YEAR 1 PROGRESS REPORT for APN PROJECT

EBLU2010-02NMY(R)-Takeuchi

Critical Analysis of Effectiveness of REDD+ for Forest Communities and Shifting Cultivation, based on Lessons Learnt from Conservation Efforts in Laos and Thailand

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Project Reference Number: EBLU2010-02NMY(R)-Takeuchi
Year 1 Progress Report

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Part One: Overview of project work and outcomes

1. Introduction and background:

Covering about 30 percent of the world's land area, forests are home to around 300 million people around the world, including many indigenous people. More than 1.6 billion people depend, to varying degrees, on forests for their livelihoods, e.g. fuelwood, timber, medicinal plants, forest foods, income and fodder, and for their cultural and spiritual identify. Forests sustain critical environmental services such as conservation of biodiversity, water and soil conservation, and climate regulation. In spite of the importance of forests, around 13 million hectares of forests were converted to other uses or lost between 2000 and 2010. Deforestation is estimated to account for almost 18% of global greenhouse gas emissions, as well as unimaginable loses in biodiversity, human and environmental well-being. Thus, the new global initiative for reduction of deforestation and degradation, including the role of conservation, sustainable management of forests and enhancement of forest carbon stocks or REDD Plus (+) has substantial potential to deliver co-benefits for climate mitigation, biodiversity conservation and livelihoods.

Successful REDD+ strategies are those that not only justify economic rationale for forest conservation versus alternative uses, but also provide positive incentives to those who live in/near forests and are dependent on forests for their livelihoods. This requires integrating and complementing traditional forest management and agro-forestry practices of many local and indigenous communities, rather than enforcing a barrier between them and their forests, as many forest conservation policies seek to do.

Traditional shifting cultivation often practiced in the tropical forests integrates a short cropping phase and a long forest fallowing phase in rotation. In the cropping phase many cereals, root crops and vegetables are cultivated to ensure a balanced diet for shifting cultivators; soil seed bank and tree stumps conserved through zero tillage to facilitate subsequent forest regeneration. In the fallowing phase forests not only produce various forest products, but also contribute nutrient inputs to soil through uptake from deep soil horizons and nitrogen fixation, sequestrate carbon, control weeds, and check soil erosion for the succeeding cropping phase. Apart from forest fallow, natural forests are maintained by shifting cultivators for timber production, water source and spiritual values. Over generation, shifting cultivators have created and accumulated profound knowledge on cropping as well as forest management. Nevertheless, shifting cultivation is under increasing pressure to shorten its forest fallowing phase and change to other land uses with implications on local livelihoods, carbon sequestration and biodiversity.

2. Participating countries:

The UN University, in partnership with National Agriculture and Forest Research Institute (NAFRI), Laos, and Chiang Mai University (CMU), Thailand, with the support of the Asia Pacific Network is undertaking a 3-year project to address the knowledge gap on potential opportunities and challenges of REDD+ for local communities to achieve co-benefits of carbon sequestration, biodiversity conservation and livelihood improvement in the shifting cultivation landscape. As part of the UNU network, the Jawaharlal Nehru University (JNU) has an ongoing research activity to assess land use and carbon storage dynamics in the shifting cultivation landscape in northeast India. The research sites of JNU will be associated to this project for sharing research experience. The project collaborators and contact details are:

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3. Objectives:

The aim of the APN project is to (1) assess the potential social, economic and environmental challenges and opportunities of REDD+ for selected communities in Laos and Thailand. Lessons will be drawn from past/ongoing forest conservation policies; (2) provide much-needed scientific evidence on the potential co-benefits of traditional forest management and agro-forestry practices and comparing it with alternative land-uses; and (3) develop participatory community-based MRV mechanisms for REDD+. Finding will assist the pro-poor design and implementation of REDD+, improve the well-being of forests dependent communities and integrate traditional agro-forestry as a climate change mitigation agenda.

4. Funding received for 2010/11:

Project duration: 3 years from 2011-2013
Funding received from APN for Year 1 in 2011: US$ 44,000

5. Outcomes and products against original proposal objectives:

According to the project document, the project targets in the Year 1 included (1) the inception workshop to finalize site selection, project framework and work plan; (2) the methodology training to develop national capacity for project implementation; (3) the field work to characterize project sites, classify and map land use as a basis for carbon stock measurement through collection and analysis of secondary data and field survey, and (4) planning for communication and advocacy of project findings in the policy arena. The inception workshop held in Chiang Mai, Thailand in January 2011 re-confirmed the above work plan, and agreed to build on the land use survey to test the carbon stock measurement methodology in Year 1 although carbon stock estimation was planned for Year 2 in the project document.

<u>Site selection</u>

The project aims to assess and compare co-benefits of three main land-use systems/landscapes in tropical mountains: shifting cultivation, transition from shifting to sedentary and sedentary cultivation and forest landscapes in order to identify potential for integration of traditional land-use systems within REDD+. The research sites will need to be selected to represent these land use systems/landscapes. In addition, the project seeks to develop participatory approaches to the community-based measurement, reporting and verification (MRV) and this project element will need the good cooperation with the communities in the study sites. As a pilot project on REDD+ for the UNU network on Sustainable Land Management in Mountainous Mainland Southeast Asia (SLM-MMSEA), it is cost-effective for this pilot project to build on the past research work of SLM-MMSEA . Soon after APN approval of the project, the project team met three national coordinators of the project separately in Tokyo, Japan and Shillong, India in December 2010 at the sidelines of the UNU-sponsored international workshops and discussed potential sites in Laos, Thailand and India. The research findings and good relationship are established with local communities through the previous collaborative research on transition of shifting cultivation at Laksip Village, Luang Prabang Province in Northern Laos will be a valuable base for the APN project to build on. It was agreed that Laksip Village should be selected as the study site of the APN project subject to final approval of the inception workshop (see below). Given that the previous study has accumulated rich information on assessment of agrodiversity and shifting cultivation at Tee Cha Village (a Pwo Karen Village in Sop Moei District of Mae Hong Son Province), it was proposed to select Tee Cha Village as the study site for the new APN project to build on the previous study and the established cooperation with local community. Characterization of both project sites, one each in Laos and Thailand was completed through review of secondary data and supplementary field survey. Characterization of both sites is described in details in **Annex1**.

In order to share experience across different countries in SLM-MMSEA, the project team discussed with the Indian partner to identify an associate project site in India with financial support from different sources. A research activity on the sedentary land use systems/landscape has been carried out in the Ratagad micro watershed, Indian Himalaya in Uttarakhand State of India to map land use/land cover changes and estimate carbon stocks in above-ground and below-ground compartments within each land use/land cover type. It was agreed to select the Ratagad micro watershed as associate study site for the new APN project to exchange carbon stock estimation method and experience. The Chinese partner of SLM-MMSEA has recently started a new Ford Foundation project to assess multiple ecosystem services of forest-shaded ancient tea gardens or tea forests in Mangjing Village in Southern Yunnan and promote it for the FAO's Globally Important Agricultural Heritage Systems (GIAHS). Inventory of high biodiversity and carbon stocks in the tea forests is a critical element of the Ford Foundation-funded project. It was agreed to select Mangjing village as an associate site for the new APN project to exchange information and experience with the Chinese partner. The project associate sites in India and China represent sedentary land use systems/landscapes in the mountainous regions.

<u>Project workshops</u>

As planned, two project workshops were organized this year as follows:

- **Project Inception Workshop,** 17-19 January 2011, Chiang Mai, Thailand. Project members reviewed and discussed the project goals and expected outcomes, and finalized the project framework, and confirmed selection of two project sites, one each in Laos and Thailand. Under the framework, project members discussed and agreed on the project work plan and responsibilities. The workshop proposed to review and develop a project methodology to guide land use survey and carbon stock inventory, and tested it this year. The methodology workshop was then planned to take place in Luang Prabang, Laos in June 2011. The workshop offered a good opportunity for the visiting project team members to appreciate different land uses and their ecosystem services, including rotational shifting cultivation practices in the Tee Cha Village, Northern Thailand. The project inception workshop report is attached as **Annex 2**.

- **Project Methodology Workshop,** 19-21 June 2011, Luang Prabang, Laos. In this workshop, different methodologies for carbon stock measurement at landscape level, and the proposed methodology for each project site in India, Thailand and Laos were reviewed and harmonized as the project methodology. The results of the workshop were then summarized as a working manual to guide carbon stock measurement in all project sites. During the field trip to the Laksip Village, the project team discussed and advised the Lao team to develop land use/land cover classification for carbon stock measurement and laying sample plots in the Laksip Village. The workshop provided a training opportunity for young researchers to learn about the methodology for carbon stock measurement in the forested landscape. The project inception workshop report is attached as **Annex 3**.

Land use survey

Each project site village represents a land use system and landscape with different land uses which support village livelihoods as well as provide ecosystem services. Tee Cha Village in Thailand represents the land use system of shifting cultivation, Laksip Village in Laos presents the land use system in transition from shifting cultivation to sedentary system. The associate sites in India and China represent sedentary land use systems. These land use systems create particular village landscapes and cover a mixture of land uses to detect and compare land use and carbon dynamics in MMSEA.

The village landscape analysis would aim to answer the questions: (i) which land uses encompass high levels of carbon stocks/biodiversity and what are the rates of losses or gains in carbon associated with different land use/management changes?; (ii) what are the factors driving conversion of high carbon stock/biodiversity land uses to low carbon stock/biodiversity land uses?; (iii) what opportunities and challenges are available for promoting conversion of low carbon stock/biodiversity land uses to high carbon stock /biodiversity land uses?; and (iv) what opportunities and challenges are available for promoting conservation of high carbon stock/biodiversity land uses?

As planned, land use survey in Year 1 was an important activity to understand land uses and their spatial distribution in the village landscape, and provide a basis for stratification of the village landscape into relatively homogenous units for carbon stock estimation (see below). The land use classification also takes into account the indigenous management systems so that local communities will be able to better appreciate impacts of their land management practices on carbon stocks. Through review of secondary data as well as additional survey, including remote sensing and GIS, land uses and their spatial distribution in both Lao project site and Thailand project site are classified and mapped.

Land uses in Tee Cha Village are classified as natural forests, agricultural lands and village settlement. The natural forests are subdivided as conservation forest and head water, community forest, utility forest and cemetery forest. The agriculture lands are mainly composed of shifting cultivation areas of different ages, and small amount of permanent fields, paddy fields and field ponds. The shifting cultivation represents the dominant agricultural land use with an overall area of about 495.6 ha or 45.8% of total area. The area for shifting cultivation with a long cycle of more than 10 years was fixed around 1950s. With increasing population pressure, the cycle of shifting cultivation has gradually reduced down to 7 years. As external markets are more accessible, the mixed annual perennial systems may be attractive in the village. Many cash crops have been introduced in the past few years and some farmers have started production on commercial scale, e.g., chili. Areas of each land use are provided in **Table 1** and spatial distribution of each land use is provided in **Figure 1**. Land use and land cover types in Laksip Village consist of forests (dense forest, open forest), teak plantation, shifting cultivation (old fallow, young fallow, and crop field), fish pond, and village settlement. Rapid land use change has taken place since 1970's, when the traditional land use system was mainly the subsistence-based shifting cultivation. One crop, mainly upland rice was cultivated after clearing. Then, the field was fallowed for more than 5 years. Currently, the land use system has become largely commercial. The most common practice is the rotational intercropping of upland rice with teak seedlings in the first year, maize with teak in the second year, job's tear with teak in the third year. The plot is left to be teak plantation from the fourth year. While rice is for home subsistence, other maize, job's tear and teak are cultivated mainly for commercial purpose. In case the fields are to be used for rice cultivation again for the next cycle, the fields are not intercropped with teak and will be fallowed for about two years only. Shifting cultivation is moving toward teak plantations. Areas of each land use are provided in **Table 2** and spatial distribution of each land use is provided in **Figure 2**.

Table 1: Land use in Tee Cha Village, Sop Moei District of Mae Hongson Province, Thailand

Type of land use	**Area**	
	ha	**%**
1. Natural forests	557.17	51.48
• Conservation forest and head water	84.21	7.78
• Community forest	47.19	4.36
• Utility forest: Deciduous	422.30	38.01
• Cemetery	3.47	0.32
2. Village site	5.50	0.51
3. Agriculture lands	519.68	48.01
• Shifting cultivation	495.60	45.79
Fallow years 2005	70.61	6.52
Fallow years 2006	57.71	5.33
Fallow years 2007	59.78	5.52
Fallow years 2008	104.43	9.65
Fallow years 2009	86.32	7.98
Fallow years 2010	69.94	6.46
Cropping year 2011	46.81	4.32
• Permanent fields	16.08	1.49
• Paddy fields, and fish pond	8.00	0.74
Total	**1,082.35**	**100.00**

Figure 1: Land use map in Tee Cha Village, Sop Moei District of Mae Hongson Province, Thailand

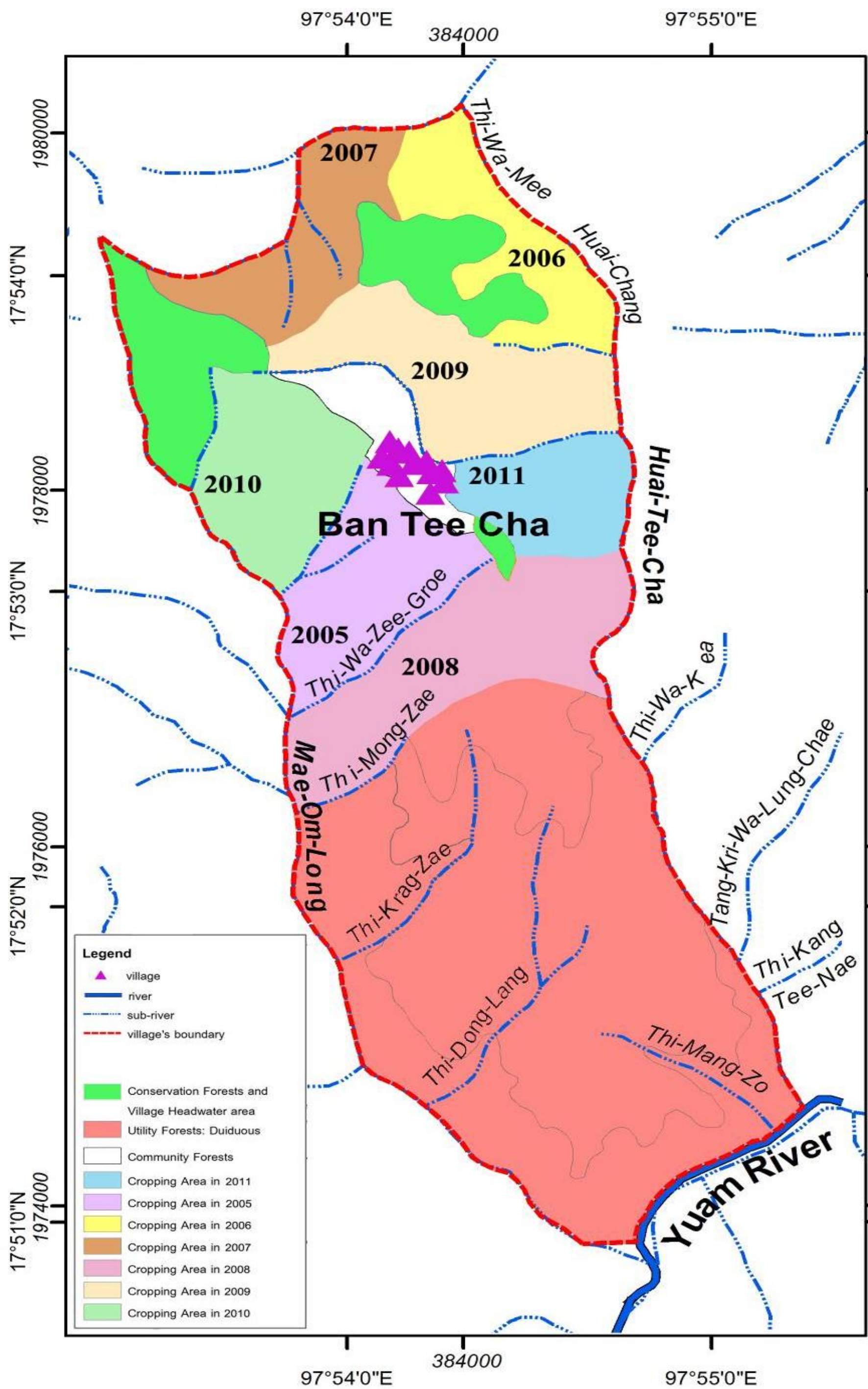
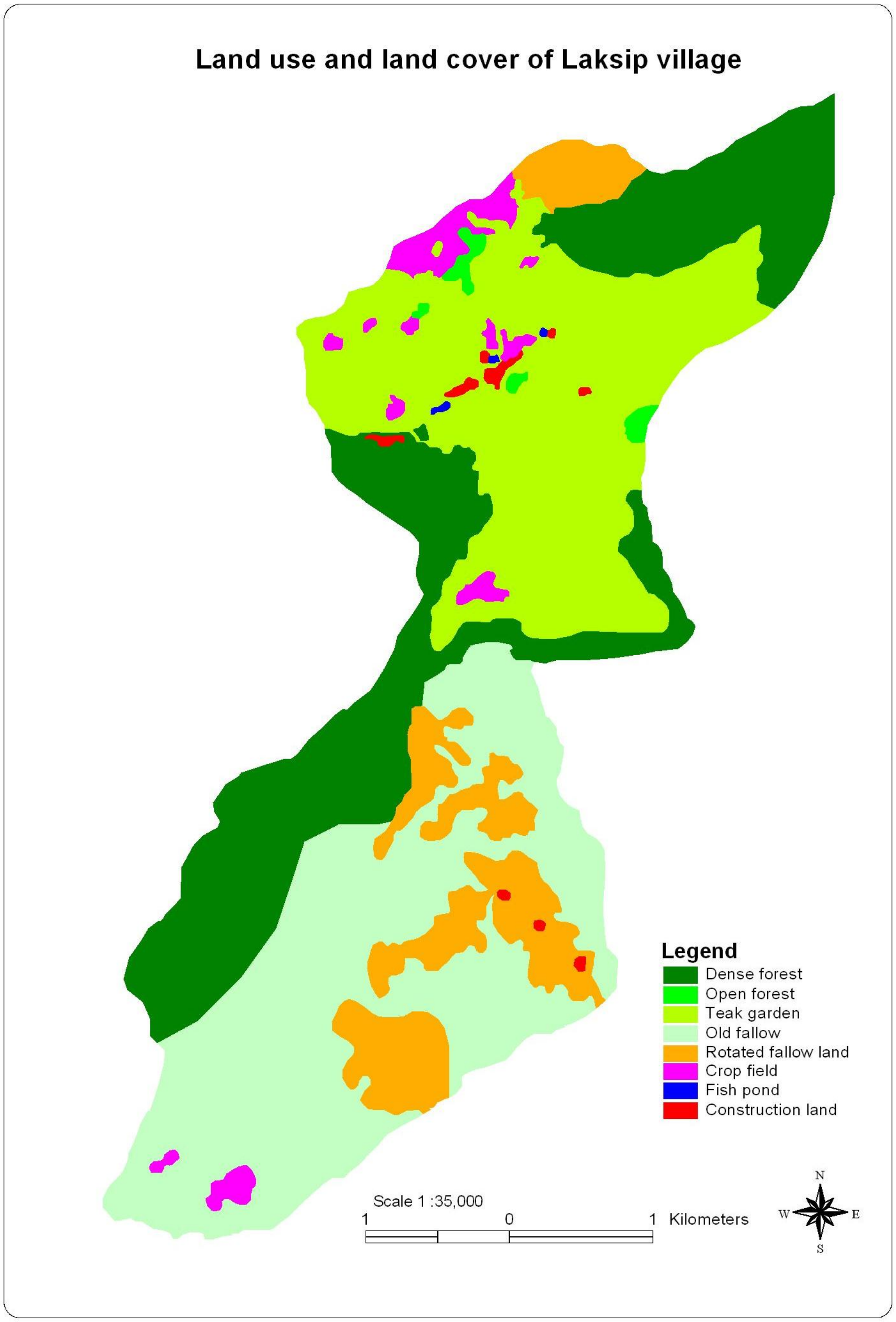


