Validation and Registration of the Project on REDD plus through Participatory Land and Forest Management for Avoiding Deforestation in Lao PDR

Technical Cooperation Report

October 2014

Japan International Cooperation Agency (JICA)

Mitsubishi UFJ Research and Consulting

Japan Forest Technology Association

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- Project Description (PD) on REDD plus Project -

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PARTICIPATORY LAND AND FOREST MANAGEMENT PROJECT IN NORTHERN LAO PDR

Developed by the Japan International Cooperation Agency (JICA)

for

The Luang Prabang Provincial Agriculture and Forestry Office (PAFO)
and
XXVV Co., Ltd. (a Japan-based private venture)

with supports from
The Department of Forestry (DOF) under the Ministry of Agriculture and Forestry,
The Department of Forestry Resource Management (DFRM) under the Ministry of Natural Resource and Environment (MONRE),

Red sentences are revised according to peer-review

Project Title	Participatory Land and Forest Management Project in northern LAO PDR
Version	Version 0.1
Date of Issue	22nd ~~6th~~ August~~June~~ 2014
Prepared By	The Luang Prabang Provincial Agriculture and Forestry Office (PAFO) and XXVV Co., Ltd. (a Japan-based private venture)
Contact	Under discussion

Acknowledgments

This project description (PD) was prepared by through a close collaboration involving the Japan International Cooperation Agency (JICA), the Department of Forestry (DOF) under the Ministry of Agriculture and Forestry, the Luang Prabang Provincial Agriculture and Forestry Office (PAFO) and Phonsay District Agriculture and Forestry Office (DAFO).

All members of REDD+ proponents and other entities wish to express their gratitude to all participants and supporters of this REDD+ activities.

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1 PROJECT DETAILS

1.1 Summary Description of the Project

Approximately 80% of the land area in Lao PDR is classified as mountainous. In the northern mountainous region of Lao PDR, multi-ethnic peoples continue to rely on slash-and-burn agriculture (i.e. shifting cultivation), which are sometimes shifting to primary/secondary forest (i.e. pioneer shifting cultivation or conversion from forest to other land use) or cultivates for short-term rotation. These practices result in deforestation and forest degradation in the area. Then unsustainable activities of shifting cultivation, which drives deforestation and forest degradation, has emerged as a major issue in northern mountainous region.

Landscape in northern Lao PDR

According to recent study on land use and forest area, which was carried out from the end of 2002 to early 2003, forest area covered about 71.6% (about 17 million ha) of the total national land area (the Ministry of Agriculture and Forestry, MAF 2005[1]), and forested areas with the canopy density of 20% or more, covered 41.5% (about 9.8 million ha) of the total land area and decreased from 47% (about 11.2 million ha) in 1992 levels. Especially in the northern area, forest area per land area (forest coverage rates) declined from 36.3% in 1992 to 27.9% in 2002 and temporary un-stocked forest (area after slash-and-burn) exceeded 60% as of 2002. Shifting cultivation is on the rise in the north, including our target site, although shifting cultivation is declining at the national level. This increase is considered the primary and major cause of accelerating deforestation and forest degradation in northern Lao PDR.

As part of the Forestry Strategy to the Year 2020 under Lao PDR (hereafter Forestry Strategy 2020[2]), the Government announced plans to restore forest coverage rates to 70% by 2020 and is currently establishing and implementing policy and measures toward this end. In 1996, Lao PDR passed its Forestry Law which most recently revised in December 2007[3] (further revision is scheduled for 2014 or later). However, forest management system in rural areas tends to be inadequate for following two major reasons: (1) lack of strategy/plan of sustainable forest management or REDD+ strategy especially at the regional level and (2) inadequate budgets and human resources.

[1] Lao People's Democratic Republic (2005) Forestry Strategy to the Year 2020 of the Lao PDR
[2] Lao People's Democratic Republic (2005) Forestry Strategy to the Year 2020 of the Lao PDR
[3] Lao People's Democratic Republic (2007) Forestry Law

This project was initiated to reduce and control deforestation caused by the expansion of pioneer shifting cultivation among natural and secondary forest and the shortening of fallow periods, based on participatory land and forest management in Houaykhing Village Cluster (HK-VC), Phonsay District, Luang Prabang Province, located in the northern part of Lao PDR.

Luang Pr~~h~~abang Province, the site where this project has been implementing, is characterized by a tropical savanna climate under the Köppen climate classification. The mean monthly high temperature ranges from 26.5°C in December to 34.6°C in April. Mean monthly low temperature ranges from 14.2°C in January to 24.3°C in July. Annual rainfall averages 1,248 mm/yr, with a monthly low of 13 mm in December and a monthly high of 226.5 mm in August[4].

To control deforestation, the project held recurring participatory workshops on land and forestry management systems and on articulated countermeasures (i.e. project activities) intended to reduce greenhouse gas (GHG) emissions from deforestation in cooperation with the REDD Office of Lao PDR, as well as Luang Prabang Provincial Agriculture and Forestry Office (PAFO), Phonsay District Agriculture and Forestry Office (DAFO). For reducing pressures on forest resources and introducing a land and forestry management system emerging from the workshops attended by rural people, the project aimed to; introduce alternative livelihoods to supplant shifting cultivation in the areas and neighborhoods where this project took place; and to plan a future land use and establish sustainable ways to manage forest resources. To implement such activities, the project applied the PAREDD Approach developed by Lao PDR side (DOF, PAFO and DAFO) and Japan International Cooperation Agency (JICA) (Appendix 1)[5].

In the targeted site, to reduce pressures on forest resources and reduce deforestation, the project applied the PAREDD Approach which consists of three stages, Planning Stage, Launching Stage and Sustaining Stage. Through the planning stage, especially in Sub-Stage 1, the project conducted problem analysis to verify their effectiveness or suitability as project activities based on capability approach which is according to natural and human rescores in the site, and moved to later Sub-Stages and Launching Stage, which introduce alternative livelihoods for reducing the dependence on shifting cultivation (it means reducing shifting cultivation), by using Village Development Fund (VDF) managed by themselves.

To monitor results of implemented countermeasures based on the PAREDD Approach, which is GHG emission reductions and removals from the atmosphere after undertaking activities (Project Activities), the project analyzed satellite images (LANDSAT TM, RapidEye and SPOT 5) from 1996 to 2010 and calibrated them using a radar image (PALSAR) to identify forest dynamics (changes in forest areas) in the target site. Additionally, the project analyzed the dynamics of each forest type and revised them on the basis of a ground truth (field survey). The project classified each forest type based on the types indicated on the Lao PDR Forest Base Map (currently being developed by the Lao PDR government with support from Japan) [6]. The project then quantified the amount of carbon stock per unit area of each forest type based on site specific emission/removal factors, including allometric equations and expansion factors, and default values provided in the IPCC Emission Factor Database (EFDB). Finally, since the change in the amount of carbon stock in shifting cultivation area was closely related to human activity, the project

[4] According to web site of World Meteorological Organization (WMO)

[5] With technical support from JICA, the Department of Forestry (DOF) under the Ministry of Agriculture and Forestry, PAFO and DAFO developed PAREDD Approach as a mitigation measure for reducing deforestation and forest degradation under a project for Participatory Land and Forestry Management for Reducing Deforestation and Forest Degradation (PAREDD).

[6] Forest base map is developed by Project of Forest Information Center (FIM) which is supported by Japan's Government from FY 2008 to FY 2012

developed a new model for the area under shifting cultivation and quantified its dynamics. From above monitoring and calculation process, as an *ex ante* estimate, the project is expected to reduce GHG by 534,290 tCO_2e within 10 years (i.e. 53,429 tCO_2e/year) of the project start date.

1.2 Sectoral Scope and Project Type

See methods in the Annex (attached).

1.3 Project Proponent

Project proponent jointly consists of the following PAFO and XXVV Co., Ltd. (a Japanese private venture);

Provincial Agriculture and Forestry Office (PAFO)

The PAFO manages the project and has task of awareness of REDD+ and introduces participatory land and forestry management and participatory forest monitoring which will be transferred from JICA. Also the PAFO has gathered opinions from the village to help make profits as an incentive to sustain REDD+ over the mid- and long-term.

Responsible: *under discussion* *(should be added)*

Address: *XXXYYY* *(should be added)*

Contact: *Tel number and/or E-mail* *(should be added)*

XXVV Co., Ltd. (a Japanese private venture)

XXVV Co., Ltd (a Japanese private venture), the project developer and proponent, initiates the project fieldwork, introduces participatory land and forestry management systems and monitoring processes. Also, the XXVV Co., Ltd. handles project management, including village development fund (VDF) management, benefits-sharing, and tasks related to validation and verification. Additionally, XXVV Co., Ltd. works closely with PAFO on REDD+ implementation to ensure consistency with REDD+ strategy in Lao PDR.

Responsible: *under discussion* *(should be added)*

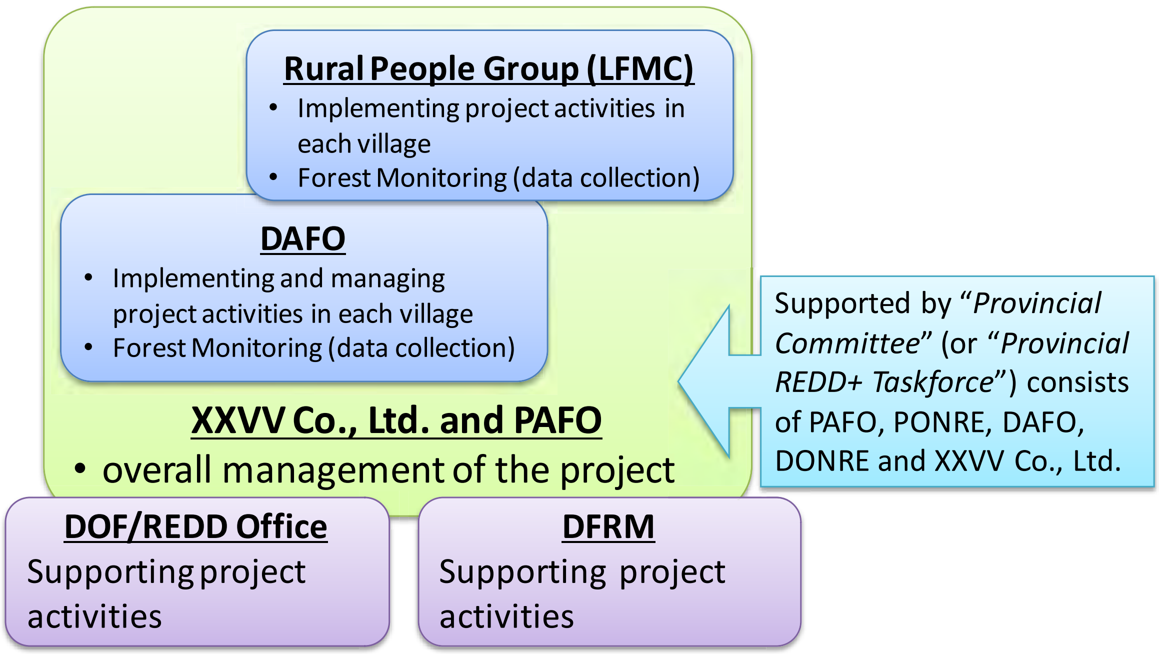
Address: *XXXYYY* *(should be added)*

Contact: *Tel number and/or E-mail* *(should be added)*

The PAFO and XXVV Co., Ltd. are in charge of overall management of project implementation. Following project implementation, the PAFO and XXVV Co., Ltd. will assume responsibility for matters related to the implementation of REDD+, including periodic post-project monitoring, coordination of proponents, and allocation of GHG emission reductions credits earned through project implementation.

1.4 Other Entities Involved in the Project

This project requires participation of various stakeholders to identify solutions to problems related to shifting cultivation, a practice arising from unplanned land and forestry resource use and a major cause of deforestation in the northern part of Lao PDR. One of the project goals is to formulate a participatory land and forestry management plan under the direction of Lao PDR and to adopt the deforestation policies and methods specified in the Forestry Strategy 2020. The following structure for implementing the project was developed as part of preliminary work (including discussion with stakeholders) (Figure 1).



Note: "*Provincial Committee*" (or "*Provincial REDD+ Taskforce*") in the figure is under discussion in Lao PDR, it will be established in a few years later after the project start and provide advices to implement activities in line on REDD+ strategy in Lao PDR and Luang Prabang Province.

Figure 1 Project implementation structure

Presented below is information (including the primary address and a summary description) for each organization listed in Figure 1, as well as the role of each organization in implementing REDD+:

Rural People Group (LFMC)

At the outset, this project must provide a substitute for shifting cultivation and secure a livelihood for rural people in the target site. To promote them, it should be required to organize and manage local communities and rural people. In addition, continuous forest monitoring for 3 to 5 years interval requires their participations for over the mid- and long-term. Therefore this project cooperates with rural people group who is the Land and Forestry Management Committee, or LFMC, established with support by JICA PAREDD Project[7] having a task to implement project activities in the village.

Responsible: *under discussion* *(should be added)*

Address: *XXXYYY* *(should be added)*

Contact: *Tel number and/or E-mail* *(should be added)*

District Agriculture and Forestry Office (DAFO)

The project also worked with the DAFO in Phonsay District. The DAFO have been worked with JICA as a counterpart and JICA has enjoyed long-standing collaborative experience with the DAFO, ensuring that this project has been undertaken efficiently and effectively. Like the PAFO, the DAFO oversaw participatory forest monitoring in the field. As the organization closest to local communities and rural people, the DAFO played a key role in field management.

Responsible: *under discussion* *(should be added)*

Address: *XXXYYY* *(should be added)*

Contact: *Tel number and/or E-mail* *(should be added)*

Department of Forestry (DOF) and REDD Office, Ministry of Agriculture and Forestry (MAF)

The DOF is the organization under the MAF provides macro-management services related to forest management, protection, and development, thereby ensuring effective and sustainable use of forest resources throughout the country. In addition, the REDD Office has responsibility of managing implementation of the readiness activities funded by the Forest Carbon Partnership Facility (FCPF) under the World Bank and organizing the Stakeholder Participation and Consultation Plan (SPCP).

In Lao PDR, following the 2012 reorganization of the government offices, the DOF has responsibility of managing forests which are classified as Production Forest accounting for 3.1 million ha (approximately 16.1%) of all gazette or to be gazette forest lands (17.2 million ha) and forested areas, mostly under village management, outside of the three forest categories. Also the Department of Forest Resource Management (DFRM, *see* below) has responsibility for managing both forests classified as Conservation Forest and lands classified as Protect Forest, accounting for 4.7 million ha (approximately 24.4%) and 8.2 million ha (42.7%) respectively.

Under the current land classification plan, the project target land (30,486 ha) consists of Production Forest (about 28.2%) and Protection Forest (about 50.4%). The project worked with the DOF and DFRM to launch this project. The project discussed methods for implementing participatory land and forestry management and for distributing profits gained in compensation for GHG emission reductions. The DOF

[7] Participatory Land and Forest Management Project for Reducing Deforestation (PAREDD) (August 2009 – August 2014): PAREDD aims to develop an approach to reduce deforestation and forest degradation at village and village-cluster levels with the participation of villagers. PAREDD is carrying out: (1) participatory land and forest use planning; (2) activities for reducing deforestation (forest management, agriculture livelihood improvement etc.); and (3) forest cover and carbon stock monitoring.

has played a key role in forest governance in Lao PDR for many years, and the department has offered extensive knowledge, reasonable human resources, and vast experience. This makes working with the DOF a key aspect of this project.

The DOF is the counterpart of JICA PAREDD and FSCAP Projects[8] undertaken through collaboration between Lao PDR and JICA. The DOF has worked jointly with JICA for a long time, boosting the efficient and effective prosecution of this project.

Department of Forestry (DOF):

Responsible: *under discussion* (should be added)

Address: *XXXYYY* (should be added)

Contact: *Tel number and/or E-mail* (should be added)

REDD Office:

Responsible: *under discussion* (should be added)

Address: *XXXYYY* (should be added)

Contact: *Tel number and/or E-mail* (should be added)

Department of Forest Resource Management (DFRM) under the Ministry of Natural Resource and Environment (MONRE), Provincial Offices of Natural Resource and Environment (PONRE) and District Offices of Natural Resource and Environment (DONRE)

The DFRM under the MONRE is a new organization established in 2011. Moreover, the DFRM has responsibility for managing both forests classified as Conservation Forest and lands classified as Protect Forest. In cooperation with the DFRM, the project adjusted the validity of measures used to assess deforestation and forest degradation. Additionally, at the target site level, the project worked with the Provincial Offices of Natural Resource and Environment (PONRE) and District Offices of Natural Resource and Environment (DONRE), a local MONRE office.

Responsible: *under discussion* (should be added)

Address: *XXXYYY* (should be added)

Contact: *Tel number and/or E-mail* (should be added)

1.5 Project Start Date

December 16, 2011 was the start date of the proposed REDD+ project activity crediting period.

[8] Forestry Sector Capacity Development Project (FSCAP) (October 2010 –September 2014): FSCAP aims to build the capacity of the Department of Forestry staff through assisting the formulation, implementation and monitoring of policies and legislation, which are related to the Forestry Strategy 2020 and the MAF five-year plan (2011-2015), as well as REDD+.

The real activities of the REDD+ project in the target site began on December 16, 2011, with the first orientation meeting in HK-VC (i.e. step 1 of the PAREDD approach, *see* following Figure 2).

1.6 Project Crediting Period

The crediting period is 20 years: from December 16, 2011 to December 15, 2030 (project period is 40 years: from December 16, 2011 to December 15, 2050).

1.7 Project Scale and Estimated GHG Emission Reductions or Removals

As per VCS guidance on REDD projects (VCS AFOLU v3 3.1.9), *ex ante* estimates to determine project scale were provided only for the first 10-year baseline period through to December 16, 2011. As the anticipated emission reductions is less than 1,000,000 tCO_2e per year, the project falls short of the definition of mega project.

Project	Less than or equal to 1,000,000 tCO_2e per year
Large project	No

The estimated mean annual GHG emission reductions by the project (i.e. after accounting for leakage and prior to buffer withholding) are provided below (Table 1). Since the first baseline period is only 10 years, total GHG benefits are 534,290 tCO_2e.

Table 1 Estimated GHG emission reductions (tCO_2e) in the project

Years	Estimated GHG emission reductions or removals (tCO_2e)
2011	10,975
2012	17,475
2013	25,244
2014	33,358
2015	42,673
2016	53,309
2017	65,409
2018	79,121
2019	94,620
2020	112,107
Total estimated ERs	534,290
Total number of crediting years	10
Average annual ERs	53,429

The average annual GHG emission reductions are 53,429 tCO_2e/year in pursuance of the calculations specified under the AFOLU Requirements section [5.4.3.1.b] and the AFOLU Guidance.

1.8 Description of the Project Activity

- Deforestation has occurred over many years in the target site due to pioneer shifting cultivation and forest resource use (*see* details in "2.4 Analysis of historical land-use and land-cover change" of Annex). This project seeks to restrict the expansion of pioneer shifting cultivation (by clearing primary and secondary forest) and to promote longer fallow periods than before the project. These goals require additional efforts to develop alternatives to the rural people's dependence on forestry resources.

- A preliminary socio-economic and natural and human resources surveys in HK-VC before the project activities confirmed the current land and forest use and the relationship between the lifestyles of the rural people and their dependence on forestry resources for their livelihood. These surveys also assessed natural resources in the village and human resources.

- All project activities were and will be conducted according to the PAREDD Approach (*see* Appendix 1), which are separated into Planning Stage, Launching Stage and Sustaining Stage (Figure 2).

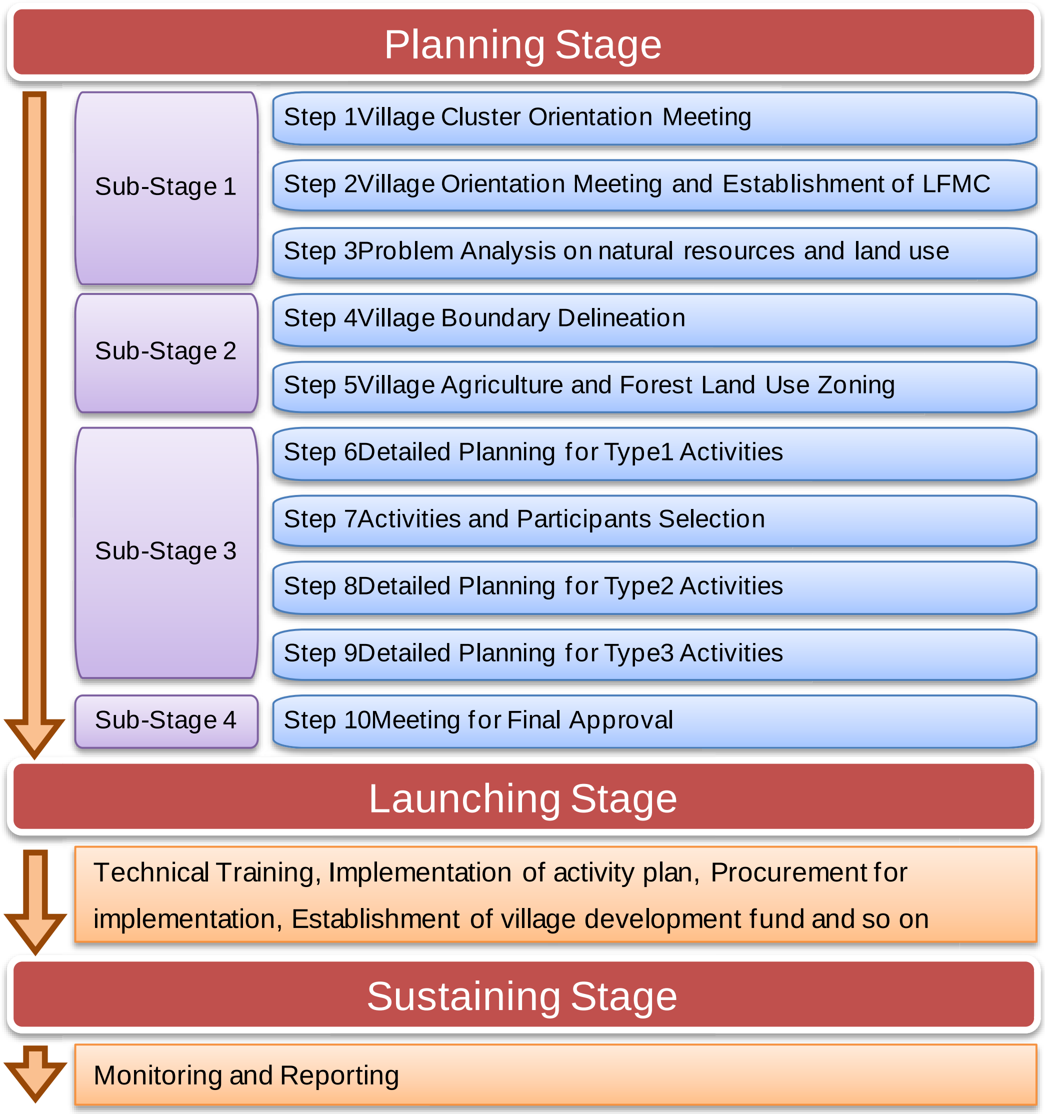


Figure 2 Activities (steps) of the PAREDD Approach

- Planning Stage consists of following 3 Sub-Stages;

1. Sub-Stage 1, which is from step 1 to step 3, was focusing on capacity development; awareness of forest conservation and land use management and knowledge-sharing on global warming and the REDD+ strategy of the central government of Lao PDR (*see* samples of materials in Appendix 2). Capacity development was undertaken based on the characteristics and circumstances of all types of rural people. In step 2, the Land and Forest Management Committee (LFMC) was established in each village (*see* Appendix 3). Also the present problems on natural resources and land and forest use through historical trend analysis and current resource mapping were analyzed (*see* Appendix 4)

2. Sub-Stage 2, which is step 4 and 5, was identification of geological village boundary delineation and development of land zoning system (i.e. village agriculture and forest land use zoning

system) (Figure 3) (*see* results of land zoning system in each village in Appendix 5). Participatory process of the zoning by the Approach stimulated residents to realize present status of their natural resources and to control their excessive land use. The Zoning basically did not reflect present status, but it will be the ideal zoning in the future. As the result of this process, the community attains the right balance between forest and agricultural land zone by itself.

