeting and a strict pro-poor targeting approach. The analysis makes these tradeoffs explicit by estimating the additional budget that PES managers may need to extend the carbon contracts to all the poor households.

One limitation of the study is the requirement that households only be eligible for a single contract of a standard size. This requirement was imposed to satisfy the requirements of incentive compatibility in the auction. As a PES project scales up it might not want to impose this condition; it may well be that low cost providers could sequester additional carbon at an opportunity cost lower than that of some other bidders. If that were the case then the supply curve would be less steep than estimated in this paper. However, the auction process would be more complicated in this case since a household would not only need to decide how much to bid but also how much land to offer for enrollment. For initial stages where local project managers are still learning about auctions, it may be better to restrict a household's bid to a standard size plot of say 0.2 or 0.4 ha (or whatever is appropriate for the local context).

Another limitation of our work concerns the use of upfront payments for carbon contracts, which of course implies that they were not really conditional on performance. As we have discussed, this does not appear to have had a negative impact on compliance as all but one of the farmers monitored honored their contracts. Discussions with farmers showed that there was substantial peer pressure as almost everyone was aware of the winners in the auction and the payment they had received for planting trees. Winning farmers also indicated during the monitoring visit that upfront payments were important in helping them cover the initial costs of planting the trees. We do not know how bids would have been affected without upfront payments. Some PES projects offer start-up investment assistance in combination with subsequent conditional payments linked to performance and this may be a way to balance conditionality with farmers' need for assistance in covering initial investment costs.

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LECTURE NOTE 5. RAPID CARBON STOCK APPRAISAL (RaCSA): a rapid but integrated way to assess landscape carbon stocks

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1. Theory

1.1. General introduction

RACSA is a tool used to quantify Carbon stock (C stock) scientifically for carbon services and has the potential to assist communities to be involved in reporting and monitoring PES contracts (Kurniatun et al., 2007). The RACSA appraisal tool provides a basic level of locally relevant knowledge and investigates activities that can improve local livelihoods and alleviate rural poverty (van Noorwijk, 2007).

The purpose of RaCSA is to provide a cost effective and time-bound (within six months) appraisal that:

- provides reliable data on C stocks in a defined landscape, its historical changes and the impact of ongoing land use change on projected emissions, with or without specific interventions to increase or retain C stocks.
- identifies the primary issues in the local tradeoffs between C stocks and livelihoods and the opportunities to achieve more sustainable development pathways.
- enhances shared understanding between stakeholders as a step towards Free and Prior Informed Consent (FPIC) in contracts to increase or retain C stocks.

Environmental service rewards for carbon storage need to deal with three important criteria:

Realistic - interventions need to be based on knowledge of C stocks and greenhouse gas (GHG) fluxes; they also need to align with the tradeoffs between economic benefits from land use change and the consequences for emissions ('abatement costs').

Voluntary - the mechanisms need to respect existing property and land use rights (compare the RATA or rapid tenure claim appraisal tool) and follow principles of FPIC; agreements require a shared understanding of the issues and options to deal with them.

Conditional - the economic incentives will be 'performance based' and thus require systems of monitoring changes in the landscape; linked to this, rewards will be based on 'additionality' (changes relative to what would have occurred anyway) and address 'leakage' (negative effects elsewhere of C stock conservation within a 'project' area).

1.2. Steps in RaCSA

RACSA is applied in six steps (Table 08) to combine local ecological knowledge (LEK), public/policy maker ecological knowledge (PEK) and modeler's ecological knowledge (MEK). RACSA team needs to be multidisciplinary in membership such as sociology, ecology/botanist/forester, GIS/RS experts, statisticians and modelers. Methods include: semi-structured interviews, focus group discussions, GIS/RS analysis, landscape analysis via groundtruthing and data collection, statistical analysis, measurement, laboratory analysis.

Table 08. Activities conducted under RaCSA approach and their relevant outputs.

No.	Activities	Objectives
1.	Initial appraisal of landscape (compare PALA), focused on dynamics of tree cover	To define the unit of assessment (integrated livelihood/landscape unit), its gradients in tree and forest cover, mineral and peat soils, legend of land use/land cover types, major 'issues' in the current debate
2.	Explore Local Ecological Knowledge (LEK) and economics of local tree/forest management combined with a rapid household socio-economic survey	To document livelihood strategies of the farmers that relate to land use practices and key drivers of change in the landscape
3.	Plot-level C data in representative land cover units and integrate from plot to time-averaged C stock of land use types. An updated version of the ASB C stock protocol provides the tree and soil level data	To assess the performance of existing land use systems as carbon sinks and/or preservation of carbon stocks.
4	Combining remote sensing imagery and ground-truthing data within a sufficiently sensitive 'legend' to provide spatial analysis of land cover change	To estimate carbon stocks of the main landuse practices at plot level as well as their integration at landscape level
5.	Explore Public/Policy Ecological Knowledge (PEK) of tree/forest management and existing spatial planning rules	To explore the opportunities to use or adjust existing policy frameworks to enhance C storage in the landscape
6.	Scenario studies of changes in C stocks and welfare through modeling land use and carbon stock dynamics in the landscape	To appraise landscape carbon stock dynamics in relation to 'drivers' of change, as a basis for selecting interventions that enhance peoples welfare and at the same time maintain/increase carbon stocks

2. Case studies

2.1 Case study 1: Carbon stock at plot and landscape levels in Tan Thai commune, Dai Tu district, Thai Nguyen province, Vietnam

Tan Thai commune, Dai Tu district in Thai Nguyen province is located about 80 km north of Hanoi, Vietnam, from $21^{0}35'21.54''$ to $21^{0}37'20.19''$ N and $105^{0}40'18.40''$ to $105^{0}42'42.51''$ E. It is a mountainous midland commune with elevation from 46 meters to 380 meters above sea level. The climate is characterized as humid tropic with two distinct seasons, rainy season from May to October and dry season from October to May. Annual mean rainfall is 1869mm with 2380mm at the highest and 1385mm at the lowest. Annual mean humidity is 70%–80% and annual mean temperature is approximately 25° C. The main land uses are forest (39%);

agriculture (14%) and other lands (47%). Main livelihoods include agriculture cultivation, tea production, fruit trees and forest exploitation.

A study was carried out from April to October 2009 to assess the C-stock of the four most common land use types and predict C stock change. RaCSA was applied combined with GIS and satellite image analysis (see *Table 09*).

Table 09. Methods used in five research steps of carbon stock estimation

No	Step	Materials and methods	Duration	Outputs
1	Scoping	Communal reports Interviewed ten key farmers in four villages, including village leaders, head of womens association, knowledgeable farmers Interviewees included three female and seven male	19 April–22 May 2009	Issues of the study area were defined through a survey of local perception and reviewing secondary reports and other data
2	Selection of study land use systems	Land use map (scale: 1: 25 000), topography map (scale: 1: 25 000 of 2007) Using GPS to check the location of main land use systems	19–20 April 2009	Study land use systems were defined through analysis of tree coverage on maps and in the field
3	Study dependency on land use by local people	Questionnaire on household income from four land use systems (tea, forest plantation, shrubs and grass land, secondary forest), conducted with 25 households	22–25 May 2009	Dependency of local people on the main land use systems were defined
4	Carbon estimation	At plot level: Hariah, 2001 At landscape level: RACSA method, 2007	20–30 June 2009	Carbon storage of the main land use systems, at plot and landscape levels, including building the logistic equation biomass of tea tree, were defined
5	Scenario development	With the assumption that bare land will be used for forest and tea plantation. Carbon estimation for scenarios using measured carbon stock and land use areas in 2009 and 2029	12–16 Septembe r 2009	Scenarios for potential land use changes and landscape carbon were estimated.

Main result

Carbon stock of poor secondary forest is about the same as tea plantation

Among land use systems of around twenty years old, the range of carbon stock of studied systems is as follows: Eucalyptus plantation > tea plantation, poor secondary forest > shrubs with tree generation > shrub vegetation, grass vegetation (see *Table 10*). Other studies in the midland of northern Vietnam show that carbon stock of Eucalyptus plantations of five years old is around 70 MgC/ha while poor secondary forest ranges between 24 and 45 MgC/ha (Ngo Dinh Que, 2008).

Table 10. Carbon stock of studied land use types at plot level.

No	Land use type	C stock (MgC/ha)	Comparison (%)
1	Eucalyptus plantation (15 - 20 ages)	56.39	100
2	Tea plantation (20-25 ages)	35.57	63
3	Poor secondary forest (25 ages)	33.73	60
4	Shrubs alternating tree regeneration	21.02	37
5	Shrubs vegetation	9.2	16
6	Grass vegetation	6.02	11

Landscape carbon stock does not reduce when forest land converts to tea plantation

On the basis of the analysis of policies for protected forests at national and local levels (Ngo, 2008), the desire of local people revealed through the PRA survey, and researcher's forestry management experience, the changes in the studied land use systems in the coming 20 years are estimated as:

- Eucalyptus plantation turns into bare land after two rotations
- 70 ha (38%) of shrubs alternating tree generation turn into tea plantation and 112 ha (62%) of shrubs alternating tree regeneration enrich into poor secondary forest
- All grass land regenerates into shrub vegetation
- All grass vegetation enriches and turns into shrub.

As a result of the above scenario, net carbon change at landscape level estimated to increase at + 3500 MgC in 20 years or 174 MgC per year^{-1}. We can say that at the landscape level, carbon stock does not reduce if shrubs alternating trees (forest land) change into tea plantation (see *Table 11*).

Table 11. Estimated landscape carbon in 2009 and projection for 2029.

No	Land cover type	**Area*** (ha)		**Plot C-stock** (MgC/ha)	**Landscape C** (MgC)	
		2009	2029		2009	2029
1	Eucalyptus plantation (15 - 20 ages)	15.5	0	56.39	874	0
2	Tea plantation (20-25 ages)	357.15	427.15	35.57	12704	15194
3	Poor secondary forest (25 ages)	83.35	195.93	33.73	2811	6609
4	Shrubs alternating tree	182.58	134.7	21.02	3838	2831

	regeneration					
5	Shurb vegetation	134.7	68.41	9.2	1239	629
6	Grass vegetation	68.41	15.5	6.02	412	93
Total		841.69	841.69	**-**	21878	25357

* The study area occupies 44% of the total area of the commune

Reflection on the methodology

RaCSA application surprisingly revealed that tea plantations (an AF system) contain almost equal amounts of carbon as forest land. Furthermore, tea plantation also provides important co-benefits in terms of economic value of its products that can help to improve the livelihood of local people.

Application of RaCSA methods for estimation of C-stock at plot level is easy and efficient as it saves time and money. In order to scale up C stock from plot to landscape level, availability of spatial data and GIS experts is essential. In this study, we use other ways to scale up ie. on the basis of the potential changes in land use. The findings may help change the perspectives of policy makers looking for a solution to trade off between protecting forest land and promoting agroforestry activities. It also provides a very useful case study for teaching in Agroforestry for climate change.