Table 2: Land use in Laksip Village of Luang Prabang Province, Laos

Type of land use	Area	
	ha	%
1. Dense forest	476	27.28
2. Open forest	12	0.68
3. Teak garden	477	27.32
4. Old fallow	531	30.42
5. Rotated fallow land	194	11.11
6. Crop field	46	2.62
7. Fish pond	1	0.08
8. Construction land	9	0.50
Total	**1,747**	**100.00**

Figure 2: Land use map in Laksip Village of Luang Prabang Province, Laos



Carbon stock measurement

The project methodology for carbon stock estimation was discussed and agreed at the project methodology workshop in Luang Prabang, June 2011. The discussion of the workshop was then synthesized as a working manual (see **Annex 4).** The methodology is composed of six elements as follows. First is to stratify the project site into strata that form relatively homogenous units through classification and mapping of land use/cover types in the village landscape. This was part of the above land use survey. Second is to decide size and number of sampling plots for estimating carbon density in each land use/cover type. Third is to estimate and average the biomass amount in different carbon pools in each sampling plots, including above-ground, below-ground biomass through allometric equation or destructive method, and soil organic matter (at depth of 0-30 cm) through soil sampling and analysis. Fourth is to convert the biomass by multiplying a conversion factor of 0.5 for carbon content, and convert the soil organic matter by multiplying a conversion factor of 0.58 for carbon content. Fifth is to sum up carbon contents of different carbon pools in each land use/land cover as the carbon intensity (tonne/hectare) for each land use/land cover type. Sixth is to estimate carbon stock in each land use/cover by multiplying carbon intensity of each land use/land cover type with its area in the project site village. Carbon stocks of different land use/land cover in the project site can be then summed up as the carbon stock of the village landscape. Details for the above second and the third elements are explained in details below. Both Thai and Lao project teams adopted similar sampling design and methods for biomass estimation, depending on land use/land cover type, and plant size and type.

(A) *Carbon storage estimation in forest areas*

The Thai project team adopted the size of sampling plot for plants with height >1.5 m as follow:

- 40m X 40m for plants with DBH (diameter at breast) ⩾4.5 cm
- 20m X 20m for plants with DBH (diameter at breast) <4.5cm

Tree biomass above ground for the above plants in each of four sampling plots was estimated with different allometric equations depending on forest type as follows:

- For conservation forest and community forest as hill evergreen forest, use the following equation by Tsutsumi et al. (1983):

Biomass of stem (W_S) $= 0.0509*(D^2 H)^{0.919}$

Biomass of branch (W_B) $= 0.00893*(D^2 H)^{0.977}$

Biomass of leaf (W_L) $= 0.0140*(D^2 H)^{0.669}$

Where, D = diameter at breast height (cm)

H = tree height (m)

W_S = stem biomass (kg)

W_B = branch biomass (kg)

W_L = leaf biomass (kg)

- For Utility forest as dry dipterocarp and mixed deciduous forest, use the following equation by Ogawa et al. (1965):

  Biomass of stem (W_S) $= 0.0396 * (D^2H)^{0.9326}$

  Biomass of branch (W_B) $= 0.003487 * (D^2H)^{1.027}$

  Biomass of leaf (W_L) $= ((28.0/Ws + W_B) + 0.025)^{-1})$

The tree biomass below ground (root biomass) was estimated with the following conversion formula:

Root biomass = 24% of aboveground tree biomass

The biomass of the groundcover plants with a height of <1.5 m and litter in the forests was estimated through destructive method as follows:

- 3 sub sampling plots with a size of 2mx2m were selected and nested in each of sampling plots
- All plants and litters were cut and collected from the sub-samples of 2mx2m.
- Samples were weighted directly and sub-samples of 3 kg for groundcover plants and 1 kg for litters were taken for oven drying at 80^o c for 48 hours. Then the dried weight was used to estimate the biomass content as well as moisture content.

Different biomass portions of the above-ground (trees, groundcover and litters) and the below-ground (root biomass) of the trees was then summed up as total biomass of the forest vegetation. The carbon content in the forest vegetation was calculated by multiplying total biomass with the conversion factor of 0.5.

The soil organic carbon stock was estimated through collection of soil sample for the depth of 0-30 cm in four sampling plots and analysis of soil organic matter. Once soil organic matter is determined, soil organic carbon is estimated as follows:

Soil organic carbon content = 58% x OM x Soil mass

Soil mass = D x A x H

Where, OM = organic matter; D = soil bulk density (g/cm^3); A = area (ha); and H = soil depth (cm)

The Lao project team adopted the size of sampling plots with height >1.5 m as follow:

- 10m X 10m for plants with DBH (diameter at breast) ⩾4.5 cm
- 5m X 5m for plants with DBH (diameter at breast) <4.5cm

Tree biomass above-ground in each of four sampling plots was estimated with different allometric equations depending on forest type as follows:

- For dense forest as hill evergreen forest, use the above equation by Tsutsumi et al. (1983).
- For open forest and old fallow as mixed deciduous forest, use the above equation by Ogawa et al.

- For teak plantations (old, medium and young teaks), use the following equation by Petmark and Sahunalu (1980):

  $\text{Log } W_S = 0.9797 \log (D^2H) – 1.6902 ; r^2 = 0.9930$

  $\text{Log } W_B = 1.0605 \log (D^2H) – 2.6326 ; r^2 = 0.9567$

  $\text{Log } W_L = 0.7088 \log (D^2H) – 1.7383 ; r^2 = 0.8523$

The below-ground tree biomass (root biomass) was estimated with the following conversion formula:

Root biomass = 24% of aboveground tree biomass

The biomass of the groundcover plants with a height of <1.5 m and litter in the forests was estimated through destructive method as follows:

- 3 sub sampling plots with a size of 2mx2m were selected and nested in each of sampling plots
- All plants and litters were cut and collected from the sub-samples of 2mx2 m.
- Samples were weighted directly and sub-samples of 0.50-1.00 kg were taken for oven drying at 80^{o} c for 48 hours. Then the dried weight was used to estimate the biomass content as well as moisture content.

Lao project team used the similar method as the Thai team to estimate the soil organic carbon.

(B) *Carbon storage estimation in agriculture areas*

Thai project team estimated the biomass in the shifting cultivation fields through destructive method as follows:

- Four sampling plots with a size of 20mx20m were selected. Separate samples were weight for branches and stems, and leaves + shoots. Sub-sample of 3 kg for each two samples was taken for oven dry at 80^{o} c for 48 hours to estimate moisture content and biomass.
- 3 sub samples with a size of 2mx2m were selected in four sampling plots to measure biomass in litters. The sub-sample of 1 kg for each three sub samples was taken for oven drying at 80^{o} c for 48 hours. Then the dried weight was used to estimate the biomass content as well as moisture content.

The biomass of permanent areas with trees was estimated using the same method for community and conservation forests.

The root biomass and the soil organic carbon were estimated with the above methods for the forest land.

(c) *Results of carbon stock measurement*

The results of carbon stock measurement at Tee Cha Village, the Thai project site, and Laksip Village, the Lao project site during Year 1 are summarized in the following tables.

In the Lao project site, the highest carbon intensity in the category of forests was founded in dense forest, with amount of carbon stock of 236.86 tons per hectare, out of which 172 tons were from above-ground biomass (stems, branches, leaves, ground cover and litter) and 64.15 tons were from below-ground (roots and soil), followed by open forest, old fallow (abounded shifting cultivation) and teak plantation forest (**Table 3**). For the fallow lands, the highest carbon intensity was found in the 4-5 year's fallow, with amount of 63.55 tons per hectare, followed by 3 year's, 2 year's and 1 year's fallow in **Table 4**. The carbon intensity in fallow lands was found higher than that in teak plantations. For the crop fields, the highest carbon intensity was found in the job's tears field, with amount of 31.02 tons per hectare, followed by rice field and maize field (**Table 5**).

In the Thai project site, the highest carbon intensity in the category of forests was founded in conservation forest, with amount of carbon stock of 230.59 tons per hectare, out of which 110.73 tons were from plant biomass (stems, branches, leaves, ground cover and litter, root) and 119.86 tons was from soil organic matter, followed by utility forest and community forest in **Table 6**. For the shifting cultivation, the highest carbon intensity was found in the 6 year's fallow, with amount of 110.35 tons per hectare, followed by 5 year's, 4 year's, 3 year's, 2 year's fallow and the cropping field (**Table 7**). Both paddy fields and permanent fields had lower carbon intensity compared with the shifting cultivation.

Table 3: Carbon stock under different forest types in Laksip Village of Luang Prabang, Laos

Type of forest	***Carbon stock (tons per hectare)***				**Total carbon stock**
	Above-ground	**Below- ground**			
	Stems, branches, leaves, ground cover and litter	Root	Organic carbon in soil	Total below ground	
1. **Dense forest**	172.74	20.30	43.85	64.15	236.89
2. Open forest	50.78	11.43	32.62	44.05	94.84
3. Old fallow	18.92	3.63	31.41	25.04	53.96
4. Young teak	4.11	0.04	26.76	26.68	30.83
5. Medium teak	4.61	0.52	25.48	26.00	30.61
6. Old teak	4.46	0.54	21.06	21.60	26.06

Table 4: Carbon stock under different age of shifting cultivation fallow in Laksip Village

Type of fallow	***Carbon stock (tons per hectare)***		**Total carbon stock**
	Above- ground	**Organic carbon in soil**	
1 year's fallow	2.94	27.68	30.62
2 year's fallow	7.43	25.12	32.56
3 year's fallow	19.36	29.40	48.75
4 year's fallow	29.57	33.98	63.55

Table 5: Carbon stock, ton per hectare under different crop field types, Laksip Village

Type of crop	***Carbon stock (tons per hectare)***		**Total carbon stock**
	Above- ground	**Organic carbon in soil**	
1. Maize	3.19	24.46	27.65
2. **Jobs steers**	3.81	26.87	31.02
3. Rice	2.11	26.01	28.11

Table 6: Carbon stock under different forest types in Tee Cha Village, Thailand

Type of forest	Carbon stock (tons per hectare)		Total carbon stock
	Plant biomass	Organic matter in soil	
1. **Conservation forest**	110.73	119.86	230.59
2. Community forest	40.91	84.73	124.64
3. Utility forest	89.85	69.39	159.24

Table 7: Carbon stock under different agricultural field types in Tea Cha Village, Thailand

Type of agriculture	Carbon stock (tons per hectare)		Total carbon stock
	Plant biomass	Organic matter in soil	
1. Shifting cultivation			
• Cropping year	0.87	71.22	72.09
• Fallow year 1	1.97	73.92	75.89
• Fallow year 2	6.74	86.99	93.73
• Fallow year 3	13.79	94.00	107.79
• Fallow year 4	18.79	93.35	112.14
• Fallow year 5	23.16	80.36	103.52
• **Fallow year 6**	29.73	80.62	110.35
2. Permanent fields	13.91	51.43	65.34
3. Paddy fields	2.53	46.91	49.44

The above methods of carbon stock measurement and the results of the pilot work will be reviewed and exchanged among the two project sites and with results from associate sites in India and China at the forthcoming workshop. The measurement of carbon stocks will be finalized early 2012. After that, the historical trends and trajectories of land use changes and carbon stocks will be analyzed to determine "reference levels" and scenarios for gains or losses of carbon stocks in forest and other land uses at the village landscape. The key of land use decisions/factors favoring maintenance/ enhancement of carbon stocks, biodiversity, sustainable land management and well-being of people will be also investigated. The knowledge gained through the analysis on land use and carbon dynamics will be the basis to educate local communities in management and monitoring of carbon stocks and support the community-based MRV.

Communication and advocacy

Cooperation between UNU-CMU-NAFRI-JNU has been strengthened the project implementation. Development of the methodology has benefited from a case study at JNU. Research members at CMU also provided technical support to field survey in the Lao project site and data analysis for carbon stock measurement. This project has also contributed to the ongoing UNU regional network on "Sustainable Land Management in the Mountainous region of Mainland Southeast Asia (SLM-MMSEA)". The working manual for carbon stock measurement has been shared with other members of SLM-MMSEA, including Southwest Forestry University (SWFU) for assessment of carbon stocks in tea forests as Chinese associate site. SWFU will host the next project workshop to review and synthesize results of carbon stock measurement across project and associate sites. As part of literature review, more than 100 peer-reviewed paper and international organizations' reports related to the project focus have been collected at different libraries in Japan though efforts of UNU team members. Review of these literatures is classified into land use and carbon dynamics, payment for environmental services, MRV and policy integration. These literatures are put into the project database to be shared with project members from developing countries who have limited access to these references. To reach out to public, the project published information as guest article in the APN Newsletter Vol. 7, Issue 3, Sep. 2011, ISSN 2185-6907 (**Annex 4**), established the project home page and shared project activities at the UNCECAR website (http://cecar.unu.edu/groups/cecarweb/weblog/c0af5/) and the MMSEA Network (http://isp.unu.edu/research/projects/agrodiversity/resources/index.html) (**Annex 5**).

One of the project targets is to establish strong linkages with policy makers, and directly feed the project findings into the policy making process on issues of REDD+, integrated agriculture and forestry, land use and sustainable mountain development. Project is fortunate that the Lao project team coordinator also serve as the National Focal Point for the United Nations Convention to Combat Desertification (UNCCD). The Thai project team coordinator has a long experience of working with local government in agriculture and forestry development. Both country coordinators will have chance to feed into project findings into the policy making. Local government officers participated in the project workshop at Luang Prabang, Laos invited. Chiang Mai University (CMU) has been doing the ongoing research to develop forest management and agricultural production system in the highland of Northern Thailand with Tambon (sub-district) administrative organization.

At the inception workshop, the project teams agreed to review the ongoing policy process related to national implementation of REDD+ and identify the knowledge gap and capacity building needs that the new APN project can help to address. The review indicated much uncertainty remains, how it will play out on the ground and there is a critical need for capacity building to harness the new international strategy of REDD+ for forest conservation, and restoration, and poverty reduction although both Thailand and Laos participate in the World Bank's the Forest Carbon Partnership Facility (FCPF) to develop reference scenarios, adopt a REDD+ strategy, design monitoring systems and set up REDD+ management at national level. This APN project has much potential to strengthen national and local capacity to understand REDD+ and build on past forest conservation efforts to better design REDD+ implementation on the ground. The project will need to explore and establish linkages to other ongoing initiatives, such as the Greater Mekong Subregion (GMS) initiative on REDD+ , for regular exchange and supporting the policy making process on this new opportunity for forest conservation in the region. In the near future, the project teams will contribute to enhance capacity of local communities at the project sites to manage and monitor carbon stocks in their landscapes through community-based training programme. At the end of the final workshop (Year 3), a special policy workshop will be organized to discuss with government officials and other key stakeholders on the policy implications of the findings and future steps. The project findings will be used to produce policy guidelines on how to minimize the potential negative social and economic impacts from REDD+ project and maximize the potential co-benefits.