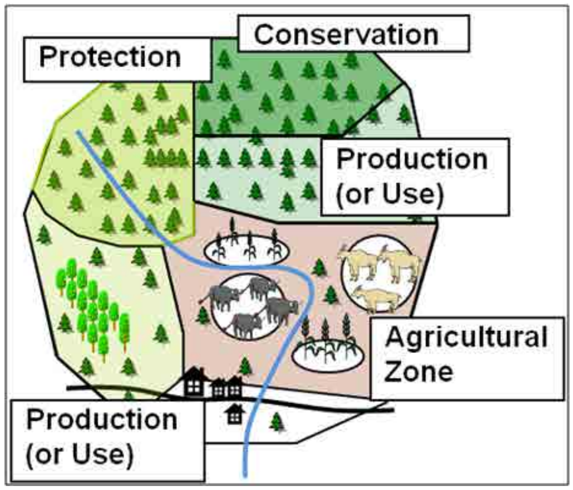


Figure 3 Conceptual Drawing of Land and Forest Zoning

Sub-Stage 3, which is from step 6 to step 9, was based on the preparatory activities achieved in the above Sub-Stage 1 and 2. The project implemented activities (Type 1 to Type 3) decided by the LFMC and all villagers (Table 2). For selecting suitable alternative livelihoods, some supplemental information was provided (*see* Appendix 6 which indicates that paddy field would be essential as alternative livelihoods). The activities helped encourage and motivate rural people to participate in project plans including land zoning system in Sub-Stage 2. Then, finally, all activities in the planning stage were approved by the meeting among all villagers (i.e. Sub-Stage 4).

Table 2 Decided activities in Type 1, 2 and 3 of Sub-Stage 3 in each village

Village	Type	Activities	Number of participating household
Houaykhing	1	Fruit tree plantation (5.3 ha)	Whole households
		Planting for reforestation (6.2 ha)	Whole households
		Equipment	Whole households
	2	Goat raising	13
		Pig raising	13
		Poultry raising	19
		Fish raising	4
	3	Repaired the village's water supply (equipment, popes and faucet)	Whole households
Houayha	1	Fruit tree plantation (1.0 ha)	Whole households
		Equipment	Whole households
	2	Goat raising	9
		Pig raising	7
		Poultry raising	10
	3	Meeting room repairing	Whole households
Parkbong	1	Fruit tree plantation (1.1 ha)	Whole households
		Planting for reforestation (1.5 ha)	Whole households
		Equipment	Whole households
	2	Goat raising	18
	3	School repairing (equipment)	Whole households
Houaytho	1	Fruit tree plantation (3.6 ha)	Whole households
		Planting for reforestation (3.8 ha)	Whole households
		Equipment	Whole households
	2	Goat raising	10
		Pig raising	4
		Poultry raising	3
		Fish raising	5
	3	Meeting room repairing	Whole households
Sakuan	1	Fruit tree plantation (1.2 ha)	Whole households
		Equipment	Whole households
	2	Goat raising	13
		Pig raising	13
		Poultry raising	5
	3	Meeting room repairing (tables, cabinets and chairs)	Whole households
Longlath	1	Work in progress	
	2		
	3		

Note: detailed information on each village is shown in following Table 4.

- Launching Stage of REDD+ activities consists of following 4 components;

  1. Technical training: supplementing villager's activities (e.g. lectures, village veterinary system, food processing and so on) have been conducted.

  2. Procurement for implementation: seedling for plantation, livestock as alternative livelihoods and other necessary materials were supplied by the project. Additionally checking quantity or quality of materials were conducted.

  3. Implementation of activity plan: various activities were conducted. For example, vaccination for livestock management, planting activities, construction for village meeting house and so on.

  4. Establishment of the VDF: by using the VDF, all activities by villagers were conducted. Participants of livelihoods improvement activities are responsible to repay when their activities bear fruit and receive incomes. Repayment will be used by other villagers who are interested in and try to start activities as their new way for livelihoods.

- Finally, the project moved to the Sustaining Stage, which is long-term implementation with continuous reports and supports. In addition, the project has an option to revise or improve land zoning system in step 5 according to results of Sub-Stage 3 or others because land zoning system is based on participatory land and forest management methods and should be revised according to further progress of the PAREDD Approach. Therefore, if needed, the project developed or revised long-term strategies with suitable project activities which are alternatives to shifting cultivation and the project has been implementing them in the target site.

  Note: project activities in this PD were implemented based on the PAREDD Approach which was developed by JICA PAREDD Project. Details of the PAREDD Approach are described in the attached document entitled as PAREDD Approach Guideline. Regarding ownership and resources access/use by all proponent(s) and stakeholder (especially rural people) were complied in documents of all steps in PAREDD Approach.

1.9 Project Location

The target site in this project is HK-VC, Phonsay District, Luang Prabang Province of Lao PDR (Figure 4). All target area is under control by the project (agreement and/or documents should be provided to the project validator in validation process)

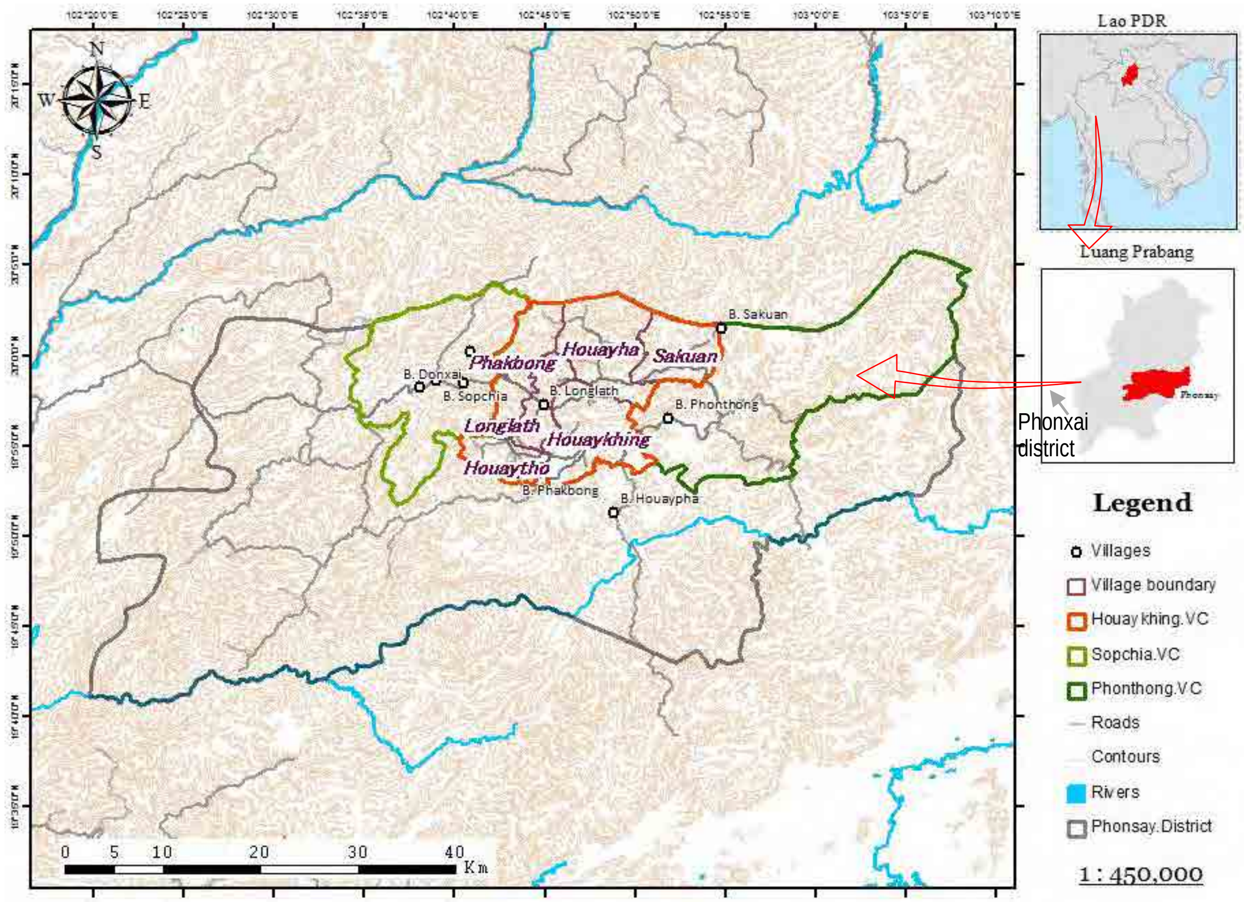


Figure 4 Project Location (Figure was improved)

Lao PDR is administratively divided into a total of 16 provinces (including the state capital, Vientiane, a special ward). Each province is divided into several districts. The target site of this project, Luang Prabang Province, is located in the northern part of a mountainous area. Measuring 30,486 ha (in total area), HK-VC is located in Phonsay District, one of the 12 districts in Luang Prabang Province.

HK-VC is located in a typical mountainous area of northern Lao PDR. The site consists of five small villages since the village reorganization in 2013 (Table 3).

Table 3 Brief history of road construction and improvement in HK-VC

Year	History
2000–2001	● Road construction from Sopchia VC (near Luang Prabang City) to HK-VC by manpower (passable only by motorbike)
2003	● Road expansion from Sopchia VC to Phonthong VC by heavy machinery (passable by automobile)
2004	● Road construction from the main road to Houayha and Sakuan villages
2005	● Road construction from the main road to Houaytho village
2011–2012	● Road expansion and bridge construction from Luang Prabang City to HK-VC

Following Table 4 provides general information, including population, number of households, and other demographic information for each village in HK-VC (*see* details of each village in Appendix 7). Although some villages have been established by Khmu and Hmong in the northern Lao PDR, a comparison to the five villages mentioned earlier shows that each village has specific and different land use characteristics attributable to geographical features, although these differences may not be significant.

Table 4 Demographic structure of target villages in HK-VC in 2012

		Houaykhing	Phakbong	Houaytho	Houayha	Sakuan	Longlath
Number of households (HH)		210	82	59	55	138	81
Population (female)		1,479 (752)	467 (236)	354 (183)	396 (192)	910 (446)	464 (238)
Lao people	No. of HH	5	1	0	0	0	3
	Population (female)	23 (12)	1 (0)	0 (0)	0 (0)	0 (0)	9 (4)
Khmu people	No. of HH	122	81	35	6	464	118
	Population (female)	787 (394)	466 (236)	129 (77)	50 (22)	464 (238)	817 (398)
Hmong people	No. of HH	83	0	24	49	0	17
	Population (female)	669 (345)	0 (0)	225 (106)	346 (170)	0 (0)	85 (44)

General characteristics of the project site

In general, the forests in the project site are secondary forest and shifting cultivation areas (i.e. slash-and-burn area and fallow area, which are degraded forests) affected by human activities.

Shifting cultivation in northern Lao PDR

The project meets the VCS REDD eligibility requirement of being 100% forested as of the project start date (December 16, 2011) and for the period at least 10 years prior to the start date (December 16, 2001), as shown in Figures 10 in 2.4 Analysis of historical land-use and land-cover change of Annex. Hence, roads, bodies of water, and any other area not qualifying as forest, which fails to meet the conditions of VM0015, were excluded.

Climatic conditions: The climate in Luang P~~h~~rabang Province, including our target site of HK-VC, is classified as tropical savanna under the Köppen climate classification. The mean monthly high temperature ranges from 26.5°C in December to 34.6°C in April. The mean monthly low ranges from 14.2°C in January to 24.3°C in July (Figure 5). Annual rainfall is 1,248.2 mm (with monthly low of 13 mm in December and monthly high of 226.5 mm in August). The project site enjoys a clear dry season from October to March and experiences a rainy season from June to September (Figure 6). Temperatures in the Phonsay District, where around the center of reference region, has been accumulated data. Annual rainfall is 966.8 mm (with monthly low of 0 mm in January and February and monthly high of 264.5 mm in August) (Figure 6).

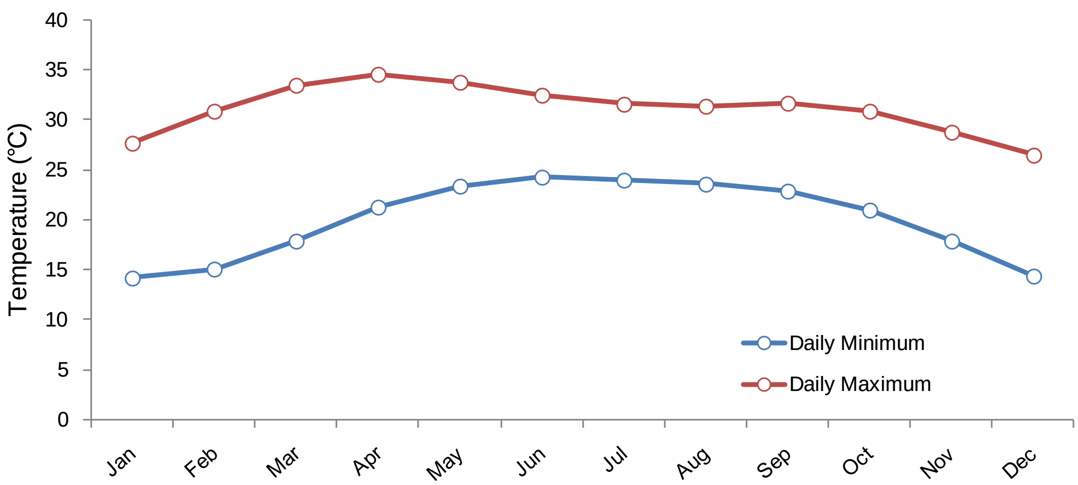
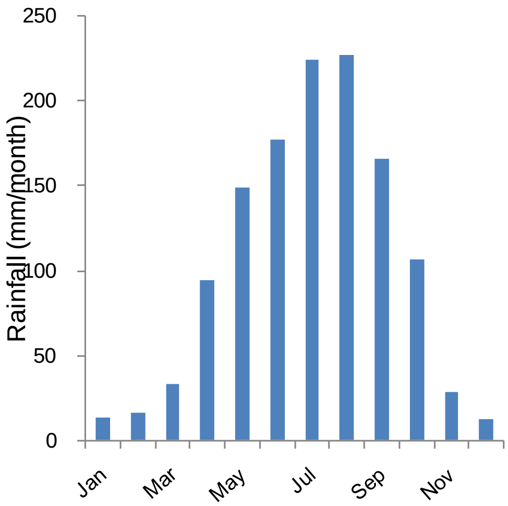


Figure 5 Temperature at the target site in Luang Prabang City (Based on monthly averages for the 50-year period 1951-2000)



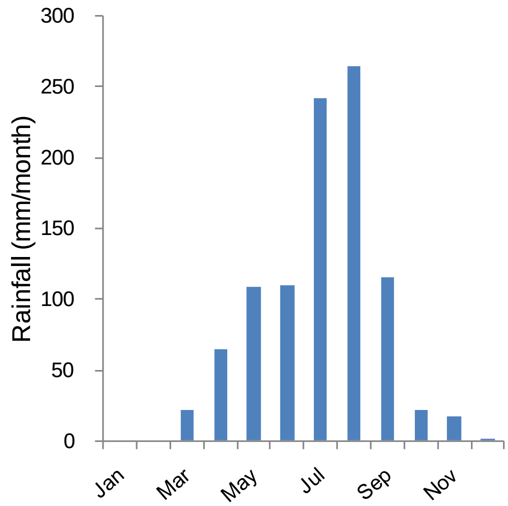


Figure 6 Rainfall in the target site (left: Luang Prabang City which is based on monthly averages for the 50-year period 1951-2000, Right: Phonsay District which is based on monthly averages for the 5-year period 2008-2012)

Ecosystem conditions: The reference region of Phonsay District is located in west side of Luang Prabang Province (latitude: N19°86′ to N20°10′, longitude: E102°56′ to E103°14′). The altitude ranges from 324 m to 2,106 m; the altitude of the main settlement in the project site is around 900 m. The native vegetation is the typical seasonal tropical forest.

Land use condition: Current land use is significantly affected by human activities. Natural forest has been converted to secondary forest (degraded forest) and fallow land (young forest) with the emergence of shifting cultivation. The results of land use analysis based on satellite imagery show the following respective areas and ratios for each forest type as of 2010; "Mixed Forest" was 14,637 ha (48.0%), "Fallow" was 13,353 ha (43.8%), "Slash-and-burn area" was 1,512 ha (5.0%) (*see* detailed in 2.4 Analysis of historical land-use and land-cover change of Annex). Land use in the project site is very similar to the typical pattern in Phonsay District in Luang Prabang Province.

Endangered species: Lao PDR ratified the United Nations Convention on Biological Diversity (UN CBD) in 1996. Based on this treaty, the country established the National Biodiversity Strategy to 2020 and Action Plan to 2010 (NBSAP) in 2004[9]. The goal of the NBSAP is to maintain biodiversity and fight poverty. Its main objectives are as follows; (1) to identify important biological diversity components and improve the knowledge base; (2) manage biodiversity on a regional basis by using natural boundaries to facilitate the integration of conservation and use-oriented management; (3) plan and implement a biodiversity-specific human resource management program; (4) increase public awareness of and encourage participation in the sustainable management of biodiversity; (5) adjust and harmonize national legislation and regulations; (6) secure NBSAP implementation; and (7) promote international cooperation. Some of the issues addressed by the NBSAP include the diversity and productivity of cultivated areas, the richness of forested land, the state and abundance of water resources, and improvements in human

[9] *See* details on CBD website <http://www.cbd.int/countries/?country=la>

settlements. While no endangered plants or animals have been found in our project site, the project will proceed accordingly if the project encounters endangered species in the future and if the importance of preserving such species is confirmed.

1.10 Conditions Prior to Project Initiation

Northern Lao PDR: Approximately 80% of the land area in Lao PDR is classified as mountainous. In the northern mountainous region of Lao PDR, multi-ethnic peoples continue to rely on slash-and-burn agriculture (i.e. shifting cultivation), which is sometimes shifting to primary/secondary forest (i.e. pioneer shifting cultivation or conversion from rich forest to degraded forest) or cultivates for short-term rotation. These practices result in deforestation and forest degradation in the area. Then unsustainable activities of shifting cultivation, which drives deforestation and forest degradation, has emerged as a major issue in northern mountainous region. According to recent study on land use and forest area, which was carried out from late 2002 to early 2003, forest area covered about 71.6% (about 17 million ha) of the total national land area (the Ministry of Agriculture and Forestry, MAF 2005[10]), and forested areas with the canopy density of 20% or more, covered 41.5% (about 9.8 million ha) of the total land area and decreased from 47% (about 11.2 million ha) in 1992 levels. Especially in the northern area, forest area per land area (forest coverage rates) declined from 36.3% in 1992 to 27.9% in 2002 and the temporary un-stocked forest (area after slash-and-burn) exceeded 60% as of 2002. Shifting cultivation is on the rise in the north, including our target site, although shifting cultivation is declining at the national level.

Phonsay District: Increase of shifting cultivation is considered the primary and major cause of accelerating deforestation in northern Lao PDR including our target site of HK-VC and reference region of Phonsay District. Characteristics of Phonsay District are shown in the box below and land use dynamics in Phonsay District is shown in following Figure 7 (*see* details in “2.4 Analysis of historical land-use and land-cover change” of Annex).

[10] Lao People’s Democratic Republic (2005) Forestry Strategy to the Year 2020 of the Lao PDR

BOX: Characteristics of Phonsay District

General Information: Phonsay District is located in the northwestern part of Luang Prabang Province, being 64 km away from the province's capital Luang Prabang City. Phonsay District shares borders with 6 districts, namely Pak Seng District and Viengkham District (North), Phou Khoun District (South), Viengthong District of Huaphan Province and Phou Khud District of Xieng Khuang Province (East) and Luang Prabang District and Xieng Ngeun District (West). There are 62 villages of 4,944 households in 2011. Administratively, Phonsay District is divided into 9 village clusters (VC) and 1 district municipality. The total population stood at 32,480 in 2011. Khmu accounts for the majority of the population (approximately 64%), followed by Hmong accounting for approximately 26%. The majority of the population was engaged in upland rice cultivation. The supportive livelihood activities were cropping and so on. Rural people rely mainly on nature and forests for livelihoods. In 2004, approximately 82% of the population practiced shifting cultivation.