2.2 Case study 2: Carbon stock assessment in different agroforestry land use systems in Quang Khe commune, buffer zone of Ba Be National Park, Vietnam

2.2.1 Procedures for assessing carbon stock and participants in each step used in RaCSA

In general, methods used in RaCSA include interviews, group discussions, spatial analysis using GIS and satellite images, landscape assessment through validation on the field, statistical analysis, measurement of growth factors on the field and sample analysis in the laboratory. The following steps were carried out in the research in Quang Khe commune:

Step 1: Collecting information on land use in Quang Khe

Our team conducted discussions with local farmers and officials to obtain information on land use systems, preferred and future plans for agroforestry land use systems. Land use history of the systems, markets for agro-forestry products in the commune, main tree species being developed in the agroforestry land use was also collected. Information on land use planning and land use change was gathered through interviews and discussions with cadastral officials of Quang Khe commune.

Participants: Local farmers, local cadastral officials and leaders, researchers

Step 2: Land use/vegetation classification

To classify land use, satelite images had been grouped, split and interpreted and classified into vegetation covers in Quang Khe commune. The interpreted satellite images were used for checking on the field to validate the interpretation and re-classification of vegetation covers in Quang Khe commune. The validation helped the team determine correct boundaries among land use systems in general and agroforestry land use systems in particular, which aimed at estimating carbon stocks at landscape levels. The validation on the field also helped the team to compare information collected in Step 1 on species components in different agroforestry land use systems, age levels and average growth of species.

Participants: Cadastral official, local farmers and researchers

Step 3: Measuring growth factors of trees at spot level on the field

When boundary determination and mapping on agroforestry land use systems were finished, growth factors such as Diameter Breast Height (DBH) and height of trees, species names were measured and determined in the sample plots. The information on elevation, longitude, latitude, slope and vegetation cover was also collected in the field. Furthermore, average ages of vegetation remaining in each sample plot and duration of each agroforestry land use system were collected by interviewing local households, forest owners and experienced officials; the collected data is considered basic information to estimate time-averaged carbon stocks of each system.

Participants: Local farmers, officials responsible for agroforestry, officials from Ba Be National Park, researchers.

Step 4: Land use change analysis based on interpreted satellite images and information collected on the field (onsite information)

The pilot research in Quang Khe used two satellite images taken in 1995 and 2008 to estimate a land use change rate of agroforestry land use systems. Land use change rate was calculated for each land use system, converted into a percentage (%) and implemented by the assistance of GIS experts.

Participants: GIS experts, researchers

Step 5: Estimating carbon stocks at landscape level and developing land use change scenarios for the future (upscaling)

Based on the land use change rate information, the area under each land use system and time-averaged carbon stock, total carbon stocks at landscape level, or the whole agroforestry land use systems of Quang Khe commune, were estimated.

Two land use change scenarios for Quang Khe commune were used to estimate carbon stock change at landscape level from 2009 to 2020. For scenario one, we used land use change rate for the period of 1995 to 2008. Scenario two was developed basing on the following factors:

- the demand for expansion of agroforestry land use systems
- average population growth
- the assumption that there is no land conversion from secondary forest to other systems.

Participants: GIS experts, researchers

2.2.2 Main outputs of RaCSA and the application of the outputs in assessing carbon stocks

Outputs of Step 1:

- Documentation of interviews and discussions to understand main agroforestry land use systems in Quang Khe, main species, the history of each system, the direction of land use etc.
- Schematic diagram of land use/vegetation cover and land use systems over time. The

diagram showed the research team the development history and land use change of each land use system. The diagram is very useful for developing land use maps and estimating time-averaged carbon stock of each system.

- Annotated maps: The maps provided general information on the land use types of Quang Khe, residential areas, public works, and key directions of land use etc. and aim at developing land use maps based on satellite images.

Outputs of Step 2:

- Interpreted satellite images to be used for the validation of different land use systems/vegetation cover in the field.
- Maps of agroforestry land use systems: The maps were developed after the information on interpreted satellite images had been validated. The maps were used to estimate time-averaged carbon stock at landscape level.

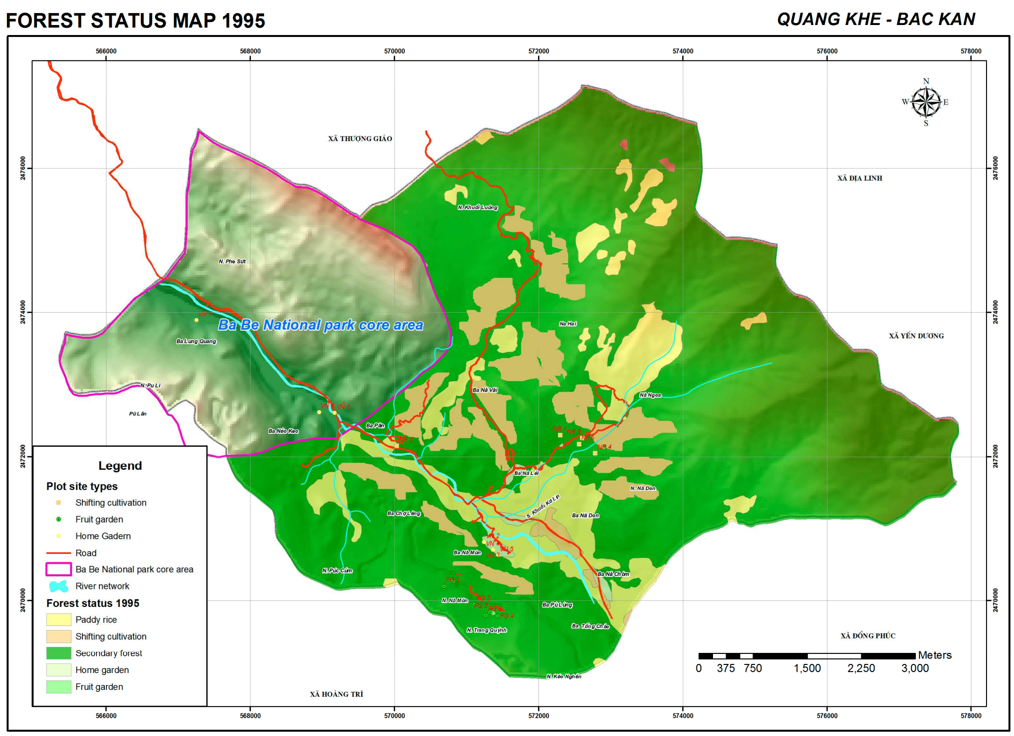

Figure 07. Vegetation cover map of different land use systems in Quang Khe.

Outputs of Step 3:

- Data on diameter and height of trees with DBH bigger than 5 cm, vegetation cover and slope at sample plots
- The information on average ages of the vegetation in sample plots.
- Time-averaged carbon stock at plot level: the carbon stock was considered as a basis to estimate carbon stock at landscape level.

Table 12. Total carbon stock of four land use systems in Quang Khe commune (Unit: Mg/ha).

Carbon sink	Secondary forest	Home	Fruit garden	Shifting	cultivation
Above ground	47.55 (48.80%)	21.59 (31%)	14.10 (30.1%)	4.35	(15.5%)

Below ground	49.97	(51.2%)	48.04	(69%)	32.70	(69.9%)	23.74	(84.5%)
Total	**97.52**		**69.63**		**46.80**		**28.09**	

Outputs of Step 4:

Summary on land use change of agroforestry land use systems from 1995 to 2008. Land use change rate was important for estimating carbon stock change over time for each land use system. If the research had aimed to cover all types of land use systems, a land use change matrix should have been used. The matrix lets you know how land use changes from one land use system to another.

Table 13. Land use change from 1995 to 2008 in Quang Khe commune.

Forest cover	**Area in 1995 (ha)**	**Area in 2008 (ha)**	**Area change (+/-)**	**Rate/year**
Fruit garden	5	18.65	13.15	1.01
Home garden	121.27	179.63	58.36	4.86
Mountain rock	3.57	3.57	0.00	0.00
Paddy rice	411.28	316.86	-94.42	-7.26
Secondary forest	3,753.29	3,200.36	-553.03	-42.54
Shifting cultivation	420.1	500.53	80.44	6.19

Outputs of Step 5:

- Land use change scenarios: The scenarios were used to assess time-averaged carbon stock change at landscape level.
- The prediction of carbon stock under the land use change scenarios: The prediction may be used in assessing the potential of PES/REDD projects in Quang Khe.

Table 14. Change in carbon storage at landscape level under Scenario 1 and 2.

Land use type	**Scenario 1 (Mg C)**		**Rate /year**	**Scenario 2**		**Rate /year**
	2009	**2020**		**2009**	**2020**	
Secondary forest	307,950	262,316	-42.54	312,099	312,099	0
Home garden	12,820	16,258	4.49	12,657	14,308	2.34
Fruit garden	922	1,463	1.05	1,052	3,032	4.17
Shifting cultivation	14,234	16,146	10.03	14,059	14,059	0
Total	336,462	302,610		339,869	342,500	

Carbon loss/gain	- 39,743	3,631

2.2.3 Conclusion

The results show that total time average carbon stock is largest from secondary forest and smallest from shifting cultivation. There is a considerable gap between underground carbon stock of secondary forest compared to other land use systems. This result shows that the underground carbon stock will be be reduced significantly if there is a land use change from secondary forest to home garden, fruit garden and shifting cultivation.

Participation by local people and staff in step 1, 2 and 3 plays a key role in determining the success of RaCSA in assessing carbon stock in different land use systems. Information on land use history, preferred future land use system, demand for system expansion and cycle for each system is essential for defining the boundaries of diffent systems as well as for calculating time average carbon stock for each land use type. The participation of local people in these research activities help them understand the role of trees in carbon sequestration, effects of land use change, as well as how they can benefit if they manage and protect these land use systems effectively.

Total carbon stock for the whole landscape will continue decreasing if the land use change pattern from 1995 to 2008 is used as a land use scenario for the period 2009 to 2020. In contrast, the total carbon stock will increase by nearly 4000 Mg C if population growth and forest management are well controlled and there is no shifting from secondary forest to other land use systems. In fact, total carbon stock for this landscape will be approximately 43.500 Mg C if the latter scenario is used. This suggests the crucial role of good management of secondary forest ecosystems and the reduction of shifting cultivation activies in Quang Khe. Changes in carbon stock for each scenario is crucial to assess the potential for PES/RES projects in the area, and can be considered as a determining factor for choosing the appropriate land use system for use in projects.

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ANNEX

Annex 1. Lecture note 1: PAPOLD – Guidelines for Focus Group Discussions and qualitative data synthesis

1. Selecting Participants

At least two days before the planned date, meet with the head of commune and the respective village leaders, in order to schedule the focus group discussion (FGD). If possible ask the head of Women/Farmer´s Union to join. If time allows, this meeting could also serve as a key-informant interview for village time line. It might be suitable to do a Venn Diagram.

Ask the village leader in advance to bring a list of all village members. During the meeting the PAPOLD team, village leader and head of commune should discuss the criteria for the participants. Usually the village leader and head of commune know all the people personally, so they are able to discuss who is suitable (however this is also considered a limitation for representativeness).

Criteria used in this study:

- Spread among living standard groups (poor/near poverty/non-poor)
- Gender (50/50)
- Spread among generations (20-35/ 35-50/ 50-80)
- Sources of income (farming, tourism etc.)

Issues to take into account:

- One village leader (~50 years old himself) mentioned problems with alcohol in the older generation and says he has some trouble finding 'reliable' older people.
- Be aware of biases the villager leader might have towards relatives or friends.
- Ask the village leader to tell the female participants to avoid bringing their children to the meeting (as this will distract their attention a lot).
- Discuss meeting room.
- Ask the village leader to be there thirty minutes early.
- Address issue of participants coming late. Village leader might consider telling them an earlier starting time.