6. Self evaluation of work performed to date:

The project was successful in meeting planned targets: selection and characterization of project sites in Laksip Village, Laos and Tee Cha Village, Thailand; organization of two project workshops; land use/land cover classification and mapping; and development of a working manual for carbon stock measurement at landscape level. Two project workshops were highly successful to review and discuss the project framework, including the working manual for the landscape level carbon stocks measurement and the 3 year research design to identify co-benefits and synergy of forest carbon, biodiversity and local livelihoods. The project teams in Laos and Thailand have reviewed the ongoing national policy-making process for REDD+ and found uncertainty of REDD+ and critical needs for capacity building, especially at local level that the new APN project can help to address. The project has strengthened cooperation between UNU-CMU-NAFRI-JNU in development methodology and working manual for carbon stock measurement, and technical support to the field survey.

In addition to the planned targets, the project team has made good progress in application of the working manual for carbon stock measurement and obtained initial results of carbon intensity in different land use/land cover at the village landscape. These results of land use survey and carbon stock inventory provide a good basis for analysis on land use and carbon stock dynamics and for educating local communities on carbon stock management for community-based MRV in Year 2

7. Appendix

Annex 1. Yimyam N., Sentaheuanghoung O. et al. Characterization of project sites

Annex 2. Liang L. and Kawasaki J. 2011. Summary Report 2011 Inception Workshop of the joint UNU-CMU-NAFRI Project on "*Critical Analysis of Effectiveness of REDD+ for Forest Communities and Shifting Cultivation, based on Lessons Learnt from Conservation Efforts in Laos and Thailand*". 17-19 January 2011, Chiang Mai, Thailand.

Annex 3. Liang L. and Kawasaki J. 2011. Summary Report Project Methodology Workshop on REDD+ for Forest Communities: Learning from Forest Conservation in Laos and Thailand. 19-21 June 2011, Luang Prabang, Laos.

Annex 4. Saxena, K. G., et al. Working Manual for Carbon Stock Estimation

Annex 5. Takeuchi K., Takahashi S., Lim A., Kawasaki J., and Liang L. 2011. REDD+ for Forest Communities. APN Newsletter Vol. 7, Issue 3, Sep. 2011, ISSN 2185-6907.

Annex 6. Liang L., Lim A., Takahashi S., Kawasaki J., and Takeuchi K. 2011. REDD+ for Forest Communities based on Lessons Learnt from Forest Conservation Efforts in Laos and Thailand. Available at http://isp.unu.edu/research/projects/agrodiversity/resources/index.html (15 July 2011)

Part Two: Request for project continuation

8. Funding requested for 2011/12: US$ 38,000

9. Budget for 2011/12

Activities for year 2: Household sampling surveys will be carried to assess provisioning services including costs and benefits of different land uses and estimate costs of opportunity for alternative land uses. The field and laboratory work (plant identification, soil analysis and GIS) will continue to complete the inventory of carbon storage and biodiversity in different land uses of the village landscape, to identify and demonstrate good practices for enhancing carbon stock and biodiversity in fallow and other land uses, to examine the historical land use and carbon stock dynamics, project future scenarios, and establish baseline/reference level. A project workshop will be organized to review results of the first-year work; including land use survey and carbon stock estimation, and plan forward. Another project workshop will be organized to discuss the operational guidelines to establish interactions and engagements between community and academia for bottom-up development of monitoring, measurement, reporting and verification (MRV) mechanisms. In addition, this workshop will serve mid-term review of project findings.

Summarized budget for year 2:

	Budget (USD)	
Int. and Nat. workshops	Travel, facilities, organization, planning, etc	31,500
Field survey	Subsistence, car rental and consumables for field work	9,000
Laboratory work (GIS, RS, carbon measurements)	Satellite image & analysis, lab tests, carbon storage estimation, data collection, surveys, equipments	6,500
Community-based MRV development	Subsistence and car rental for community workshops and training (facilitated by young local researchers)	2,500
Other, miscellaneous	Printing, publications, communication, etc	2,500
Total (a): APN funding	Source: APN funding	**38,000**
Total (b): UNU funding	Source: UNU (monetary, see column 3)	14,000

Budget Estimate for year 2: 2011/2012 (Co-funded by APN and UNU)

One international workshop in China, and one national workshop in Thailand

	Round-trip: Airfare (average)	**Per diem: Accommodation (4 days)**	**Per diem: Allowance (4 days)**	**No. of participants**	**Total (US$)**	**Note: Co-funding of UNU ***
Travel					**22,360**	
1. International workshop						
Tokyo—China	1,900	160	60	4	8,480	
Thailand- China	1,000	160	60	1	1,220	
Lao PDR- China	1,200	160	60	1	1,420	
India-China	1,400	160	60	1	1,620	
Local researchers and policy makers	100		60	10	1,600	
2. National workshop						
Tokyo-Thailand	1,000	160	60	3	3,660	
Lao PDR-Thailand	600	160	60	2	1,640	
India-Thailand	900	160	60	1	1,120	
Local researchers and policy makers	100		60	10	1,600	
3.Other costs					**9,140**	
Local transportation/airport transfer					2,500	
Communication					250	
Catering (Tea, coffee, snacks, lunch)					3,000	
Dinners					2,000	
Copying/printing					400	
Consumables					490	
Workshop proceedings					500	
Total (A)					**31,500**	**14,000***

Field survey					
Items	**Unit price per day**	**Days**		**No. of countries**	
Car rental (15 days / survey)	60	15		2	1,800
Group Food	100	15		2	3,000
Consumables					600
Accommodations for researchers	30	15	4 persons	2	3,600
				Total (B)	**9,000**
Laboratory work (GIS, RS, carbon measurements)					
Items	**Unit price per village**			**No. of countries**	
GPS and PDA equipment	1,000			2	2,000
Soil and vegetation analysis	1,500			2	3,000
Consumables	750			2	1,500
				Total (C)	**6,500**
Community training and dialogue to develop MRV					
Items	**Unit price per day**	**Times**	**Persons**	**No. of countries**	
Car rental	250	1		2	500
Group food				2	1,520
Accommodations for researchers/facilitators	30	1	8	2	480
				Total (D)	**2,500**
Final and progressive reporting					
Copying/printing					1,000
Dissemination of report & tools					1,500
				Total (E)	**2,500**
				GRAND TOTAL FOR YEAR 2 (US$): (A+B+C+D+E)	**52,000**

Note: * Supported by co-funding of project members time spent on the project implementation.

10. Definitive project targets for 2011/12

The main work plan of this year will include:

i. Socio-economic community-impact assessments

Household surveys and field work will be use to assess: 1)costs and benefits of various land use types; 2) opportunity cost /forgone profits of forests and alternative land uses; 3) cost and benefits of agriculture intensification - changes in yield, labor requirement, farming technologies and chemical-based inputs; 4) costs and benefits of developing alternative livelihoods (off-farm); 5) biodiversity impacts of alternative land uses; and 6) identify and harmonize potential impacts of REDD+ on community livelihoods and develop participatory impact assessment guidelines.

ii. Carbon storage assessment and establish baseline reference level

Field and laboratory work (plant identification, soil analysis and GIS) will include: 1) complete the inventory of carbon storage and biodiversity in different land uses of the village landscape; 2) compare carbon stocks in time and across different land-use systems/landscapes; 3) examine the historical land use and carbon stock dynamics, project future scenarios, and establish baseline/reference level; and 4) assess underlying causes of past deforestation and degradation, lessons of past forest conservation efforts, and identify how REDD+ can build on the past lessons to address the causes of deforestation and degradation.

iii. Demonstration of good land management practices

Good land management practices will be identified through land use and carbon stock assessment at the village landscape for demonstration. In particular, good practices for fallow management will be shared among community members. National project teams will hold field demonstration for local communities to appreciate good land management practices, including fallow enrichment for carbon sequestration as a part of mechanism development for community-based measurement, reporting and verification (MRV).

iv. Project workshops

A forthcoming project workshop will be hosted by Southwest Forestry University in Jinghong, China in the upstream of Mekong River to review results of the first-year work, including land use survey and carbon stock estimation, and exchange information and experience with associated sites, and plan forward. The second project workshop will be organized to discuss the operational guidelines to establish interactions and engagements between community and academia for bottom-up development of monitoring, measurement, reporting and verification (MRV) mechanisms. In addition, this workshop will serve mid-term review of project implementation and plan forward.

Detailed timeline of Year 2:

Project Activities	Year 2 (2011/2012) (from 09 December 2011 – 08 December 2012)											
	1	2	3	4	5	6	7	8	9	10	11	12
Assessment of carbon storage reference level & socio-economic community impact and opportunity costs of land use												
Mid-term review workshop												
Community-based MRV												
Demonstration of good land management practices in each project site												
Progressive report												

Project workshops of Year 2:

Date	Venue	Event	Estimated no. of participants
25-27 December 2011	Jinghong, China	Project workshop on carbon stock assessment	30
18-20 June 2012	Chiang Mai, Thailand	Project workshop for mid-term review and community-based MRV	30

APPENDIXES:

Annex 1: Characterization of Project Sites: Tee Cha Village, Thailand and Laksip Village, Laos

Two project sites, one each from Thailand and Laos have been selected and confirmed. Tee Cha Village, the project site in Thailand represents the traditional land use system of shifting cultivation. Laksip Village, the project site in Laos represent shifting cultivation in transition. Location of both sites is indicated in the F**igure a1.1 at end of the annex**. Details of each of these two project sites are characterized in the following two sections.

Thailand Project site: Tee Cha Village

Tee Cha Village is Karen ethic village in Sop Moei District, Mae Hong Son Province, located at 17° 53' 22'' N, 97° 54' E, 700 MASL. Most agricultural fields are on steep slopes with an altitude from 600 to 900 m. Most soils in this village are sandy loams and the climate is tropical monsoon with wet (June-September), cool (November-February) and hot (March-May) seasons. Temperature ranges from 10 °c to 41°c, with average temperature of 24 °c. The village was established permanently around 1950s with permanent fields for their traditional shifting cultivation with a fairly long cycle of >10 years, when the village population numbered about 30 people (8 households). At present, the village has 172 people in 48 households. Reduction of the shifting cultivation cycle rather expansion into natural forests has been the community strategy to cope with increasing population. As a result, the cycle of shifting cultivation has been gradually reduced down to the minimum of 7 year rotation which covers 48% of total village area or 520 ha. Apart from the dominant land use of shifting cultivation, natural forests, including conservation forest, utility forest and community forest cover approximately 52 % of total village area or 557 ha. Many paddy terraces were developed with external assistance but only a few remain in production due to lack of water. Five households only own paddy and a total area is less than 8 ha. Few farmers have developed permanent fields with mixtures of fruit trees, annual and perennial cash crops (such as Arabica coffee, cabbage, passion fruit) for alternative income generation. Cash copping may be attractive to villagers with improvement of communication and transportation for the past few years. Areas of crop fields, 1-6 years' fallows, paddy fields, permanent fields and various forests in the village in 2011 are provided in Table 1 and their distribution is showed in the land use map **(Figure 1) in the above progress report**.

The Tee Cha villagers maintain their shifting cultivation system with richness of agrodiversity and swidden crop species (over 50 species). The swidden crops range from cereals, grain legumes for food crops to vegetables, spices, cut flowers, for cooking as well as ceremonial purposes. The average number of species grown by farmers in the whole village remained fairly constant 35 species in spite of a high rate of turn-over. These crops are sown in association with rice in the main fields. Seventeen wild rice varieties are still growing in this area. Three non-glutinous rice (Bue Bang, Bue Gau and Bue Mue Ta Bong) and Pa Ai Khu Phae for glutinous rice are the dominant rice varieties. The upper part of fields is planted to glutinous rice to prevent mixture of non-glutinous rice planted in the lower part. Furthermore, each family plants 3-5 rice varieties, depending upon the conditions of the field and their preference. In Tee Cha, farmers are managing *Macaranga Denticulata* to sustain their traditional shifting cultivation for subsistent production of upland rice and a rich diversity of other swidden crops with fairly short rotation.

In addition, villagers are able to maintain rich biodiversity in various forests. Species richness in the *Macaranga* dominant bush fallow is less than those of forests that are community-managed as well as unmanaged natural ecosystems. Species richness and utility are provided in the following table.

Table a1.1: Number of plant species in various land use stages and field types of Tee Cha Village

Land Use Stags/Field Types	Number of Species	
	Total	Useful
Undisturbed headwater forests	72	64
Community forests (>200 years)	64	57
Utility forests (Dry Dipterocarpus)	54	45
Bush fallow with reduced cycle (7 years)	41	37
Cropping year in shifting cultivation	84	64
Mixed perennial and fruit trees garden (*Mr. Nopporn*)	49	40
Home gardens	85	nd
Total	308	nd

Notes: from Rerkasem (2000); nd= not determined

In Tee Cha Village, land allocation and tenure arrangement are basically based on local tradition, customary rules and regulations. Shifting cultivation fields were originally managed on communal basis. Community made almost every decision from choosing land for opening up, time of slashing and burning, allocation of land to individual household for upland rice production. With increasing pressures on land, the previous plots allocated for household production is fixed permanently to household members in the village. Rights to land ownership are determined from the family who open up the land first and big trees are often used as the land mark. One of the rules for shifting cultivation is that every household in the village has access to at least a piece of land for upland rice cultivation. The land has to be redistributed among the member households.

Most of household income came from farm activities. The average annual income was around 1,500 THB per person (Provincial report, 2010), chilli was main sources of cash income. Over 50% of villagers have gone out to lowland village for *Longan* picking as wage labours, while forest products (mushroom, honey, bamboo shot) are alternative income. Raising pigs and chickens are for household consumption and use for spiritual rituals during the rice growing season and sickness of members in their family. So far, cash income earning activities are supplementary to the overall livelihood of the household. Villagers in Tee Cha are concerning with rice production for subsistence of the farming household. It is said that surplus production from one year of swidden cycle could adequately support the family for at least the next 2 years of poor production.

Lao Project site: Laksip Village

Laksip Village is located at 10 kilometers from Luang Prabang along the national road No. 13 linking the northern provinces of the Lao PDR to Vientiane. The village site is at 19° 50’ 56’’ N, 102° 10’ 7’’ E, 417 MASL. The village covers a land area of1, 746 ha between 102° 08’ 38” E and 102° 11’ 33” E and between 19° 47’ 42”N and 19° 52’ 00” N. This area has a tropical monsoon climate with a hot and wet season from April to October, the cool and dry season is from November to March. Settlement of Laksip Village began in 1962 by Pho Thao Phuy from Oudomxay, and two more families followed him. The population increased slowly between 1962 and 1975 with the arrival of new families fleeing the war in the northern provinces of Laos, temporally resettled in the village and then moved out from the village. In 1997, after Huaynokpit Village merged with Laksip Village, the village land was extended, and covered the whole land of Huaynokpit Village, based on the agreement of the district committee dated 27 April 1999.

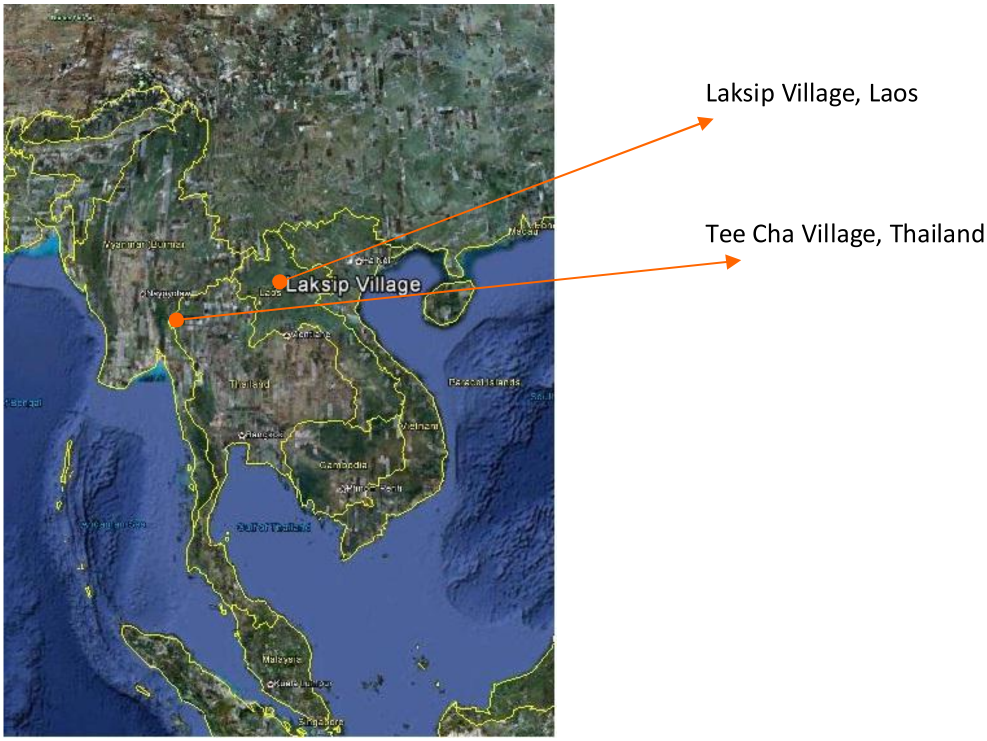
Currently, Laksip Village covers an area of 1,746 ha largely allocated for agriculture and forests. Agricultural land are mainly composed of crop fields and 1-4 years’ fallows under the short rotational shifting cultivation around the village and mostly distributed in narrow valleys and catchments.