Poverty: The poverty rate stood at approximately 40% covering 47 villages or 76% of the total villages. In other words, there were 1,373 poor households. The land use planning (LUP) was completed in 5 villages of 322 households.

Infrastructure: The district has a main road heading to Xieng Khuang Province. During the dry season, approximately 95% of the roads are accessible in all villages. The development of road networks to remote areas or villages are made depending on the funding. The road development projects with 231.4 km were implemented.

Education: There are vocational training centers, secondary schools and primary schools in each village. There were 69 schools (e.g. 1 kindergarten with 40 children, 15 pre-primary schools with 579 children, 66 primary schools with 6,713 pupils, 3 lower secondary schools with 1,144 pupils and 1 upper secondary school with 310. Approximately 95% of children attended schools.

Health: The district has 1 hospital, 8 dispensaries, and 6 pharmacies that cover 48 villages. Approximately 99% of women and children had vaccination. Twenty three villages were labeled "hygienic or clean". Fifty seven villages had gravity-fed water system accounting for approximately 91% of the total population.

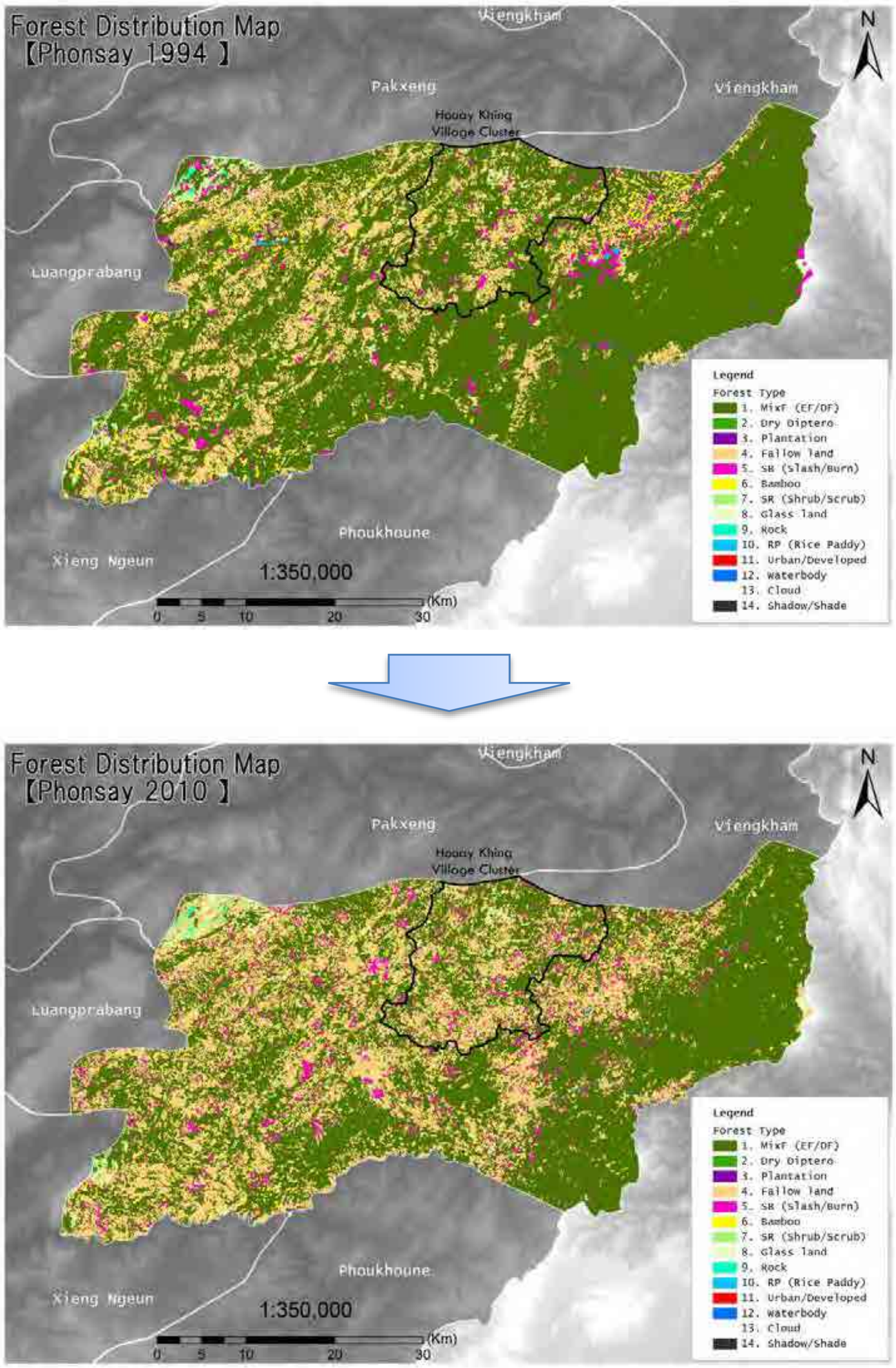


Figure 7 Land use change in project site and reference region from 1994 to 2010

1.10.1 Before the project

The proportion of forest in Lao PDR was around 70% during the 1940s. However, over the course of some decades, deforestation and forest degradation became prominent in Lao PDR. Up until around 1995, in the northern Lao PDR, people engaged in traditional shifting cultivation. However, some earned sufficient cash income from poppy cultivation. At the time, these populations had no need to deploy expansion of pioneer shifting cultivation, a method overly relying on forest resources.

After the 2000s, the cultivation of commercial crops such as rubber and corn for fodder spread rapidly in northern Lao PDR, largely driven by foreign investment. Methods of land and forest use changed significantly. In 2005, the Lao PDR Government developed the Forestry Strategy 2020, and in 2007, the Lao PDR Government revised the Forestry Law to manage forest and clarify forest use rights. Moreover, the Government treated REDD+ as a highly effective approach to improve the livelihoods of rural people, which is strongly dependent on forest resources.

Typical land use of shifting cultivation (next year after harvest)

Thus, the MAF requested technical cooperation from Japan to develop methods to reduce deforestation and forest degradation. In August 2009, JICA launched a technical cooperation project, as readiness activities, entitled the Participatory Land and Forestry Management Project for Reducing Constrain Deforestation in Lao PDR, based on the Participatory Land and Forestry Management Approach, which seeks to reduce dependency of shifting cultivation (the PAREDD Approach). This project targeted the Xiengngun and Phonsay Districts (target site of this project), Luang Prabang Province. In December 2011, JICA accelerated its activities and support efforts, including concrete measures to promote REDD+.

1.10.2 Compliance with Laws, Statutes and Other Regulatory Frameworks

All land in Lao PDR is managed as national land under the Land Law, and Forestry Law, which determines forest categories: Production Forest, Conservation Forest, and Protection Forest. Production Forest is managed by the DOF under the MAF. Conservation Forests and Protection Forest are managed by the DFRM under the MONRE.

Approximately 28.2% of the target site is under Production Forest designation; the remaining approximately 50.4% is classified as Protect Forest, meaning the targeted forest is managed directly by the DOF and the DFRM (central government), and each local organization (PAFO and PONRE). Commercial timber harvests in Production Forest are managed by relevant Departments. In both Production Forest and Conservation Forest, local communities and rural people are granted rights of land-use under the oversight of Luang Prabang Province and Phonsay District (i.e., via PAFO and DAFO). Resources within villages are managed through agreements formed in village meetings. Before the project start, however, there was no way to determine if a system based on village meetings would actually work and result in sustainable land and forestry management.

To carry out this project, the project discussed land and forest management in the target site with the DOF and DFRM, confirming compliance with the Forestry Law and forestry resources management methods based on laws related to REDD+ implementation strategy. Additionally, based on conferences with Luang Prabang Province and Phonsay District (the details of PAFO and DAFO are mentioned above), the local authorities agreed that promoting participatory land and forestry management methods under the project did not depart from conventional policies and allowed the project to move forward.

With local communities and rural people who hold the forest usage rights and through participatory workshops, the project discussed land and forestry management methods for the time REDD+ would be put into phased practice. This was established after discussing the problems facing REDD+ and providing an explanation of participatory land and forestry management system and the meaning of the PAREDD Approach. The target site is home to various ethnic groups, including Hmong, Khmu, and Lao; each ethnic group has different lifestyles and therefore differing dependence on forestry resources. To reach consensus with local communities and rural people, the project studied the parties in question and each capability, then held repeated workshops for the stakeholders concerned. In this way, the project confirmed local understanding of the local land forestry management system (*see* above Figure 2).

Slash-and-burn areas, or areas under shifting cultivation with short rotation periods, are used as temporary cropland in the target site of the project. Nevertheless, this land meets the definition of forest (average tree height of 5 m, crown ratio of 20% and above, smallest area size of 0.5 ha) after three fallow years. The area is then classified as forest and governed by the Forestry Law in Lao PDR and in line with the concepts of the IPCC Guidelines (*see* details in Figure 1 and 2 in Annex).

1.10.2.1 Compliance with laws

Land Law: The objectives of this law are to determine management regimes and land use and protection to ensure efficiency and compliance with laws and regulations and to contribute to national socio-economic development, as well as to protect the environment and the national borders of Lao PDR.

According to the law, the land in Lao PDR is owned by the national community, as specified in Article 17 of the Constitution, which states that the land is a national heritage and that the state protects the property rights and the inheritance rights of organizations and individuals. The Land Law therefore charges the state with responsibility for centralized and uniform management of land throughout the country and for allocating land to different actors for use, lease or concession.

The Land Law assigns land management responsibilities to a national land management authority, provincial and city land management authorities, district and municipal provincial and city land management authorities, and village land units.

This project and all project activities comply with the Land Law.

Forest Law: The Forestry Law originally established in 1996 was revised in 2007 based on the Forestry Strategy 2020 established in 2005. The Forestry Law stipulates three types of forest, the basic units for forestry management identified, to preserve forests and to develop sustainable resources (Table 5).

These three types are Protection Forest, Conservation Forest, and Production Forest. While each type of forest is specified on maps, there are no clear boundaries on site. Villagers who live in the forest rarely know in what category of forest they live or harvest. With assistance from the Forestry Sector Capacity Development Project (FSCAP) (2010–2014), a JICA technical cooperation project, the Department of Forestry (DOF) has been engaged in activities to establish guidelines and signposts indicating the boundaries between the three types of forest and to educate the local residents about forest classifications. This is among the agency's most important objectives.

Table 5 Objectives, area, and summary of the three types of forest

Category	Area (million ha)	Situation
Protection Forest (is not officially established according to the regulations and is under discussion)	8.2	Protection forest is identified to protect water resources and prevent soil runoff. Much of the water for the numerous hydroelectric plants in Lao PDR are identified as Protection forest. According to a decree of the Prime Minister regarding Protection Forest (2010), the developers of hydroelectric plants and mines as well as ecotourism business owners working within the area of the Protection Forest are required to pay 1% of their profits to the Forest and Forestry Resource Development Fund to maintain Protection Forest. Based on the regulations in this decree, cooperation with the energy sector should accelerate and help compensate local residents who participate in the activities and secure financial resources to help maintain Protection Forest.
Conservation Forest	4.7	Under the decree of the Prime Minister issued in 1993, the National Biodiversity Conservation Area (NBCA) was identified and renamed a Conservation Forest in 1996, when the Forestry Law was established. This indicates the oldest of the three types of forest. The country is mountainous and characterized by a mosaic of forest vegetation, including a dry dipterocarp forest, broad-leaved evergreen forest, broad-leaf deciduous forest, and coniferous forest, stretching from north to south. Fauna, including elephants and tigers, make this a globally well-known region with extraordinary biodiversity and charismatic species, an area where new species are still being discovered. To maintain this precious forest ecosystem, forests around the borders with Vietnam, Thailand, and Cambodia are generally identified as Conservation Forest. In the times ahead, it will be important to establish a structure to manage Conservation Forests by introducing a system for participatory forestry management involving local residents and enlisting ecotourism, thereby supporting the livelihood of local residents in ways that do not endanger local wild species. Also important is educating business owners and local residents concerning the various applicable regulations.
Production Forest	3.1	Among the three forest types, this is the only type for which the production of commercial timber is permitted. Various activities to maintain these forests have been undertaken with the support of SUFORD (Finland/World Bank). Other activities have sought forest certification and the distribution of timber profits.

Note: The total area of the three types of forest and the area excluded from the three types of forest significantly exceed the forest area of about 9.8 million ha in 2005 (*see* above "1.10 Conditions Prior to Project Initiation"). This is because the three types of forest include areas that do not meet the standards of a "current forest" (e.g., devastated areas, farmland).

~~Source: Document published by the DOF; the area is as of March 2011.~~

This project targets, approximately 50.4% of the forest classified as Protection Forest in the Table 5 above and approximately 28.2% of the forest classified as Production Forest. The method of forest maintenance applied in implementing the REDD+ project complies with that specified under the Forestry Law; the project complies with Lao PDR Forestry Law, as confirmed in discussions with the REDD Office.

In June 2011, the National Assembly chose to amend the Forestry Law once again to incorporate new concepts related to climate change countermeasures. As of July 2012, with the support of various donor nations, including Japan, the Lao PDR government has explored ways to plug loopholes in the existing Forestry Law by introducing effective zoning methods for the three types of forest, by developing land use plans, by distributing land to local villages, and by identifying types of forest other than the existing three types, while introducing the new concepts, submitting the reform bill to the National Assembly in December 2013. In implementing this project, the REDD+ activities are to be undertaken in cooperation with the REDD Office (introduced below), in compliance with the revised Forestry Law.

Forestry Strategy 2020: Forestry Strategy 2020 was established in 2005 to restore forested land to 70% of all land by 2020. Based on this strategy, the Lao PDR Government has amended the Forestry Law (established in 1996). In 2007, the Lao PDR Government established the Wildlife Law. The Government has also taken various measures and established various systems to strengthen enforcement, including establishing a forest audit office in 2008 within the MAF. Forestry Strategy 2020 prioritizes poverty reduction, to be achieved through the rational development of the forestry sector. The agricultural and forestry sectors are listed under the National Growth and Poverty Eradication Strategy as one of four areas capable of helping to eradicate poverty. In terms of the forestry sector, it can contribute to poverty eradication by increasing employment opportunities and revenue through the use of forest at industrial and household levels, as well as by processing NTFPs. Forestry conservation is also key to preserving the quality of water resources, including drinking water, agricultural water, and sources for hydroelectric power generation. Such areas are regarded to contribute indirectly to poverty eradication. The strategy sets the following four goals;

- Restore the proportion of forested land to 70% by 2020 by regenerating 6 million ha and planting trees on 500,000 ha
- Produce forest products in a sustainable manner to contribute to household income, national revenue, and foreign exchange earnings
- Preserve endangered species and their habitats
- Preserve the environment through the conservation of soil and water resource areas

Furthermore, the Strategy sets eight policy directions, including the establishment of a land use plan (established in each village to identify the territory of the village and to classify the land within the territory as forest, agricultural land, or residential land, depending on vegetation and land use), to achieve the four objectives above. An action proposal has also been drafted consisting of 146 items based on these objectives and policy directions.

The method applied to project implementation in this project is in complete accord with the method of forestry management set forth in Forestry Strategy 2020 and fully complies with Lao PDR Forestry Law, as confirmed through discussions with the REDD Office.

1.10.2.2 Status of Governmental Procedures of REDD+ Implementation

The government of Lao PDR established REDD Taskforce in 2008, specifying various issues that need to be resolved before implementation. Also, in 2011, the government established the REDD Office as an organizer of the REDD+ implementation in Lao PDR and an implementation structure for the Lao PDR REDD+, as shown in Figure 8.

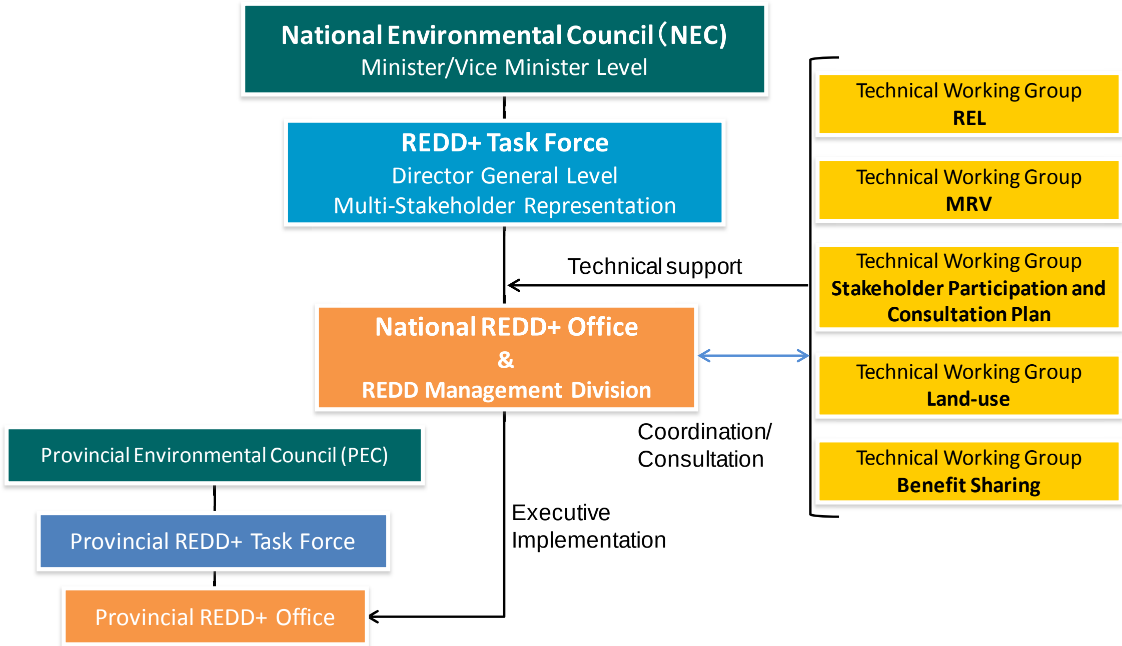


Figure 8 REDD+ implementing structure in Lao PDR

To implement REDD this project, REDD Office permitted all activities described in this PD and includes agreement of implementation of project activities with collaboration among all proponents (before submitting PD, the Memorandum of understanding (MoU) will be exchanged between REDD Office and Proponent(s)).

1.11 Compliance with Laws, Statutes and Other Regulatory Frameworks (this chapter is added)

Before submitting PD, the MoU will be exchanged between REDD Office and Proponent(s). The MoU will explain appropriate approaches regarding to compliance with lows and other in Lao PDR, and the MoU will be provided to the project validator in validation process

1.12 Ownership and Other Programs (chapter title was improved according current PD format)

1.12.1 Right of Use (chapter title was improved according current PD format)

All forests in Lao PDR are government-owned and managed by the Provincial and District Governments (i.e., PAFO and DAFO). As mentioned above, our target site is separated into Protection Forest, managed by DFRM under MONRE, and Production Forest, managed by the DOF under MAF. Rights of use in our target forest are allocated to rural people in accordance with Forestry Law, and all the rural people agreed to implement REDD+ in the area through participatory consultation process. DFRM/DOF, PAFO/DAFO, and other entities as project proponents received permission to implement REDD+ activities before starting all the project activities (before submitting PD, the Agreement or the MoU will be exchanged between REDD Office and Proponent(s)). Regarding ownership and resources access/use by all proponent(s) and stakeholder (especially rural people) were complied in documents of all steps in PAREDD Approach

1.12.2 Emissions Trading Programs and Other Binding Limits (chapter title was improved according current PD format)

Any reductions in GHG emissions achieved through this project will not be used to meet compliance requirements, whether regional or national. Neither Lao PDR nor the regional or local governments have established a national target, a compliance program, or a cap-and-trade system.

1.12.3 ~~Participation under Other GHG Programs~~

~~This project will seek registration only under the VCS. The project will not seek to register credits with any other program.~~

1.12.4 Other Forms of Environmental Credit

This project has not and will not seek to generate environmental credits in any other form.

1.12.5 Participation under Other GHG Programs (chapter title was improved according current PD format)

This project will seek registration only under the VCS. The project will not seek to register credits with any other program.

1.12.6 Projects Rejected by Other GHG Programs (chapter title was improved according current PD format)

This project has not been rejected by any other GHG program.

1.13 Additional Information Relevant to the Project (chapter title was improved according current PD format)

Eligibility Criteria

Grouped projects have not been applied in this project.

Leakage Management

Leakages will be mitigated through project activities in areas surrounding the project site. These activities focus on engaging local communities and other stakeholders to continue current agricultural activities and ensure the management and financial sustainability of the activities; to build local capacity for sustainable land use; and to improve quality of life in sites. Section ~~"1.8 Description of the Project Activity" provides more information on these project activities; additionally, *see* "1.1.3 Leakage belt" and~~ "1.1.4 Leakage management area" provides more information on these project activities~~of Annex for further discussions~~.

Commercially Sensitive Information

This project had been conducted readiness activities to implement activities by participatory methods (JICA PAREDD Project). Though participatory workshops or other activities (minutes of workshops in each village *will be provided to the project validator in validation process*), there were no sensitive information related the project in target site.

Further Information

This project is in line of policy and measure of REDD+ and/or forestry strategy in Lao PDR. Therefore, it means all activities are acceptable in central and regional government and rural people living in the target site or neighbouring regions. Lao PDR required activities for reducing deforestation and forest degradation in HK-VC and surrounding area to JICA, and PAREDD Project had been implemented from 2009. All activities related to REDD+ were reviewed by JICA and Lao PDR, and should be eligible from all aspects (e.g. legislative, technical and so on) described in applied methodology in this PD.

2 APPLICATION OF METHODOLOGY

2.1 Title and Reference of Methodology

VM0015 "Methodology for Avoided Unplanned Deforestation"

2.2 Applicability of Methodology

Please refer to "2 Applicability Conditions" of the Annex.

2.3 Project Boundary

Please refer to the "Step 1. Definition of the Boundaries of the Proposed and Project Activity of VM0015" Annex.