2. Introduction

Start the meeting with an introduction. It is very important that the people understand why the research is being done, what activities will take place and exactly and how long it will take. If possible, do the introduction together with the village leader (according to local customs).

The introduction includes:

- Thanks for participant attendance.
- Introduction about the World Agroforestry Centre (ICRAF) and an introduction of all staff by name.
- Explain objectives: to better understand socio-economic context of the village and get local perspectives on livelihood activities *(and environment).*

- Be carefull not to raise expectations too high. Participants should not think that the research will bring a big project and money in the future. They should not have expectations that will not be kept in the near future.
- Explain that the research will have value for the village, as the data will be shared with them in Vietnamese after it has been analyzed. Explain that this is done to make the process as transparent as possible, so that they can see all the information collected. This gives them the possibility to agree or disagree and prevents misunderstanding and wrong conclusions.
- Overview of the exercises that will occur during the meeting:
    1. Village Time Line
    2. Poverty Ranking
    3. Poverty Indicators
    4. Stages of Progress
    5. Break
    6. Household progress over time in two groups
    7. Venn Diagram in two groups
    8. Current and Future Livelihood activities ranking
- Advise that it will take about four hours, with one break in-between and plan to finish before lunch time. Offer drinks and snacks.
- Thanks for attendance and participation and advise that their time and energy will be acknowledged with a small compensation at the end of the meeting (do not mention the amount).
- Ask whether everybody has written down their names on the list.

3. Village Time Line
Duration: ~ 20 minutes
Output: overview of village history; reference dates for step 5 “HH progress over time”

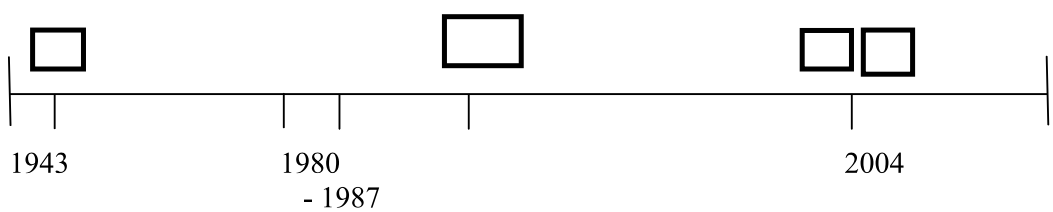

Figure 08. Example of a village time line.

In this step well known events in the past are chosen to make it easier for people to refer to past times and their well-being during earlier times. This helps us (as a basis for the next step) to identify the processes a HH has gone through with respect to its livelihood activities.

Important: It might be difficult for them in the beginning to think of events.

How to do it?
1. Explain: This is to make it easier for the group to discuss events in the same time periods.
2. Draw a time line on the paper (two flipchart papers taped together).
3. Ask someone (village elderly if present) to shortly tell the village history.
4. Write down all the events that people remember on pieces of paper and pin them above the timeline. This it to be able to move them around until consensus is reached.

5. If they do not mention it themselves, ask when the first tourists came to the village, and the first homestays were opened. Ask whether in 2009 there was any problem.

4. Poverty Ranking

Duration: ~ 20 minutes
Output: table presenting participant´s poverty/wealth classifications according to their opinion (not official governmental ranking) and notes

Table 15. Example of an indicator table.

Poor (Ngheo)	Near poverty (Can ngheo)	Non-poor (Thoat ngheo)
Name Name	Name Name Name	Name Name

Important: Poverty can be a sensitive issue. When explaining this exercise the facilitator should mention that people are/become poor for many reasons and that more often than not, the individual has no control over these reasons. In the beginning avoid using the term 'poor'. Instead say "households that have very few resources" or "households with many needs". Carefully find out which term they are familiar with and is locally used to refer to those households. These terms are then put in the columns as shown above.

How to do it?

1. Let all participants write their name on a piece of paper.
2. Collect the papers and mix them.
3. Hand them out randomly again, so that everybody gets someone else´s name.
4. Ask participants to come forward to the flipchart paper and put the name (i.e. household) in the category in which they think this household fits.
5. After all HH have been placed, let them explain why they put a HH in a certain category. Discuss if everybody agrees on this classification.
6. This discussion already gives very useful insights into the next exercise.

5. Poverty Indicators

Duration: ~ 30 minutes
Output: list of poverty indicators and notes

Table 16. Example of a poverty indicator table.

Parameters	**Poor (Ngheo)**	**Near poverty (Can ngheo)**	**Non-poor (Thoatngheo)**
Monthly income	About 100.000	200.000–300.000	More than 500.000
Subsistence	Very little, governmental subsidies	Dearth (a little)	Have excessive products to sell
Land	No land or little land	Have land (but have many children)	Have land, intelegence

Motorbike	0–1 old Chinese motorbike	2 Chinese motorbikes	2–3 good motorbikes
Sources of income	Catch fish; cultivate, cattle breeding, temporarily employed	Catch fish; cultivate, cattle breeding, temporarily employed	Have savings from parents
Labour	0–1	2–3	

How to do it?

1. Use the notes and information obtained in the previous exercise. The idea is now, to put the parameters, which participants (maybe sub-consciously) used in the poverty ranking to put a HH in a certain category. Ask them to re-call the indicators they used before. Write those in the first column.
2. Ask for the differing parameters/criteria for each poverty category.
3. It is good to prepare a list of parameters beforehand that can be suggested to the group.
4. If they do not mention by themselves the following indicators could be considered:
    - size of cultivation land
    - main source of income
    - involvement in tourism
    - need to use forest resources

Ask whether everybody agrees on this. If they do not agree, ask what they want to change and why. Facilitate until consensus is reached. Make detailed NOTES of the conversations.

6. Stages of Progress

Duration: ~ 30 minutes
Output: Different stages of progress for HH

Table 17. Example of Stages of progress.

6	Savings in bank
5	Buy boat, build homestay
wealth line	
4	Build/repair house, buy furniture, pay loan back
3	Find products to stablise the income of local people, part loan repayment
poverty line	
2	Undertake new jobs (embroider, weave, knit), expansion to chicken and pig raising
1	Buy land until enough for monthly rice/maize needs
0	Income 300.000/month, no boat, lack of food for 3 or 4 months

How to do it?

1. Using a flip chart with a pre-prepared blank table ask participants: what a "poor" household does to gradually climb upwards from the stage of acute poverty and which expenditures are the very first ones to be made.

   Important: The aim is to find out what a HH 'actually' does not what a HH 'should' do. Actual experiences of typical households are sought, not the community´s opinion of what people should or should not do.

2. Discussions among the group might arise. It is very common that different suggestions arise for each stage. Be patient and facilitate the discussion until agreement is reached on the first stage e.g. repeat all the suggestions to the group by saying: "I hear food, clothes, and shelter is suggested, which of these would come first?" "I´m hearing almost everyone say food comes first, do we all agree?" Remember: reaching consensus does not mean the majority wins, but finding a solution with which everyone feels comfortable to some extent.
   Write the first stage down at the bottom of the flip chart paper.

3. Continue with: "Which one follow immediately after?" "After time, the HH has more money, what does this HH do on the second stage, the third and so on."

4. The higher up the stages ladder, the more disagreement is to be expected. This exercise is not only writing down what the group says, but the facilitator needs to think it through as well. Some suggestions might be to general eg. 'send children to school' →clarify for primary or secondary school; 'start a small business' → clarify for 'shop, guesthouse, carpenter, tour guiding'. Some other suggestions might be too detailed eg. 'buy cups, buy utensils" → group as 'buy kitchen items'.

5. You will end up with something like:

Table 18. Example of a resulting table.

Stages	
6	Savings in the bank
5	Buy boat, build homestay
4	Build/repair house, buy furniture, pay loan back
3	Find products to stablise the income of local people, make part loan repayment
2	Do new jobs (embroider, weave, knit), expand into raising chickens and pigs
1	Buy enough land to meet monthly rice/maize needs
0	Income 300.000/month, no boat, lack of food for three or four months

6. Define poverty and prosperity cut-off lines in order to find out at what point a HH is no longer considered "poor."
   Go through the stages one at a time. Stand right next to the chart and pointing at the stage, ask: "Is the household considered 'poor' *(use local term)* if it can raise pigs?" If the answer is yes, move to the next stage to ask the same question: "is the household still considered 'poor' if it can raise cows and buffalos?" This continues until the group agrees where to draw the line. After the first line where the HH is not called rich, the term "non-

poor" is used and the question is asked until the point where another line is drawn. A second person makes detailed NOTES during the discussion.

7. Break

Duration: ~10 minutes

Important: Use this break for preparing the next step; it needs to be done quickly as there is very little time. On the prepared blank forms for assessing the HH progress over time integrate the results of the village time line. Choose important years or certain time periods in order to provide points of references to make it easier to assess the progress over time.

8. Individual HH Progress Over Time (in two groups)

Duration: ~25 minutes (strongly depends on the size of the groups)

Output: Overview of changing livelihood activities of HH over time

Table 19. Example of HH progress.

Nam / Year Ten / Name	1946	1963-1972	1974-1980	1989	1992	1995	2000	2002-2004	2005	2007	2010
Stage		0	0	1	1	1	2	2	3	4	6
Toản				Borrow money from bank, raise pig							
							Continue to raise pig, invest in fertilizer and new variety				
									Have stable income from salary, Continue to raise pig and chicken		
										Pay loans back, Continue to raise pig and chicken	
Giới							0	0	0	1	2
							Borrow money from bank, farm				
									Borrow money from bank, raise cow, farm		
										Invest in fertilizer and new variety, raise pig	

1. Split the participants in two groups. Criteria for splitting: poor/average and average/not poor. In order to prevent big difference within the groups, as this might make participants feel intimidated.
2. Use the Village Time Line and Stages of Progress and explain the exercise within the group.
3. Ask whether they have any questions. If they do not understand, the facilitator can use themselves as an example and write it down on the prepared form.
4. Do the same with each group member.
5. The findings will not be discussed in the big group but the HH progress paper is placed in an accessible part of the room so that people can have a look at it if they are interested.

9. VENN Diagram (in two groups)

Duration: ~60 minutes

Output: Overview of existing institutions and organizations; their roles and relative importance to villagers and notes.

Example for applying VENN diagram (this example was produced as a result of PRA conducted in Quyet Tien village, Dich Qua commune, Thanh Son district, Vinh Phu province provided by Dr. Nguyen Ba Ngai): a VENN[16] diagram is contrsucted of circles (not squares), in which the circle in the center is the research issue or field to be analysed. This example analyses institutional impacts on village socio-economic development as identified by local people. The size of the circle reflects the level of importance to village development (the research issue identified in the example)—the larger the circle, the more important it is. The distance from the central circle (the research issue), reflects the impact to village development—the shorter the disctance to the central circle, the greater the impact.