Agriculture covers 240 ha or 14 % of the total village area. Forests consist of dense forest (conservation, sacred, cemetery forests), open forest (dry dipterocapus and degraded forests), teak plantations and old fallow (abandoned from shifting cultivation for more than 5 years). Forests cover 1,496 ha or 85.6 % of the total village area. Forest land can be subdivided in 3 sub groups: conservation forest, protection forest, and production forest. Most of conservation forest is located at high mountains in the north and southwest part of the village. Teak plantations have expanded from less than 20 ha in 1995 to 477 ha in 2011. Most teak plantations are developed through intercropping of teak seedlings with annual crops in the shifting cultivation. The common practice is to intercrop teak seedlings with rice in the first year, maize in the second year and job's tear in the third year. The plot is left to be teak plantation since the fourth year. As a result, teak plantations gradually take up the fallow land at expenses of its rotation for annual crops. Due to allocation of the old fallows for forest conservation and conversion of the short fallows for teak plantation, land available for cropping has been significantly reduced. Consequently, fallow period has to be shortened from more than 8 years in 1970' to about 2 years at present. Areas of crop fields, fallow, teak plantation and forests are provided in Table 2 and their distribution showed in the land use map (**Figure 2**) **in the above progress report**.

In spite of transition to a commercial production under the short shifting cultivation, local farmers continue to conserve and grow crop diversity. However, NTFPs have been reduced as a result of conversion of fallow land to teak plantation. Nevertheless, the Laksip Village is still home to a diversity of plant species. More than 900 plant species have been identified in forests and other land uses in the village.

Total population is 450 with 95 households. Three main ethnic groups currently live in Laksip Village: 89% for Khmu, 9.5% for Laolum, and 1.5% for Hmong. The majority of family heads graduated only from primary school. Few graduated from the secondary school. Shifting cultivation remains the livelihood for majority of villagers. Annual cropping takes place within a rotational shifting cultivation system, and plots are commonly cultivated for one or two successive years before two or three year fallow period. The main crops include upland rice for subsistence as well as maize, while their cash income comes from vegetable production, collecting forest products (e.g. job's tear, fuel wood, mushrooms, bamboo shoots), livestock farming, and perennial tree production. Some villagers are now working in off-farm activities such as government officers, traders and handicraftsmen in Luang Prabang City nearby.

Figure a1.1: Location of Project Sites



Annex 2: Summary report of the inception workshop of the join UNU-CMU-NAFRI project on "*Critical analysis of effectiveness of REDD: for forest communities and shifting cultivation, based on lessons learnt from conservation efforts in Laos and Thailand*", 17-19 January 2011, Chiang Mai, Thailand.

1. Background

Chiang Mai University (CMU) and United Nations University Institute for Sustainability and Peace (UNU-ISP), with the support of the Asia-Pacific Network for Global Change Research (APN), jointly organized the project inception workshop "REDD+ for Forest Communities" in Chiang Mai, Thailand from 17 to 19 January 2011. The workshop included two days of in-house discussion and one day to visit the Thai project study site, Tee Cha Village in Sop Moei District, Mae Hong Son Province of the Northern Thailand.

The objectives of the workshop were

- Review the project goals and expected outcomes
- Discuss and finalize the project methodology
- Discuss and finalize the project workplan and responsibilities
- Initiate the field work in Thailand

Overview of the workshop

Monday 17 January 2011:

- Welcome remarks
- Overview of the project, objective and study site
- Session I: Community-based monitoring of land use and forest
- Session II: Community-based monitoring of land use and forest
- Session III: Payment for ecosystem services and livelihoods
- Session IV: Integration of policy

Wednesday 18 January 2011: Field visit to *Ban Tee Cha*

- Group meeting with staff and village headman
- Field walk observing village landscape and land use practices
- Meet with village group and local officials to discuss problems, ideas and history of forest management

Thursday 19 January 2011:

- Review and discussion of the work plan and responsibilities
- Budget

2. Participants

The workshop was attended by

Prof. Theera Visitpanich, Dean, Faculty of Agriculture, Chiang Mai University

Prof. Benjawan Rerkasem, Faculty of Agriculture, Chiang Mai University

Prof. K.G. Saxena, School of Environmental Sciences, Jawaharlal Nehru University (JNU)

Mr. Oroth Sengtaheuanghoung, National Agriculture and Forestry Research Institute (NAFRI)

Dr. Narit Yimyam, Highland Research and Training Center, Chiang Mai University (CMU)

Mr. Luohui Liang, United Nations University Institute for Sustainability and Peace

Dr. Shimako Takahashi, United Nations University Institute for Sustainability and Peace

Dr. Jintana Kawasaki, United Nations University Institute for Sustainability and Peace

Ms. Alva Lim, United Nations University Institute for Sustainability and Peace

3. Summary of the Discussion

1. Prof. Theera Visitpanich, Dean of the Faculty of Agriculture, Chiang Mai University warmly welcomed the participants to Chiang Mai. He highlighted the value of the project and that it complemented well with recent efforts the University is doing with regards to forest carbon stocks.

2. As Chair of the first session, Prof. Rerkasem emphasized Prof. Visitpanich's sentiments, and then invited all participants to briefly introduce themselves before beginning the presentations.

3. In the first presentation, Mr. Liang gave an overview of the new joint project between UNU-CMU-NAFRI with the support of APN, titled "Critical analysis of effectiveness of REDD+ for forest communities and shifting cultivation, based on lessons learnt from conservation efforts in Laos and Thailand". As explained in the programme and project concept, the project will be of 3 year duration, starting from 9 December 2010, and would include two project sites: one site in Laos and one site in Thailand; and two associate sites: one site in India and one site in China.

4. The aims of the Project are to:
(1) Assess the potential social, economic and environmental challenges and opportunities of REDD+ for selected communities in Laos and Thailand. Lessons will be drawn from past/ongoing forest conservation policies;

(2) Provide much-needed scientific evidence on the potential co-benefits of traditional agro-forestry practices and comparing it with alternative land-uses; and,

(3) Develop participatory community-based MRV mechanisms for REDD+. With our findings we hope to assist the pro-poor design and implementation of REDD+, improve the well-being of forests dependent communities and integrate traditional agro-forestry as a climate change mitigation agenda.

5. In simple terms, he explained that the core objectives of the project are to identify technological and policy options and develop national capacity that promote synergies and co-benefits of REDD+ in the management of community forest and agroforest systems in shifting cultivation areas. Specifically, the synergies and co-benefits, as well as trade-offs could include:

- Food and livelihood security
- Carbon storage enhancement from REDD+
- Biodiversity conservation
- Watershed services
- Enhancing adaptation to climate change

6. Mr. Liang also provided some of the key outputs to be expected from the research project, in particular: methodologies for comprehensive carbon storage assessment of short, medium and long forest fallows; quantified comparisons of carbon storage and sequestration of forest-agriculture landscapes; data, research materials and methodologies on estimates of socioeconomic impacts,

biomass and soil carbon, biodiversity, RS/GIS for Laos and Thailand; development of bottom-up processes in Measuring, Reporting and Verification Systems (MRV); and report and recommendations for prevention and mitigation of possible adverse impacts of REDD on forest communities and optimal integration of agriculture-forest management systems into REDD+. Finally, it is hoped that the project would lead to increased face-to-face engagements between local communities, policymakers and scientific community on REDD+ and shifting cultivation.

Lao Project Site: Laksip Village, Luang Prabang District, Luang Prabang Province

7. Mr. Oroth **Sengtaheuanghoung** presented an overview of the Laos project study site: Laksip Village, near Luang Prabang City in Luang Prabang Province in Northern Laos. Laksip village consists of 95 households and has a population of 450 people. The major ethnic group is the Khmu (89%), followed by the Lao Lum (9.5%) and the Hmong (1.5%). The main occupation of the villagers is the practice of shifting cultivation (62%) with rice, vegetables and livestock as the main source of on-farm income. However, rice yields (ton/ha) have been declining, particularly during 1990-2009 and the village is currently undergoing changes in cropping patterns away from rice and towards teak plantations; from around 10 hectares of teak plantations in 1995 to more than a 100 hectares by 2008. In the same period, the area of rice production has dropped from 60 hectares to a little over 20 hectares by 2008. More notably, the average fallow period for annual crops has dropped from 8 years to 3 years from 1970 to 2009 because land resources for shifting cultivation have been reduced through the policy implementation. Lack of viable methods to sustain rice yield in the reduced cycle of fallows, local people are converting their fallows to teak plantation and undertake off-farm job for cash income to purchase rice.

8. The categorization of land use in Laksip is as follows: *Conservation forests* (Evergreen, Mix deciduous, Dry Dipterocarpus forest) are areas designated for protection and conservation of natural resources (plant, wild life species, biodiversity), and for cultural, tourism and educational purposes;

9. *Protection forests* (Dry Dipterocarpus, Bamboo, and Old fallow forests >10 years) are areas designated as forest lands for the purpose of protecting watershed areas, rivers, roads, and controlling of soil erosion, land degradation, etc;

10. *Production forests* (Bamboo, Old Fallow) are defined as natural or planted forests for utilization purposes such as for harvesting timber and forest products to meet the social needs and livelihoods of local peoples; and

11. *Production land / Agricultural forests* (Teak plantations of ages > 10 years, 5-10 years, and < 5 years, Fallow land, and Annual Crop Fields) is defined as land that can be used for agricultural production purposes including tree, crop plantation and animal farming.

12. *Construction or housing lands* are areas where construction is permitted. *Construction or housing lands* are areas where construction is permitted.

Thai Project Site: Ban Tee Cha, Sop Moei District, Mae Hong Son Province

13. Dr. Narit **Yimyam** presented details of Tee Cha Village ('Ban Tee Cha' in Thai) in Sop Moei District, Mae Hong Son Province. It is located 246km from Chiang Mai in the mountains of Northern Thailand, the village lies at an altitude of 700-900 mean sea level (MSL).

14. The people of Tee Cha belong to the Karen ethnic minority group. There are 48 households with a population size of 172, and one primary school. All households are involved in subsistence farming based on short rotational shifting cultivation. Main sources of case income come from cash crop e.g. chili, non-timber forest products e.g. mushroom, bee honey, bamboo shoot and bamboo worm, and wage labour e.g. longan picking.

15. The area experiences three seasons: rainy season (June-September), cool (November-February) and summer (March-May). Average annual rainfall is 2,104 millimeters. Soils are poor loamy clay with a low pH.

16. One of the challenges faced by the people of Tee Cha is land degradation from deforestation, and soil erosion and degradation. This has reportedly been a direct consequence of the forced shortening of the fallow cycle due to reduction of land resources for shifting cultivation through the policy implementation. This has been part of a long term development strategy by the government to replace opium production under shifting cultivation with alternative cash crops. Most recently, the Royal Forestry Department has introduced a law that enforces land restrictions over the practice of traditional shifting cultivation and expands forest conservation areas. As a result, fallow periods have been reduced from 10 to 7 years. In addition to this, other pressures from increased population, unsecure tenure and conservation demands have lead to increased tensions. In order to cope with the reduced cycle of fallow, local people are innovative to enrich soil through planting of pada in Thai (*Macaranga Denticulate),* a tree has led to maintenance of upland rice yield with enriching property. Rice yields and biomass in the fallow of dense *Macaranga* are higher than those in the fallow of sparse *Macaranga.*

17. Overall, government policies have shown to be the main drivers of land use change in Northern Thailand. With pressures on land and the absence of legal rights, traditional land tenures have changed to certain extent. Individual ownerships are becoming the common pattern in agricultural land. In Karen village, community still maintains traditional decision in managing land for upland rice. Natural forests arekept under community control in most of the highland villages, regardless of ethnic background and traditional land management practices.

18. The land use change, especially the reduction of fallow periods and expansion of cash cropping happening at two above project sites represent a general trend in the Mountainous Region of Mainland Southeast Asia (MMSEA) home to a rich bio-cultural diversity and source of the Mekong and other major rivers. The land use change has implications on biodiversity, carbon storage, watershed service as well as local livelihoods. The project is timely to assess carbon storages under different land use patterns and to help local community and government to identify synergy between biodiversity, carbon storage and local livelihoods in the implementation of REDD+.

Session I: Land use and carbon storage dynamics,

19. In this session, Prof. K.G. Saxena assessed land use/ cover change and its implication on carbon storage using a case study in India. In order to understand the change in time and space, land use/cover will need to be mapped at 2-3 points of time. Enhancing thematic details, including carbon stocks in the assessment may be achieved through integrating tools-topographic/revenue/forest maps as well as remote sensing data, GIS, and plot sampling. Plot sampling can be done through repeated measurements on a single site, paired sites or chronosequences where neighbouring sites experienced land use change at different times in the past.

20. Coupling of ecological and socio-economic system is necessary to appreciate trade-offs of carbon stock dynamics. Assessment of strengths and weaknesses of land use systems and practices will help find out win-win options to optimize ecosystem functions, ecosystem goods and services, reducing dependency, increase resilience/resistance of the social-ecological systems. High soil organic matter stores high carbon, but would not necessarily contribute to the soil quality due to low labile carbon or to the soil health due to abundance of pathogens. Thus, understanding thresholds is essential in assessing potential synergy between carbon storage and other ecosystem services. Nutrient transfer among different land uses, such as from forests to agriculture is important to understand the landscape process. Environmental science will need to be linked with policy and human dimensions so as to harmonize diverging goals of different stakeholders.

21. With regard to methods of assessment, Prof. Saxena explained four important components in

choice of methods: (a) Phytosociology concerning number, size, shape and distribution of quadrates; taxonomic resolution; growth forms/life forms and plant functional types (trees, shrubs and herbs - epiphytes; non-vascular plants), (b) Soil physical-chemical properties concerning bulk density, soil texture, pH, Cation Exchange Capacity (CEC), water holding capacity, total and/or available nutrients (major and/minor nutrients), plough layer or multiple layers covering the whole profile, (c) Carbon calculation concerning biomass component relations between above ground and below ground, allometry, conversion of biomass to C using 48-50% of oven dry biomass, (d) Land use - land cover dynamics concerning spatial and temporal scale of observation and mapping, classification scheme (Level I, II, III), interpretation tools, NDVI etc. Existing methods will need to be reviewed to develop a suitable methodology for the project.

22. In connection, Prof. Saxena discussed data quality. Accuracy of data depends on definition of variables, time of measurement and other factors. Choice of methods is affected by costs of measurement and accessibility of sampling plots affect. He also explained a few common indexes in assessment, such as (a) Carbon Pool Index (CPI) which is total C of a given land use/Total C of the reference land use, (b) Lability Index (LI) which is labile carbon content of a given land use/Non-labile carbon content of a given land use, (c) Carbon Management Index (CMI) = CPI * LI * 100, and (d) Landscape CMI' = sum of the products of multiplication of the CMI values of different land uses and their relative areas (%).

23. Using the case study on Ratgad Watershed in Central Himalaya India, Prof. Saxena illustrated that the main land use change from 1963 to 2005 was abandonment of some agricultural fields while forest areas remain unchanged. Intensity of carbon stock in home gardens is more than those in pine forests and close to those in oak forests. The total carbon in the watershed increased from 1964-2005. However, the total carbon increased from 1964-1998, but declined from 1998-2005.

Session II: Community-based monitoring of land use and forest

24. In this session, Dr. Shimako **Takahashi** started her presentation on community-based MRV with a brief review of REDD+ mechanisms. Expanding agriculture is often at expense of forest areas. A trade-off between agriculture and forestry has to be made, especially new recognition of high carbon stocks and other values in the forests. REDD+ provides payment to avoid forest conversion to agricultural and other land uses. The payment from REDD+ has to compete with incentives arising from forest conversion. Moreover, the REDD+ payment is based on reliable and credible system of monitoring, reporting and verification (MRV) to assess changes in forest carbon stocks. MRV should be cost-effective, but also compatible with a multiple levels of payment scheme at global, national, and local levels.

25. Forest area changes (number of hectare) and carbon stock change estimation/carbon density (carbon per hectare) will need to be monitored. The measurement is often based on remote sensing and ground verification. The national forest monitoring system, verification, and reference emission levels will need to take into account national circumstances. Transfer of scientific measurement to the MRV system will need to be fostered to develop robust and credible MRV system. MRV at community-level will need to build on interest and capacity of forest communities and indigenous people. Capacity development is required to enhance communities in MRV. In addition to carbon credits for good practices, other incentives should be considered to supporting alternative livelihood options, enhancing land tenure and local resource rights, intensifying productivity on non forest lands. Pressure to reduce deforestation needs to be spread across many levels to reduce the burden on forest communities.

Session III: Payment for ecosystem services and livelihoods

26. In this session, Dr. Jintana **Kawasaki**'s presentation was focused on concept of opportunity costs and trade-offs between forests and alternative land uses. The opportunity cost of forest land is defined as the difference between the benefits provided by the forest and the alternative land uses.

Benefits of conserving forest lands would include values of non-timber forest products as well as credits due to reduced emission from deforestation and forest degradation, and intangible values due to cultural services and biodiversity conservation. Benefits for alternative land use, for example, agricultural land uses would include values of agricultural crops and timber harvesting. The credits or payment from REDD+ as incentives for forest conservation will need to be comparable to the opportunity cost in order to avoid forest conversion. Dr. Kawasaki noted the presence of shifting cultivators really cause deforestation still depends on the type of forest. Therefore, economic assessment is to examine economic profitability of the shifting cultivation and permanent cultivation, and on the economic adjustment process of how shifting cultivators might adopt fallow rotation system as a means to naturally improve agricultural productivity. Dr. Kawasaki has also proposed the work plan to assess opportunity costs. In Year one, assessment would cover the socio-economic characteristics of people and communities, including cost-benefits for agricultural production, and the ratio between on-farm and off-farm income, direct and indirect benefits of forest. In Year two, the investigation will examine and compare the opportunity costs of alternative land uses with the traditional agro-forestry practices, including values of carbon storage. In Year 3, appropriate strategy will be recommended for forest conservation to take into account social and economic benefits and beneficiaries of land uses.