2.4 Baseline Scenario

The baseline scenario is the expanding area of shifting cultivation in the target site, the expansion of such area into secondary forest, and a decreasing fallow period (i.e. fallow years). The scenario has been identified through preliminary survey and by following the steps of the approved VCS methodology VM0015.

The identification and selection of alternative land use scenarios for baseline determination and additionality assessment were carried out in accordance with the VT0001 Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities, Version 3.

Step 1. Identification of ~~y~~ alternative land use scenarios to the proposed VCS AFOLU project activity

Sub-step 1a. Identify credible alternative land use scenarios to the proposed VCS AFOLU project activity

The following alternative land use scenarios were identified for the project:

Alternative 1: Continuation of deforestation activities taking place prior to the activities in the target site

Alternative 2: Creation of large industrial/agricultural projects as alternative livelihood to shifting cultivation

Alternative 3: Management and protection of the area as Protection Forest by the National Lao PDR Government or Provincial Government of Luang Prabang

Alternative 4: Project activities taking place without registration as VCS projects

As discussed above, the Lao PDR Government lacks the funds to manage and protect the target site and has no corresponding plans. Therefore, Alternative 3 is considered implausible.

The remaining four alternatives are considered below.

Sub-step 1b. Consistency of credible land use scenarios with enforced mandatory applicable laws and regulations

Alternative 1 entails deforestation due to shifting cultivation (excluding pioneer shifting cultivation). Either activity is considered legal or acceptable by the government. Presumably, the activities would have been allowed to continue in the region. This alternative remains plausible.

Alternative 4 includes all project activities not currently registered as VCS projects. As outlined in “1.10.~~3~~2 Compliance with Laws, Statutes and Other Regulatory Frameworks”, all activities comply with all applicable laws and regulations.

Alternative 2 includes the granting of agricultural concessions or the development of large-scale agricultural initiatives in the area. Since the project site is recognized as land managed by rural people, it would be illegal to grant concessions in most parts of the project site. For this reason, Alternative 2 is eliminated from further consideration.

Alternatives 1 and 4 remain as plausible alternatives.

Sub-step 1c. Selection of the baseline scenario:

The investment analysis in following “2.5 Additionality”, demonstrates that Alternative 4 is significantly less financially attractive than Alternative 1, prompting the conclusion that Alternative 1 is the most likely baseline scenario.

2.5 Additionality

The project applied the steps outlined in the VCS Tool, VT0001, “Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities,” to demonstrate the additionality of the project.

2.5.1 Investment Analysis

Sub-step 2a. Determine appropriate analysis method

This project generates no financial or economic benefits other than VCS-related income. Therefore, Option 1, a simple cost analysis, is the appropriate analysis method. This analysis focuses solely on revenues generated by the project that can be used for project activities.

Sub-step 2b. – Option I. Apply simple cost analysis

The annual management costs associated with the project are roughly $0.1 million (USD). Based on 2011 data, an estimated 30% of these costs are for introduction of alternative livelihood. Approximately 50% of the costs are for information gathering and data analysis (including GIS), program development, coordination, and monitoring. The remaining 20% is used for financial and office administration. Detailed financial information from 2011 to 2013 will be provided to the project validator.

With successful project validation and verification, annual costs are expected to increase 10% to an estimated average of $0.11 million (USD) annually. The additional costs are necessary to expand land use and extension activities to a larger number of communities; to undertake carbon monitoring and verification of carbon credits; to expand project communication with stakeholders; to undertake outreach and capacity building among other REDD+ proponents in Lao PDR; and to account for inflation for costs such as salaries, transportation, and equipment. A financial statement highlighting projected expenses and revenues for the period 2011~~–~~-2030 will be provided to the validator.

Moving forward, revenues from the sale of carbon credits will be used directly to cover the costs of introduction of alternative livelihood, additional activities related to the project, and the establishment of an endowment to ensure long-term financing for project activities. This will allow all proponents to continue project activities that ensure reduced emissions from deforestation. Any remaining revenues will be shared with the Lao PDR Government. The Lao PDR Government has reviewed and agreed to a specific revenue-sharing agreement.

The project has no other revenue sources. There is no established government funding for the management of the REDD+ or the protection of the intact forest. The project site will not be used for any revenue-generating purpose. The organizations that have financed the REDD+ project to date will not provide additional funds once verified carbon credits have been generated.

Since the proposed project activity generates no financial benefits other than VCS-related income, the project proceed to the common practice assessment below.

2.5.2 Common Practice

Step 4: Common Practice Assessment

The project has management contracts with the Lao PDR Government to oversee project activities. Project activities are managed by the project. However, the management contracts differ markedly. The project has a 20-year, full-management contract for all activities. When the project began, the project had a 20-year contract limited to biological research, which corresponds to roughly 30% of all project activities. While the term of the activity management contract has been increased to 20 years, the limited scope remains.

In project activities, the project budget indicates $0.11 million (USD) was spent on the site. The financial plan includes mention of partnerships with the project and other organizations to assist in financing the protection services. The project, whose purpose is land and forest management and engagement of neighboring communities to ensure the long-term success of the conservation efforts, spends roughly $0.1 million (USD) annually. In sites managed by national and regional governments, extensive activities beyond land use planning or environmental education tend to be limited. The overall funding available for protected areas is clearly limited.

Due to the proponent’s unique management plan and significantly more extensive activities, this project does not reflect common practice, a key distinction between it and other sites and conservation projects in Lao PDR. Thus, Alternative 1 is the most likely baseline scenario.

2.6 Methodology Deviations

No methodology deviations have been applied. Please refer to the Annex for further details.

3 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

3.1 Baseline Emissions

Please refer to the “Step 6: Estimation of baseline carbon stock changes and non-CO_2” of the Annex.

3.2 Project Emissions

Please refer to the “Step 7: Ex ante estimation of actual carbon stock changes and non-CO_2” of the Annex.

3.3 Leakage

Please refer to the “Step 8: Ex ante estimation of leakage” of the Annex.

3.4 ~~Summary of~~Net GHG Emission Reductions and Removals (chapter title was improved according current PD format)

Please refer to the “Step 9: Ex ante total net Anthropogenic GHG Emission Reductions” of the Annex.

Revision of the baseline

The baseline, as outlined here in the PD, is valid for 10 years, or through December 2011. The baseline will be revised every 10 years from the project start date. Since the entire project site is deforested as of the first 10-year baseline period, the deforestation rate and emissions in the baseline for all subsequent baseline periods are zero.

Monitoring of actual carbon stock changes and greenhouse gas emissions

The monitoring of actual carbon stock is conducted by participatory methods (*see* 4.3 Description of the Monitoring Plan), is scheduled for around 5 years intervals from the start of the project.

4 MONITORING

4.1 Data and Parameters Available at Validation

Data Unit / Parameter:	2010 Forest Cover Benchmark
Data unit:	Map
Description:	Digital map showing the location of forest land within the project area at the beginning of the crediting period
Source of data:	LANDSAT 5 and LANDSAT 7
Value applied:	n/a
Justification of choice of data or description of measurement methods and procedures applied:	LANDSAT-based land-cover classification is applied. The minimum map accuracy is 80% for the classification of forest/non-forest in the remote sensing imagery.
Any comment:	n/a

Data Unit / Parameter:	Reference Region
Data unit:	map
Description:	Digital map of reference region boundaries
Source of data:	GIS data (elevation, slope, protected areas, precipitation, administrative boundaries)
Value applied:	232,665 ha~~n/a~~
Justification of choice of data or description of measurement methods and procedures applied:	LANDSAT-based land-cover classification is applied. The minimum map accuracy is 80% for the classification of forest/non-forest in the remote sensing imagery
Any comment:	None

Data Unit / Parameter:	Leakage Belt
Data unit:	map
Description:	Digital map of leakage belt boundaries
Source of data:	GIS data (elevation, slope, routes, urban centers, forest edges, project boundaries)
Value applied:	55,871 ha~~n/a~~
Justification of choice of data or description of measurement methods and procedures applied:	LANDSAT-based land-cover classification is applied. The minimum map accuracy is 80% for the classification of forest/non-forest in the remote sensing imagery
Any comment:	n/a

Data Unit / Parameter:	ABSLRRi,t
Data unit:	ha y^{-1}
Description:	Annual areas of baseline deforestation in the reference region
Source of data:	Historical deforestation (1994-2010) in Phonsay District
Value applied:	n/a
Justification of choice of data or description of measurement methods and procedures applied:	Annual deforestation was estimated by results of LANDSAT-based land-cover
Any comment:	n/a

Data Unit / Parameter:	ABSLPAi,t
Data unit:	ha y^{-1}
Description:	Annual area of deforestation in the project area for 2011-2030
Source of data:	GIS processing
Value applied:	n/a
Justification of choice of data or description of measurement methods and procedures applied:	Annual deforestation was estimated by results of LANDSAT-based land-cover
Any comment:	n/a

Data Unit / Parameter:	ABSLLKi,t
Data unit:	ha y^{-1}
Description:	Annual area of deforestation in the leakage belt for 2011-2030
Source of data:	GIS processing
Value applied:	n/a
Calculation method:	n/a
Justification of choice of data or description of measurement methods and procedures applied:	Annual deforestation was estimated by results of LANDSAT-based land-cover
Any comment:	n/a

Data Unit / Parameter:	Ctotcl
Data unit:	tCO_2e ha^{-1}
Description:	Tons of carbon dioxide equivalents per hectare
Source of data:	Field measurements
Description of measurement methods and procedures to be applied:	Sum of carbon stock of above-ground, and below-ground pools per forest type
Frequency of monitoring/recording:	once
Value applied:	Please refer Table 22 in Annex~~n/a~~
Calculation method:	Allometric equations and root to shoot ratio.
Justification of choice of data or description of measurement methods and procedures applied:	n/a
Any comment:	n/a

Data Unit / Parameter:	Ctot~~fcl,t~~
Data unit:	$tCO_2e\ ha^{-1}$
Description:	Mean post-deforestation carbon stock in the post deforestation class
Source of data:	Field measurement, aerial survey
Description of measurement methods and procedures to be applied:	Biomass stock of each non-forest class was estimated by IPCC default values from IPCC EFDB
Frequency of monitoring/recording:	once
Value applied:	Please refer Table 24 in Annex~~n/a~~
Calculation method:	n/a
Justification of choice of data or description of measurement methods and procedures applied:	n/a
Any comment:	n/a

4.2 Data and Parameters Monitored

Data Unit / Parameter:	Forest Cover Maps (2011-2015)
Data unit:	map
Description:	Digital map of forest cover in the project area and leakage belt for the verification period
Source of data:	LANDSAT 5 and LANDSAT 7
Description of measurement methods and procedures to be applied:	LANDSAT-based land-cover classification using decision tree methods. GPS waypoints might be used during the ground truth
Frequency of monitoring/recording:	At every verification period
Value applied:	2 ha of forest patch as minimum mapping unit
Monitoring equipment:	ArcGIS 10.0
Purpose of data	Calculation of project emissions
QA/QC procedures to be applied:	Quality Control and Assurance procedures are detailed in the Methodological Annex. The minimum map accuracy is 80% for the classification of forest/non-forest in the remote sensing imagery.
Calculation method:	n/a
~~Any comment~~Comment:	n/a

Data Unit / Parameter:	ABSLPAi,t
Data unit:	ha yr^{-1}
Description:	Annual area of observed deforestation in the project area during the verification period
Source of data:	GIS processing
Description of measurement methods and procedures to be applied:	Results of overlaying the forest cover map with the project area boundaries
Frequency of monitoring/recording:	At every verification period
Value applied:	GIS files of the project boundary
Monitoring equipment:	Computer and ArcGIS software
QA/QC procedures to be applied:	Projection system and datum will be kept consistent. Clear and detailed documentation and independent desk review to assure consistency and accuracy of the GIS procedures
Purpose of data	Calculation of project emissions
Calculation method:	n/a
~~Any c~~Comment:	n/a

Data Unit / Parameter:	ABSLLKi,t
Data unit:	ha y^{-1}
Description:	Annual area of observed deforestation in the leakage belt for the verification period
Source of data:	GIS processing
Description of measurement methods and procedures to be applied:	Results of overlaying the forest cover map with the leakage belt boundaries
Frequency of monitoring/recording:	At every verification period
Value applied:	GIS file of the leakage belt
Monitoring equipment:	Computer and ArcGIS software
QA/QC procedures to be applied:	Projection system and datum will be kept consistent. Clear and detailed documentation and independent desk review to assure consistency and accuracy of the GIS procedures
Purpose of data	Calculation of leakage
Calculation method:	n/a
~~Any c~~Comment:	n/a

4.3 ~~Description of the~~ Monitoring Plan (chapter title was improved according current PD format)

JICA PAREDD Project undertook the trainings on forest monitoring to conduct forest monitoring efficiently. This project will carry out monitoring by utilizing outcomes of those trainings.

Forest Monitoring Training conducted by JICA PAREDD

Please refer to "Part 3 - Methodology for Monitoring and Re-validation of the Baseline" of the Annex for a description of technical aspects of the project monitoring plan. The data and parameters monitored during the project's lifetime are described in the previous section of this PD. Presented below is a description of the project data management plan.

Purpose of GHG monitoring plan:

- Standardize methods and procedures applied to the collection, compilation, and analysis of the data used to estimate the GHG benefits of the project (Figure 9).

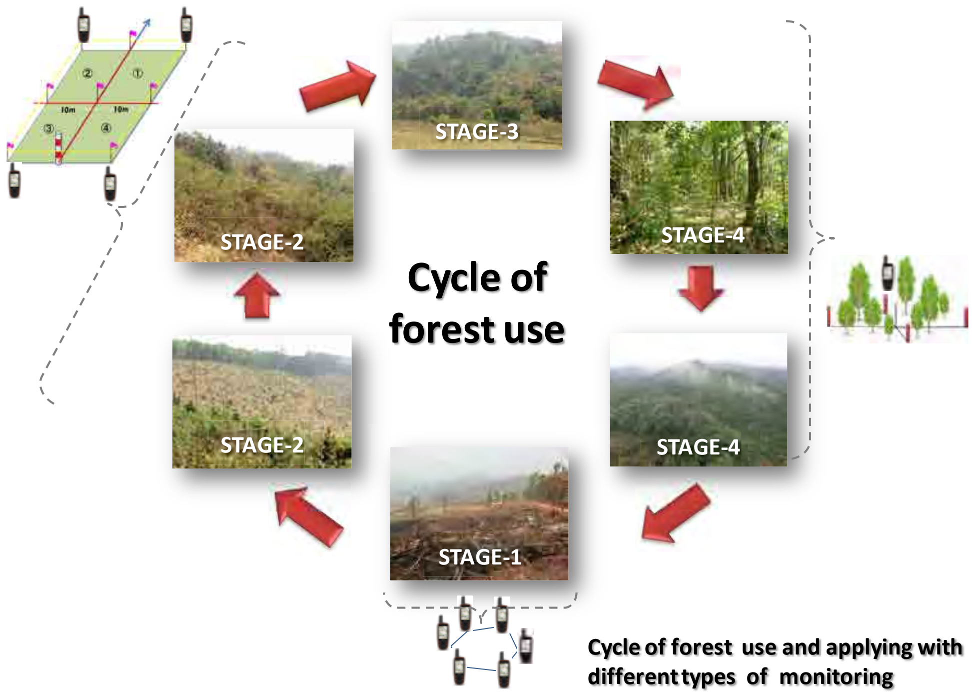


Figure 9 Monitoring cycle~~structure~~

- Guarantee that the information is processed consistently throughout the project lifetime, comparable to data and processes used during validation and in accordance with VCS approved methodology VM0015

- Ensure that GHG benefits are estimated in a conservative manner and accurately, precisely, and reliably

- Document results to demonstrate the achievement of the project's goals in terms of emission reductions in the HK-VC

Organization(s) and staff involved:

The organization responsible for project data management will be XXVV Co., Ltd (a Japanese private venture), supported by suitable partners (following Table 6):

- Overall administration and supervision: Project manager – XXVV Co., Ltd (a Japanese private venture)

- Data storage and organization: GIS Manager – DOF and PAFO/DAFO

- Backup and system security: IT manager – DOF and PAFO/DAFO

- Remote sensing processing: RS Specialist – DOF/DFRM and JV-REDD

- GIS analysis - GIS specialist: DOF/DFRM and XXVV Co., Ltd (a Japanese private venture)

- Documentation and outreach: Communications coordinator - XXVV Co., Ltd (a Japanese private venture)

Table 6 Subjects and responsibilities of Forest Monitoring

Subjects	Responsibilities	Methods
STEGE-1:Boundary delineation of S/B	Villagers	Boundary measurement by GPS
STAGE-2:Growth monitoring of fallow lands (16 years below)	Villagers	Rectangle plot survey on the field
STAGE-3:Growth monitoring of fallow lands (16 years above)	Villagers	Circular plot survey on the field
STAGE-4:Growth monitoring on Natural Forest	PAFO/DAFO	Circular plot survey on the field
Development of biomass parameters	PAFO/DAFO	Destructive sampling
Forest area change analysis(Past)	JICA Project	Satellite analysis
Forest area change analysis(Future)	FIPD/PAFO	Satellite analysis

Description of the data to be collected:

- The GHG benefits of the HK-VC project will be estimated by comparing the baseline GHG emissions to actual GHG emissions during each monitoring period. Actual GHG emissions will be estimated by measuring deforestation (i.e., conversion of land from forest to other) in each stratum, multiplied by the respective emission factor. Note that emission factors will be constant during the project lifetime, since the carbon stock of each forest class is deemed constant and the post-deforestation class is estimated as the weighted average of all non-forest classes in the historic reference period. Thus, the only data measured at each monitoring event will be forest loss due to changes in land use.

- Forest losses will be estimated in each monitoring period by analyzing a time series of LANDSAT TM images. See the Annex for the methods used in acquiring, pre-processing (including cloud removal), classifying, and post-processing images. Subsequently, the forest loss map will be overlaid with the project site and leakage belt to estimate the area converted to non-forest within those boundaries.

- The HK-VC straddles two LANDSAT TM scenes. Images will be compiled from USGS and UMD archives, with enough dates within a one-year period to ensure the lowest possible degree of cloud cover issues. Areas obscured by clouds and remaining in the project site and leakage belt will be temporarily excluded from the project until the next verification period.

Plans for storage and data management:

- All GIS data, including raw and processed satellite images, will be stored at the DOF and PAFO/DAFO.

- All data will initially be backed up using an external drive with weekly backups to a network drive. The network drive uses the special server system and provides redundant backup to ensure a retrieval system will be in place in the event of computer, hardware, or internet connection failure.

- The folder structure will be reflected in the backup system to ensure the integrity of GIS map files (e.g., mxd for ArcGIS) and unbroken links.

- The backup system will be tested systematically (monthly) to ensure the system is functioning properly.

- Any data collected as hard copy (paper) will be converted into digital form (using scanners) unless otherwise specified in the monitoring report.

- The GIS manager of the project will be responsible for storing hard copies in a secure location, protected from intense humidity or sunlight exposure. The GIS Manager will be in charge of collecting, copying, and storing any relevant files generated by partners or external consultants.

QA/QC process:

- Date collection and management and its QA/QC process will be conducted according to ISO14064 series.

Legal and ethical issues:

- Unless otherwise specified, data collected or generated by the HK-VC project are the property of the project. Where applicable, every effort will be made to maintain the confidentiality of research subjects to ensure continuing participation in research and monitoring activities.

Access policies and provisions:

- Unless disclosure is contractually prohibited, all data collected or generated by the HK-VC project will be made publicly available upon request. Contact information is provided in the PD.

For more information concerning the HK-VC GHG monitoring plan, please refer to the monitoring section of the Annex.

5 ENVIRONMENTAL IMPACT

The major positive environmental impact of the project is ensuring the conservation of critical forest areas, as well habitat for threatened flora and fauna. With 30,486 ha of the project site represents nearly 13% of the land area of Phonsay District as reference region. In the absence of the project it is likely that forest in the project site will be reduced in the next 10 years through land conversion. The project seeks to conserve and regenerate fallow area into secondary forests through reducing shifting cultivation and/or expand fallow period in area of shifting cultivation. Such project activities will restore unique habitat for amphibians, reptiles, mammals, and birds, while restoring high value and endangered tree species.

The introduction of a small quantity of exotic fruit trees (e.g. coffee trees) are not expected to negatively impact indigenous species in the project area and reference region. These fruit trees may reduce the consumption of native fruits and other native foods, aiding the distribution and propagation of native vegetation. Coffee and other fruits trees introduced in this project will provide subsistence crops to local communities, reducing dependence on shifting cultivation. These species are not known to be naturally invasive nor do they carry any disease unknown to the region. Without the project, local communities will continue to utilize forest foods at an increasing rate that may exhaust the supply for native regeneration. If alternatives are not provided, shifting cultivation will continue to increase in order to feed the growing population at the expense of forest cover.

6 STAKEHOLDER COMMENTS

Before implementing this project, the project collected stakeholder's comment in target site and neighbourhood villages. Following are collected comments from village meetings in each village of HK-VC and some village in reference region;

Rural People in HK-VC:

- In HK-VC, the area of shifting cultivation shows upward trend along with the population growth. The shifting cultivation is being undertaken in the forests where, to date, the shifting cultivation has not been done aiming at water source protection; therefore, access to water sources including drinking water is a concern. In that situation, we have high expectations of the progress of forest conservation through REDD+ implementation because it leads to maintaining and restoring the function of water source protection.

- Shifting cultivation is the only way to ensure sufficient livelihoods in HK-VC. It is highly expected to create opportunities to promote such as livestock management, nursery management and weaving production. Particularly, for women who have over worked, alternative livelihoods (weaving production) are a big hope.

- We can learn methods of livestock management through Livestock Management and techniques for raising seedlings through Nursery Management, so it is more than welcome that our techniques are improved through REDD+.