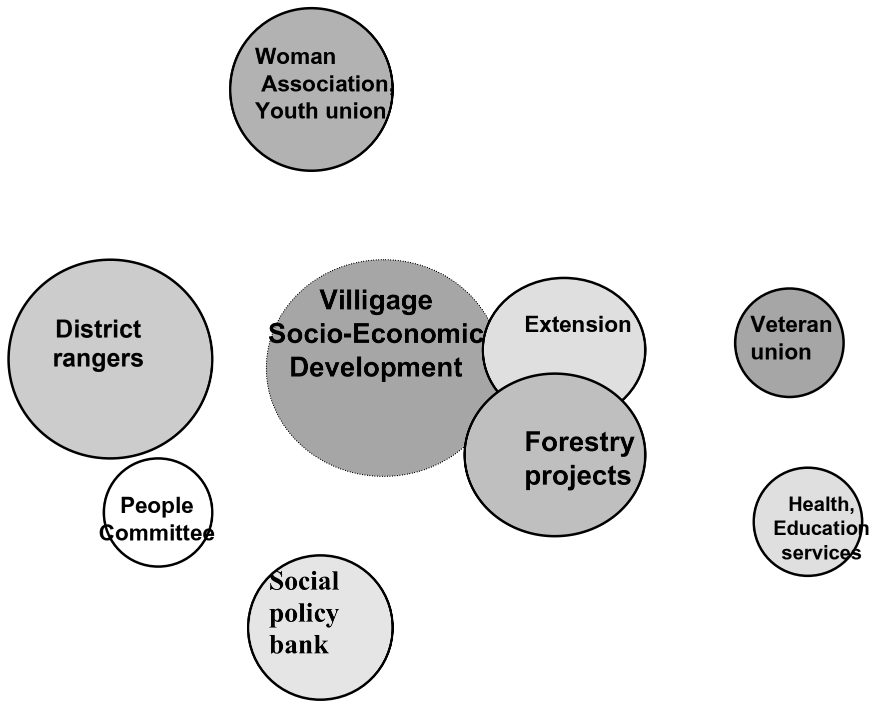

Figure 09. VENN diagram for institutional analysis.

Table 20. Institutional analysis. *(This example was produced as a result of PRA conducted in Quyet tien village, Dich Qua commune, Thanh Son district, Vinh Phu province - provided by Dr. Nguyen Ba Ngai)*

Order	Name	Functions	Importance	Present impacts
1	Village representative group	Directly guide community, lead them in implementing village plans, represent the community to interact with related organizations	Very important	Financial and technological supports
2	Farmer association, women association, youth union, communist party	Interact daily with the community, guide production activities and technology transfer, protect community in many aspects, They determine the success of village socio-economic development plan	Important	Guiding and providing funds
3	People's council and people's committee	Directly monitor and lead planning and implementation of plans by community.	Play roles in leading and	Imporant in encouraging

[16] VENN is the name of a mathematician who invented a method to analyse mathematically links between events. This method was adjusted to become a social science qualitative analysis method.

		Directly manage, distribute, allocate land tenure to farmers, ensure legal status for village representative groups to interact with other social-economic organizations.	guiding production	people's participation
4	Forest rangers and extension at district level	Provide helps for community in terms of science-technology, production, livestocks, seedlings, and other investment such as plant protection and veterinary. Help village representative group for technology transfer to community	Important for forest protection	Help community work with provincial projects
5	Forestry project and procincial department of agriculture and rural development	Directly manage projects, help community, assess local needs and invest for farmers.	Technological and financial support	Training courses, technical instruction, credit supports
6	Health and Education	Provide care for children's health and education		
7	Social policy bank	Give loans for production	Very important	Give limited loans
8	Local security, veteran association	Helps ensure security and protects community		

Important: the inner circle varies according to research objectives. Also the meaning of different sized papers can be adapted. It is important to make sure participants understand the meanings used.

How to do it?

1. Split participants into the same groups as above.
2. Put the different sized pieces of paper on the table, have enough pens ready and explain the three different sizes.
3. Ask participants to write down the organizations, companies, groups or individuals (stakeholders) that are important/powerful in the area. Write the very important ones on the biggest piece of paper, those of some importance on the middle sized pieces and those with little importance on the smallest sized pieces. NOTE: it may be good to have a list of possible stakeholders ready that are most relevant to the research.
4. Ask participants to place their papers around the middle circle (labeled "local people") in relation to how effective the organization/program/individual is functioning FOR the local people and the level they feel their interests are represented through it. The closer the organization is placed to the middle circle the more effective and representative they are considered. The further away from the middle circle, the less effective and representative they are considered.
5. Discuss the results. Ask: "Why did you put it on a small/middle/big piece of paper?" "Why do you put it far away?" Take careful NOTES during the whole discussion when they decide about the size and where to place the pieces.
   In the end tape the pieces on the flip chart paper.
6. If time allows, discuss the two (probably different) Venn Diagrams with the whole group.

10. Ranking of Livelihood Activities

Duration: ~20 minutes
Output: have an overview of the existing livelihood activities and their importance
Table 21. Example of ranking livelihood activities.

Current livelihood activities	**Importance (1 = highest)**	**Future livelihood activities**	**Importance (1 = highest)**
Cultivation(rice/ maize)	1	Expand pig and chicken raising	1
Raising pigs/ chickens	2	Improve quality of tourism service (boat, homestay, restaurant, learn English to communicate with foreign tourists)	2
Transport service (boat)	2		
Homestay service	3		
Catching shrimp/ fish	4		
Small trading	5		

How to do it?

1. Ask for their current livelihood activities. They should mention ALL of them, no matter how small.
2. Ask to rank them according to their importance to the majority of villagers and the village in general.
3. Ask for their hopes/plans for future (alternative) activities. "Do you want to change anything?"
4. Look at this together in the group. There will be several boxed with the same activity, write those again on one other piece of paper and try to find consensus on where they are ranked. A second person takes careful NOTES of the discussion.

11. Final words

Thank everybody again for coming. Invite them to have another look at the flipchart papers if they are interested or have another cup of tea and snacks. Ask if they have any more questions. When they leave, hand over the envelope with the small compensation.

12. Qualitative data analysis using Excel file

Example screens-shot of an Excel file arranged according to livelihood assets:

	A	F	G	H
1	**Physical Asset**			
2		**village**		
3	**Reference**	1.1.5.2.	1.1.6.1.	1.1.6.2.
4	**Name**	**Leo Keo**	**Bo Lu**	**Pac Ngoi**
6	**Production tools (differences between household groups)**			
7	* Production (access to seeds, plants, livestocks, fertilizers): w	> program 135 suppported the village with one ploughing machine > some HH buy ploughing machine together	> fishing net (which is not allowed to exceed a maximum size) (I NP) > no dinamite fishing allowed (I NP) > need more machines for cay (I) > - Cattle breeding: *Poor: are supported money to buy buffalo (the village has 1 household)	> fishing nets (regulations for a maximum siz > no dynamite fishing allowed (I NP) > first boat service started in 1989; from 1989 boats. In 1992 change to diesel oil boats, sinc died, makes it difficult for fishery (villagers g noise and pollution of the motor) (P)
8	* Management (pen, paper, computer, telephone, fax, radio, T	> most villagers seem to have a mobile phone (P contact list) > since electricity arrived in 2005, they have radios and TVs	> the HH who is building tourist information centre has computer (O)	> village house is well equipped many blackb and chairs (P) > most villagers seem to have a mobile phon
9	* Conservation (shoes or specific clothes for going into the woods, guns, etc.)			
10	* Property (map,field boundaries, etc.)	> Commune has cadastral map on paper A0 DoNRE has cadastral map of all communes		> in 1995 first villager (Mr. Toan) offers his ro stay (P) > in 1997 have first official homestay; Mr Toa
11	*** Infrastructure**			
	Community House	Yes, small, quite old. Wooden house with small wooden benches. Gets very cold in the winter. (O)	No. Villagers complain about the lack of this (I)	Yes. New, big and very well equipped. (O, I)

Socio-Cultural Asset / Financial Asset / Human Asset / **Physical Asset (Infrastructure)** / Natural Asset / Hot

Annex 2. Participatory Landscape Analysis

1. PaLA at community level

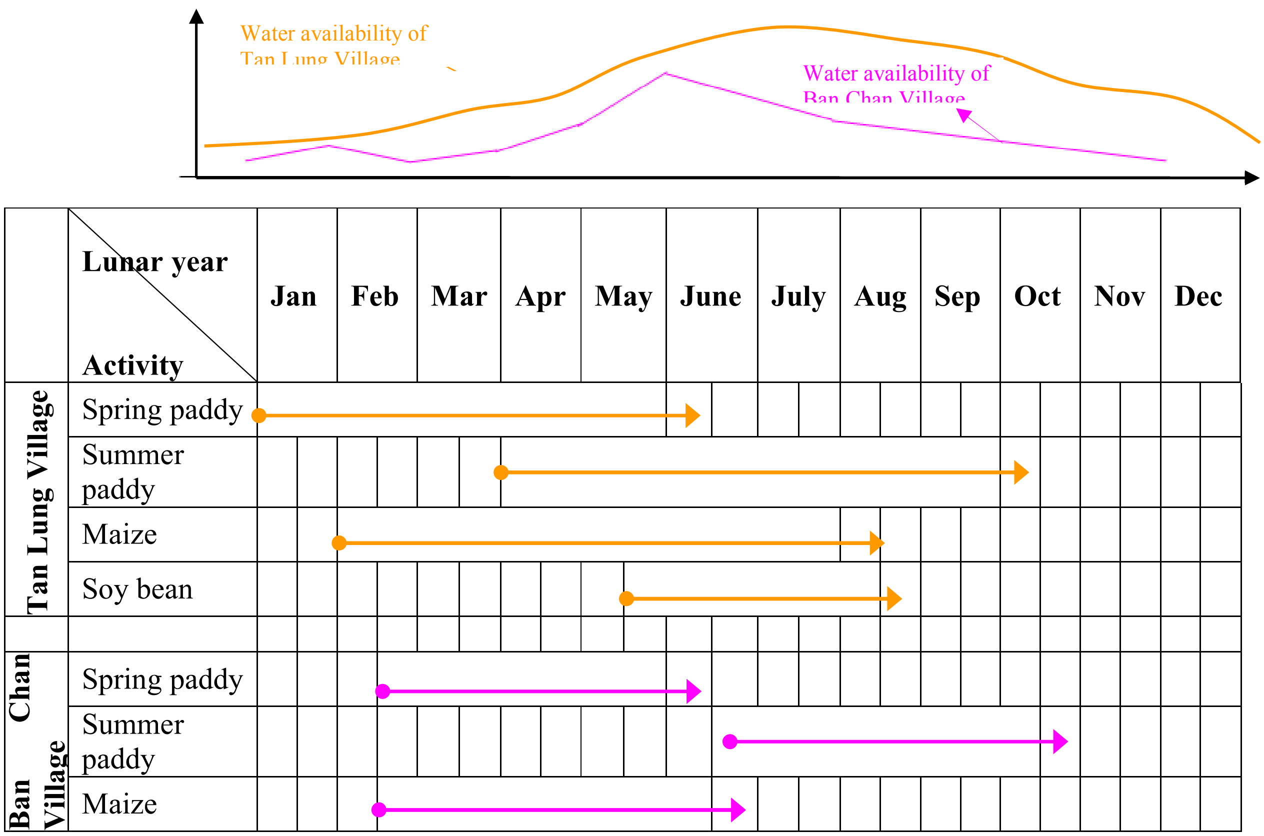

Figure 10. The relationship between Tan Lung and Ban Chan villages in term of water at household level.