Session IV: Integration of policy

27. In this session, Ms. Alva **Lim** reviewed the current policy-debate on REDD+ at the international level and discussed its Implications for our project. Kyoto Protocol only recognizes offsets from projects that create new forests, not from projects that protect existing ones. As a result of afforestation and reforestation policies global forest areas expanded, mainly, but global carbon stocks decreased because of tropical deforestation and degradation. Thus, REDD+ is important to main forest carbon. The negotiation on REDD+ to be included in the next commitment period (post-Kyoto 2012) is underway. The COP16 of UNFCCC at Cancun, Mexico, December 2010 has decided to encourages developing country Parties to contribute to mitigation actions in the forest sector by undertaking the following activities, as deemed appropriate by each Party and in accordance with their respective capabilities and national circumstances: (a) Reducing emissions from deforestation; (b) Reducing emissions from forest degradation; (c) Conservation of forest carbon stocks; (d) Sustainable management of forest; and (e) Enhancement of forest carbon stocks.

28. There is a debate on national criteria and procedures for establishing reference levels. Historical baselines need to adjust to 'national circumstances'. Historical baseline is estimated from past forest deforestation, forest degradation, carbon degradation (DDD) & resulting greenhouse gas (GHG) emissions over years. Business As Usual (BAU) baseline is projected emissions from DDD without REDD+ project. The reduced emission below the crediting baseline/Reference level as benchmark level (cap) would be entitled to receive credits. Reference level will be affected by national policies, including economic and rural development goals, land tenure, forestry policies, demographic policies, agricultural policies and energy policies.

29. Our project goes beyond REDD+ scope as it is currently negotiated not to cover soil carbon and non-forest land uses. The first step is to understand the current (pre-REDD+) situation and identify those land uses which are carbon rich and at high risk of conversion to other land uses. The second step is to project and map land use scenarios with or without REDD+, and compare net emissions from the land use scenarios with BAU baseline and the project reference level. For example, to receive carbon credits would require that fallow become longer in Tee Cha or the harvesting cycle of teak plantations become longer in Laksip. We also need to improve understanding of the drivers of deforestation/ degradation and local needs to develop other measures to address these root causes for forest conservation in addition to the carbon credits. Finally, Ms. Lim stressed that project outputs be fed into the national process.

Field visit to *Ban Tee Cha*

30. The field trip to Tee Cha Village, one of project sites in Northern Thailand offered a good opportunity for the workshop participants to appreciate different land uses with their ecosystem services in the village. The village land use pattern is composed of forests, agricultural land under shifting cultivation, permanent agricultural fields (paddy fields) and village settlements. Forests are further divided into conservation forest and headwater, community forests, utility forests and cemetery. The field trip started off with the group meeting with villagers who are used to work with Dr. Yimyam. These villagers then took participants to observe different land uses in the village.

31. The first land use observed was the utility forests where use of timber may be permitted. The Dipterocarpus forests are maintained in the utility forests. From point of the utility forests participants had observed agricultural land under different age of fallow at a distance. These fallows are largely covered by *Macaranga* bush to enrich soil in the reduced cycle as previous study revealed. Forests along the boundary of these fallows were protected to mark land property. Carbon stocks in the fallows may be determined according to the age of the *Macaranga* bush. The second land use observed was paddy fields. Part of paddy fields was already abandoned due to lack of water. The third land use observed was the community forests in which conversion to bamboo and coffee plantations are taking place. The fourth land use observed was the conservation forests and headwater where tree planting had been made to enrich the forests.

32. During the field trip, participants also observed village off-farm activities, such as local rice whisky making. Finally, participants and villagers wrapped up the field trip at the field demonstration site of the Royal Forest Department where various tree seedlings were prepared and distributed to encourage tree planting in the village. Villagers asked participants for advice on combating land degradation where *Macaranga* bush was sparse and the possible options for income generation. As *Cassia* trees have been already introduced to this village, villagers may try to plant *Cassia* trees in those fallows without much *Macaranga* and coppice them to enrich soils. As there are many orchids in the village forests and home gardens, identification and cultivation of some medicinal orchids may help villagers generate alternative incomes in addition to new cash crops such as Arabica coffee being experimented. Participants appreciated the villagers for their time to share their knowledge about forests in the village before departure. During the field trip, participants also observed village off-farm activities, such as local rice whisky making. Finally, participants and villagers wrapped up the field trip at the field demonstration site of the Royal Forest Department where various tree seedlings were prepared and distributed to encourage tree planting in the village. Villagers asked participants for advice on combating land degradation where *Macaranga* bush was sparse and the possible options for income generation. As *Cassia* trees have been already introduced to this village, villagers may try to plant *Cassia* trees in those fallows without much *Macaranga* and coppice them to enrich soils. As there are many orchids in the village forests and home gardens, identification and cultivation of some medicinal orchids may help villagers generate alternative incomes in addition to new cash crops such as Arabica coffee being experimented. Participants appreciated the villagers for their time to share their knowledge about forests in the village before departure.

Review and discussion of the work plan and responsibilities

33. Discussion on work plan started with review of an overall work plan for three years based on the project proposal prepared by UNU-ISP (See below). It was agreed that three main outputs will be achieved in Year One, including (1) Review and harmonization of carbon stock measurement with a manual, (2) Review of relevant policies on REDD+ and development of communication plan to participate in the policy process, and (3) Interim reports of carbon stock measurement at project sites in Thailand and Laos, and associate sites in India and China, including review of secondary data. UNU-ISP will be responsible for overall coordination of the project while CMU and NAFRI will manage field activities as well as national coordination. JNU will provide technical support to develop a manual on carbon stock measurement.

Project Work Plan: The main activities of this project will include

Year 1 Inception workshop to finalize agreement on study sites, project strategy and 3 year plan. National workshop and training on methodology for local communities and authorities. Remote sensing/GIS for land-use classification and tracking land-use change. Secondary data collection and census surveys;

Year 2 Household sampling surveys, field and laboratory work, including plot sampling for estimation of carbon storage intensity. National workshops for mid-term review and preliminary findings. Community academia engagements for bottom-up development of monitoring, measurement, reporting and verification (MRV) mechanisms; and

Year 3 Synthesis of project findings. Final international workshop to present findings to local officials, communities, researchers, policymakers and international community, develop policy recommendations, and future steps for collaboration.

Accordingly, the **project work plan will be as follows:**

Year 1 (2010/2011)	
Month/Year	**Detailed Activities**
December, 2010	Selection of project sites in Laos and Thailand, and project associate sites in India and China
January, 2011	Project inception workshop Thailand
March-May, 2011	Collection of secondary data
	Assessment of land use and ecological impacts of land use change by review of secondary data, including GIS data.
	Review of different methodologies for carbon stocks measurement at landscape level
	Review of forest policy of study countries
June, 2011	Project methodology workshop in Laos
July-September, 2011	Pre-test of methodologies for land classification, carbon stocks measurement at landscape level
November, 2011	Interim Report
Year 2 (2011/2012)	
January, 2012	International workshop in Thailand
January-May, 2012	Assessment of carbon storage in each project site
	Assessment of socio-economic community impact and opportunity costs of land use
June, 2012	National Workshop in Laos
July-September	Demonstration on good land management, including fallow enrichment for carbon sequestration
November, 2012	Interim report
Year 3 (2012/2013)	
December, 2012-April, 2013	Building local capacity in Measurement, reporting and verification (MRV)
May-July, 2013	Policy Analysis of forest resource management and REDD+
August, 2013	Final Project Workshop in Thailand
November, 2013	Final Report

34. The discussion finalized the work plan for Year I (See below). From March to June 2011, existing knowledge and information about the study sites with regards to the biodiversity, carbon stocks,

livelihoods, and traditional knowledge in forest, and soil management will be reviewed and knowledge gaps identified. The methodologies for measurement of carbon stocks (including biomass above ground, below ground, and soil organic matter) in the forested landscape in the contexts of national REDD process will be also reviewed. A methodology workshop will be held in June 2011 to harmonize methods across participating countries as the provisional project methodology. The provisional methodology will be then tested and finalized from July to September 2011. The pre-test will cover classification of land use and land cover, and sampling of plots in different land use and land cover categories. The land use and land cover mapping and carbon stock measurement in different land use/land cover categories will be carried out based on the approved project methodology from July to November 2011 and will continue in Year 2. From March to October 2011, all relevant policy for national REDD+ implementation will be reviewed and synthesized to help develop a communication plan for policy impact. After the work plan for Year One was finalized, the project budget was also agreed among project partners to implement the work plan for Year One. The project methodology workshop has been proposed to take place in Luang Prabang, Laos in June 2011. This forthcoming workshop will discuss the carbon stocks measurement at landscape level and to harmonize the national methods for a project methodology for comparable measurement across the study sites in Thailand and Laos as well as associate sites in India and China.

35. Finally, the workshop was closed with Dr. Takahashi's remarks to thank CMU's excellent organization of the workshop as well as valuable inputs of all workshop participants.

Detailed national work plan for Year I will:

Month/Year	Detailed Activities	Proposed Outcome
December, 2010	Selection of project sites (one site in Laos and one site in Thailand) and associate sites (one site in India and one site in China) through meeting with national coordinators, the meeting plan were: December 13, 2010 Selection of Project site in Laos; December 20-23, 2010 Project site in Thailand; and December 24, 2010 Associate site in India	Two project study sites and two associate sites
January 17-19, 2011	Project Inception Workshop in Chiang Mai, Thailand	The project goals and expect outcome of project, different project methodologies for each country, work plan, and responsibility
March-May, 2011	1) Data collection 2) Assessment of land use and impacts of land use change by using of GIS data base 3) Review and harmonization of methodologies for carbon stocks measurement at landscape level	1) Data sets for project sites including methodologies of carbon measurement, fallow management, land use of forest, forest community, forest policy, and etc. 2) Comparison of land use and impacts of land use change between forest land and agricultural land 3) Appropriate methodologies of carbon

		measurement across the region
June 27-29, 2011	Project methodology workshop in Laos	Different methodologies harmonized for carbon stocks measurement for each project site, and project work plan updated
July-September, 2011	Pre-test of methodologies for land classification, carbon stocks measurement at landscape level	Land use classification and carbon storage for each project site
March to October, 2011	All relevant policies for national REDD+ implementation will be reviewed and synthesized to help develop a communication plan for policy impact	A communication plan for policy impact
November 15, 2011	Preparation of project activity reports and detailed financial reports in Laos and Thailand, and summary reports in India and China	Tentative interim project report

Annex 3: Summary report of project methodology workshop on *"REDD+ for forest communities: Learning from forest conservation in Laos and Thailand"*, 19-21 June 2011, Luang Prabang, Laos.

1. Background

National Agriculture and Forestry Research Institute of Lao PRD (NAFRI) and United Nations University Institute for Sustainability and Peace (UNU-ISP), with the support of the Asia-Pacific Network for Global Change Research (APN), jointly organized the project methodology workshop "REDD+ for forest Communities" in Luang Phabang, Lao PDR from 19 to 21 June 2011 to bring together experts from UNU, Laos, Thailand and India and discuss the carbon stocks measurement at the landscape level. The workshop included two days of in-house discussion and one day to visit the Lao PDR project study site, Laksip Village which is located at ten kilometres from Luang Phabang City in the Northern Lao PDR.

The objectives of the workshop were 1) review different methodologies for carbon stocks measurement at landscape level, including the proposed methodology for each project site; 2) discuss and harmonize different methodologies as the project methodology; 3) initiate the field work in Laos; and 4) review project progress and plan forward.

Overview of the workshop

Sunday 19 June 2011:

- Welcome Remarks
- Overview of the project workshop and brief introduction to the associate project site in China
- Discussion of the work plan forward Session III: Proposed methods for carbon stocks measurement in Laos project site

Monday 20 June 2011: Field visit to Laksip Village

- Field walk observing village landscape and land use practices in both northern and southern parts of the Village
- Discussion of sampling methods in each land use practices for carbon stock measurement in the

Village

Tuesday 21 June 2011:

- Harmonize and propose provisional project methodology with a special reference to Laksip Village site
- Discussion of the work plan forward

2. Participants

Name	Organization
Prof. Kazuhiko Takeuchi	UNU-ISP
Mr. Luohui Liang	UNU-ISP
Dr. Jintana Kawasaki	UNU-ISP
Prof. K.G. Saxena	Jawaharlal Nehru University
Prof. Kottapalli Sreenivasa Rao	University of Delhi
Mr. Oloth Sengtaheuanghoung	National Agriculture and Forestry Research Institute
Mr. Aloumsawath Chanphengxay	National Agriculture and Forestry Research Institute
Mr. Saysama Inthavong	National Agriculture and Forestry Research Center
Dr. Narit Yimyam	Chiang Mai University
Ms. Utumporn Chaiwong	Chiang Mai University

3. Summary of the Discussion

1. Mr. Oloth Sengtaheuanghoung, the Deputy Director of NAFRI-ALRC on behalf of NAFRI's Director-General warmly welcomed the participants to Luang Phabang and gave a brief outline of the workshop agenda.

2. The official welcoming remarks were given by Prof. Kazuhiko Takeuchi, Vice-Rector, United Nations University/ Director, Institute for Sustainability and Peace. He highlighted decisions of COP10/CBD and COP16/UNFCCC with regard to REDD+ and emphasized a particular need to integrate climate change and biodiversity policies, and to establish effective international frameworks on adaptation and REDD+ as well as that on mitigation.

3. Following the opening session, Mr. Luohui Liang, UNU-ISP, gave an overview of the workshop objectives in the context of the project works plan in 2011 and stressed that the project methodology need to conform to international standards as well as adapt to local circumstances of project sites.

4. The project work plan in 2011 is to:

(1) Different methodologies for carbon stocks measurement at the landscape level (i.e. to estimate carbon stocks above and below ground in different land uses in the landscape) need to be harmonized as the project methodology and applied in the project sites in Thailand and Laos, as well as the associate sites in India and China so that findings from different countries can be compared and synthesized at the regional level;

(2) Carbon stock at landscape level at all project sites will be measured along with land use mapping;

(3) Ongoing policy development on REDD+ in each country will be reviewed and synthesized to develop a policy action plan so that project findings will be fed into the national process.

5. Mr. Liang explained the project concept and expected outcomes, including the methodology for the landscape level carbon stocks measurement, which is the main focus of this workshop. He also

reviewed the 3 years of research design to identify co-benefits and synergy of forest carbon management and local livelihoods. He introduced two project sites where shifting cultivation is practiced: one site in Northern Laos and one site in Northern Thailand, and two associate sites: one site in North India and one site in Southwest China.

6. He also presented a brief introduction to the land use system in the Mangjing Village, the associate study site where tea production is the main source of income. There are two major types of tea production: one is traditional tea forests where tea is cultivated in natural forests and other is modern tea plantation on the terraces. These two types of tea production contrast in terms of carbon storage, biodiversity and sustainability. Recent appreciation of tea from the tea forests has helped revival of the traditional practice.

Session I: Carbon stocks measurement at landscape level with special reference to India

7. In this session, Prof. K.G. Saxena explained carbon stock estimation using a case study in India. Coupling of ecological and socio-economic system is necessary to appreciate trade-offs of carbon stock dynamics. Assessment of strengths and weaknesses of land use systems and practices will help find out win-win options to optimize ecosystem functions, ecosystem goods and services, reducing dependency, increase resilience of the social-ecological systems. Thus, implementation of national policies and measures and national strategies or action plans that could involve further capacity building, technology development and transfer, and results-based demonstration activities.

8. With regard to methods of carbon assessment, Prof. Saxena explained two measures: (1) measuring the stocks at two points of time; and (2) measuring the fluxes over a period of time.

9. Prof. Saxena discussed the following in details:

(1) In order to understand the change in time and spaces, land use/cover will need to be mapped through tools of RS/GIS. Plot sampling can be done through repeated measurement at different times. Through systematic sampling and stratified sampling, the assessment of carbon stock needs to cover carbon pools in aboveground biomass, roots, litter, soil in different land uses in the village landscape.

(2) The assessment will also include participatory land use mapping and carbon inventory, identification and selection of land holdings having all land use/cover classes and covering the village landscape variability.

10. Aboveground biomass of woody plants (DBH.=>10 cm) is normally estimated through allometric model. The root biomass may be estimated as a percentage of the aboveground biomass. Biomass of understorey species with a DBH<10 cm is estimated by destructive sampling with a sample of material oven dried and weighed. Dead wood may be estimated to take into account the dropping of leaves. In conclusion, there is no universal standard for estimating biomass or carbon of a tree, which depends on local circumstances as well as availability of resources.

11. Prof. K.S. Rao discussed reduction of the emissions from deforestation and forest degradation (REDD+) with Indian case studies and potential REDD+ activities to increase carbon stocks or to avoid loss of carbon stocks in the forested landscape in the Indian Himalaya. . He explained diversity of the Himalayan ecosystems covers a wide range of mixed land uses under the categories of forests, settled farming, shifting agriculture and home gardens. Biomass measurement in these land uses often integrate different tools-remote sensing, on the ground verification, and stratified mapping.