Village Meeting

Officials of PAFO/DAFO:

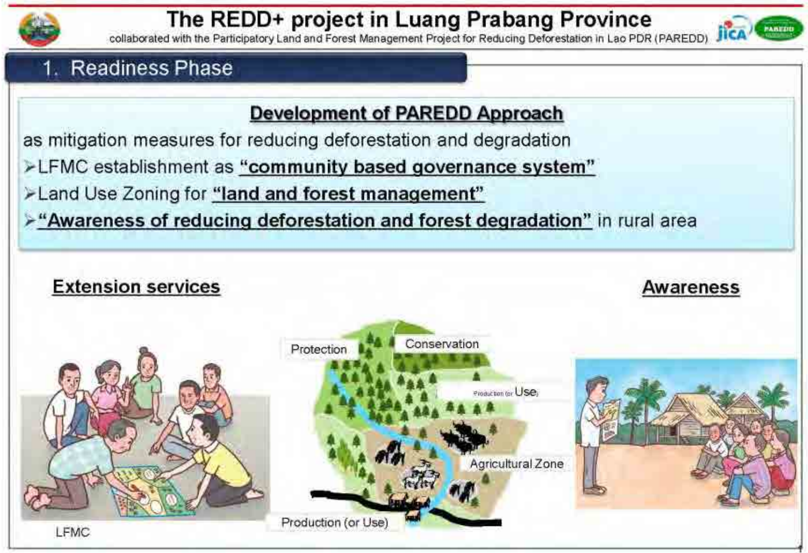
- Among the activities, which will be carried out by REDD+, such as weaving production and market system are the additional activities cannot be undertaken by only PAFO/DAFO. It is expected that those activities lead to improvement of the quality of life in HK-VC. However, there were the unsuccessful cases, such as Weaving Production introduced to northern Lao PDF. For this reason, it is preferable if Weaving Production and so forth as the REDD+ activities are carried out carefully, taking into account rural people's capacity.

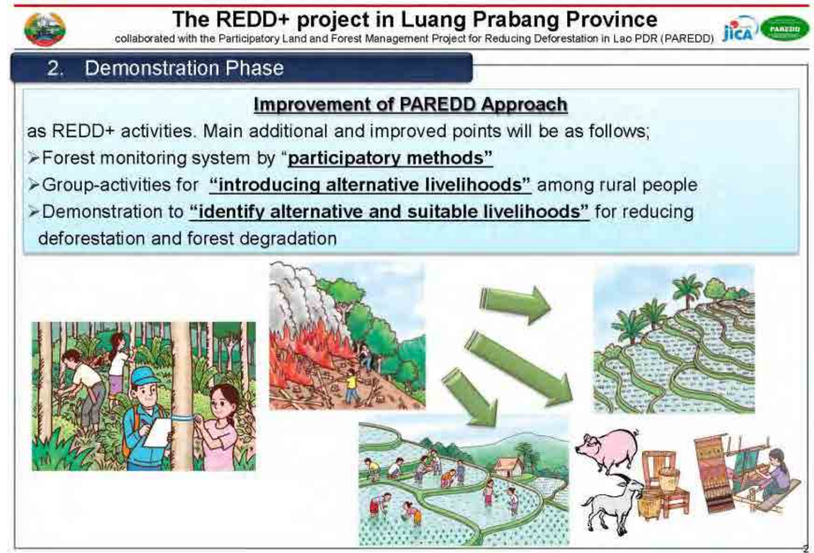
- There was not sufficient incentive for forest conservation activities. REDD+ activities are expected to provide big incentive since it can be carried out as receiving technical and financial support from overseas. In addition, it will be long-term activities over 20 years; therefore, REDD+ activities are desirable when think about local people's capability development.

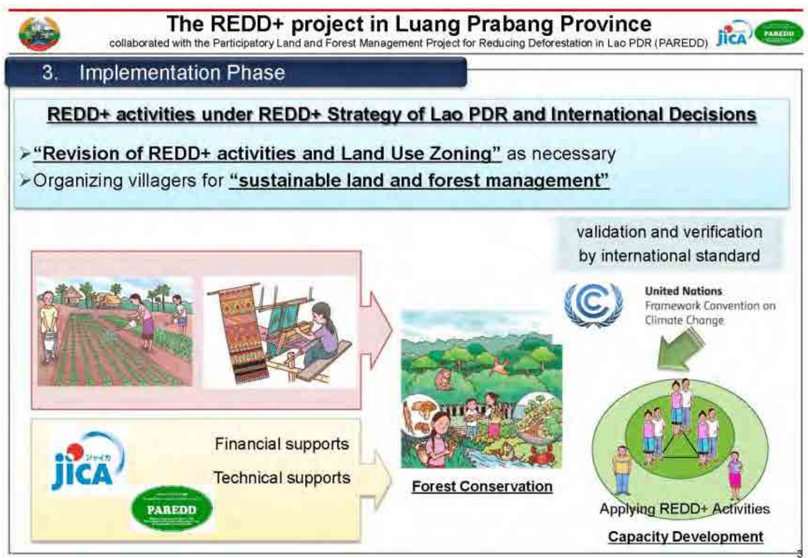
- In HK-VC, electrification is underway so that there is a possibility that the way of utilizing forest resources will also be changed. In that situation, thinking about land management plan actively through LFMC is considered contributing to developing an appropriate way of land use. Therefore, we expect that a sustainable land use will be introduced by REDD+.

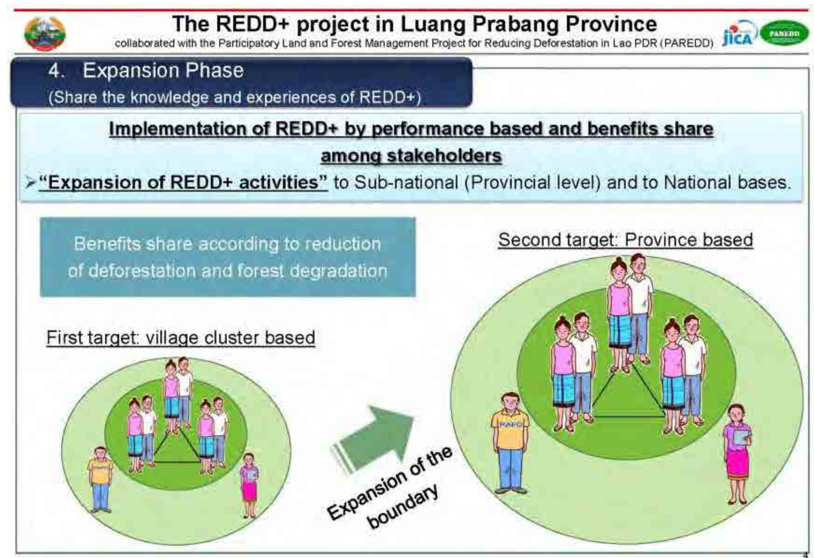
APPENDIX 1: STAGES AND STEPS OF PAREDD APPROACH

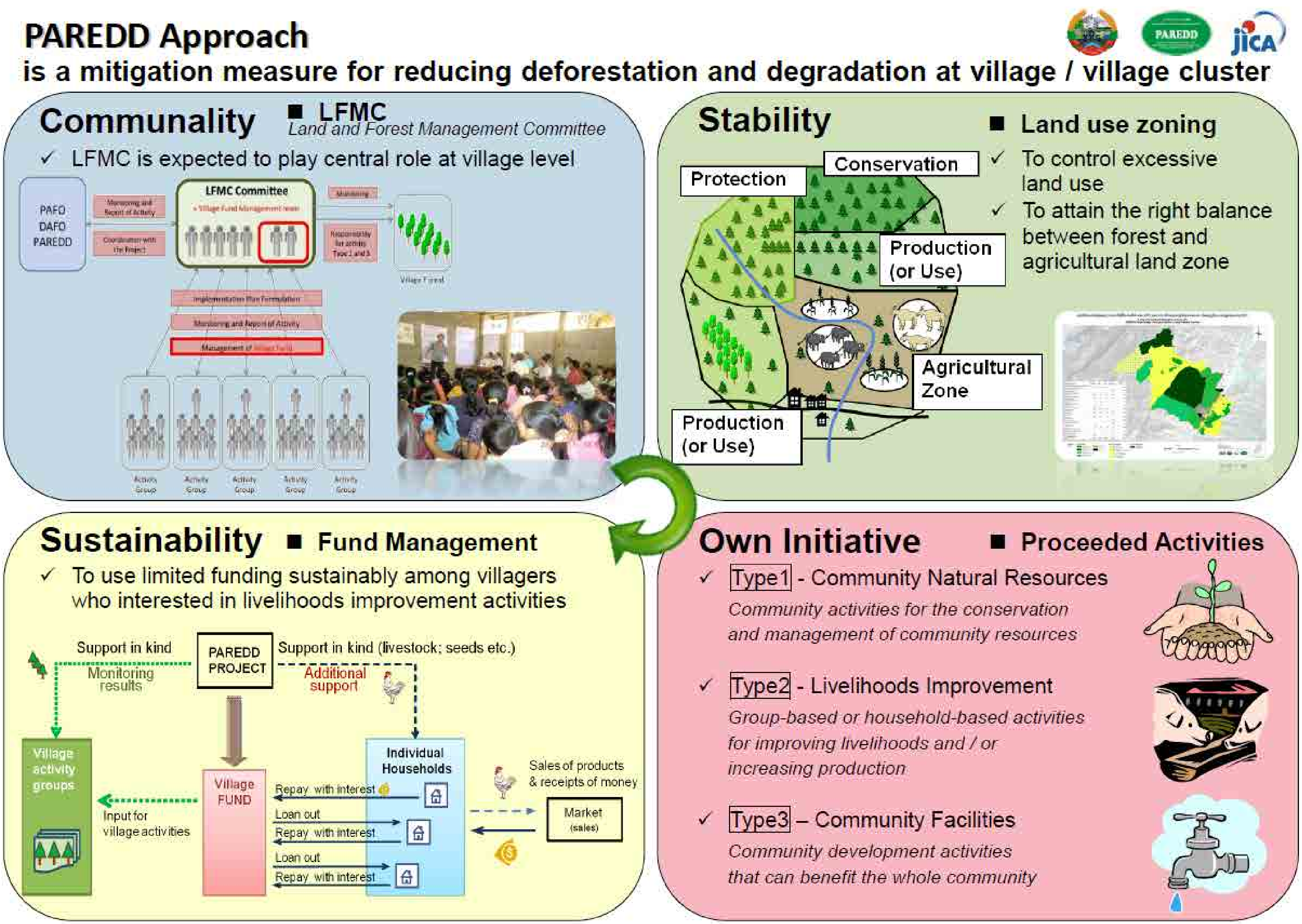
APPENDIX 2: METERIAL FOR AWARENESS










PAREDD Approach
is a mitigation measure for reducing deforestation and degradation at village / village cluster
PAREDD
Communality
■ LFMC
Land and Forest Management Committee
✓ LFMC is expected to play central role at village level
PAFO
DAFO
PAREDD
LFMC Committee
Village Forest
Activity Group
Stability
■ Land use zoning
✓ To control excessive land use
✓ To attain the right balance between forest and agricultural land zone
Conservation
Protection
Production (or Use)
Agricultural Zone
Production (or Use)
Sustainability
■ Fund Management
✓ To use limited funding sustainably among villagers who interested in livelihoods improvement activities
Support in kind
Monitoring results
PAREDD PROJECT
Support in kind (livestock; seeds etc.)
Additional support
Village activity groups
Input for village activities
Village FUND
Individual Households
Repay with interest
Loan out
Repay with interest
Loan out
Repay with interest
Sales of products & receipts of money
Market (sales)
Own Initiative
■ Proceeded Activities
✓ Type1 - Community Natural Resources
Community activities for the conservation and management of community resources
✓ Type2 - Livelihoods Improvement
Group-based or household-based activities for improving livelihoods and / or increasing production
✓ Type3 – Community Facilities
Community development activities that can benefit the whole community

APPENDIX 3: LAND AND FOREST MANAGEMENT COMMITTEE (LFMC)

1 OBJECTIVES

For implementing the approach at the village level, the project shall set up village land and forest management committee (hereinafter, refer to as LFMC). The LFMC is expected to play central role for project management at the village level.

This project shall support to strengthen their capacity for village forest management as follows:

(1) General project management
(2) Forest management

2 MEMBER OF THE COMMITTEE

The Committee should be comprised of representatives of the Village Administrative Authority, the Cluster Committee and a cross-section of villagers, both men and women, and including a Lao Women's Union member. It should include the Village Head or Deputy Village Head and consist of a small uneven number of members, preferably 5 or 7 people. Some members are required the capability of management for village fund. The formation of the LFMC is acknowledged by the District Authorities using a "Village Land and Forest Management Committee Formation Agreement" of members, preferably 5 or 7 people.

3 ROLES AND RESPONSIBILITIES OF LFMC

The LFMC assists the Village Authorities and District authorities with the following tasks:

(1) General project management

- To make a coordination between the villagers and proponents in this project
- To support formulating activity plans
- To endorse proposals that villagers made
- To support implementing Project activities described in "1.8 Description of the Project Activity".
- Monitoring and follow-up of project activities

(2) Forest management

- To support village boundary demarcation and endorse it with stakeholders
- To support delineation of village boundary
- To formulate agriculture and forest land zoning
- Establishing village forest management rules and regulation with the villager
- Disseminating village forest management rules and regulation to the villager
- Monitoring and Patrolling to village forest for implementing village forest management rules and regulations
- Patrolling, investigating, consulting and solving village land and forest problems
- Reporting the result of monitoring to relevant authority in every 3 months
- Keeping records of forest land zoning, land use planning and land allocation data
- Participating in inter-village networking activities within the village cluster

APPENDIX 4: PROBLEM ANALYSIS OF THE CHANGE OF NATURAL RESOURCES

Use of natural resources	Problem	Cause	Solution
Forest	-Villagers still do not understand how to protect the forests -Villagers still slash the cultivation area within the dense forests -Villagers do not use up the whole tree -Villagers cut tree for building house	-Villagers practice shifting cultivation not grouping in the same place and not following the guidelines of the higher authorities -Mostly villagers rely on nature for their livelihoods -Increased population -Raising animals by letting them roaming freely -Cutting young tree for making fence -Cutting tree for getting moth/insect for food -Agricultural production for commercial purpose, i.e. sesame, job's tear, corn -No lowland for rice paddy field -No sufficient farming area -No consuming market for commercial production, no buyers/collectors	-Allocation of forest and agricultural production area -Make forest management regulations for the village -Planting tree for reforestation -Replace shifting cultivation by other livelihood alternatives such as crop production, live-stock raising, weaving and rice paddy field expansion -Need company to come and buy the farm produce such as corn
Non-timber forest products (NTFPs)	-Slash the forest area where there are NTFPs -Collect for house-hold use -Collect for sale -Increased population -Forest fire	-No proper management and protection -NTFPs have good prices therefore villagers collect more -Destructive way of collecting NTFPs -Increased buyers coming to buy NTFPs -Improved road access	-Replanting the kind of NTFPs that can be domestic-cased -Make village forest management regulations (incl. NTFPs) -Protect the forest -Use the forest properly
Wildlife	-Deforestation -Villagers did not understand and not willing to protect the forest -Villagers disturbed the wildlife habitat -Hunting for consumption and sale	-Because no permanent job -Increased population -Wildlife meat is delicious -Villagers have hunting rifle or weapon -There were no regulations for wildlife management	-Make and enforce wildlife management regulations -Regenerate the forest -Confiscate hunting rifle or weapon -Prohibit to hunt wildlife for food and raise domestic livestock for diet instead -Prohibit to hunt wild animals during breeding season -Classify (zoning) the conservation area and the hunting area
River	-Free slashing the forest for cultivation -Cutting the watershed forest -Forest fire	-No permanent job -No protection of the water-shed forest/water source -No forest management regulations -Increased population	-Change to other agricultural production alternatives such as farming, livestock raising and other income generating activities which earn more money that shifting cultivation -Protect the forest -Planting tree on the water-shed forest area

Note: Solution ideas in the table were not considered upper limit of Village Development Fund (VDF) and/or feasibility in the target village

APPENDIX 5: LAND USE DATA OF TARGET VILLAGES IN PHONSAY DISTRICT (TENTATIVE)

Land and Forest Category	Houaykhing	Phakbong	Houaytho	Houayha	Sakuan	Longlath	Total (ha)
Conservation Forest Area	4	231	92	78	627	*work in progress*	*work in progress*
Protection Forest	2,359	1,206	165	3,990	1,223	*work in progress*	*work in progress*
Managed Use Forest	124	76	90	105	51	*work in progress*	*work in progress*
Tree Plantation Area for Regeneration	6	2	4			*work in progress*	*work in progress*
Cemetary Forest	11	10	26	3	4	*work in progress*	*work in progress*
Sacred Forest	5		2		6	*work in progress*	*work in progress*
Building Land	73	4	7	7	9	*work in progress*	*work in progress*
Fruit Tree Plantation Area	6	1	5	1	1	*work in progress*	*work in progress*
Agricultural Area	4,036	2,152	2,290	2,040	2,830	*work in progress*	*work in progress*
Livestock Raising Area	1,257	297	364	2,077	801	*work in progress*	*work in progress*
Paddy Field	89					*work in progress*	*work in progress*
Total (ha)	7,970	3,979	3,045	8,301	5,552	*work in progress*	*work in progress*

APPENDIX 6: PRELIMINARY~~PRIMALY~~ ANALYSIS FOR SELLECTING DEMONSTRATION ACTIVITIES

1 INTRODUCTION

We carried out preliminary surveys to identify suitable project activities. This involved identifying general information on household budgets, the agricultural calendar, and land use systems, which we used to analyze the capabilities of each ethnic group inhabiting the REDD+ target site. According to survey by Minato (2012), introducing paddy (as key of alternative livelihood) contributed to reduce the number of upland rice plot per household. We then analyzed the capabilities of each ethnic group and the characteristics of the various rural people, differences in current lifestyles or agricultural systems, and so forth. Finally, we analyzed various village customs with respect to grouping activities and decision-making.

2 SURVEY METHOD

The analysis presented in here is based on primary data collected between October and December 2012 through interview survey. The household samples in Houaykhing village were selected by random sampling from total households 220 in the village, and selected households were totally 41. The selection criteria looked at the groups of ethnicity, gender, wealth ranking and farming type.

3 VILLAGE LAND USE AND LIVELIHOOD

As shown in Table 3 in Project Description (PD), the two major ethnic groups living in the project target are Khmu and Hmong. The project should account for the capabilities and customs specific to each ethnic group when implementing the project activities. We also performed a socio-economic survey to assess each group's customs and land use tendencies.

Based on household income, agricultural calendars, and land use systems, we divided the village people into four groups: Khmu/*Saohai*[11] (Khmu lacking paddy fields); Khmu/*Saonar*[12] (Khmu cultivating paddy fields); Hmong/*Saohai* (Hmong lacking paddy fields); and Hmong/*Saonar* (Hmong cultivating paddy fields). As mentioned in following Figure 10, the mean number of plots cultivated per household had risen in all groups, but with the groups exhibiting following differences.

- Khmu were increasing the plots of shifting cultivation land regardless of whether they have paddy fields or not.
- Hmong/*Saohai*'s plots of upland rice were increasing, but modulus was slightly lower than Khmu
- Hmong/*Saonar*'s increasing rate of upland rice plots cultivated per household was lower than other groups.

This is because Khmu's daily life level is poor and it's difficult to replace shifting cultivation with paddy cultivation for improving/maintaining their daily lives. For example, compare to Khmu and Hmong, Khmu critically suffered from rice shortage. The Khmu and Hmong demonstrated significant differences in times

[11] *Saohai* means the farmer of upland rice in Lao.
[12] *Saonar* means the farmer of paddy in Lao.

affected by rice shortages[13] ($F_{1,37} = 4.11$, $p < 0.05$). And for an average, Khmu's rice shortage period was more than two months of each year. On the other hand, Hmong's rice shortage period was less than one month of each year. In addition, Khmu tended to sell their rice production to earn money for sudden change of household budget such as education fee of children, curing disease and so forth, although they can't get enough production for family. Their poorly planning of household budget was one of the ~~reason~~reasons.

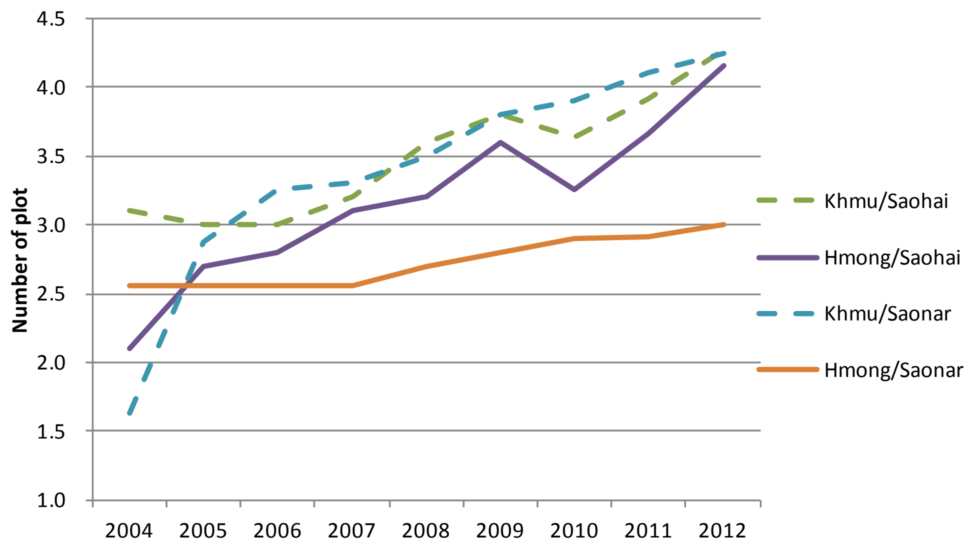


Figure 10 Transition of household plot numbers (mean)

Note: The samples were chosen randomly based on villager list in village and pick up same number of each ethnic and farmer. Khmu/*Saohai* is 12 household (HH), Khmu/*Saonar* is 12 HH, Hmong/*Saohai* is 13 HH, and Hmong/*Saonar* is 12 HH.

~~Source: Minato (2012) Socio-economic survey ih HouayKhing village~~

Also, compare to annual rice production between Hmong/*Saohai* and Khmu/*Saohai*, Hmong/*Saohai* could get large production in a year (Figure 11). But there was no difference between mean monthly consumption in Hmong/*Saohai* and that in Khmu/*Saohai*.~~.~~ As mentioned in Figure 11, Khmu/*Saonar* couldn't get enough production from their paddy cultivation because of lacking technique. Meanwhile, Hmong/*Saonar* got much production from paddy cultivation. It would be one of the reason Hmong/*Saonar* could suppress the plot number of upland rice.