2. PaLA at household level

2.1 Village sketch

- Vừ A Cho house -250 m2 Vừ A Cho rice field -7000 m2 Vừ A Cho slope land field

Figure 11. Map Tìa Ghênh C village, include Vừ A Cho household. *Source: Scoping survey for JICA project in Đien Bien, 2010 and household interview 2/2011*

Table 22. Locations of sloping land fields of three surveyed households in Tìa Ghênh C village.

Name of household	Name for their sloping land fields
Vừ A Cho	Sloping land field Háng Chơ
Vừ Chờ Chu	Sloping land field Háng Chơ
Ly Sông Chìa	Sloping land field Sa Mẳn hill foot

2.2 Questionnaires at household level

Table 23 and 24 describe questionnaires completed for households and tables for surveying characteristics of each paddy field in Vừ A Cho houshold, Tìa Ghênh C village

Table 23. Filled questionnaire Vừ A Cho houshold, Keo Lôm commune.

Questionnaire for houldshold

Province: **Điện Biên** District: **Điện Biên Đông** Commune: **Keo Lôm** Village: **Tìa Ghênh C**

Name of Farmer: **Vừ A Cho** Sex**: Nam** Age: **2**1 Ethnicity: **H' Mông**

1. Household characteristics

1.1 How many people are living in your household: 3 people 1 male 2 female, people of labouring age: 2

What is your main income activity?

- Agriculture: **upland rice and wet land rice.**
- Forestry
- Trade
- Salary/Wage labour
- Retirement Pension
- Other (please specify)

1.2 If agriculture is your main activity, what crop(s) give you most money?

Upland rice
Wet land rice
Maize

2. Farming

2.1 For how long have you been farming?

10 years

2.2 What is your total farm area? How many plots? **2 plots**

Wet rice: 250m2 (1 plot)

Rice rettace: 7000m2 (1 plot)

2.3. What are the main limitations for good yields?

- Soil fertility, soil erosion: **soil erosion**

- water (access to irrigated/stream water, water collecting…), rainfall: **Use stream water for wet rice and rain water for rice terrace**

- size of fields, access to fields, access to inputs, access to transport road systems: **wet rice near house, upland rice far from house and road**

- health, labour: **both husband and wife have good health, the wife was hospitalized last year due to eye problems**

2.3.1 How have these limitation factors changed over the last 5 years?

Reduction in water quantity

Redution in soil fertility

Germplasms have reduced quality

2.4 Do you know whom to contact for answers to your questions related to soil fertility and soil erosion?

No

3. Tree planting and Agroforestry practices

3.1 Do you have trees (forestry trees, industrial trees, and fruit trees) on your farm? Yes **No**

Want to plant trees but do not have land, if land is available, will plant Eucalyptus because they have seen a household in the village that planted Eukalyptus, which grew very fast.

Do not want to grow Acacia, because acacia grows slowly.

They have seen several households' plant fruit trees but have not been able to sell products.

3.2.1 Have you planted the trees yourself? Yes **No**

3.2.2 If yes, which species do you plant? ……………………….

3.2.3 Where do you plant? ……………………………………

3.2.4 What planting material did you use?

- Seeds: own farm, market, neighbours/fellow farmers, NGOs/research
- Seedlings: collected from nature, purchased, raised in own nursery
- Grafts: purchased, raised in own nursery

3.3.1 Have you ever raised your own nursery for trees? Yes **No**

3.3.2 If yes, which difficulties did you encounter? …………………………………….

3.4 Which difficulties do you have with taking care of trees on your farm?

3.5 Do you know whom to go to for answers to your questions related to propagation and management of trees on your farm?

Would you be willing to plant more trees? Reasons? Which species? Where?

4. Marketing of tree products

4.1.1. Do you sell tree products? **Yes** No

4.1.2. If yes, which products? **Upland rice** ……………………………

4.1.3. In which markets do you sell these tree products? **To traders in the village**

4.1.4. Who brings the products to the market/buyers? **The husband**

4.1.5. Are tree products sold separately or with other food items? **Yes, seperately**

5. Extension

5.1 Where/from whom do you learn about improved farming techniques?

- From family: **yes, in most cases**
- Other farmers
- Farmer groups
- Government extension worker: **participated in training classes in the village but have forgotten because did not keep traininig material and did not take note during the training**
- NGOs/projects
- Media (TV, radio, newspapers)
- Others (please specify)

5.2 Which of the above sources are most important for your learning?

1st **Household;** 2nd………………………; 3rd…………………………..

6. Income sources and expenses (household budget calendar)

Income

1. List all sources of income for the household (let respondent talk but probe if you think they have forgotten something)
   - Cash crops, short day trees, food crops (rice, maize, cassava etc.), and trees: **upland rice (sell early if harvest exceeds household consumption needs)**
   - Trade
   - Salary/wage labour
   - Retirement/ pension
   - Other

2. Ask to rank by order of importance: **only upland rice**

3. Indicate on the calendar the amounts received per source of income and per month

Expenses

1. List all expenses made by the household (let respondent talk but probe if you think they have forgotten something)
   - Food
   - Other daily household expenses: soap, salt ,… **Monthly**
   - Clothes: **buy to celebrate the new year holiday**
   - Farm implements (tools) and inputs (fertiliser, pesticides, seeds, …)
   - Health: **Had to go to the central hospital once**
   - School fees
   - Transport: buy motorbike fuel to go to the terrace and to travel daily
   - Leisure (eg. drinks, cigarettes)
   - Construction & repairs, house and kitchen equipment (eg. TV, radio, bicycle)
   - Other

2. Ask to rank by order of importance.

3. Indicate on the calendar the amounts spent per month.

INCOME

ITEMS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upland rice									=500.000 VND (18 bags for using, 2			

									bags for selling)			
Wet rice										2 bags for household consumption		

EXPENSE

ITEMS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily necessities	20.000 VND/month *12 months = 240.000 VND/year											
Fuel cost for daily travel	40.000 VND/month *12 months = 480.000 VND/year											
Fuel cost for transporting harvested products from upland fields									200.000 VND			
Health care costs							1 million VND					
Clothes	1 million VND											

Source: Household survey, Keo Lôm, 02/2011

Table 24. Survey form for farm plot characteristics Vừ A Cho, Keo Lôm village**.**

Farm/upland plot characteristics of household

Province: Điện Biên District: Điện Biên Đông Commune: Keo Lôm Village: Tìa Ghềnh C

Farmer: Vừ A Cho Gender (Female, Male): **Male**

Plot 1: Wet rice field closed to the house

Current cultivation?	Terrace, wet rice□cultivation
Land owners□ip (red book, tax□)	inherited, red b□ok
Estimated area (Ha or m^2)	250m^2
Altitute	High (>800m) **Medium (600-800m)** □ Low (<600m)
Slope	20^0
Tree species and short day food crops being cultivated in this plot	Wet rice (strain 64)

Cultivation history in this plot (what was planted before)	It was forest land before being converted to terraces for wet rice cultivation Now planting wet rice 1 season/year
Current agroforestry systems being applied	None
Changes to soil type and soil fertility in the last 5 years	Rice productivity is decreasing due to soil becoming less fertile and tougher Some areas are no longer suitable for planting upland rice
Have there been changes to water sources and irrigation water in the last 5 years?	Irrigation water has become increasingly scarce
Current issues	Water shortage Degenerated soil due to lack of fertilizer application
Opportunities (future plans for the field)	Considering alternatives plants if the land is no longer cultivable for rice

Plot 2: Upland rice field in Háng Chơ area (Banana forest)

urrent cultivation?	Upland rice
Land ownership (red book, tax…)	Inherited, no red book
Estimated area (Ha or m^2)	6000 – 7000m2
Altitue	C High (>800m) **Medium (600-800m)** Low(<600m)
Slope	Above 30^0
Tree species and short day food crops being cultivated in this plot	Upland rice or Maize (1season/year)
Cultivation history in this plot (what was planted before)	"Banana" forest → slash and burn, shifted to upland rice cultivation → Fallow →2008 planted mize→209,2010 planted uplnd rice
Current Agroforestry systems being applied	None (monocultivation with maize or upland rice)
Changes to soil type and soil ferility in the last 5 years	The soil in this plot is good compared with others in the village Soil is becoming less fertile, tougher and prone to erosion
Have there been changes to water sources and irrigation water in the last 5 years?	Totally dependent on rain Rain water becomes scarcer Soil becomes drier
Current issues	Soil fertility is getting more and more degenerated, decreasing water, rodents destroy crops→ Upland rice productivity is reducing Want to grow one more maize season but it is the time for cattles grazing, so have to leave fallow land
Opportunities (future plans for the field)	Next year will grow upland rice →then grow hybrid maize for three years without applying fertilizers →then have to apply fertilizers for hybrid maize. When this land area is unarable, move to another land area (inherit or slash and burn). What plants to grow are not decided based on discussions with neibouring households.

Source: Household survey, Keo Lôm, 2/2011

3 Data analysis

Results from surveying six housholds in Tìa Ghênh C and Huổi Múa A villages were analyzed and presented in Table 6.

Table 25. Household survey results in Tìa Ghênh C and Huổi Múa A villages, Keo Lôm commune

	Poor households		**Medium households**		**Better off households**	
Indicator	**Vừ A Cho, village Tìa Ghênh C**	**Lò Thị Chanh, village Huổi Múa A**	**Vừ Chờ Chu, village □□a Ghênh C**	**Sổng A Chẩu, village Huổi Múa A**	**Ly Sông Chìa, village Tìa Ghê□h C**	**Lò Văn Hoan, village Huổi Múa A**
Part 1: Synthesis from household survey						
Social p□rameter:		□				
Total people (□ersons)	3	1	6	4	7	4
Pe□sons in labour ag□	2	1	3	2	□	3
Age of household owner	21	43	37	45	58	51
Ethnicity	H'mô□g	Thái	H'm□ng	H'mông	H'mông	Thái
Economic parameter:						
Income sources	Upland rice	Upland rice, wage for child care activities	Upland rice, maize, cassava, cows/buffalo raising	Upland rice, maize, labour selling	Wet rice, upland rice, maize, cassava, cows/buffalo/pig raising, salary, social support for disable person	Wet rice, upland rice, maize, cassava, cows/buffalo/pig, fish, labour selling
% income based on (on-farm) agriculture (% total income)	100	14	100	93	73	95
Total agriculture land area (m2)	7250	1500	33000	4600	55000	>50300