12. Prof. Rao highlighted possible options for improvement of degraded ecosystems, including replaced ecosystem with creation of alternative ecosystem, and rehabilitated ecosystem with several components resembling original ecosystem. Recent conversion from traditional land use system to intensive wet paddy field and tree crop plantation will have significant impact on biodiversity as well as carbon stocks in the landscape.

Session II: Proposed methods for carbon stocks measurement in Thailand project site

13. In this session, Dr. Narit Yimyam started his presentation on an overview of the land use system in the Thailand project study site: Tee Cha Village in Sob Moei District in Mae Hong Son Province. The land use system is composed of forests (conservation & head water forest, community forest and utility forest), agricultural land (shfitng cultivation, permanent fields and paddy fields) and village settlement. He also explained tenure arrangement for each land uses.

14. Dr. Narit then explained the methodology the Thai team is using to measure carbon stocks in different land uses. Carbon storage in the forests was estimated as follow: Carbon storage = plant biomass x 0.5. Biomass of large tree (> 1.5 m high and diameter >15 cm girth at breast) was calculated by allometric equation: Tsutsumi et al. (1983) for hill evergreen; Ogawa et al. (1965) for dry dipterocarp, while small tree (>1.5 m high and diameter < 15 cm girth at breast) were measured by by destructive sampling, i.e. cutting every plants at ground level in the area 2 m x 2 m. Plants were weighted directly and sub-sample of 3 kg was taken for oven dry at 80 ^{o} c for 48 hr for moisture content and biomass. Carbon stocks in agricultural land were also estimated by destructive sampling. Soil carbon storage was estimated based on the soil organic matter collected from the soil depth 0-30 cm. Carbon Storage (Cs) = 58% Organic matter x Soil mass in which Soil mass = Soil bulk density (g/cm^3) x Area (ha) x H Soil depth (cm).

15. With carbon storage of Thai forest above ground, Dr. Narit reviewed some previous studies and illustrated that it depended on type of forest. The total carbon in dry evergreen forest is about 70.29± 7.38 ton per ha, but hill evergreen is 142.32+3.36 ton per ha. He also explained amount soil carbon depend on type of land use such as 270 ton per ha for virgin forest, 200 ton per ha for second forest, and 80 ton per ha for crops. Results of this study will be compared with previous studies.

Session III: Proposed methods for carbon stocks measurement in Laos project site

16. In this session, Mr. Oloth Sengtaheuanghong purposed the methods for the Laos study site. Using the case study on Nam Theun study site in Laos, two types of organic carbon stock could be distinguished: the above ground (including living biomass of tress, bamboos, lianas and dead biomass) in sample plots- 10 m x 10 m in size, and the below ground (roots). The assessment of the vegetation distribution was carried out on the basis of a 2,000 spot image in village with 1:35,000 map for ground check. The 9 sampling points per vegetation type were chosen. As result, the thickness of soil layers consider for the calculation of below ground organic carbon stock was not clearly defined that carbon stock was calculated down to 30 cm.

17. The methods for carbon stocks measurement in Laos project site: Laksip Village will depend on type of land use/cover. The currently total land area of Laksip is 1,746 ha consisting of three main land use types: forest land (including conservation forest, protection forest and production forest), production/agricultural land (crop production), and residential land. According to local terminology, forest land includes conservation forest, sacred forest, cemetery forest, and young forest while agricultural land includes old fallow forest, rotated fallow land, sifting cultivation, garden, and fish pond. For carbon stock measurement, conservation forest, sacred forest and cemetery forest are grouped as dense forest. The teak garden is divided into young teak 1-5 year old, medium teak 5-10 year old, and mature ld teak >10.

18. Biomass of large trees will be measured through allometric equation. Biomass of tree seedlings and other shrubs, herbs etc. will be determined by destructive sampling , i.e. cutting off the ground level. Plants were weighted directly and the data were med to estimate above ground biomass. Soil carbon stocks and fluxes in Laksip will be estimated based on soil organic matter. Mr. Oloth presented shifting cultivation could contribute to soil carbon storage. When plots were cleared and burned, 20 grams of carbon per kg of soil as biochar could get into soil profile.

19. Over 900 plant species are found in Laksip study site. Diversity indices were derived in order to compare the species richness, distribution and evenness in different land uses.

Field visit to Laksip Village

20. The field trip to the Laksip Village offered a good opportunity for participants to observe different land use and land cover and assist Lao researchers in designing the forthcoming field survey of landscape-level carbon stocks. The customary land use/land cover classification is used for stratification of the village landscape for sampling survey to better engage local communities in monitoring of carbon stocks in their land management.

21. The first land use observed was the production land. Annual cropping took place within a rotational shifting cultivation system. The main crop included upland rice for subsistence as well as maize and vegetable production (chilli, beans and parsleys)., Participants observed teak plantations in village. Teaks play very important role in contributing to household source of income. As it is in the rainy season, farmers have already sown upland rice. Rice usually is sown conventionally with dibbling stick with traditional rice varieties. Harvesting will start on October or early September. The second land use observed was the production forests where teak plantation area has been expanded.

22. During the field trip, participants also discussed on land use classification for carbon stock measurement, and laying sample plots-20 m x 20 m in natural forest and 10 m x 10 m in plantations and all other land use/cover classes. Number of plots in each land use will be based on (a) resource availability and accessibility, (b) relative area of different land use-more plots in more extensive land use, and (c) variation within land use.

Reviews and discussion of the work plan and responsibilities:

23. With reference to Laksip village, Prof. Saxena finalized land use classification and methodology on carbon stock measurement as follows:

(1) Forest

- Dense forest -Conservation, Sacred forest, Dense forest, and Cementary forest
- Open forest-Young forest

(2) Shifting cultivation

- Shifting cultivation abandon fields-old fallow land
- Shifting cultivation current fallow-rotated fallow land
- Shifting cultivation cropped field – shifting cultivation (Hai)

(3) Forest plantations-teak gardens(Suan maysak)- Teak 1-15 years

- Young teak 1-5 years
- Medium teak 5-10 years
- Old teak-more than 10 years)

(4) Horticultural plantations-banana garden (2-3 years)-pine apple garden (Suan Kuay, maknut)

24. Enumeration of mature live trees in 20 m x 20 m or 10 m x 10 m plots, Prof. Saxena suggested to start from one corner of the plot and also explain GBH and DBH and a few common indexes in assessment such as (a) Convert GBH to DBH, for dicot trees $Y = \exp\{-2.134+2.530 \times \ln(D)\}$ where Y = tree biomass/kg; D: DBH in cm (FAO, 2004), (b) Radius = 10/2 = 5 cm, (c) Circumference/ girth = 2 x 3.14 x 5 = 31.4 cm ($2\pi R$), (d) Basal are area = 3.14 x 5 x 5 = 78.5 cm^2 (πR^2), (e) Determine biomass of each tree, species, all live trees in plot.

25. Enumeration of saplings: girth < 10 cm and nest a quadrate of 5 x 5 m size within 20 x 20 m or 10 x 10 m quadrate. We can use tape for measuring girth or calliper for measuring diameter. The shrubs will use the quadrates laid for sapling enumeration through count number of individuals by species as: harvest 10% of individuals of species; take fresh weight of the harvested individuals (x kg); take a

sample of fresh biomass (y kg); dry in oven at 8^o deg C for 48 hours.

26. The litter (dead plant material lying on the ground) biomass will be collected in the plots laid for herbaceous biomass estimation as follows: segregate litter into woody and non-woody fractions; take fresh weight in the field; take samples for determining dry weight; determine dry woody and non-woody litter biomass on per ha basis.

27. The soil will take soil of 0-30 cm horizon. One composite sample from each 20 m x 20 m or 10 m x 10 m plot will determine for bulk density, soil organic carbon by Walkley-Black method (room temperature), soil organic carbon on per ha basis (=%C x Bulk density x 30 cm x 100 cm x 100 cm = g/m^2 convert to ton/ha)

28. The root biomass will be estimated by using available regression to determine root biomass as a percentage of the aboveground biomass. The conversion to carbon stock will take 50% of oven dry biomass as carbon content in oven dried plant biomass. Prof. Saxena will also summarize the methodologies based on this workshop and previous study of India, and to draft a project manual for all researchers by the end of June (see the **annex 4**).

29. The provisional carbon stock measurement of Laos study site will be then tested in 7-13 July 2011. The pre-test will cover land use classification, and lay sample plots. The Thai team (Dr. Narit and Ms. Utumporn) will provide technical support to the field survey in the Laos study site.

30. The policy reviews with policy action plans are expected to complete on November 2011.

31. Finally, the workshop was closed with Prof. Saxena's remarks to thank everyone for their effort and hard work in making the workshop and discussion fruitful and successful. Dr. Jintana Kawasaki, UNU-ISP, appreciated NAFRI for excellent organization of the workshop as well active contributions from participants.

Annex 4: Working manual for carbon stock estimation

Keeping in view the time frame of the project, resource availability and local people-focus of the UNU-APN-REDD project, it was agreed that village landscapes, covering an area of 1,000-5,000 ha would constitute the spatial scale of operation/observation in each site.

Village landscapes, very often superimposed over natural regions like micro-watersheds, will be appropriate for understanding existing land use practices in relation to climate change mitigation and learning from as well as educating marginal mountain farmers to new opportunities of economic development by maintaining/enhancing carbon stocks, biodiversity and tree cover. Nevertheless, an overview of regional/national scope of responding to REDD+ as international programme would always be in the background. Thus, the village landscape scale observations/data/methods will be put within the context of national/international programmes and activities relevant to REDD+.

The village landscape analysis would aim to answer the questions: (i) which land uses encompass high levels of carbon stocks and what are the rates of losses or gains in carbon associated with different land use/management changes? (ii) what are the factors driving conversion of high carbon stock land uses to low carbon stock land uses? and (iii) what opportunities are available for promoting conversion of low carbon stock land uses to high carbon stock land uses?.

Though all sites (Lao, Thailand, China, and India) sites are located in marginal mountain areas, sites vary in terms of biophysical, socio-cultural and policy factors. A synthesis of studies carried out in different sites is likely to facilitate exchange of good practices between countries and to avoid environmental costs incurred in one country in the past in the other countries at present/future in addition to recommendations and conclusions applicable on a larger regional scale.

The study would bring out for each site at least : (1) land use/cover map of the selected village landscape at 1:10,000 to 1:1,000 scale, (2) area of each land use/cover type, (3) pathways/trajectories of land use changes and factors driving them, (4) carbon density (tons C/ha) in each land use/cover type and (5) key land use decisions/factors favouring maintenance/enhancement of carbon stocks, biodiversity, sustainable land management and well-being of people.

Broad steps in methodology	Details	Comments and suggestions requested from (Liang, Narit, Oroth, Shen, Rao)
1. Identifying and mapping land use/cover types in the landscape: stratification of landscape into different classes differing in terms of C stocks	The core aim of this step is to classify a landscape in land use/cover types more uniform in terms of attributes determining carbon stocks. The number of land use/cover classes would depend based on the nature and magnitude of heterogeneity within a given landscape, scale of mapping and technique of mapping. To illustrate, in the Laksip village in Lao PDR, the land use classes would encompass (i). Natural forests: dense (crown > 60%), (ii) Natural forests: open (crown cover 20-60%), (iii) Teak plantations: old (> 10-year-old), (iv) Teak plantations: middle-age (5-10-year-old), (v) Young plantations: young (< 5-year-old) (with or without intercropping of annual crops), (vi) Abandoned shifting agriculture, (vii) Current fallows:1-2-year old, (viii) Current fallows: 3-4 years old, (ix) Cropped fields: annual crops (without teak), (x) Cropped fields: perennial crops. If national forest cover maps are available, it may be useful to develop classification schemes close to the widely applicable national schemes. For example, if the national scheme considers 30-70% as moderately dense and > 70% crown cover as dense forest, it may be appropriate to adopt these limits for classification in village landscape too. Customary classification schemes need to be taken in account so as to better facilitate participation of local communities in mapping and monitoring land use/cover and carbon stocks. It would be useful if land tenure/right	

	system/management system is also mapped (e.g., a map depicting distribution of production, protection and conservation forests in Laksip). By superimposing land tenure/management system type map, one can find out which tenure/management system is more effective in enhancing carbon stocks. Based on participatory discussions, the land use/cover stages preceding the present ones and probable reasons of changes should also be identified. To illustrate, there could be three patches of permanently abandoned shifting cultivation land similar in terms of land cover but different in terms of land use histories, with depletion of soil fertility forcing abandonment in one patch, weed infestation in the second patch and land allocation policy forcing abandonment in the third patch. Area (ha) of each land use type/subtypes should be estimated. The country team can take final decision on the scale of mapping 1: 10,000 to 1: 1,000 and mapping technique (participatory mapping, interpretation of satellite data, interpretation of aerial photographs)	
2. Deciding size and number of plots for estimating carbon density in each land use/cover type:	The past studies suggest a minimum plot size of 400 m^2 (20 m × 20 m) in natural forests and 100 m^2 (10 m × 10 m) in plantation forests for enumeration of trees, of 25 m^2 (one 5 m × 5 m quadrat) nested in the central area of tree plot for shrubs and 1 m^2 (5 quadrats of this size, one each around central and corner points of the tree-plot. The plots should be located in the central portion of a land use patch. If a land use is represented by several patches, as many patches as possible (preferably all) should be sampled. If a size of a patch is smaller than the size of tree plot, the whole patch should be analyzed and its area recorded. Sampling intensity/number of plots would be guided by desired level of confidence level,	Details of statistical analyses (confidence, standard error, etc) will be placed in annexure: this is being prepared and will be circulated at a later stage

	usually the observed mean lying within 10-20% of true mean with 95% confidence interval. To illustrate, if we get a mean biomass value of 20 t/ha and standard error of mean of 1.2 t/ha based on observations recorded in 17 plots (n =17), we are 95% confident that true mean lies between 22.544 t/ha [20 + {2.12 (*t* value at *P* = 0.05 and df 16) × 1.2}] to 17.456 [20 - {2.12 (*t* value at *P* = 0.05 and df 16) × 1.2}]. 22.544 and 17.456 in the present case mean 95% confidence limits and the range 22.544-17.456 95% confidence interval. The number of plots to be sampled could be determined by finding out variability within a land use based on past studies and, in the absence of passed studies, on a quick small scale sampling (say 3-5 plots) in a given land use: Number of desired sample plots (n) = $(t \times s/E)^2$ or E = 2 × s/square root of n; E, desired half-width of the confidence interval = mean ×0 .1 or 0.2 (10 or 20% precision); t = 2 (sample size is unknown); S = standard deviation. For example, if mean = 50 t/ha; S = 10 t /ha; desired precision = within 10% of the true mean; then E = 50 × 0.1 = 5, n = $(2 \times 10/5)^2$ = 16 plots. The project areas in the present case are such that quite reliable carbon stocks could be estimated based on observations in sampling at 4-8 plots in each land use/cover type. Nevertheless, all areas being located in difficult mountain terrains, number of plots would, apart from statistical considerations, be guided by, resource availability, accessibility. One may start with enumerations in 4-5 plots in each land use, determine standard deviation/coefficient of variation and increase number of plots in land uses with high degree of variation such that standard deviation is less than 30% of the mean.	
3. Estimating aboveground biomass of live trees (DBH > 5 cm or 16 cm CBH/GBH,i.e., 3.14 × 5 or basal area of 19.6 cm^2,	Mark location of a plot in map, Measure and note down the slope of the plot (for applying slope correction at the end), average height of trees and crown cover: (in case of plots laid in forests) Start from one corner of the plot	Start from one corner of the plot Note down the name of species (scientific and local name) and CBH tree by tree

i.e., 3.14 × 2.5 × 2.5)	Note down the name of species (scientific name, local name and local uses) and CBH/GBH (circumference or girth at breast height) tree by tree Take some measure to avoid duplication, e.g., by marking a tree after noting down its GBH Measure tree height if it figures as an independent variable in the regression equation decided to be used for biomass estimation. In most of the tree species in the project sites relationship of aboveground with DBH/CBH/basal area is likely to be as strong as with DBH^2 × height and hence measurement of height may not be needed. Country teams need to decide on the regression equation to be used. However, in case of palms and bamboos height is often more strongly correlated with biomass than DBH and hence height measurement for these species would be necessary. Drawing allometric regression equations (statistical relationships between easily measurable tree attributes with biomass drawn based on harvesting of trees covering the whole range of variation in tree size) for each site would provide the most accurate estimates of biomass as the nature and strength of biomass – DBH and/height relationship varies by species, climate, soil properties and management practices. However, this may not be feasible within the time and resource constraints imposed by the project on one hand and site/country-specific constraints on the other. A proper choice of available regression equations may provide estimates with reasonable accuracy, a viewpoint also reflected in guidelines issued by organizations like FAO, GEF and IPCC. The country team should choose the regression equations which have been derived by others but in climatic/ecological conditions quite close to the project site. Some of the relevant available equations have been compiled in Table 1, while Table 2, giving an example, illustrates a wide range of variation in aboveground biomass estimates derived from different regression equations.	Take some measure to avoid duplication –by marking trees after noting down the GBH Convert GBH to DBH or basal area depending on the requirement of regression equations: For dicot trees: $Y = \exp\{-2.134+2.530 \times \ln(D)\}$ where Y = tree biomass/kg; D: DBH in cm (FAO, 2004) Determine aboveground biomass of each tree in the plot Determine biomass of each species in the plot Determine biomass of all live trees in plot Determine biomass on per ha basis