[13] This results are supported by Supporting Information 1

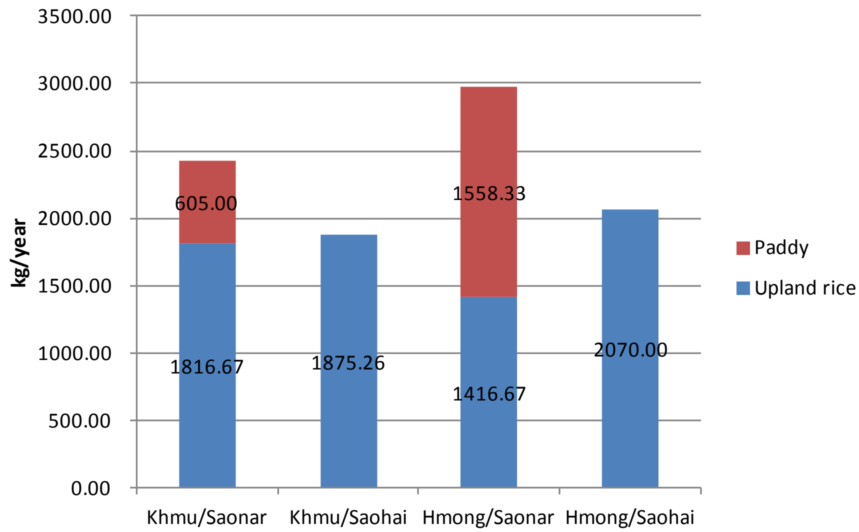


Figure 11 Annual household production (mean)

4 CAPABILITIES AND FUNCTIONS OF EACH GROUP

Livelihood capabilities and functions can explain the lifestyle differences mentioned in the former section.

Based on our survey results, the Khmu/*Saohai* were the most vulnerable of the four groups and had the most difficulty sustaining life day to day. The Hmong/*Saonar* demonstrated strengths in farming and improvements in daily lives relative to the other groups.

Based on this analysis of socio-economic circumstances, the livelihood options for each group are summarized and presented in Table 7 and Table 8.

Table 7 Livelihood options of Khmu group

	Saonar	*Saohai*
Khmu	<Status of daily life> Expanding numbers of upland rice plots Unable to achieve surplus production from paddy cultivation	<Status of daily life> Expanding numbers of upland rice plots. Unable to achieve adequate production from shifting cultivation; lacking opportunities to try other ways to make their livelihood.
	<Capabilities & functions> ● Resources related to paddy cultivation: Shortfalls in information, understanding, techniques, capital, machinery, and labor ➢ Some villagers borrowed money from the policy bank or sold their livestock. ➢ Lacked experience and knowledge in working cooperatively with other farmers. ● Irrigation: ➢ Introduced water in their paddy field individually. ● Demonstrated poor planning for household budgets	<Capabilities & functions> ● Primitive farming techniques overly affected by the weather ● More than 70% villagers within our samples suffered from shortfalls in rice production needed to sustain a family (ranging from two to six months of each year)[1] ● Provided the low production area ● Some villagers were hired by Hmong people during the farming season to perform weeding, despite the need for work in their own land, resulting in failure to complete their farming tasks ● Some villagers owned money to the policy bank; livestock bought using policy bank loans had been killed by foot-and-mouth disease[2] ● Lacked knowledge understanding of paddy cultivation methods ● Demonstrated poor planning for household budgets

1: According to interviews, each household consumed approximately 120 kg of rice per month (average);
2: In the whole village, about 90% of villagers accepting policy bank loans had encountered such problems.

Table 8 Livelihood options of Hmong group

	Saonar	*Saohai*
Hmong	<Status of daily life> Plots of upland rice stable or growing increasing Larger and more productive paddy fields than Khmu/*Saonar*	<Status of daily life> Plots of upland rice expanding, but modulus lower than for Khmu Able to provide enough rice for family subsistence
	● Resources related to paddy cultivation: They were able to buy the land, tractor, and labor needed because the Hmong traditionally sought to save money. (Some villagers had earned money from opium in earlier times) ➢ Some villager went on study tours with relatives to learn about paddy cultivation. ● Lack of technique: Lack of understanding of the best way to use natural compost material, such as manure or paddy straw, storing and managing water ● Irrigation: ➢ Some villagers shared their water sources with other *Saonar*. ➢ Some villagers formed group to buy materials to make a dam.	● Some villagers hired another villager (almost always Khmu) to finish their work on time (hiring around 10 persons/time). ● Some villagers earned income from surplus rice. ● They wanted to learn better techniques to increase production and income: Their farming style was not intensive and overly affected by weather.

5 ANALYSIS OF SUTABLE APPROACH

To verify differences from group to group, this survey focused on customs and capabilities related to cooperative group activities and statements made in the village. These capabilities are also important for sustainable forest management by rural people who rely on forest resources.

5.1 Different capabilities in cooperative group activities by farming style and ethnic group

Cooperative grouping activities are a crucial element in improving livelihood and implementing REDD+. The survey indicated villages lacked management groups for farming, livestock, or forestry. For example, shifting cultivation operation to clear field and making irrigation are one of the hard/difficult works for villagers. However villagers have not had enough experience to cooperate with others for such activities. In Figure 12 (b) and (c), both *Saonar* and *Saohai* indicated low cooperation experience for those activities. However, analysis cooperating general activities in village indicated slight differences between *Saonar* and *Saohai* (Figure 12 (a)). Example of general activities mentioned in Figure 12 (a): almost were related to customary event in village such as cleaning village public place like school/road and labour exchange and so forth. *Saonar* tended to demonstrate greater experience with cooperative efforts in their daily lives, especially concerning water management (Figure 13). However, this feature was not applied every *Saonar*. And individuals with knowledge of cooperative grouping activities represented a small portion of the Hmong/*Saonar*, with their talents in the village as given below:

- Recognized as a good farmer in village
- Formed water management group for paddy on their own
- Planned/implemented study tour to learn agricultural techniques on their own
- Current/Former member of village committee

Some ordinary villagers mentioned difficulties with cooperative efforts in areas like water management for daily use/farming due to problems in adjusting for conflicting interests among villagers. This is one reason villagers appear for the most part simply to exchange labour.

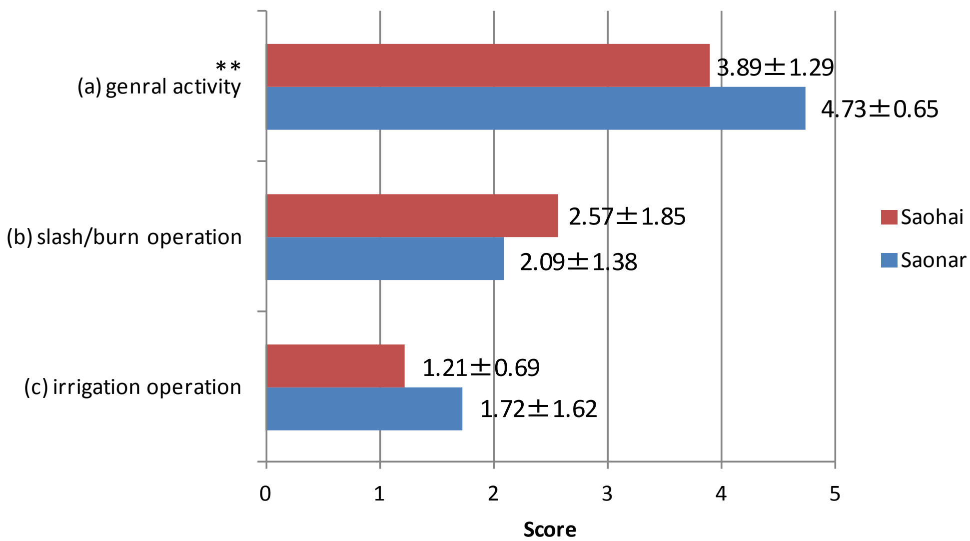


Figure 12 Experience with village cooperative group activities

Note: On an ascending scale of 1 to 5, interviewees were asked to score their experiences in response to the following questions: (a) How often do you join the cooperative group activities to cooperate with each other for improving your daily life? (b) Have you ever cooperated with others in carrying out slash/burn activities to clear farming fields? (c) Have you ever cooperated in irrigating paddy fields? We assessed significance using one-way analysis of variance (ANOVA) (** $p < 0.05$). Values in the figure are indicated as standard deviations

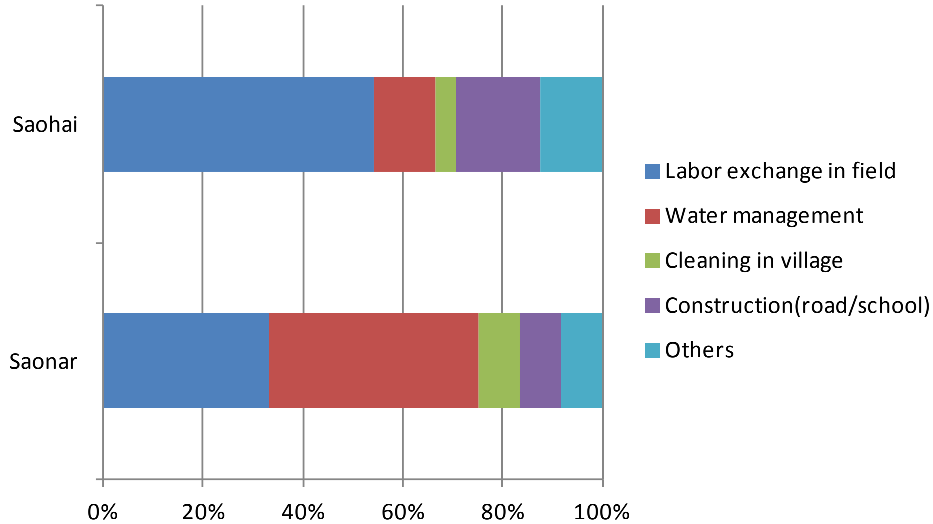


Figure 13 Type of cooperative group activities

5.2 Different capabilities and participation in discussions by gender

A focus on women is also required for their empowerment. Women face more obstacles to participating in village activity not just in farming activities, but in discussions. In Figure 14, villagers were asked the experience of making statement for each four topics in village meeting. There are significant differences between men and women on each four topics. And it indicated that women failed to speak up compared to men. Beyond village customs, work styles and the Lao language appear to be factors here. However, women had much local knowledge based on their daily life to offer, such as feeding livestock, collecting firewood or water and so on. Empowering women through project activities is important if we are to utilize their knowledge in forest management and conservation.

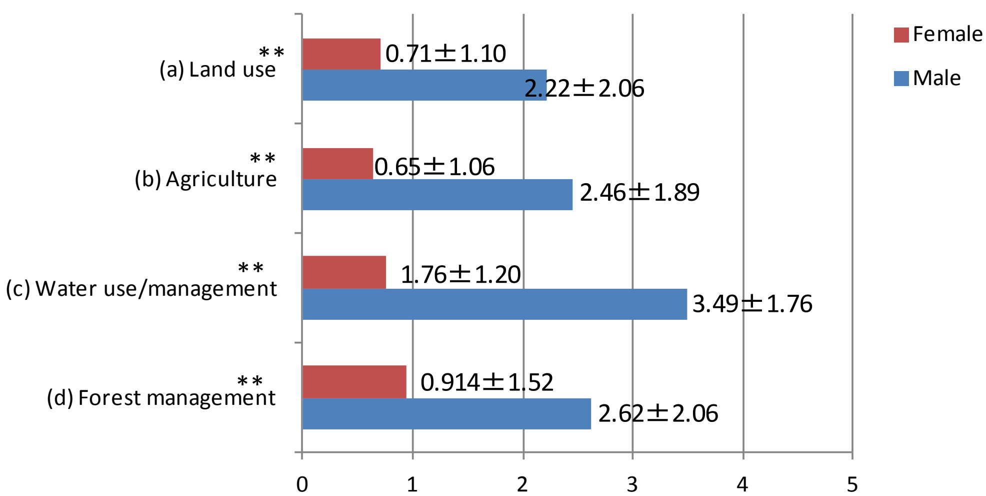


Figure 14 Speaking up in village meetings

Note: Interviewees were asked to score on an ascending scale of 0 to 5 their recognition of following questions: (a) Have you participated in any discussions on determining land use in the village? (b) Have you participated in any discussions on agricultural topics? (c) Have you participated in any discussions on use of water sources (springs or wells)? (d) Have you participated in any discussions to set rules for forestry management/operations? We assessed significance using one-way analysis of variance (ANOVA) (** $p < 0.05$). Values in the figure are indicated as standard deviations

6 CONCLUSION

As a result of survey, Hmong/*Saonar* showed good practice to mitigate the shifting cultivation (Figure 10). And their capabilities related to maintain livelihood were higher than other groups (Table 7 and Table 8). For example, they got the resources for cultivating paddy by themselves. And some villager implemented the study tour with relatives because they were ambitious to get knowledge for improving livelihood. And paddy cultivation triggered making group to manage water for paddy cultivation. From these analyses, introducing paddy cultivation will become one of alternative livelihood to reduce the shifting cultivation in Houay Khing village. Also, from the survey, when we focused on the difference of ethnic, farming type and gender, their capabilities and functions were different among each group. Such results indicated that, when implementing the project activities, it would be needed to focus on vulnerable groups such as Khmu/*Saohai* and women. Therefore when we focus on women, weaving could be one of the proper activities in Houay Khing. It was high needs activity among women.

APPENDIX 7: GENERAL INFORMATION ON TARGET SITE (VILLAGE CLUSTER)

	Houaykhing	Phakbong	Longath	Houaytho	Houayha	Sakuan
Distance from District Center	36 km	27 km	31 km	39 km	38 km	46 km
Land Area	7,425.8 ha	4,781.0 ha	*Work in progress*	2,731.5 ha	7,497.8 ha	4,626.4 ha
Establishment of the Village	2003	2001	*Work in progress*	70-100 years ago	Around 1970	Around 1960
Migrated from	Three villages merged into one village; villagers moved to roadside habitations	Phakbong Village was relocated to an area close to the current village area and finally settled to a roadside habitations following merge with Houaysoy Village	*Work in progress*	Houaytho was known as Khmu Village at the current location; Hmong moved from Napieng Village located 8 km away in 2003	Houayha villagers were moved to an area close to the current village area, finally settling in the present area.	Hmong have lived at the current location for 50 years; Khmu people moved from the Phakseng District in 2002.
Reason for Migration	Government policy to merge small villages into bigger villages and to provide better road access to improved main road	Government policy to merge small villages into bigger villages and to provide better road access to improved main road	*Work in progress*	Hmong moved to the village in 2003 due to government policy to merge small villages into bigger villages and to provide better road access	Need for arable land	Khum moved from Pakseng District in 2002 due to government policy to merge small villages into bigger villages and to provide better road access

ANNEX
(EXPLANATION FOR METHODOLOGY)
DRAFT VRSION

Red sentences are revised according to peer-review

As requested by the methodology, this document refers to each of the steps and sub-steps using the same titles and numbers of the methodology so that its application can be transparently validated.

Table of Contents

PART 1 – SCOPE, APPLICABILITY CONDITIONS AND ADDITIONALITY

1 SCOPE OF THE METHODOLOGY

Under Forestry Strategy to the Year 2020 of Lao PDR (Forestry Strategy 2020), Lao PDR decided to promote forest conservation in all over forest area and countermeasures of pioneer shifting cultivation as one of the unplanned drivers of deforestation. Therefore, this project is categorized as the Avoided Unplanned Deforestation (AUD) of VCS AFOLU category.

- Sectoral scope: Agriculture, Forest and other Land Use (AFOLU)

- AFOLU project category: Reducing Emissions from Deforestation and Degradation (REDD)

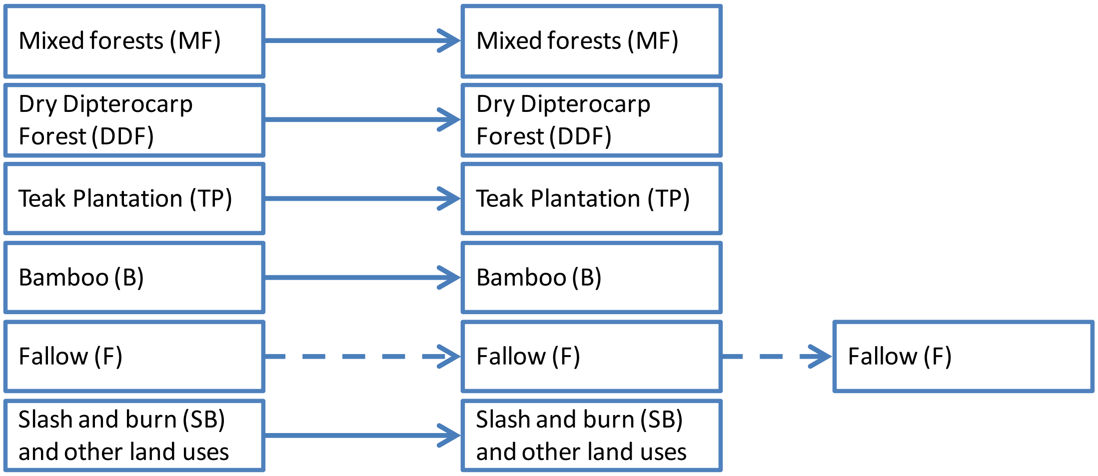
- Type of Activity: Avoid Unplanned Deforestation (AUD)

Baseline activities include deforestation in natural and secondary forests without logging; therefore, the project is categorized as E of the eligible activities included in the scope of this methodology (Table 1).

Table 1 Scope of the methodology

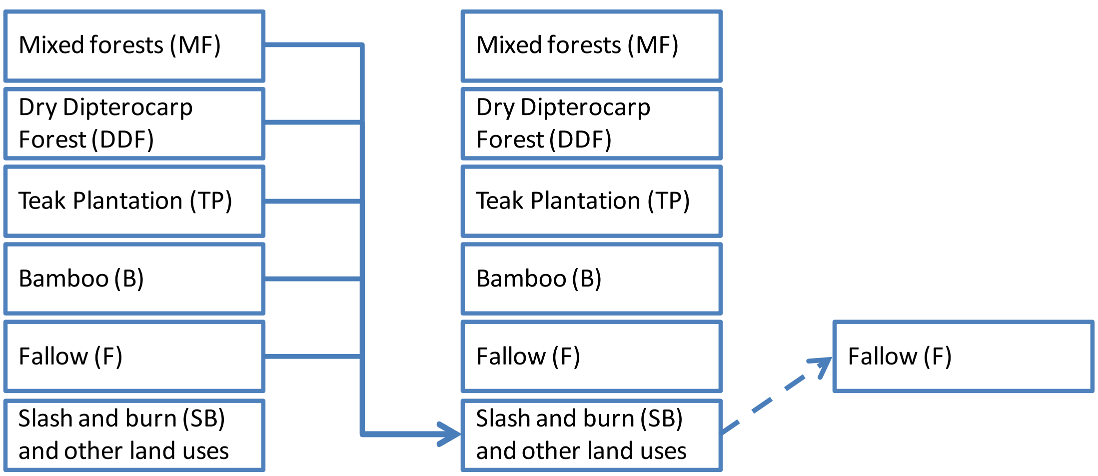
<table>
<tr><td colspan="3" rowspan="2"></td><td colspan="2">PROJECT ACTIVITY</td></tr>
<tr><td>Protection without logging, fuel wood collection or charcoal production</td><td>Protection with controlled logging, fuel wood collection or charcoal production</td></tr>
<tr><td rowspan="8">BASELINE</td><td rowspan="4">Deforestation</td><td>Old-growth without logging</td><td>A</td><td>B</td></tr>
<tr><td>Old-growth with logging</td><td>C</td><td>D</td></tr>
<tr><td>Degraded and still degrading</td><td>E</td><td>F</td></tr>
<tr><td>Secondary growing</td><td>G</td><td>H</td></tr>
<tr><td rowspan="4">No-deforestation</td><td>Old-growth without logging</td><td>No change</td><td>Degradation</td></tr>
<tr><td>Old-growth with logging</td><td>IFM</td><td>IFM-RIL</td></tr>
<tr><td>Degraded and still degrading</td><td>IFM</td><td>IFM</td></tr>
<tr><td>Secondary growing</td><td>No change</td><td>Degradation</td></tr>
</table>

For using methodology 0015, this PD applied land and forest classifications in Lao PDR and in accordance with methodology 0015, concepts of deforestation and forest degradation are as follows (Figure 1 and Figure 2).



Note: Arrows with solid line means no land use changes and no carbon stock changes (land remaining in the same category). Arrows with dash line means no land use change and having carbon stock change (increase) according to following Figure 18.

Figure 1 Cases of no deforestation (i.e. no land conversion (land remaining in the same category~~ or no deforestation~~) and having forest degradation and carbon enhancement



Note: Arrows with solid line means land use change (deforestation: forests to croplands) with carbon stock changes (decreases). In cases of deforestation (land conversions to slash-and-burn (SB)), 86.3% of converted lands (SB) are return to fallow (F)[1] and 13.7% are remained as croplands in Phonsay District (reference area)[2]. Then, converted lands to SB (86.3%) is categorised as "forest degradation (no land use change)" and activities for reducing "forest degradation" is ~~emitted~~ omitted in this PD according to applied methodology. Carbon stock increase from SB to F (dash line) (13.7%) is credited by applying Figure 18, which is according to methodology 0015.

Figure 2 Cases of deforestation (land-use-change)~~ (land conversions or deforestation)~~

[1] Fallow is clarified as forests because fallow area has enough potential to recover to forest and slash-and-burn area is classified as cropland because these are used for cultivation in constant

[2] Ratios of SB returns to fallow and remain as SB was quantified by applying observed values from 2000 to 2005.

2 APPLICABILITY CONDITIONS

The project meets the following four applicability conditions of the methodology VM0015 (Table 2).