Number of farming plots (rice field and home gardens)	0	0	0	1 home garden	1	5 rice fields, 1 home garden
Number of upland plots	1	1	7	3	3	4
Market for food crop	Traders in the village	Not selling	Traders in the village	Traders from outside	Traders from outside	Traders from outside
Market for livestock	-	NA	-	Family need	Traders from outside	Traders from outside
Total forestry area (m2)	0	0	0	0	0	0
Forestry trees and long day trees	Not grow	Not grow	“Vối thuốc” (Schima wallichii Choisy), “ban trắng” (Bauhinia variegate), “Thôi chanh” (Alangium barbatum)	A□acia, fruit trees	Peach,□plum, jackfruit	-
Germplasm sources for □orestry □□ees and long day trees	NA	NA	Extension service	Provided by government	Provided by government	Set income
Market for forestry trees and long day trees	NA	NA	For f□mily use	Not harvested yet	For family use	-
Agriculture practice	10	33	19	35	50	8

experience (year)						
Learn agricultural techniques	From family	From community	From community and extension staff	From family, community, extension staff and training	From family, community, extension staff , projects and mass media	From family and training courses
Total income 2010 (not including foods for household consumption) (millions VND)	0,5	5,4	14,7	3	59,78	18,1
Total expense 2010 (millions VND)	2,42	2,75	5,98	9	21	11
Part 2: Summary from survey form on farm plot characteristics						
Land use types						
Farm field (Home garden) (m2):	Farm: 250	Not have	Not have	Home garden + fish pond: 600	Farm: 4000	-
Land tenure status	Inherit, have red book	NA	NA	-	Red book	Allocated, not yet have red book
Altitute (m)	600-800	NA	NA	600-800	600-800	600-800
Slope (degree)	20	NA	NA	-	-	10
Main plants	Wet rice	NA	NA	Euphoria, longana, mango	Wet rice	Farm: wet rice
Productivity	4	NA	NA	-	2,2	-

(ton/ha)						
Agroforestry models being applied	None	NA	NA	Fish pond-fruit tree	Garden-Fish pond-Livestock	-
Current issues	Water shortage, soil degradation	NA	NA	Water shortage, degenerated germplasm	Water shortage, soil degradation, pests, lack of good germplasm and modern technology	Water shortage for agricultural production
Upland fields (current area in use) (ha):	7000	1500	17000	2500	51000	-
Land tenure status	Inherit, no red book	Inherit, red book	Allocated, no red book	Upland field from slash and burn by the family, no red book	Allocated, no red book	Allocated, no red book
Altitute (m)	600–800	600–800	600–800	-	600–800	600–800
Slope (degree)	>30	<5	15 – 20	20-30	<30	10-20
Main plants	Lúa nương	Upland rice	Cassava, upland rice	Upland rice, maize	Cassava, upland rice, maize	Cassava, upland rice, maize
Productivity (ton/ha)	1,43	1	-	Rice: 3,2	Upland rice: 1,2	-
Agroforestry models being applied	None	None	None	None	None	None
Current issues	Soil erosion and degradation, drought, destruction by rodents	Soil degradation, lack of labor, water shortage, degenerated rice germplasm	Soil degradation, drought	Drought, flood, pests	Drought, soil degradation, pests	Soil degradation, drought

Fallow upland area (m2)	0	0	16000	1500	0	0
Major crops/plants	NA	NA	"Vối thuốc" (Schima wallichii Choisy), "ban trắng" (Bauhinia variegate), "Thôi chanh" (Alangium barbatum)	Acacia	NA	NA
Forest (ha)	0	0	0	0	0	0
Note: (-): Information not available (NA): Not applicable						

Source: Household survery at Keo Lôm commune, 2/2011

Annex 3. Auctions and Reverse Auctions

1 Vickrey auction model

In this model, farmers have an incentive to reveal their true opportunity cost of land use change and the project manager can use the bids to select the lowest cost providers, but still give them a higher payment. The model works as follows. If there are 100 farmers and they bid in an auction. Once all the bids have been made, the auctioneer orders these bids as follows:

$$f_1 < f_2 < f_3 < \ldots\ldots < f_{100}$$

where, 'f_1' is the farmer with the lowest bid and 'f_{100}' the highest bid. This means that farmer 'f_1' is the lowest cost provider for an environmental service while farmer 'f_{100}' is the maximum cost provider.

For example: the price for the lowest cost farmer (f_1) is \$1, the price for the second lowest cost farme (f_2) is \$2, and so on until the price for the highest cost farmer (f_{100}) is \$100. If the project manager contracts with all farmers, and pays them discriminatory payments, the total cost is:

$$\$1 + \$2 + \$3 + \ldots\ldots + \$100 = \$5{,}050$$

However, the local farmers may not like it since they receive different payments, with some receiving very little. As an alternative, in the uniform payment system, all farmers will receive the same payment, which is equal to the highest payment of \$100 each, so the total cost for the project will be \$10,000. Now suppose that the project manager only has a budget of \$2,000. Following the auction process and the uniform payment system (under Vickrey model), the lowest rejected bid is \$45, and so 44 farmers starting from 'f_1' to 'f_{44}' will all receive \$45 each for a total cost of \$1,980:

$$\$45 \times 44 \textit{ farmers} = \$1{,}980$$

This means that even though the bid of farmer 'f_1' is \$1, and the bid of farmer 'f_2' is \$2 and so on, each farmer receives the same \$45 each. Therefore, by receiving the same amount of money, local farmers may find it fairer than discriminatory payments, while the PES project is able to utilize the budget well by identifying and selecting the lowest cost suppliers.

2 Results

Table 26. Mean values for households that participated in the field auctions (n = 251).

Variable	Mean	Standard Deviation	Minimum	Maximum
Male headed HH (0/1)	0.69	0.46	0	1
Age of the HH head (years)	43	14.85	16	90
HH size (number of people)	7	3.1	1	17
Education of HH head (years)	4	3.4	0	10
HH head born in the same village (0/1)	0.79	0.40	0	1
Farm ownership (number of plots)	5	2.6	0	17
Farm ownership (area in ha)	3.56	5.24	0	70.92
Total agricultural expenditure (\$)	129.30	230.40	0	1910.20

Animal ownership (livestock units)	0.16	0.33	0	2.58
Value of assets owned ('000 TSH)	250.60	1691.44	0	24,260

Table 27. Trade-offs from different targeting approaches.

Auction round	Targeting approaches	Cost of contracting (in thousand TSH) under different enrollment targets[a]		
		25%	**50%**	**75%**
Round 1[b]	Efficient	2802.7	9287.8	18351.8
	Pro-poor	8041.5	17162.5	27326.8
		(5238.8)	(7874.7)	(8975.0)
Round 2[c]	Efficient	2593.5	8963.5	17713.5
	Pro-poor	7463.5	15793.1	25769.6
		(4870.0)	(6829.6)	(8056.1)

[a] Figures in parentheses represent loss in efficiency with respect to cost of enrollment under least-cost targeting.

[b] In Round 1, there were a total of 251 valid bids, each corresponding to 0.2 ha. The total acres that could potentially be contracted was 50.2 ha. Therefore, 25% enrollment target corresponded to 12.55 ha, 50% to 25.1 ha, and 75% to 37.65 ha respectively. [c]In Round 2, there were a total of 247 valid bids. So the total number of acres that could potentially be contracted was 49.4 ha. Corresponding acreage for 25%, 50%, and 75% was 12.35 ha, 24.70 ha, and 37.07 ha respectively.

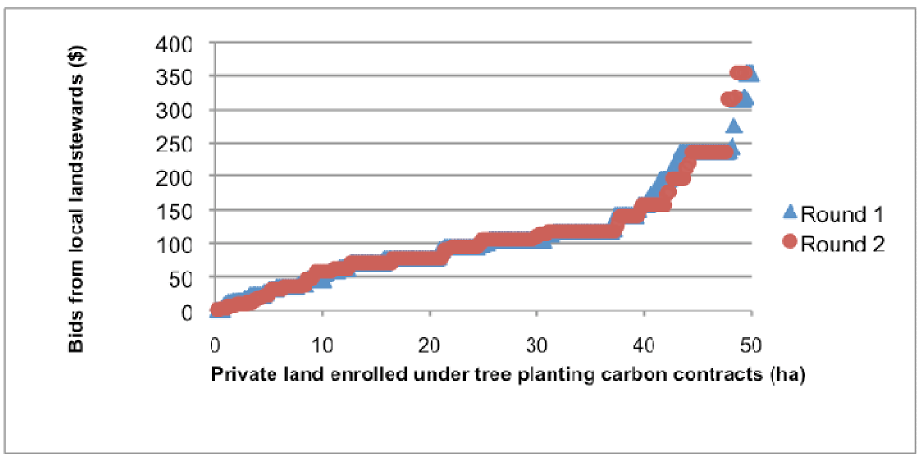

Figure 12. Cost of enrolling land for tree planting carbon contracts. The upward sloping supply curves with bids from the two rounds mostly overlap with each other.

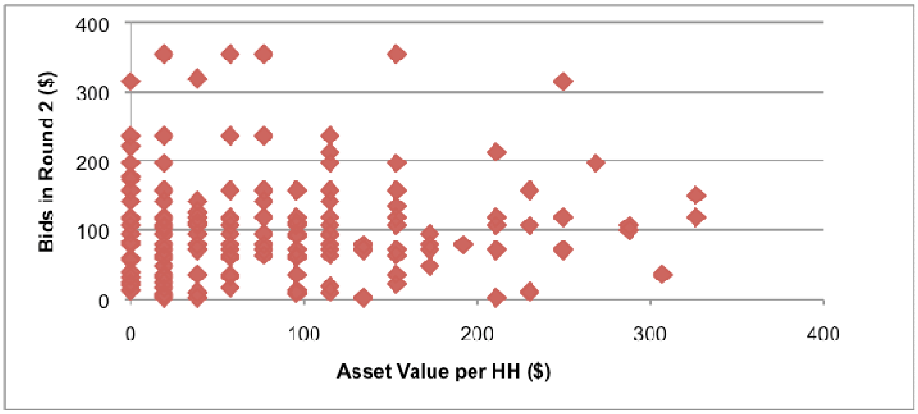

Figure 13. Relationship between the wealth status and the auction bids. The plot of wealth status against farmers' bids in the auction shows that many poor households with assets less than $39.40 in value hag a low opportunity cost in terms of their bids and were therefore enrolled in carbon contracts

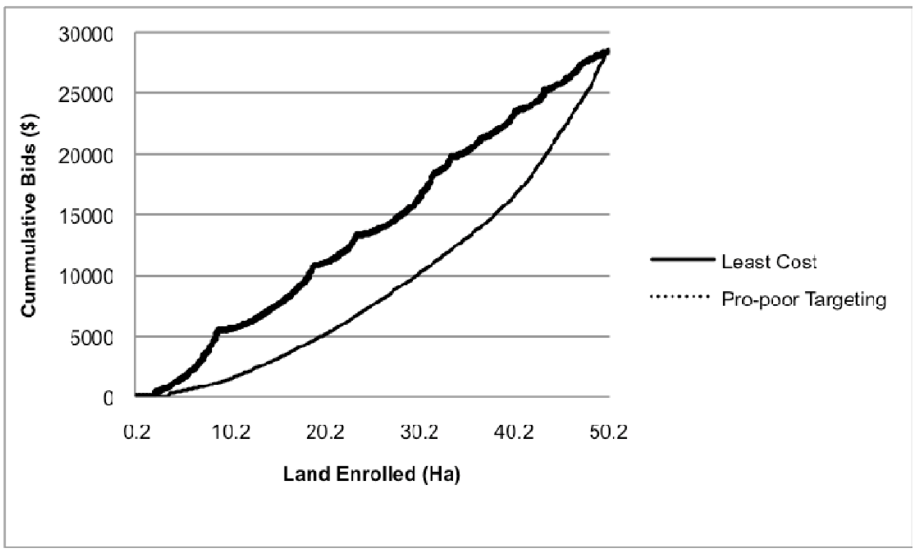

Figure 14. Trade-offs in pro-poor targeting of PES contracts (Round 1).