	Determine aboveground biomass of each tree in the plot Aggregate individual tree biomass values by species in the plot to get aboveground biomass of a species in the plot Sum up biomass of all species to get total aboveground live tree biomass in the plot Apply slope correction: work out true horizontal length for the length of the plot along slope as Length along slope x Cos of angle of slope (degree). Slope corrected area of rectangular plot = Width x horizontal length Slope corrected area of a circular plot = 3.14 × actual radius x horizontal radius Determine biomass on per ha basis from the plot level values. For example if slope corrected area of the plot is 250 m^2, biomass of trees in the plot is 10 t, biomass per ha would be (10,000/250) × 10 = 400 t/ha	
4. Estimating aboveground biomass of dead trees	Determine tree wise, species wise and total biomass as in the case of living trees. Reduce biomass by 10% to account for the loss of leaves, twigs and branches (Delaney et al., 1998). Apply slope correction and determine biomass per ha	
5. Estimating biomass of lianas	As in case of trees, except for use of regression equations drawn for lianas	
6. Estimating biomass of saplings (individuals of tree species with GBH/CBH < 10 cm	Nest a quadrat of 5 m × 5 m size within 20 m × 20 m or 10 m × 10 m quadrat Start from one corner of the nested quadrat Using a caliper, measure basal diameter (diameter 10 cm above ground) of each individual identifying its species Pool all individuals not identifiable by species as	

	miscellaneous species Convert basal diameter to basal area 3.14 × (basal diameter /2) × (basal diameter/2) Using regression equation, determine biomass of each individual Determine species wise biomass of saplings in the plot Apply slope correction and determine species wise biomass of saplings on per ha basis Determine total biomass of all saplings on per ha basis	
7. Estimating shrub biomass	Enumerate shrubs in the quadrats used for sapling enumeration Count number of individuals by species and pool individuals not identifiable by species as 'miscellaneous species' Harvest 10% of individuals of a species Take fresh weight of the harvested individuals in the field: 1-3 kg fresh weight taken for oven drying Take a sample of fresh biomass Dry in oven at 80 deg C for 48 hours and determine dry weight Determine dry weight of species wise shrub biomass in the plot Determine species wise biomass on per ha basis Determine total shrub biomass on per ha basis	
8. Estimating herbaceous biomass	Herbaceous biomass Nest five quadrats, each of 1 m × 1m size, at each corner and the centre of 10 m × 10 m or 20 m × 20 m sample plots Harvest all vegetation, segregate by species and pool all individuals not identifiable by species as 'miscellaneous' species and separate the	

	harvested biomass into above and belowground components Take fresh weight of harvested individuals Take a sample of fresh biomass (around 500-1000 g) of each species, dry in oven and determine dry weight Determine species-wise biomass in the plot Apply slope correction and determine species-wise belowground and aboveground biomass on per ha basis Sum up species-wise belowground and aboveground biomass, getting total herbaceous biomass per ha	
9. Estimating root biomass of trees and shrubs	Use available regression equations to determine root biomass	
10. Estimating litter biomass	Collect litter in the plots laid for herbaceous biomass estimation Segregate litter into woody and non-woody fractions Take fresh weight in the field Take 200-1000 g samples for determining dry weight after keeping at 80 deg C for 48 hours Apply slope correction and determine woody and non-woody litter biomass on per ha basis Sum up woody and non-woody litter biomass and get total litter biomass on per ha basis	
11. Estimating carbon stock in vegetation	Carbon content-oven dry weight/biomass relationship varies as shown in Table 3. In most cases, 50% of oven dry weight is taken as carbon content. Country teams can decide this value	
12. Estimating carbon in soil	Keeping in view the operational constraints, soil organic content in upper 30 cm soil layer will estimated Take soil of 0-30 cm horizon: sample 0-10 cm, 10-20 cm and 20-30 cm layers separately and average for 0-30 cm layer depending upon suitability of local conditions	

	Obtain one composite sample from each 20 m × 20 m or 10 m × 10 m plot Determine bulk density following broadly the method outlined by Anderson and Ingram (1989) • Remove surface material from the spot where soil is to be sampled and level the spot • Drive a 5 cm diameter thin-sheet metal tube of known weight (W1) and volume (V) 5 cm deep into the soil surface • Excavate the soil from around the tube and cut the soil beneath the tube bottom • Trim excess soil from the tube ends • Dry the soil at 105 deg C in an oven for two days and weigh (W2) • Calculate bulk density as (W2-W1, i.e., weight of oven dry soil collected in the tube from the field)/V as g/cm^3 • The size of tube can be changed based on the local circumstances Determine soil organic carbon by Walkley-Black method as outlined in Anderson and Ingram (1989) • Air dry the soil samples (200-500 g of composite sample) at about 40 deg C • Sieve the soil through a 2 mm sieve, and gently rub the crumbs through the mesh leaving the gravels and roots/other debris. • Grind all the material to pass a 0.15 mm mesh • Weigh 0.1-0.5 g of ground soil and pour it in a 250 ml conical flask, noting down the exact weight of soil (W) • Add 5 ml of 1 M potassium dichromate solution (dissolve 49.04 g of dry potassium dichromate in 800 ml of distilled water in a 1,000 ml volumetric flask and make up the volume to 1000 ml), gently stir the solution, add 7.5 ml of concentrated sulphuric acid slowly and then stir the solution so that all soil particles are exposed to the solution • Keep the solution at room temperature	

	till the solution comes down to room temperature • After solution comes down to the room temperature, add 0.3 ml of indicator solution (0.1 g N-phenylanthranillic acid and 0.1 g sodium carbonate in 100 ml of distilled water) • Titrate the digest with 0.20 M ferrous ammonium sulphate (dissolve 78.390 g ferrous ammonium sulphate in 50 ml of concentrated sulphuric acid and dilute to 1000 ml with water) and note down the volume of the solution when end point, i.e., change of colour of solution from violet to green, (T) • Calculate organic carbon (%) as (T × 0.2 × 0.3)/W • Determine soil organic carbon on per ha basis = %C × Bulk density × 30 cm x 100 cm x 100 cm = g/m^2 and convert to t/ha)	

Table a4.1: Regression equations available for plant biomass estimation

Life form	Regression equation	Author and ecoregion
Trees and palms > 5 cm DBH	Y = species specific wood density* x exp (-1.499 + 2.148 ln (DBH) + 0.207 (ln (DBH))^2 – 0.0281 (ln (DBH))^3	Chave et al. (2005) for tropical forests
Trees	Y = -1.638 + 2.08 ln DBH	Pilli et al. (2006) building on the model of WBE model of West et al. (1999)
Anacardium excelsum	ln Y_c = -3.4931 + 2.4843 ln (DBH) ln Y_c = -3.4577 + 2.4889 ln (DBH) ln Y_c = -3.4278 + 2.4830 ln (DBH) ln Y_c = -3.4877 + 2.5143 ln (DBH) ln Y_c = -3.7179 + 2.1936 ln (DBH) + 0.4132 ln height (m) DBH in cm	Losi et al. (2005) Tree size 1.8 to 11.2 cm DBH for plantations in Panama
Dipteryx panamensis	ln Y_c = -2.6344 + 2.5170 ln (DBH) ln Y_c = -2.6362 + 2.5339 ln (DBH) ln Y_c = -2.2433 + 2.3661 ln (DBH) ln Y_c = -2.6203 + 2.5327 ln (DBH) ln Y_c = -3.3814 + 2.8645 ln (DBH)	Losi et al. (2005)
Trees	Y(pine) = 0.084 × $DBH^{2.47}$ Y(oak) = 1.91 × $DBH^{1.782}$ Y (fir) = basal area × height × taper factor × wood density × expansion factor	Ordonez et al. (2008) for montane forests in Central Mexico

Trees	ln Y_c = -2.7450 + 2.6244 ln (DBH) ln Y_c = -2.0619 + 2.3088 ln (DBH)	Shepherd and Montagnini (2001) for plantations in humid tropics
Dicot trees	Y = exp{-2.134+2.530 x ln (D)} where Y = tree biomass/kg; D: DBH in cm R^2 = 0.97	FAO (2004) for DBH < 80 cm in 1500-4000 mm rainfall regime
	Y = exp{-1.996 + 2.32 x ln (D)} where Y = tree biomass/kg; D: DBH in cm R^2 = 0.89	FAO (2004) for 5-40 cm DBH in 900-1500 mm rainfall regime
	Y = 10 (raise to the power) (-0.535 + $\log_{10}$ (3.14 r^2) Y = tree biomass/kg; r: DBH in cm R^2 = 0.94	FAO (2004) for DBH 3-30 cm in < 900 mm annual rainfall regime
	Y = exp {-2.4090 + 0.9522 x ln (DBH2) x height x wood density R^2 = 0.99	Winrock from Brown, Gillespie and Lugo, 1989) for DBH > 5 cm in 1500-4000 mm rainfall regime
	Y = exp {-3.1141 + 0.9719 x ln (DBH2) x height R^2 = 0.97	Winrock from Brown, Gillespie and Lugo (1989) for DBH > 5 cm in 1500-4000 mm rainfall regime
	Y = 34.4703 – 8.0671 DBH + 0.6589 DBH^2	Winrock from Brown, Gillespie and Lugo (1989) for DBH > 5 cm in <1500 annual rainfall regime
Dicot trees and bamboo	Y = -122.297+13.065 DBH (Dillenia indica) Y = -163.332 + 15.09 DBH (Shorea robusta) Y = -144.678 + 144.678 (DBH) (Schima wallichii) Y = -63.06 + 10.562 DBH (Castanopsis indica) Y = -91.137 + 10.887 DBH (Garcinia cowa) Y = -229.852 + 17.451 DBH (Gmelina arborea) Y = -233.191 + 18.276 DBH (Artocarpus chaplasa) Y = -115.659 + 9.998 DBH (Vitex peduncularis) Y = 4.435 + 5.219 DBH (Milusa roxburghinana) Y = -80 + 6.5 x (Sterculia villosa) Y = -16.987 + 4.20 DBH (Dendrocalamus hamiltoni)	Singh (1980) for sub-tropical humid forests
Cooconut palms	Y = 5.5209 tree age + 89.355	Kumar (2011)
Other palms like Arecanut and	Y = 4.5 + 7.7 height	Brown (1997)

Borassus flabellifer		
Bamboo (*Bambusa* sps.)	Ln Y = 4.437 + 2.576 ln (DBH)	Kumar et al. (2005)
Tropical pine	Y = 5.508 + 2.008 DBH	Das (1980)
Sal plantation	Ln Y = 2.0473 DBH – 1.4516	Singh and Ramakrishnan (1983)
Lianas ≥ 1 cm	$Y = 10^{(0.12-0.91 \log (BA))}$	Putz (1983) for lianas in Venezuela
Shrubs	$Y = 0.363 \ln (diameter_a \times diameter_b \times height) + 0.7829$ $diameter_a$ and $diameter_b$ are two perpendicular diameters of shrub crown	Ordonez et al. (2008) for montane forests in Central Mexico
Saplings ≥ 1 cm Basal diameter < 5 cm DBH	Y = exp[3.965 + 2.383 ln (BD)]	Kirby and Potvin (2007) tropical moist forests in eastern Panama
Tree snags ≥ 5 cm DBH	species specific wood density $[3.14 (DBH/2)^2 \times height \times 0.78]$	Nascimento and Laurance (2002) for Amazonian rainforest
Dead trees ≥ 5 cm	90% of total aboveground biomass of live trees	Delaney et al. (1998) in six life zones of Venezuela
Downed woody debris	Density of dead wood $[3.14 \times 3.14 \sum (d^2)/8$ transect length] × slope correction factor	Brown and Roussopoulos (1974) for small fuels
Root/shoot ratio	0.25	Cairns et al. (1997) for oak and avocado orchards
	0.26	Cairns et al. (1997) for pine
	0.26	Ordonez et al. (2008) for shrubs in Central Montane forests in Mexico
	0.10	Ordonez et al. (2008) for agriculture in Central Montane forests in Mexico
	0.18	Jaramillo et al. (2003) tropical dry forests of Mexico
For dicot trees: Y = exp{-2.134+2.530 x ln (D)} where Y = tree biomass/kg; D: DBH in cm (FAO, 2004)	Y = exp{-2.134+2.530 x ln (D)} where Y = tree biomass/kg; D: DBH in cm	

Root biomass of trees, palms and lianas ≥ 1 cm DBH	24% of aboveground biomass	Cairns et al. (1997)
Root biomass in forests	20% of above ground biomas	Santantonio et al. (1977)
Ratio of belowground to aboveground biomass in forests	0.2	MacDicken (1997)
Ratio of belowground to aboveground biomass	0.28, 0.19 and 0.61 for tree, shrub and herb component, respectively, in Acer forest in Himalaya 0.36, 0.31 and 0.9 for tree, shrub and herb component, respectively, in Betula forests in Himalaya 0.49, 0.50 and 0.89 for tree, shrub and herb component, respectively, in Rhododendron forests in Himalaya	Garkoti and Singh (1995)
Belowground biomass as percentage of total tree biomass	6% in early successional and 21% in late successional species in sub-tropical humid forests	Ramakrishnan et al. (1982)
Belowground: aboveground biomass ratio of annual crops	0.03 to 0.14	Kritika (unpublished) in Himayan region
Aboveground-belowground biomass regression pooling all vegetation components	Ln Belowground biomass = 0.5667 ln Aboveground biomass -1.1212 R^2 = 0.87	Mustafa (unpublished) in Himalayan region
Agroforestry trees	Ln Y = 0.645 Ln basal area- 0.33 (R^2 = 0.51 in abandoned agricultural land) Ln Y = 1.0601 Ln basal area – 2.0679 (R^2 = 0.67 in degraded forest land) Ln Y = 0.8714 Ln basal area – 1.3643 (R^2 = 0.70 pooled data)	Semwal unpublished data in Himalayan region

*if species specific wood density is not known, a generalized value of 0.54 g cm^{-3} for standing trees, 0.453 g cm^{-3} for sound downed deadwood and 0.319 g cm^{-3} for rotten dead wood

Table a4.2: Variation in biomass estimates of a tree with DBH of 14.66 cm (or basal area 168.47 cm^2) and actual biomass of 49 kg) derived from different regression equations

Regression equation	Author	Biomass estimate
Y = species specific wood density* x exp (-1.499 + 2.148 ln (DBH) + 0.207 (ln (DBH))^2 – 0.0281 (ln (DBH))^3	Chave et al. (2005)	184.0
Y = -1.638 + 2.08 ln DBH	Pilli et al. (2006)	51.8
ln Y_c = -2.7450 + 2.6244 ln (DBH)	Shepherd and Montagnini (2001)	147.7 (2 x Yc)
Y = exp{-2.134+2.530 x ln (D)} where Y = tree	FAO (2004)	105.6

biomass/kg; D: DBH in cm $R^2 = 0.97$		
Y = exp{-1.996 + 2.32 x ln (D)} where Y = tree biomass/kg; D: DBH in cm $R^2 = 0.89$	FAO (2004)	69.0
Y = 34.4703 – 8.0671 DBH + 0.6589 DBH^2	Winrock from Brown, Gillespie and Lugo (1989)	57.8
Ln Y = 0.645 Ln basal area- 0.33 ($R^2 = 0.51$ in abandoned agricultural land) Ln Y = 1.0601 Ln basal area – 2.0679 ($R^2 = 0.67$ in degraded forest land) Ln Y = 0.8714 Ln basal area – 1.3643 ($R^2 =$ 0.70 pooled data)	Semwal unpublished data in Himalayan region	19.5 28.9 22.3

Table a4.3: Relationship of carbon content with oven-dry weight (biomass) used by some researchers in carbon stock estimations

Relation of carbon content and oven dry weight/biomass	Authors
● 50% of dry biomass	Brown, 1986; Montagnnini and Porras, 1998
● 45% of dry biomass	Whittaker and Likens, 1973
● 45% for litter, 43% for seedlings, 41% for grass, 50% for downed woody debris and 47% for trees, palms and lianas	Hughes et al., 1999
● A common value of 47.5%	Fujisaka et al., 1998; Kotto-Same et al., 1997
● A common value of 46%	Elias and Potvin, 2003
● 48% based on analysis of samples	Losi et al., 2003

Annexure 1: Statistical analysis: formula and examples (being prepared)

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Annex 5: Journal on "REDD+ for Forest Communities". APN Newsletter Vol. 7, Issue 3, Sep. 2011, ISSN 2185-6907.

Forests are home to around 300 million people around the world, including people of indigenous and tribal groups, who are largely dependent on forests. More than 1.6 billion people depend to varying degrees on forests for their livelihoods. Not only that, forests sustain critical environmental services such as conservation of biodiversity, water and soil conservation, and climate regulation.

Similar to payments for environmental and ecosystem services (PES) mechanisms, REDD+ is expected to provide incentives to forest owners and users for not converting forests to other uses to prevent loss of forest carbon stocks, or for not overusing forests to avoid degradation of forest carbon stocks. The incentives or payments are based on the net change in carbon stocks for a specific period in comparison to a reference level. The net change in carbon stocks are measured and calculated into certified 'carbon credits' which can be eventually bought and sold on a carbon market or paid through a fund. However, the global architecture for REDD+ still remains under development. REDD+ should promote the multiple values of forests, not only carbon benefits but also co-benefits of food and livelihoods and biodiversity conservation.