Table 2 Applicability condition of VM0015 and reasons for justifications of the project

Applicability Conditions of VM0015	Reasons for justifications
a) Baseline activities may include planned or unplanned logging for timber, fuel-wood collection, charcoal production, agricultural and grazing activities as long as the category is unplanned deforestation according to the most recent VCS AFOLU requirements.	The project promotes activities that avoid deforestation in the HK-VC which is not under planned activities. Therefore, it is categorized as the Avoided Unplanned Deforestation (AUD) of REDD.
b) Project activities may include one or a combination of the eligible categories defined in the description of the scope of the methodology.	Baseline activities include deforestation and forest degradation in mixed forest ~~natural~~ and secondary forests by pioneer shifting cultivation. But there are no protection activities of logging, fuel wood collection or charcoal production ~~and other human activities including expansion of grazing area and so on~~. Therefore, the project is categorized as the Avoided Unplanned Deforestation (AUD).
c) The project area can include different types of forest, such as, but not limited to, old-growth forest, degraded forest, secondary forests, planted forests and agro-forestry systems meeting the definition of "forest".	The Lao PDR's Government has adopted parameters to define forest under Forestry Strategy 2020 and forest classification, and the project includes different types of forest, such as mixed forest, secondary forest and fallow land, are adopted by Lao PDR (Evidences should be provided to the project validator in validation process).
d) At project commencement, the project area shall include only land qualifying as "forest" for a minimum of 10 years prior to the project start date.	From results of satellite imagery analysis from 1994 to 2004 (*see* Figure 9), we confirmed that land use of the project area is categorized as "forest".
e) The project area can include forested wetlands (such as bottomland forests, floodplain forests, mangrove forests) as long as they do not grow on peat. Peat shall be defined as organic soils with at least 65% organic matter and a minimum thickness of 50 cm. If the project area includes a forested wetlands growing on peat (e.g. peat swamp forests), this methodology is not applicable.	The forest land located within the project boundary is characterized by seasonal tropical forest, therefore no forested wetland is found within the project area.

3 ADDITIONALITY

Please refer to "section 2.5 Additionality" in Project Description (PD).

PART 2 - METHODOLOGY STEPS FOR *EX-ANTE* ESTIMATION OF GHG EMISSION REDUCTIONS

1 STEP 1. DEFINITION OF THE BOUNDARIES OF THE PROPOSED AUD PROJECT ACTIVITY OF VM0015

As for definition of the boundaries, we identified following 4 types of boundaries; Spatial boundaries, Temporal boundaries, Carbon pools, Sources of emissions of GHG (other than carbon stock changes). Definition of each type of the boundary is as follows;

1.1 Spa~~ec~~tial boundaries

According to VM0015, ~~special~~ spatial boundaries consist of Reference Region, Project Area, Leakage Belt, Leakage Management Areas and Forest (Figure 3). In this project, the project set ~~special~~ spatial boundaries based on following concepts;

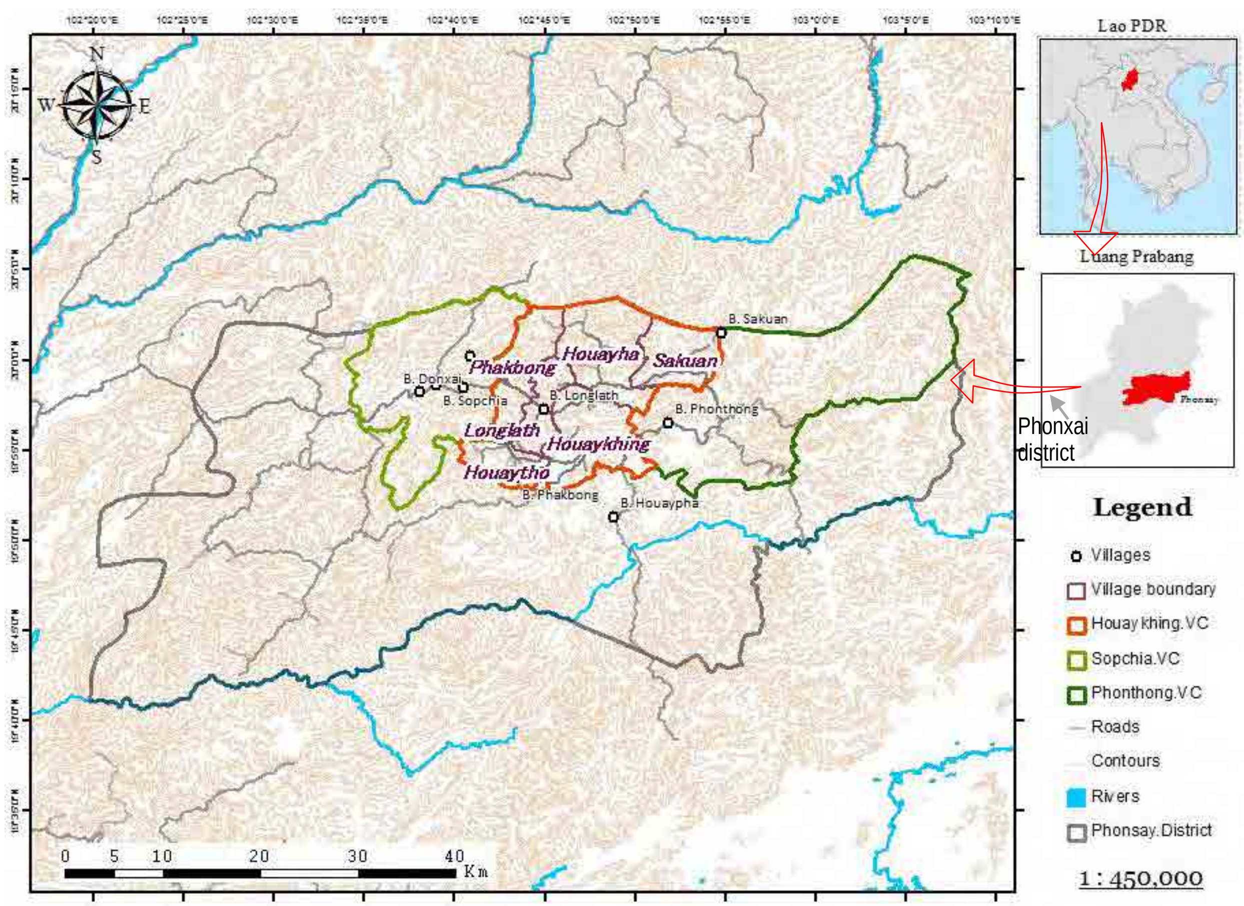


Figure 3 Concept of ~~special~~ spatial boundaries in this project[3] (Figure was improved)

[3] Please refer Figure 6 for identifying forest and non-forest in project area.

1.1.1 Reference region

In Luang Prabang Province, Lao PDR, there had not been developed national or sub-national baselines. Therefore, reference region was determined for application to this project which is according to VM0015.

Reference region was identified as overall Phonsay District including the project area. It was because there is a typical forest ecosystem which consists of Mixed forests of evergreen, deciduous trees and the forest ecosystem is similar to the project area of HK-VC. Therefore, it is appropriate to set overall Phonsay District as the reference region for the project area. In the overall Phonsay District, the area under shifting cultivation is expanding due to population increase, which makes it even more appropriate to identify the overall district as the reference region for the project area.

The reference region has an area of 232,665 ha (consist of 222,437 ha of forest area and 16,718 ha of non-forest area) – approximately 8 times bigger than the project area and is located in west side of Luang Prabang Province (latitude: N19°86′ to N20°10′, longitude: E102°56′ to E103°14′). The criteria used to define the reference region were based on forest/vegetation classes, ~~elevation~~, ~~precipitation,~~ slope, rainfall, socio-economic and cultural conditions. The reference region meets the following conditions:

a. Agents and Drivers of deforestation

To analyze the agents of drivers of deforestation in the HK-VC, the project proponent(s) used participatory methods (PRA). A detailed description of the agents and drivers of deforestation in the HK-VC are compiled in Appendix 4 of PD (i.e. shifting cultivation by small farm holders). Also from interviews to PAFO and DAFO, proponent(s) identified that there are similar condition of agents and drivers of deforestation in both within Phonsay district (reference region) and HK-VC (project area).

Agents groups: The agents of deforestation both within Phonsay district (reference region) and HK-VC (project area)~~within the reference region and project area~~ are almost all of small farm holders using conventional techniques to convert natural forests and secondary forests into lands of shifting cultivation (i.e. pioneer shifting cultivation). There are also some other agents in the area, i.e. expansion of grazing land.

Infrastructure Drivers: In both Phonsay district (reference region) and HK-VC (project area), t~~T~~here are new improved infrastructures which introduce electric power ~~to the HK-VC~~ and road construction to access smoothly~~ near or inside the project area~~. Also hydroelectric power generation is planned in both areas.

Other spatial drivers expected to influence the project area: From interviews to PAFO and DAFO, ~~No~~ no other major drivers were identified in both Phonsay district (reference region) and HK-VC (project area)~~in the reference region during the public consultation and~~, therefore, no additional drivers are expected to emerge near or inside the project area.

b. Landscape configuration and ecological conditions

Ecological condition in reference region is as follows;

Forest/vegetation classes: In both Phonsay district (reference region) and HK-VC (project area), forest classification are almost same. Over 90% of HK-VC (project area) has forest classes that exist in at least 90% of the rest of Phonsay district (reference region) (*see* Figure 10).

Slope: As demonstrated in Figure 4 and Figure 5~~below~~, the mean slope in the project area is 19.3 degrees which is almost the same as the reference region of 20.6 degrees. Average slope of at least 90% of HK-VC (project area) are within ±10% of the average slope at 90% of the rest of Phonsay district (reference region).

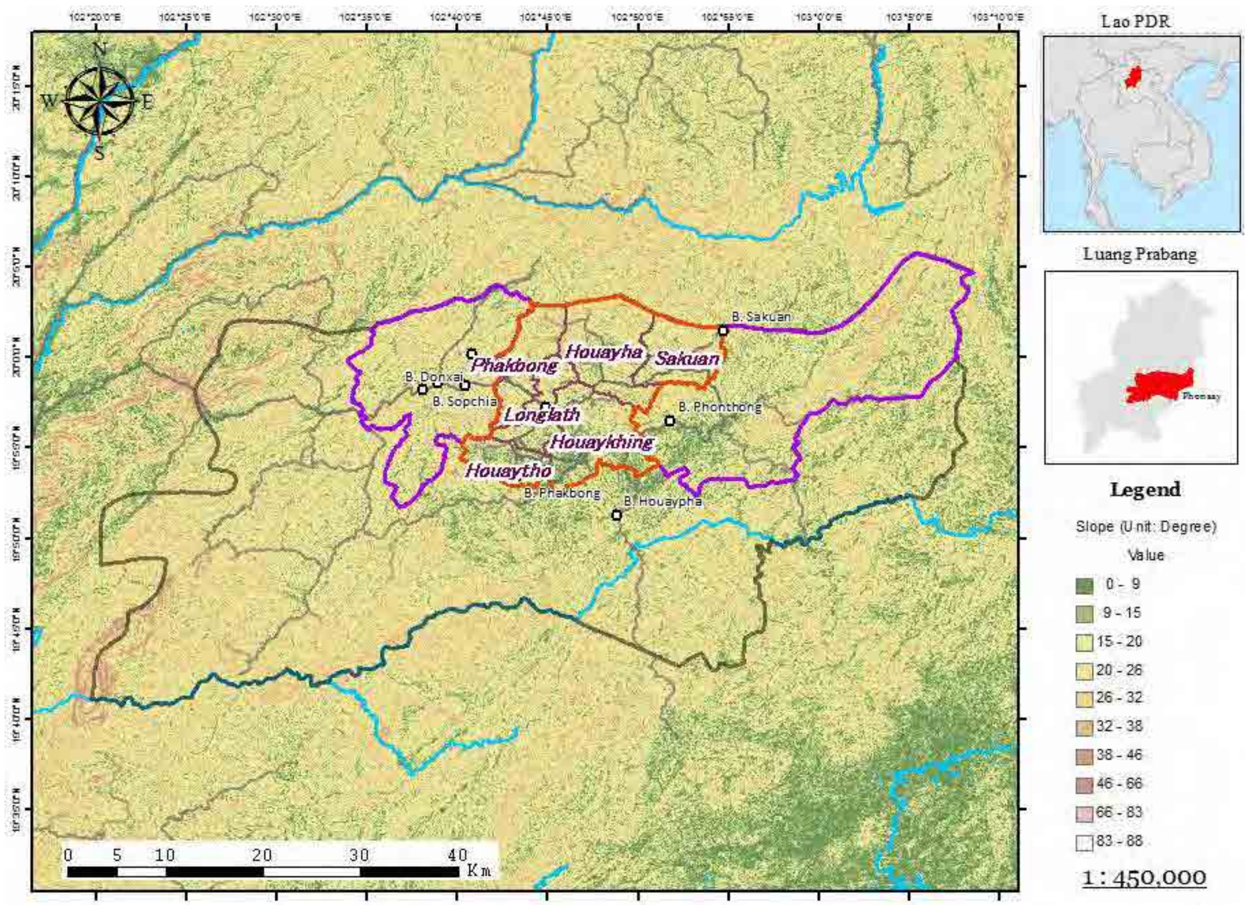
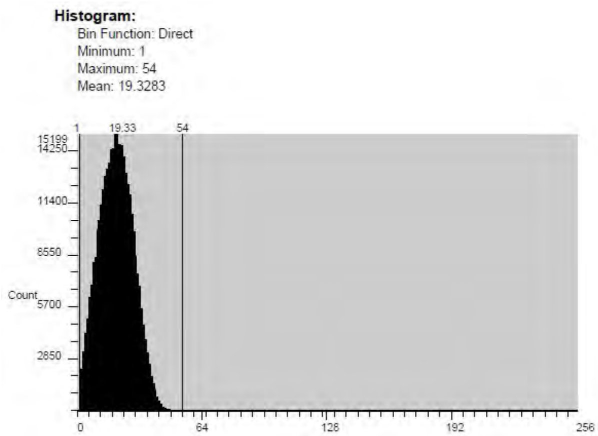


Figure 4 Slope in target area of Phonsay District (reference region) and HK-VC (project area) (Figure was improved)



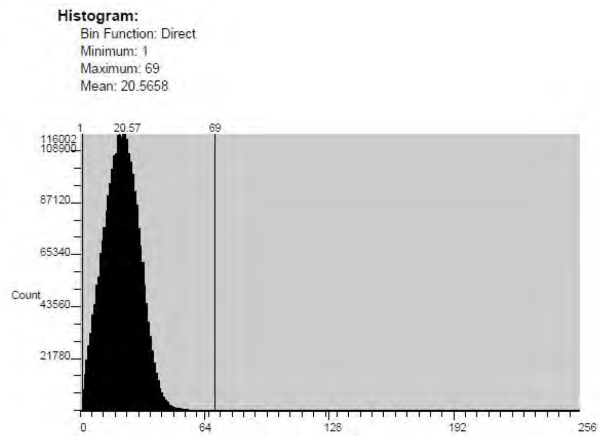


Figure 5 Slope in the project area of HK-VC (left) and reference area of Phonsay District (right)

Rainfall: As demonstrated above (*see* Figure 6 in 1.9 Project Location of Project Description of PD), the mean rainfall in the rest of the Phonsay District (966.8 mm/yr) is considered as similar as the project area of HK-VC, because the HK-VC is located in almost the centre of the District and ecologic condition is quite similar.

c. Socio-economic and cultural conditions:

Legal status of the land: According to the Land Law (Art. 11), land is to be classified into eight categories according to usage: agricultural land, forestland, water-area land, industrial land, communication land, cultural land, land for national and security defence, and construction land. The Ministry of Agriculture and Forestry (MAF) is responsible for further classification, management and development of agricultural land, forest land, and water bodies. The Land Law (Art. 12) stipulates that the Government holds national responsibility for zoning and demarcation of boundaries for each land category.

Land tenure: Long term use right of natural forest can be allocated to individuals and organizations according to the Forestry Law (Art. 5). Natural forest can be also leased or granted to concessionaires for protection and harvesting (the Forestry Law Art. 56). However, the government has so far only allocated natural forest to villages through the land and forest allocation program. Individuals and organizations to whom the government allocates protection, conservation and management of forest and forest that land have rights to various compensatory benefits such as use of trees and Non-Timber Forest Products (NTFPs) collection rights in accordance with regulations issued by concerned agencies (The Forestry Law Art. 7).

Land use: The reference region which covers whole Phonsay District includes various types of land categories. The project area, HK-VC owned by the Government and its land use according to eight land use classification is managed by rural people with permission from Phonsay District.

Enforced policies and regulations: High demand for woods and NTFPs in the markets of wood deficient neighbouring region and countries brings high pressures on forest resources in Lao PDR. In addition, pioneer shifting cultivation practices are still the main cause of deforestation particularly in the northern Lao PDR. However, in Lao PDR, there are not specific regulations as countermeasures.

1.1.2 Project area

The location of the project area, including each village, main road and other related information are shown in Figure 6.

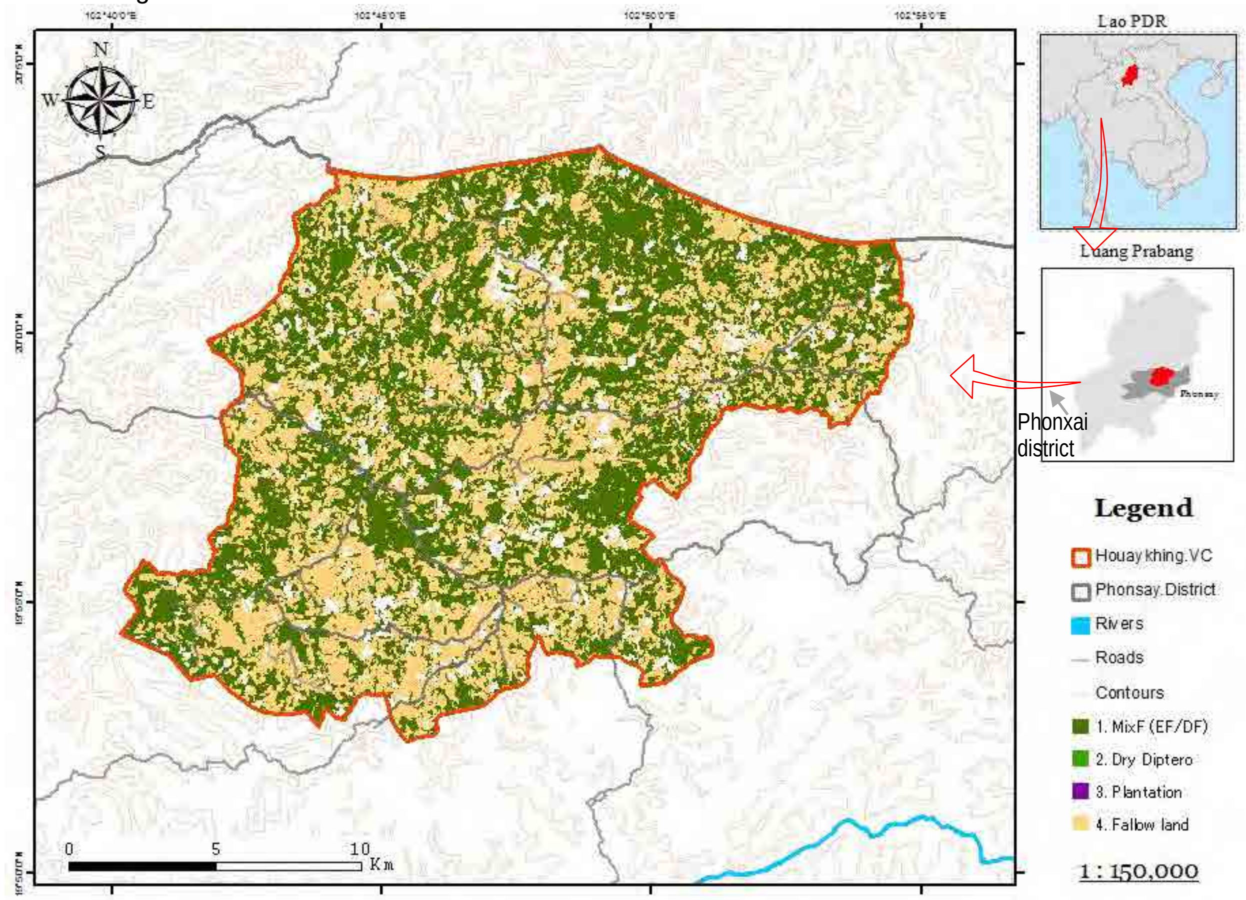


Figure 6 Main road and river in the target area of HK-VC (Figure was improved)

The project area includes all forests area observed according to draft Forest Base Map 2010 within the boundaries of the project area and reference region, as illustrated in Figure 3. The total project area (HK-VC) is ~~30,486 ha (~~27,992 ha (HK-VC is 30,486 ha including ~~of forest area and~~ 2,496 ha of non-forest area) and location in each village is mentioned in Appendix 7 in PD.

Physical boundaries of each discrete area of land included in the project area

See above Figure 3.

Description of current land-tenure and ownership, including legal arrangement related to land ownership and the avoided unplanned deforestation (AUD)

See section "1.11 Ownership and Other Programs" in PD

List of the project participants and brief description of their roles in the proposed AUD project activity

See sections "1.3 Project Proponent" in PD.

1.1.3 Leakage belt

Step a: From results of preliminary survey before the commencement of the project and mobility analysis (Option II of the applied methodology) (*see* Appendix 1) by expert opinion and participant rural appraisal (PRA) of the project, leakage belt was identified as neighbour regions of Soptia VC where is west side of HK-VC and Phonton VC where is east side of HK-VC.

Step b: ~~It is because the Village Clusters are located west and east of HK-VC respectively; are along with main road from Luang Prabang City; and people can move easily. Also northern side is faced to Nampa, Namther and Huaypha National Protection Forest and southern side faces to Nam Khan River so that activities or people movements were hardly to occur. In addition, activities of rural people are based on or along with main road (pink collared in Figure 9) which is from Luang Prabang City to Phonton VC; therefore, it is applicable to identify leakage belt as both Soptia VC and Phonton VC.~~According to analysis of some criteria (*see* step c), leakage belt are drawn as following Figure 7.