For a project that would specifically like to contract poorer households first, there would thus be efficiency and budgetary implications. Figure 14 shows the tradeoffs when least-cost targeting is replaced by pro-poor targeting in which irrespective of the auction bids, the poorest households are contracted first followed by the wealthier ones. As we can see the cumulative cost curve for least-cost targeting is significantly lower than the pro-poor cost curve, which indicates that enrolling poorer households first would require additional budgetary allocation. It is important to note that this is not a recommendation to take an ethical stand on whether or not PES projects should target poorer households first, but rather to make it clear that policy makers and buyers of environmental services should be prepared to bear additional cost if such a choice is made. For instance, based on auction results from round 1 (where 100% enrollment corresponds to 50.2 ha), enrolling 25% of the potential land (i.e. 12.55 ha) would induce an additional cost of $4,125 under pro-poor targeting (table 27).

Table 2 also reports trade-offs at higher enrollment levels, though the two curves merge at 100% enrollment[17].

These estimates should however be used with caution when projecting actual budgets, because: (1) the estimates are based on auction results where bidders were informed that contracts would be awarded on the basis of the bids (or the opportunity cost of a specific land parcel) alone. If the bidders were to know that their bids would instead be ranked using a poverty score, they would have reason to strategically increase their bids to maximize their gains from the scaling criteria. (2) Similarly, in the auction, we selected winners using the uniform pricing rule (each contracted household received the lowest rejected bid) while the trade-off analysis conducted above is based on discriminative payments, where each household receives a payment equal to its opportunity cost. Again, bids would change if bidders knew that contracts would be allocated under a discriminatory payment system.

[17] The same process can also be used to estimate budgetary allocations and trade-offs for contracting plots of land that are considered ecologically more vulnerable or higher priority than others.

Annex 4. Step by step manual for applying RACSA

1. Step 1: Initial appraisal of landscape

An essential purpose in RaCSA is to understand local perceptions on their landscape such as: land cover, land use, land use sytem, and land use management that are important for their life, and activities that lead to changes in landscape.

Objectives:

- Understand stakeholders and their motivations in research area
- List of land use types, land cover, and land use systems
- Identify where and when information for each land use type, land cover and land use sytems, and who participates in activities (according to seasons and rotations) in the area
- Examine plans in reality as compared to management, regulations and implications of land use planning, land use rights
- Identify relevant history, socio-economics and cultural aspects
- Identify land use change and factors that affect land use change
- Identify challenges and opportunities for the sustainability of livelihoods
- Identify frequency, intensity and characteristics of conflicts and forest fire

Secondary data needed:

- Satellite maps, land use maps, land cover maps, GoogleEarth maps
- Maps for transport infrastructure, residential area, administrative boundaries
- Geographical maps

Activity:
Interviews and focus group discussions with stakeholders from governmental organizations, scientists, and land use managers (including farmers and other land owners)

Results:

- Sketches/maps of each land use type, vegetation cover and land use system in each time period, land management, and land use planning by government
- Map legends
- Interview data and survey results

2 Step 2: Land use planning

Spatial planning which divides the total area into different land cover types and areas can create substantial differences and risk in final options. Several aspects need to be considered in order to introduce a meaningful classification system and proposal for planning and quantifying Carbon sequestration in a landscape. Three main factors are: (i) vegetation cover/land cover, (ii) non-human factors that affect productivity and species composition such as altitude, climate, soil, geography and (iii) human factors that affect biomass types, species composition, growth, and create changes.

Management types are important parameters for planning, but as they cannot be detected from satellite images, supporting data is required. This includes base maps, policies, regulations, spatial analysis and data on local context. This is particularly relevant in areas which allow forest use, agriculture and the harvest of trees for wood.

In summary, land cover types selected for research should be based on:

- a meaningful classification approach to assess Carbon sequestration value. Sample plots need to be consistent to represent characteristics of all land use types
- classification and planning based on ecological factors (for example soil and climatic area) and human factors
- replicate samples, for example different geography in one river basin
- a data source that combines local ecological knowledge and base maps
- integrated participatory mapping with available spatial data.

3. Step 3: Determine number of sample plots and design random plot system

Calculate number of plots needed according to a multi-layer statistical standard as follows:

+ Maximum number of plots in the area

$$N = A/AP; N_i = A_i/AP$$

Where: N = maximum number of plots in the area; A = total area for each land use status (ha); AP = plot area (ha); Ni = number of maximum plots for status i; i = status index; Ai = area for status i (ha)

+ Total number of plots in the area

$$n = \frac{\left(\sum_{i=1}^{L} NiSi\right)^2}{\frac{N^2E^2}{t^2} + \sum_{i=1}^{L} NiSi^2}$$

Where: n = total plots in the surveying area; i = index for a status from 1 to L; L = total number of statuses; Ni = maximum number of plots for status i; Si = standard error for status i; N = maximum number of plots in the area; E = predefined error; t = value of the distribution function at confidence interval of 95%, t normally = 2 if the plot size is unknown.

$$ni = n.\frac{Ni.Si}{\sum_{i=1}^{L} Ni.Si}$$

Where: ni = number of plots for status i; i = index for status from 1 to L; n = total number of plots in the area; Ni = maximum number of plots for status i; Si = standard error for status I; L = total number of statuses.

To ensure objectiveness in estimating carbon stock, plots need to be randomized on the map, thereby obtaining defined coordinates for each plot as a basis for a field survey to collect data on tree biomass to estimate and monitor forest carbon changes. Randomisation of plots can be done using functions to create random points on ArcGIS.

Number of fixed sampling plots depends on forest area and status as defined in step 1 and 2. Sizes and shapes of sampling plots must be consistent for the whole research area.

4. Step 4: Field survey

This step includes measuring activities on field and subsequent data analysis. Data consists of information at plot and individual tree level. At plot level, the most important data is: plot history, especially present plot age and plot position. Plot age is useful for assessing time average carbon stock. This information can be collecting by interviewing land owners or local people living around the plot. The plot position, which is determined by GPS, is important for linking/assessing accuracy between reality and spatial data.

Above ground carbon stock (live trees, shrubs, dead trees, and necrosis) and underground (roots, and soil at 15 cm layer) are determined for different forest status' or land use types in research area. Carbon stock in different land use types is measured in time series or trend for land use change. Use the approach "Various land use types across different spatial location can tell the history" to determine C sequestration in a chain of land use changes.

Measurement methods and analysis are described in Kurniatun Hairiah (2001).

+ Establish plots for measurement

Plots are established using nested design. Trees with large diameter (breast height diameter at position 1.3 m from the ground =dbh > 30 cm) are measured in a rectangle 20 m x 100 m = 2000 m^2 (plot level 1), smaller trees (dbh from 5–30 cm) are measured in secondary plots 5 m x 40 m = 200 m^2 (plot level 2) within plot level 1, and shrubs and necrosis are measured in smaller squares (Figure 1).

For plantation forest systems with low density (from 300 to 900 trees/ha) establish plots of 500 m^2 (20 x 25 m) instead of 200 m^2. Plots are selected in a 1 ha area, avoiding boundary lines except for pre-determined plots. Selection is randomized.

Measuring biomass in this approach includes destructive and non-destructive methods for necrosis, shrubs, and wooden trees.

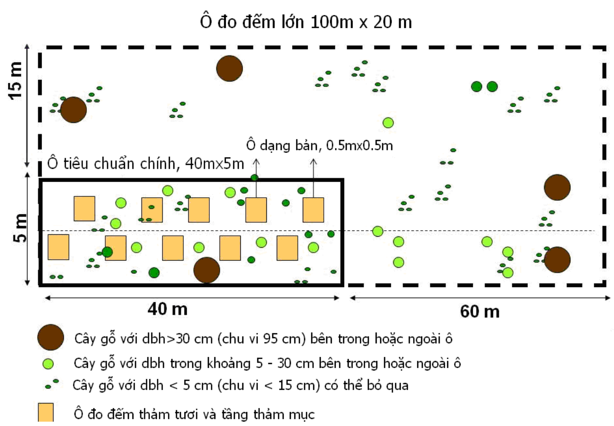

Figure 15. Allocation of measuring plots. 40mx5m = main sample plot (continuous line). 100mx200m = large sample plot (dotted line). 0.5mx0.5m quadrat (yellow). Brown circle = big wooden trees with dbh >30 cm (perimeter >95cm) in and outside main sample plot. Green circles = wooden trees with dbh from 5–30 cm. Blue circles = small trees with dbh <5 cm.

a. Life biomass:

Trees store large Carbon stock in their above ground biomass (shoots, branches, leaves) and underground parts (roots). Measuring C stock from trees starts by quantifying biomass then converting to C stock by multiplying biomass to a converting parameter.

(1) Above ground biomass (trees with dbh >30cm and 5cm< dbh <30cm)

Use non-destructive measurement. Calculate biomass based on existing formulas.

Steps

- In level 1 plot, measure dbh=D (1.3 m) of all trees with dbh>30cm; in plot level 2 measure all trees with dbh >5 cm to 30 cm. Can measure perimeter then convert to diameter.
- Perimeter can be converted to diameter using following formula:

d = Chu vi/ (=~3.14)

- Write down scientific names and local names of all trees, which will help determine wood density later.
- Write down all measurements to fill form 1A for big trees (dbh >30 cm) and form 1 B for small trees (dbh >5 cm to 30 cm)
- Use measured values for calculating above ground biomass with the following formulas:

  - For natural forest: $Y = 0.118\ D^{2.53}$ (Brown *et al.*, 1989)

  (Y = biomass, kg/tree; D = dbh, cm)

  - For plantation forest and agroforestry systems:
  $Y = 0.11\ \delta\ D^{2+c}$ (Kettering *et al.*, 2001)
  (Y = biomass, kg/tree; D = dbh, cm; δ = wood density= 0.5, g/cm^3; $c = 0.62$)

(2) Measure root biomass using allometric equation
Under ground root biomass = above ground biomass/SR ratio
(SR ratio = Shoot:root ratio = 4:1)

Equipment for tree measurement
1. Line for center of transect, 50m, 40 m and 5m long for standard plot
2. Sticks to measure width, 2.5 m long
3. Wooden sticks of 1.3 m length
4. Measurement tape (linear or special ones for tree diameter/perimeter)
5. Knife
6. Tree height measurement device (e.g. 'Hagameter' or Suunto clinometer, optional)
6. Tools for measuring diameters of small trees 7. Dao chặt
8. Pencil, labeling pen
9. Chalk to mark measured trees
10. Survey form
12. GPS

b. Estimate other dead and alive above ground biomass
In forest and agricultural ecosystems, C is stored mainly in vegetation biomass (above and underground) and in soil. Above ground biomass include all wooden trees, branches, leaves, liana, shrubs, and green vegetation. For agricultural land, biomass consists of planted trees and weed. C sink for dead biomass (necromass) include dead felling trees, raw broken wooden parts, necrosis and coal (or parts left over after fire) above ground.

(1) Measure understorey biomass
Understorey biomass include: wooden trees with diameter <5cm, regenerated trees, shrubs, fresh small vegeration.

Procedure
On a 5mx40m plot, establish 8–10 squares of 0.25 m^2 each. Cut all plants inside each square. Determine fresh weight = FW on field ($g/0.25\ m^2$). Chop into small pieces and mix well before sampling. Take a representative 100g fresh sample, keep in a paper bag, dry the sample to determine dry weight (DW). Fill in form 2.