The APN project

In order to address the knowledge gap on potential opportunities and challenges of REDD+, the UN University, in partnership with the National Agriculture and Forestry Research Institute of Laos, and Chiang Mai University, Thailand, with the support of the Asia Pacific Network is undertaking a 3-year project that aims to:

- assess the potential social, economic and environmental challenges and opportunities of REDD+ for forest communities in Laos and Thailand. Lessons will be drawn from past/ongoing forest conservation policies;
- provide much-needed scientific evidence on the potential co-benefits of traditional forest management practices and comparing it with alternative land-uses; and
- develop participatory community-based MRV mechanisms for REDD+ to enable local communities to incorporate carbon stocks into their forest management.

Findings will assist the pro-poor design and implementation of REDD+, improve the well-being of forests dependent communities and integrate traditional agriculture and forestry as a climate change mitigation agenda.

Learning from the past

Learning the lessons from the past and how the experience will be translated into REDD+ are only partially considered in current mainstream debates on REDD+. Greater understanding is needed on why past forest conservation and rehabilitation efforts have failed and how to properly address the drivers of deforestation. The introduction of any additional forest conservation measures, even those like REDD+ with its carbon storage-focus, cannot be analysed in a vacuum separated from the past but as part of a continuum of one of many forest conservation efforts. Nor can it be developed in isolation from communities who not only depend on forests, but who are also critically needed and supported for the long-term and on-the-ground management, monitoring, reporting and verification (MRV) of forests within REDD+, so as to benefit from carbon finance as additional source of income from forests. The realities of forest conservation policies and its success in achieving stated goals and the socio-economic impacts, spatial and temporal, on local communities must be clearly evaluated. If the development of REDD and REDD+ follow similar paths taken by past forest conservation efforts, it may result in stand-alone approaches that focus purely on carbon accounting and erects barriers between local communities and forests. What could result is a fragmented mosaic where 'conservation islands' of protected forest areas exist next to poverty-ridden forest-agriculture frontiers.

Going beyond REDD+

The approach of REDD+ has so far mirrored present conservation approaches to treat 'nature' and human societies as separate entities. That is, exclude, even, expulse humans from protected forest areas (carbon sinks) as their intervention causes its degradation. This thinking devalues the role of local and indigenous communities in shaping and maintaining the surrounding landscapes and ecologies with which they live in, and ignores the positive impacts that their traditional (agri) cultural practices can have on the integrity, richness and resilience of ecosystems and landscapes.

With the uncertainty of future climate change, it is necessary to enhance the resilience and adaptability of these landscapes by enhancing diversity and flexibility of social-ecological systems. Because of the role socio-ecological landscapes play in soil fertility, carbon sequestration, biodiversity, food and water security, livelihoods and increased climate change resilience for the poor, they must be incorporated and supported by REDD+ mechanisms. Socio-ecologically productive landscapes maintain ecosystem functioning and support a rich repository of agricultural biodiversity through social mechanisms of exchange and use of many varieties and species.

REDD+ is about recognizing the multiple values of forests and should not narrowly emphasize forests as carbon sinks. The traditional forest and trees-based land-use systems and landscapes offer many models to integrate many values of forests and trees into REDD+. Systematic research and scientific data are needed to evaluate past/ongoing forest conservation efforts and assess their stated objectives to the actual realities on the ground, and then translate the lessons learned into improving future forestry schemes like REDD+.

The success of any REDD+ projects must consider the sustainability of forest communities whose livelihoods depend on forest ecosystem services. REDD+ strategies need to go *beyond carbon* benefits to promote co-benefits for environment and forest communities through the harmonious integration of multiple values of forests, including poverty reduction, food and livelihood security, biodiversity conservation, climate change mitigation and adaptation. Carbon benefits for global climate regulation should not be achieved at expense of forest functions to support local livelihoods and biodiversity.

Annex 6: Journal on "REDD+ for Forest Communities based on Lessons Learnt from Forest Conservation Efforts in Laos and Thailand". Available at http://isp.unu.edu/research/projects/agrodiversity/resources/index.html (15 July 2011)

Forests are home to around 300 million people around the world, including people of indigenous and tribal groups, who are largely dependent on forests. More than 1.6 billion people depend to varying degrees on forests for their livelihoods, e.g. fuelwood, medicinal plants, forest foods and income, and for their cultural and spiritual identity. Forests sustain critical environmental services such as conservation of biodiversity, water and soil conservation, and climate regulation.

According to FAO's the Global Forest Resources Assessment 2010, the world's forests covered just over four billion hectares, or 31 per cent of total terrestrial area, and stored more than 650 Gt of carbon, presenting a significant global carbon stock. However, 13 million hectares of forests mainly in tropical regions was lost every year between 2000 and 2010. Deforestation is estimated to account for almost 20% of global greenhouse gas emissions, resulting in loses in biodiversity, environmental services and human well-being.

Forest carbon stocks can be increased through reforestation and afforestation (See Figure 1). The Clean Development Mechanism of Kyoto Protocol (CDM) allows industrialized countries to meet a part of their carbon emission reduction commitments by carrying out afforestation and reforestation (AR) in developing countries. On the other hand, losses of forest carbon stocks as emission of greenhouse gases can be avoided through conservation of standing forests that would be otherwise lost and degraded, i.e. reducing deforestation and forest degradation (See Figure 2). Nevertheless, avoided deforestation to reduce emission is not included under the Kyoto Protocol.

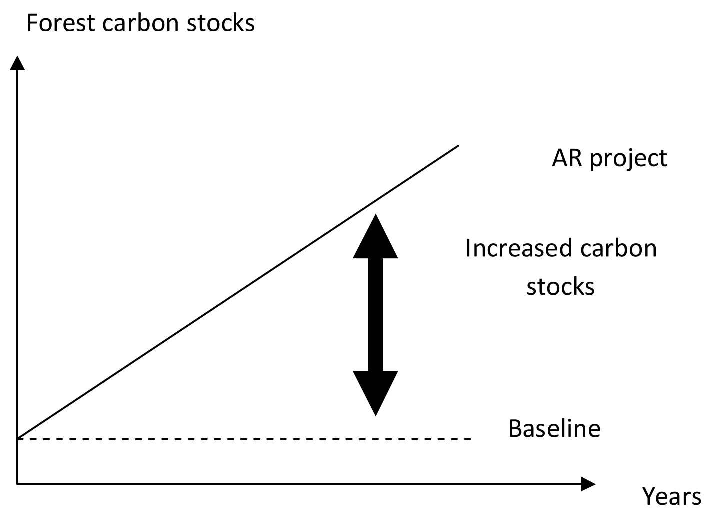

Figure a6.1: Increasing forest carbon stocks through AR projects

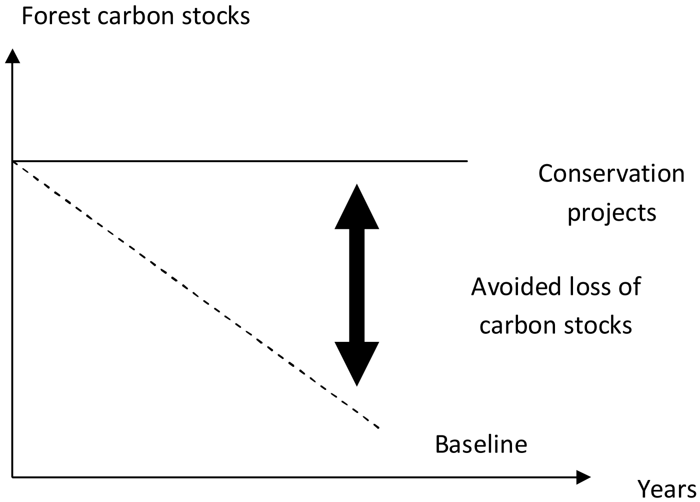

Figure a6.2: Avoiding loss of forest carbon stocks through conservation of standing forests

Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD) is an emerging international instrument initially proposed at the COP 11 of UNFCC in Montreal in 2005 to provide economic incentives to developing countries to undertake actions for protection and enhancement of standing forest carbon stocks. Discussion on REDD was focused first on 'reducing emissions from deforestation' or RED. 'Avoided degradation' – the second D in REDD – was officially added later at COP13 in Bali, 2007, when it was realized that for some countries, forest degradation was an even bigger problem than deforestation. There was further recognition that even greater climate benefits could be achieved if positive actions, such as conservation of forest carbon stocks, sustainable management of forest and enhancement of forest carbon stocks could be combined with avoided deforestation and degradation. The positive actions became the '+' in REDD+, and was officially endorsed one year later at COP14 in Poznan.

Similar to payments for environmental and ecosystem services (PES) mechanisms, REDD+ is expected to provide incentives to forest owners and users for not converting forests to other uses to prevent loss of forest carbon stocks, or for not overusing forests to avoid degradation of forest carbon stocks. The incentives or payments are based on the net change in carbon stocks for a specific period in comparison to a reference level. The net change in carbon stocks are measured and calculated into certified 'carbon credits' which can be eventually bought and sold on a carbon market or paid through a fund. However, the global architecture for REDD+ still remains under development. COP16 of UNFCCC at Cancun, Mexico adopted a phased approach to REDD+ implementation as follows:

- Phase I: development of national strategies or action plans, policies and measures, and capacity-building;
- Phase II: implementation of national policies and measures and national strategies or action plans that could involve further capacity-building, technology development and transfer and results-based demonstration activities;
- Phase III: results-based actions that should be fully measured, reported and verified;

CO16 also required REDD+ implementation take into account safeguards to reduce poverty, ensure environmental integrity (biological diversity and other environmental benefits of forests) and respect for the knowledge and rights of indigenous peoples and members of local communities. In another words, REDD+ should promote the multiple values of forests, not only carbon benefits but also co-benefits of food and livelihoods and biodiversity conservation. Any attempts that enforce a barrier between local people and their forests, without consideration of their needs or other conflicting policy priorities, may do little to alleviate poverty, and even fail to enhance carbon stocks and prevent biodiversity loss in the long term.

The success of any REDD+ projects must consider the sustainability of forest communities whose livelihoods depend on forest ecosystem services. REDD+ strategies need to go *beyond carbon* benefits to promote co-benefits for environment and forest communities through the harmonious integration of multiple values of forests, including poverty reduction, food and livelihood security, biodiversity conservation, climate change mitigation and adaptation. Carbon benefits for global climate regulation should not be achieved at expense of forest functions to support local livelihoods and biodiversity. Furthermore, a whole- landscapes approach is necessary to ensure against 'leakage' whereby the carbon benefits from areas protected under REDD+ are offset by severe reductions in carbon storage and biodiversity from inappropriate land use intensification and land degradation in surrounding areas.

Learning from the past

From a historical perspective, REDD+ is only one out of a long line of many other approaches that have been used for forest conservation. Past and ongoing forest efforts have had mixed results, they include forest regulations and laws, zoning of protected areas, projects to rehabilitate degraded forests and lands, relocation of forest communities, etc. While some may have achieved objectives for increased forest cover, it has often been at the expense of forest communities. In some cases, perverse and unintended consequences have emerged or even resulted in the worsening of deforestation rates. This raises many ethical, equitable and sustainability concerns that should not be repeated under REDD+.

One of the past efforts for forest conservation is to deal with shifting cultivation which includes a short period of cropping and a relatively long period of forest fallow. Many forest communities, including those in Southeast Asia rely on shifting cultivation as one of their main livelihoods. A wide-scale forest conservation policy has been implemented to restrict and stop shifting cultivation by promoting sedentary agriculture, allocating forest fallows for forest conservation and resulting in land shortage for shifting cultivation. Without providing alternative livelihoods and capacity development, forest communities have had to increase the cropping period of the shifting cultivation and decrease the fallow period to cope with the land shortage, but at the risk of accelerating land degradation (Liang, et al, 2010). Time-averaged aboveground carbon stocks could decline by about 90% if the long fallow periods of traditional swidden cultivation are reduced to 4 years short fallow system (Bruun, et al, 2009). REDD+ can be both a challenge and opportunity for shifting cultivators (Mertz, 2009).

Restrictions on forest access, reductions in available land for shifting cultivation, and then on top of that, increased population density, competing land-use pressures and conflicting policies have led to significant acceleration in land degradation and unsustainable agricultural intensification, as well as observed reductions in soil fertility and species and plant biodiversity. This in turn has caused increased hardship, food insecurity, and social tensions. It is likely that at the landscape level, the overall carbon-storage balance was also affected negatively, yet more scientific research is needed to determine this. Other perverse consequences include the loss of crop diversity embraced in the traditional shifting cultivation.

Learning the lessons from the past and how the experience will be translated into REDD+ are only partially considered in current mainstream debates on REDD+. The introduction of any additional forest conservation measures, even those like REDD+ with its carbon storage-focus, cannot be analysed in a vacuum separated from the past but as part of a continuum of one of many forest conservation efforts. Nor can it be developed in isolation from communities who not only depend on forests, but who are also critically needed and supported for the long-term and on-the-ground management, monitoring, reporting and verification (MRV) of forests within REDD+ so as to benefit from carbon finance as additional source of income from forests. The realities of forest conservation policies and its success in achieving stated goals and the socio-economic impacts (spatial and temporal) on local communities must be clearly evaluated. Without understanding why past forest conservation and rehabilitation efforts have failed and how to properly address the drivers of deforestation will only guarantee failure. As it stands, the development of REDD and REDD+ appears to follow similar paths taken by past forest conservation efforts, i.e. as stand-alone approaches that focus purely on carbon accounting and seek to erect barriers between local communities and forests. What could result is a fragmented mosaic where 'conservation islands' of protected forest areas exist next to poverty-ridden forest-agriculture frontiers.

Going beyond REDD+

The approach of REDD+ has so far mirrored present conservation approaches to treat 'nature' and human societies as separate entities. That is, exclude, even, expulse humans from protected forest areas (carbon sinks) as their intervention causes its degradation. This thinking devalues the role of local and indigenous communities in shaping and maintaining the surrounding landscapes and ecologies with which they live in, and ignores the positive impacts that their traditional (agri)cultural practices can have on the integrity, richness and resilience of ecosystems and landscapes (Takeuchi, et al, 2002; van Oudenhoven, et al, 2010).

With the uncertainty of future climate change, it is necessary to enhance the resilience and adaptability of these landscapes by enhancing diversity and flexibility of social-ecological systems. Because of the role socio-ecological landscapes play in soil fertility, carbon sequestration, biodiversity, food and water security, livelihoods and increased climate change resilience for the poor, they must be incorporated and supported by REDD+ mechanisms. Rerkasem (2003) and Hajjar *et al*, 2008 argue that the complex mosaic landscapes of traditional land-use systems, with well-managed forest fallows, provide a range of environmental and social services: hydrology, biodiversity, carbon storage, and livelihoods. They are socio-ecologically productive landscapes that maintain ecosystem functioning and support a rich repository of agricultural biodiversity through social mechanisms of exchange and use of many varieties and species. In addition, the indigenous knowledge and technology have been adapted to deal with the social and economic change (Rerkasem, et al, 2009; Liang, et al, 2009).

Presently, the objectives and scope of REDD+ remain narrow with its focus on carbon sequestration and 'officially-defined' forests areas. One of the difficulties is the complicated definitions of what is a forest and what to do with the many trees that exist outside areas officially defined as forests, such as on farms. In developing countries, around 1.2 billion people practice farming that combines both agriculture and forestry, or agroforestry (FAO, 2005). It is also at these agricultural-forest interfaces where much soil and land degradation can occur from land-use pressures should those trees be removed. Agricultural-forest interfaces, agroforests and tree-based land-use systems managed by farmers still remain at the fringes of the REDD+ debate. However there have been calls to include agriculture, agroforestry and other land use types (AFOLU) in the carbon accounting (Smukler, S., and Palm, C., 2009). More recently, the 'reducing emissions from all land uses' (REALU) approach has been put forward for arguing that "a whole-landscape approach to reducing emissions and managing carbon stocks can help address the drivers of deforestation, reduce problems like leakage, and eliminate the need for precise forest definitions" (van Noordwijk, M. *et al*, 2009.)

REDD+ is about recognizing the multiple values of forests and should not narrowly emphasize forests as carbon sinks. The traditional forest and trees-based land-use systems and landscapes offer many models to integrate many values of forests and trees into REDD+. Systematic research and scientific data are needed to evaluate past/ongoing forest conservation efforts and assess their stated objectives to the actual realities on the ground, and then translate the lessons learned into improving future forestry schemes like REDD+.

The new APN project

In order to address the knowledge gap on potential opportunities and challenges of REDD+ as discussed above, the UN University, in partnership with National Agriculture and Forestry Research Institute, Laos, and Chiang Mai University, Thailand, with the support of the Asia Pacific Network is undertaking a 3-year project that aims to:

- assess the potential social, economic and environmental challenges and opportunities of REDD+ for forest communities in Laos and Thailand. Lessons will be drawn from past/ongoing forest conservation policies;
- provide much-needed scientific evidence on the potential co-benefits of traditional forest management practices and comparing it with alternative land-uses; and
- develop participatory community-based MRV mechanisms for REDD+ to enable local communities to incorporate carbon stocks into their forest management.

Findings will assist the pro-poor design and implementation of REDD+, improve the well-being of forests dependent communities and integrate traditional agriculture and forestry as a climate change mitigation agenda.

The project was launched in Chiang Mai University in Jan 2011 with identification of two study villages, one each in Northern Thailand and Northern Laos. The rotational shifting cultivation remains the major livelihood in the study village in Northern Thailand while the shifting cultivation is converting to the timber plantation in the study village in Northern Laos. Two villages offer a good comparison of traditional land use systems in transition. In addition, UNU research network members in China and India will associate two of their study villages to the research projects so that a cross-region comparison can be made. A methodology for carbon stock survey at the village landscape level was agreed in June 2011. The project is expected to complete the survey of carbon stocks by November 2011.

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