Box 1. Example for measuring understorey biomass

In a plot 0.25 m^2 , obtained 750 g FW, took 100 g, dried in a drier at 80°C in 48 hours, and got DW = 55 g. Thus, total dried weight was = 55 g/100 g x 750 g = 412.5 g in the plot 0.25 m^2 . Total DW for: 1m^2 = 412.5 g x 4 = 1650 g/m^2 = 1.65 kg/m^2 = 16.5 ton/ha

(2) Dead trees are one part in dead biomass

Procedure

- Within the plot of 200 m2 (5x40 m) all trunks (unburned part), dead standing trees, dead trees on the ground and stumps are sampled that have a diameter >5 cm and a length of > 0.5m.
- If the dead trees having diameter > 30 cm present in the measuring plot, it is required to measure at bigger plot (20 mx 100 m) and measure all dead trees with diameter > 30 cm.
- Their height (length) is recorded within the 5 m wide transect (see Figure 6) and diameter (halfway the length included), as well as notes identifying the type of wood for estimating specific density.

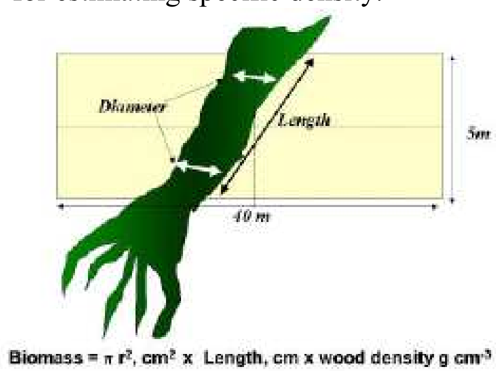

Figure 16. Estimate felling tree biomass by multiplying volume to wood density

(3) Necrosis

Procedure

- Collect all necrosis in plots of 0.25 m^2 (plots that have other understorey samples collected). Measure weight in two steps.
- Coarse litter, (any tree necromass < 5 cm diameter and/or < 50 cm length, undecomposed plant materials or crop residues, all unburned leaves and branches) is collected in 0.50 m x0.50 m quadrats (0.25 m2), on a randomly chosen location within the understorey sample.
- All undecomposed (green or brown) material is collected to a sample handling location. Fine litter: Subsequently collect the 0–5 cm soil layer in the same quadrats (including all woody roots) and dry-sieve the roots and partly decomposed, dark litter. If time allows, the sieving can be done on-site, but it may be more convenient to collect bags of the topsoil and process elsewhere.

Process necrosis samples

- To minimize contamination with mineral soil, the samples should be soaked and washed in water; the floating litter is collected, sun dried and weighed, the rest is sieved on a 2 mm mesh sieve and added to the fine litter fraction. Depending on the total amount, a subsample can be taken at this stage for obtaining an 'oven-dry' correction (oven at 80^0C). As alternative to the washing procedure, samples can also be ashed (at 650^0C) to correct for mineral soil contamination.

- The litter (incl. dead roots) and (live) root material collected on the 2 mm sieve (by dry sieving) is washed and dried. The soil passing through this sieve is collected as 0–5 cm sample for C_{org} or C fraction analysis. Analysis is carried out in laboratory.

Equipment needed to collect understorey samples, decomposed materials and soil

1. Plastic quadrat frame of 1 x 1 m and 0.5 x 0.5 m to collect understorey samples, decomposed materials
2. Metal quadrat frame 20x20x5cm^3, 20x20x10cm^3 and metal tubes (d = 5 cm, h = 5cm) to take soil sample
3. Spade, hammer, "bay" (a tool for digging soil)
4. Knives and/or scissors
5. Scales: one allowing weights up to 10 kg (with a precision of 10 g) for fresh samples and one with a 0.1 g precision for sub-samples
6. Marker pens, plastic and paper bags
7. Sieves with a 2 mm mesh size

c. Below-ground organic pools

The below-ground organic pools include soil-C, roots and microbial biomass.
Two types of soil samples can be distinguished:

- disturbed soil samples for chemical analysis (where the results will be expressed per unit dry weight of soil); the samples are normally 'composites' obtained by mixing small amounts of soil from different sub-samples; and,
- undisturbed soil samples for physical analysis, especially the 'bulk density' (specific gravity) of the soil which is essential to convert the soil dry weights into soil volume.

(1) Procedure for taking disturbed soil samples for chemical analysis

Field procedure

Locate sampling frames within the 40 * 5 m transect, as indicated in Figure 1, collect samples at three random sites along the central rope.

- Continue after removing the 0–5 cm (usually organic) layer and take samples of the 5–10, 10–20 and 20–30 cm soil depth. Approximately 1 kg of fresh is sufficient, combining soil from three patches within the 0.5 * 0.5 m2 sample grid.
- Soil samples from the same depth taken in the replicate sampling grids within a single transect can be combined directly in the field, or subsequently mixed in the sample processing site.

Sample processing

- Mix the composite sample thoroughly, and divide into 2 bags: 0.5 kg of fresh soil for chemical analysis and another 0.5 kg of soil for archiving; the remainder can be discarded.
- Air dry the soil of all three sub-samples by placing them in a shallow tray in a well ventilated, dust and wind free area. Break up any clay clods, and crush the soil lumps so that gravel, roots and large organic residues can be removed

- Sieve the soil samples intended for chemical analysis through a 2 mm sieve, and grind them in a mortar in order to pass through a 60 mesh screen.
- Write clear labels for each sample using a waterproof marker pen of each sample, and wrap into a second plastic bag to prevent it from physical damage during transportation. Send it to laboratory for chemical analysis.

Box 2. An example for calculation
What is the carbon stock (ton/ha) in the 10 cm soil layer, if soil density is 1.0 kg/dm^3 or 1.0 ton/m^3, and Organic Carbon ratio in the soil is 2.0%.
Soil weight in 1 ha = 100 m x 100 m x 0.1 m x 1.0 ton/m^3 = 1000 ton
Carbon stock stored in the soil = 1000 ton x 0.02 = 20 ton/ha.

(2) Procedure for taking (undisturbed) soil sample for soil bulk density measurement

- Use metal frame with a sharp edge and of known volume (20x20x5 cm^3) and (20x20x10 cm^3)
- Sample close to the sample sites for destructive samples, but avoid any place with possible soil compaction due to other sampling activities
- Remove the coarse litter layer and insert the first ring gently directly from the soil surface, to sample the 0–5 cm depth layer; if the sample could not be inserted smoothly (e.g. due to woody roots or stones), try again nearby
- Excavate the soil from around the ring and cut the soil beneath the ring bottom
- Remove excess soil from above the ring using a knife: first remove excess soil on top of the sample, then place a cover on top of the ring and turn it upside down to remove soil adhering to the ring and cut a smooth surface at the bottom of the ring
- Put all soil samples into a linen bag and weigh (W1 =g/2000cm3)
- Repeat for the 10–15 cm depth layer
- Collect about 6 (18) per land use sample

Calculation

Soil volume (V) = 2000 cm^3
Volumetric soil water content (W) = (W1/W2) x (W3-W2) g
Soil density = W / V g/cm^3

d. Measure C stock at plot level

After calculating all C stock in all sample plots, we can summarise them in table 1 and estimate total cacbon stock in each plot level 1.

Table 28. Calculate total C stock in a plot level 1

Land use type	**Representative**	**Trees * ton/ha**	**Understorey ton/ha**	**Necromass ton/ha**	**Roots** ton/ha**	**Soil 0–5 cm ton/ha**	**Soil 5–15 cm ton/ha**	**Total C stock ton/ha**
		1	2	3	4	5	6	1+2+3+4+5+6
	1							
	2							
	3							
	4							
	5							
	6							

*= estimate tree biomass using allometric formulas
**=dry weight for root in 0–5cm layer.

Box 3. Calculate C sequestration

After all biomass has been converted to kg dry weight/ha. A total dry weight can be calculated and from that converted to C stock.

Formula:

$$W_{carbon} = 0.46*DW \text{ (kg/ha or ton/ha)}$$

Where:
W_{carbon} = C sequestration (kg/ha or ton/ha)
DW_T = Total dry biomass (kg/ha or ton/ha)
0.46 = a constant for converting that is accepted by ICCP (2003)

e. Time average C-stocks

In this case, information on carbon sequestration in different land use types (other than forest) will be used to calculate time average C-stock. The leakage or storage of Carbon in one system is not determined by its maximum value or a value at a particular time point but more accurately an average value according to time in a rotation of that system. Time average carbon can be assessed only for above ground C because data for roots and soil is not suitable for this type of assessment.

$C_{average}$ depends on: C sequestration speed, C maximum and C minimum, time to reach C maximum, time for each rotation of the system (Figure 3).

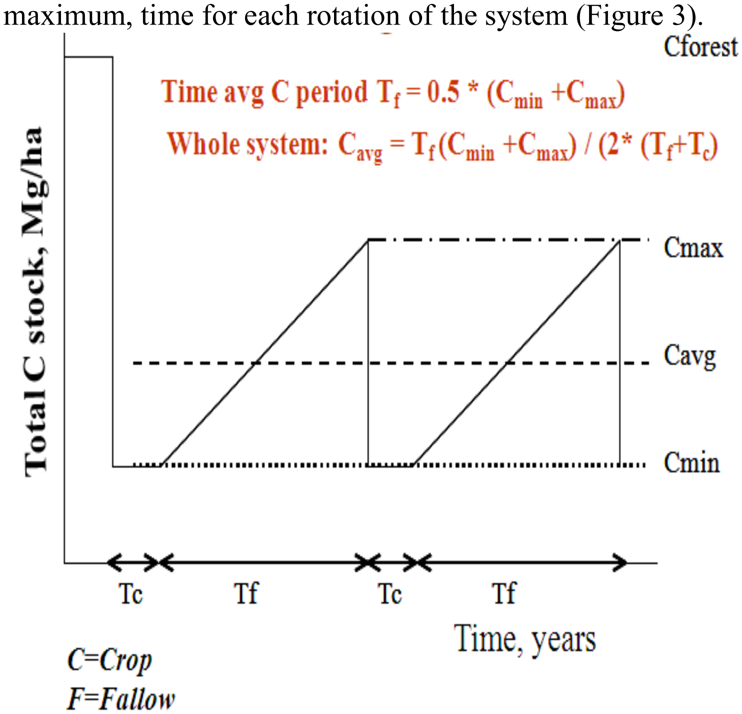

Figure 17. A graph for C stock changes and calculation for time average carbon stock after the forest was cleared and replaced by other systems: Cultivation – Fallow and plantation

5. Step 5: Analyze on the ground data and interpreting images and analyze changes

Use processed satellite images in combination with maps and surveys on field to find out gaps in plantation cover between map and reality. Analyze changes, then assess change in C stock. Extrapolate C stock for the landscape

This step requires GIS specialists and modelers.

6. Step 6: Upscaling

Combine data from all vectors for time average C stock for all land use types into a matrix showing changes including: current, future or past land use statuses. Develop scenarios on land use changes and C sequestration at plot and landscape levels. When impacts by CO_2 emission have been assessed, it is the basis to bring about solutions for negotiation between "buyers" and "sellers" in forest C service, and is useful data for different stakeholders.