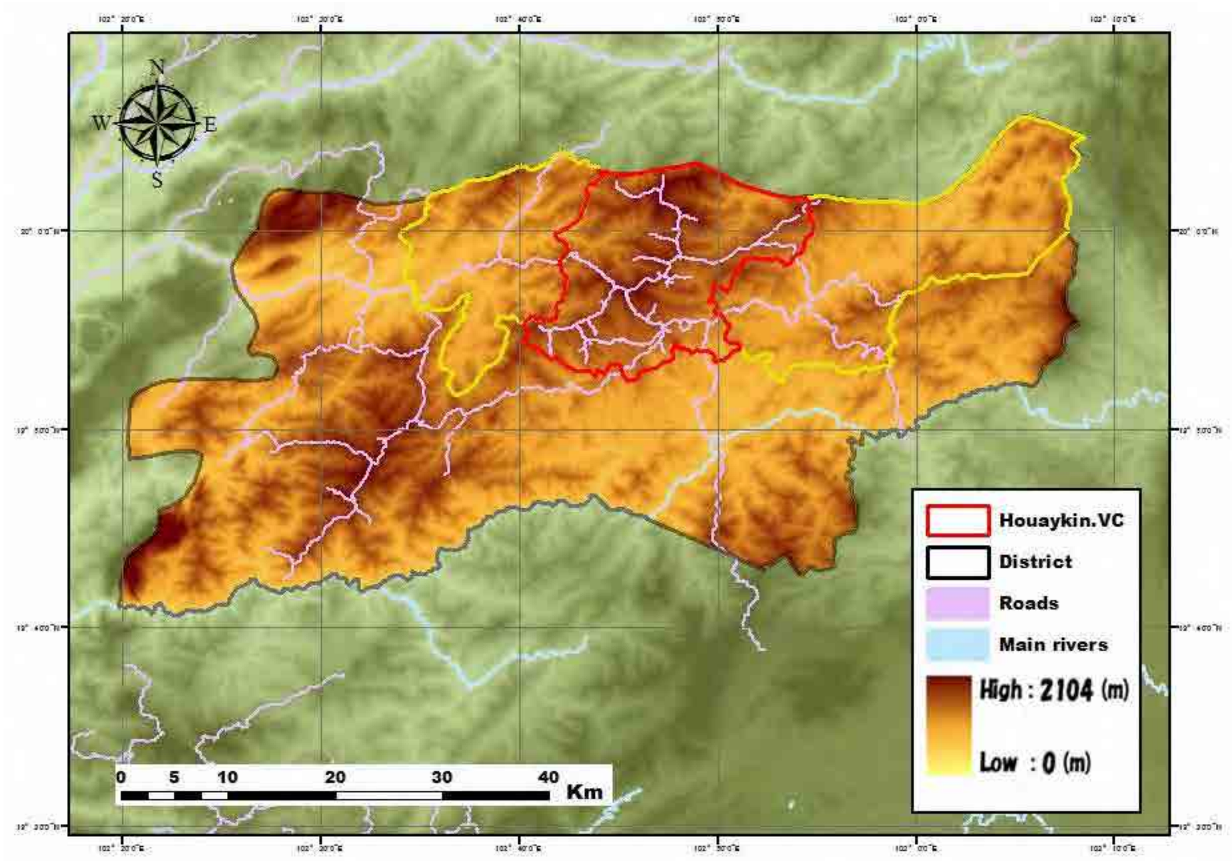


Figure 7 Main road and river in the target area of Houaykhing Village Cluster (HK-VC) (Figure was improved)

Step c: Soptia and Phonton Village Clusters are located west and east of HK-VC respectively; are along with main road from Luang Prabang City; and people can move easily. Also northern side is faced to

Nampa, Namther and Huaypha National Protection Forest and southern side faces to Nam Khan River so that activities or people movements were hardly to occur. In addition, activities of rural people are based on or along with main road which is from Luang Prabang City to Phonton VC; therefore, it is applicable to identify leakage belt as both Soptia VC and Phonton VC.

Step d: Results of identification of leakage belt by above steps were evaluated by discussion with officials of PAFO and DAFO, and documentations of discussions will be provided to the project validator in validation process,

1.1.4 Leakage management area

The objective of leakage management area is to reduce pressures on leakage activities; therefore, this project identified leakage management areas as permanent croplands (i.e. paddy fields) in reference region to stabilize farmers' activities (Figure 8). It is considered that introduction of alternative livelihood (not shifting cultivations) in permanent croplands will have effects on reducing motivation of shifting activities (leakage) and then reducing shifting cultivation.

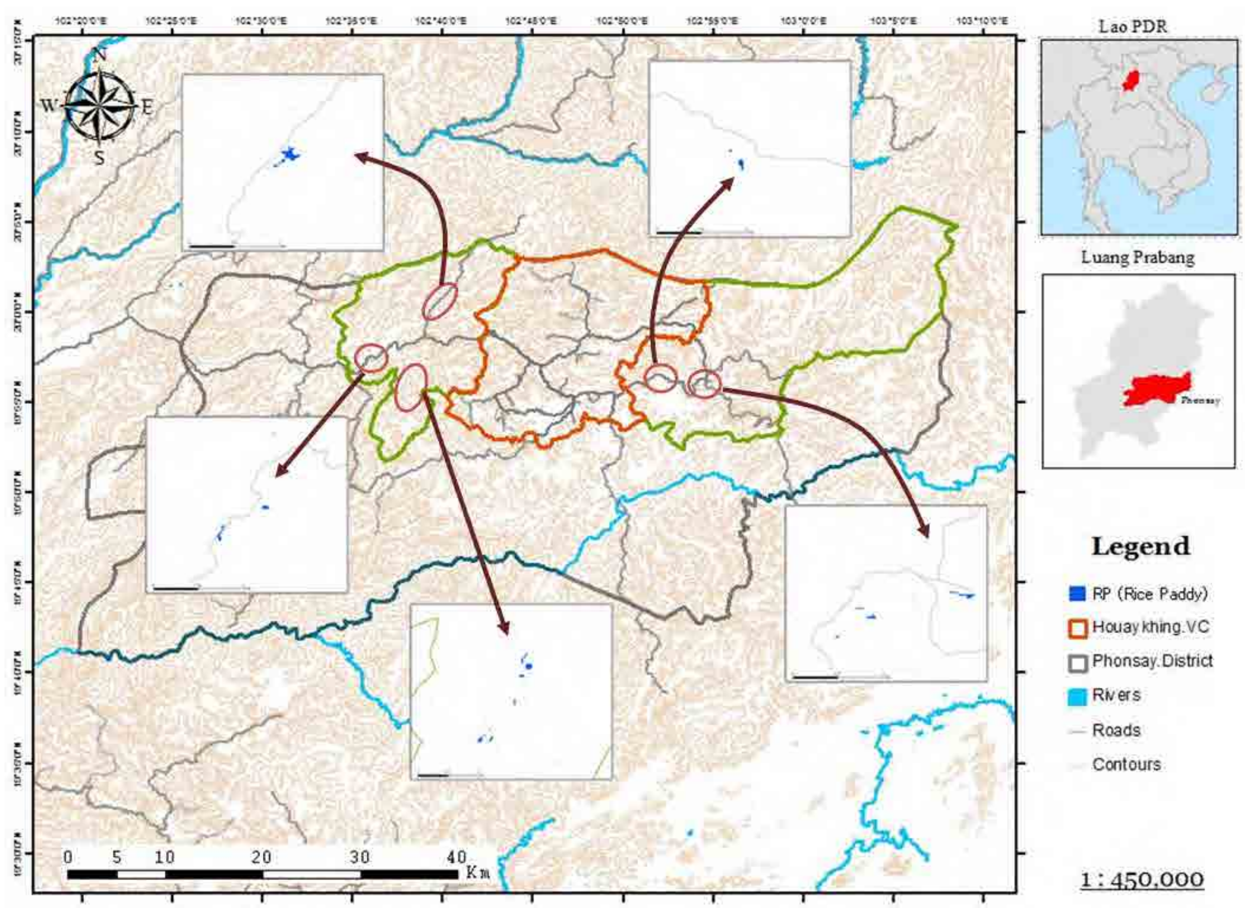


Figure 8 Location of leakage management area

1.1.5 Forest

According to the definition of current forests in Lao PDR, the specific definition of forests in this project is identified and applied to the project as follows;

Minimum area of land: 0.5 ha

Average tree height: 5 m

Minimum tree crown cover: 20% and above

Also, forest classification such as mixed forest, secondary forest and fallow land, are adopted by Lao PDR (Evidences should be provided to the project validator in validation process). The baseline scenario is based on a multi-temporal historical analysis of deforestation, which mentioned in Figure 9. The analysis yielded a digital map of forest cover, deforestation that was filtered to a minimum-mapping unit (MMU) of 1.0 ha; the forest class has an overall accuracy of 80%. The forest benchmark was generated from the multi-temporal historical analysis. Also some area covered by clouds and shadows were analyzed according specific methodology (*see* Appendix 3).

1.2 Temporal boundaries

1.2.1 Starting date and end date of the historical reference period

The historical reference period is from 1996 to 2010, totaling 15 years.

1.2.2 Starting date of the project crediting period of the AUD project activity

The start and end date of the project crediting period, 20 years in total, are December 16, 2011 and December 15, 2030, respectively. The project crediting period is subject to renewals.

1.2.3 Starting date and end date of the first fixed baseline period

The fixed baseline period covers a 10 years period from 2011 to 2020.

1.2.4 Monitoring period

The minimum duration of a monitoring period will be one year and will not exceed the fixed baseline period. It is expected that monitoring reports will be issued every 3-5 years, depending on project circumstances.

1.3 Carbon pools

According to VM0015, carbon pools, which are target of GHG emissions and removals, are defined as following Table 3;

Table 3 Selected Carbon Pools

Carbon pools	Included/excluded	Justification/Explanation of choice
Aboveground	Included	The baseline land use in the project area is conversion of forests to other land use, and degradation of natural and secondary forests by pioneer shifting cultivation. Therefore the carbon stock in this pool is likely to be relatively large compared to the project scenario.
Belowground	Included	Recommended by the methodology as it usually represents between 15% and 30% of the above-ground biomass.
Dead wood	Excluded	Conservatively excluded (the carbon stock in this pool is not expected to be higher than the baseline compared to the project scenario).
Harvest wood products	Excluded	Under the baseline scenario, illegal or selective logging occurs at very small scale. Such results were supported by results of preliminary survey in Appendix 1. Therefore, harvested wood products have been considered insignificant.
Litter	Excluded	Not to be measured according to the latest VCS AFOLU Requirements (version 3.2).
Soil organic carbon	Excluded	The baseline land-use of the project area is conversion of forests to other lands, and degradation of natural and secondary forests by pioneer shifting cultivation. The soil organic carbon is not to be measured in such cases according to the latest VCS AFOLU Requirements (version 3.2). Some scientific literatures also supported such justification (*see* Appendix 2).

1.4 Sources of GHG emissions

According to applied methodology VM0015, GHG types, which are target of GHG emissions and removals, are defined as following Table 4.

Table 4 Identified source of GHG types

	Gas	Included?	Justification/Explanation
Biomass burning	CO_2	Excluded	Counted as carbon stock change
	CH_4	Included	The non-CO_2 emissions related to biomass burning are related to shifting cultivation practice. Therefore emission of CH_4 is counted.
	N_2O	~~Included~~Excluded	Considered insignificant according to VCS Program Update of May 24th, 2010~~The non-CO_2 emissions related to biomass burning are related to shifting cultivation practice. Therefore emission of CH_4 is counted~~.
Livestock emissions	CO_2	Excluded	Not counted as carbon stock change
	CH_4	Excluded~~Included~~	Not a significant source~~The project promotes livestock management as alternative livelihoods of shifting cultivation. Therefore emission of CH_4 is counted~~.
	N_2O	Excluded~~Included~~	Not a significant source~~The project promotes livestock management as alternative livelihoods of shifting cultivation. Therefore emission of N_2O is counted~~.
Paddy field	CO_2	Excluded	Not counted as carbon stock change
	CH_4	Excluded~~Included~~	Not a significant source~~The project promotes paddy field as alternative livelihoods of shifting cultivation. Therefore emission of CH_4 is counted~~.
	N_2O	Excluded	Not to be measured according to the latest VCS AFOLU Requirements (version 3.2).

2 STEP 2: ANALYSIS OF HISTORICAL LAND-USE AND LAND-COVER CHANGE

2.1 Collection of appropriate data sources

An analysis of land-use and land-cover change in the reference region was conducted in each year for the reference period (1996-2010) using medium resolution satellite imagery, and then it was validated using a combination of high-resolution satellite imageries and aerial photography. All data sources used in these analyses are listed in Appendix ~~3~~4.

2.2 Definition of classes of land-use and land-cover

There is specific definition of forests in Lao PDR. The Forestry Strategy has definition of forests for Lao PDR, which is a minimum area of land of 0.5 ha, with a minimum tree crown cover (or equivalent stocking level) of 30% and with trees with a minimum height of 5 m. The land-cover change analysis conducted met these criteria, and applies criteria that result in a conservative estimate of both forest cover in the benchmark map and forest loss between the period analyzed.

The best practice in the remote sensing field emphasizes the use of medium resolution imagery as a very cost-effective method for classifying and monitoring forest cover and loss, and the type of spectral analysis using such imagery is sufficient to accurately distinguish closed-canopy forest from many vegetation formations. LANDSAT imagery, one such type of medium resolution imagery, was used in this project to map the forest cover and loss.

Following pictures shows areas of typical fallow in the project site.

Fallow area in HK-VC

Fallow area in Sobchia VC

According to criteria in applied methodology VM0015, LU/LC classes are identified as following Table 5.

Table 5 List of all land use and land cover classes existing at the project start date within the reference region

Class identifier		Trend in carbon stock	Presence in[1]	Baseline activity[2]			Description (including criteria for unambiguous boundary definition) according to draft Forest Base Map 2010
ID	Name			LG	FW	CP	
1	Mixed forest	Decreasing	PA, RR, LK	N	Y	N	Mixed forest of deciduous and evergreen trees
2	Dry dipterocarp forest	-	-	-	-	-	Natural and semi-natural forest
3	Teak plantation	Constant	PA, LK	N	N	N	Plantation Forest
4	Fallow	*See* Figure 11	PA, RR, LK	N	Y	N	After slash-and-burn area[3]
5	Slash-and-burn	-	PA, RR, LK	N	N	N	Slash-and-burn area. This land cover is identified as cropland according to IPCC Guidelines
6	Bamboo	-	PA, RR, LK	N	N	N	Bamboo dominated area. This land cover will be included in forest area, but carbon stock of bamboo is not estimated according to conservative approach
7	Scrub	-	PA, RR, LK	N	N	N	Scrub area in constant. This land cover will be included in forest area, but carbon stock of bamboo is not estimated according to conservative approach
8	Grassland	-	PA, RR, LK	N	N	N	Grassland in constant
9	Rice paddy	-	PA, RR, LK	N	N	N	Rice paddy fields in constant
10	Other land uses	-	PA, RR, LK	N	N	N	Including settlement and so on

1: PA = Project area, RR = Reference region, LK = Leakage belt
2: LG = Logging, FW = Fuel-wood collection; CP = Charcoal Production (Y/N)
3: Fallow is clarified as forests because fallow area has enough potential to recover to forest and slash-and-burn area is classified as cropland because these are used for cultivation in constant.

2.3 Definition of categories of land-use and land-cover change

The project defined 4 land-cover classes, and 16 possible combinations of land-cover change categories, as showed in Table 6 and Table 7.

Table 6 Potential land-use and land-cover change matrix

		Initial LU/LC class			
		Mixed forest (MF)	Dry dipterocarp forest (DDF)	Teak plantation (TP)	Fallow (F)
Final LU/LC class	Slash-and-burn (SB)	MF / SB	DDF / SB	TP / SB	F / SB
	Bamboo (B)	MF / B	DDF / B	TP / B	F / B
	Scrub (S)	MF / S	DDF / S	TP / S	F / S
	Grassland (G)	MF / G	DDF / G	TP / G	F / G
	Rice paddy (RP)	MF / RP	DDF / RP	TP / RP	F / RP
	Other land uses (OL)	MF / OL	DDF / OL	TP / OL	F / OL

Table 7 List of land-use and land-cover change categories

ID	Name	Trend in carbon stock	Presence in	Activity in the baseline case			Name	Trend in carbon stock	Presence in	Activity in the baseline case		
				LG	FW	CP				LG	FW	CP
MF / SB	Mixed forest	Constant	PA, RR, LK	N	Y	N	Slash-and-burn	Decrease	PA, RR, LK	N	N	N
MF / B	Mixed forest	Constant	PA, RR, LK	N	Y	N	Bamboo	Decrease	PA, RR, LK	N	N	N
MF / S	Mixed forest	Constant	PA, RR, LK	N	Y	N	Scrub	Decrease	PA, RR, LK	N	N	N
MF / G	Mixed forest	Constant	PA, RR, LK	N	Y	N	Grassland	Decrease	PA, RR, LK	N	N	N
MF / RP	Mixed forest	Constant	PA, RR, LK	N	Y	N	Rice paddy	Decrease	PA, RR, LK	N	N	N
MF / OL	Mixed forest	Constant	PA, RR, LK	N	Y	N	Other land uses	Decrease	PA, RR, LK	N	N	N
DDF / SB	Dry dipterocarp forest	Constant	RR	N	Y	N	Slash-and-burn	Decrease	RR	N	N	N
DDF / B	Dry dipterocarp forest	Constant	RR	N	Y	N	Bamboo	Decrease	RR	N	N	N
DDF / S	Dry dipterocarp forest	Constant	RR	N	Y	N	Scrub	Decrease	RR	N	N	N
DDF / G	Dry dipterocarp forest	Constant	RR	N	Y	N	Grassland	Decrease	RR	N	N	N
DDF / RP	Dry dipterocarp forest	Constant	RR	N	Y	N	Rice paddy	Decrease	RR	N	N	N
DDF / OL	Dry dipterocarp forest	Constant	RR	N	Y	N	Other land uses	Decrease	RR	N	N	N
TP / SB	Teak plantation	Constant	RR	N	Y	N	Slash-and-burn	Decrease	RR	N	N	N
TP / B	Teak plantation	Constant	RR	N	Y	N	Bamboo	Decrease	RR	N	N	N
TP / S	Teak plantation	Constant	RR	N	Y	N	Scrub	Decrease	RR	N	N	N
TP / G	Teak plantation	Constant	RR	N	Y	N	Grassland	Decrease	RR	N	N	N
TP / RP	Teak plantation	Constant	RR	N	Y	N	Rice paddy	Decrease	RR	N	N	N
TP / OL	Teak plantation	Constant	RR	N	Y	N	Other land uses	Decrease	RR	N	N	N
F / SB	Fallow	Constant	PA, RR, LK	N	Y	N	Slash-and-burn	Decrease	PA, RR, LK	N	N	N
F / B	Fallow	Constant	PA, RR, LK	N	Y	N	Bamboo	Decrease	PA, RR, LK	N	N	N
F / S	Fallow	Constant	PA, RR, LK	N	Y	N	Scrub	Decrease	PA, RR, LK	N	N	N
F / G	Fallow	Constant	PA, RR, LK	N	Y	N	Grassland	Decrease	PA, RR, LK	N	N	N
F / RP	Fallow	Constant	PA, RR, LK	N	Y	N	Rice paddy	Decrease	PA, RR, LK	N	N	N
F / OL	Fallow	Constant	PA, RR, LK	N	Y	N	Other land uses	Decrease	PA, RR, LK	N	N	N

1: PA = Project area, RR = Reference region, LK = Leakage belt
2: LG = Logging, FW = Fuel-wood collection; CP = Charcoal Production (Y/N)

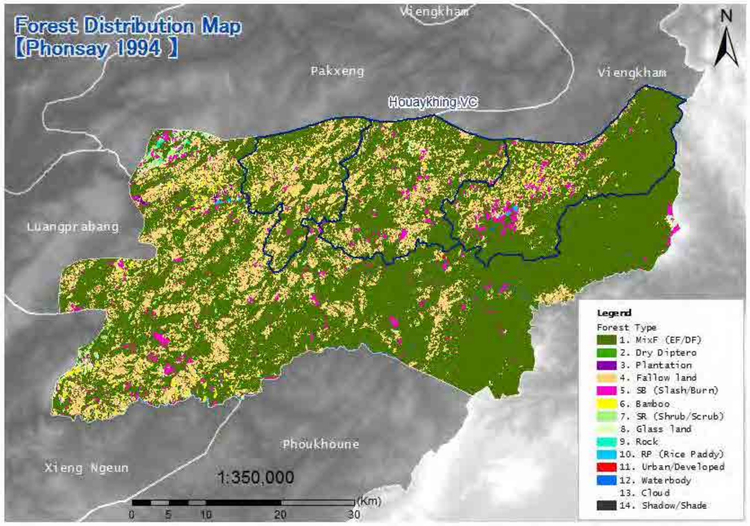
2.4 Analysis of historical land-use and land-cover change

Land-cover change data for the reference region were mapped by JICA PAREDD collaborated with FIM[4], via time-series analysis using satellite imagery of optical sensor data: LANDSAT-Thematic Mapper (TM) LANDSAT-Enhanced Thematic Mapper Plus (ETM+), SPOT, RapidEye, synthetic aperture radar (SAR) data and ALOS PALSAR, for the reference period of 1994 to 2010. As a result, five classes were mapped, including forest cover and loss, non-forest, cloud, and water.

In order to assure a high quality analysis, 2.4.1 Pre-processing, 2.4.2 Interpretation and classification, and 2.4.3 Post-processing steps closely followed JICA PAREDD's standard change detection methodology ~~(*see* Appendix 3)~~ for details of the methodology applied (*see* Appendix 3 for details). The methodology of time-series analysis used to generate the maps based on remote sensing analysis techniques and was used in a scientific literature (Inoue et al. 2010)[5]. Followings Figure 9 and Figure 10 are results of historical land-use and land caver change (forest area dynamics).

[4] Project of Forest Information Center (FIM) which is supported by Japan's Government from FY 2008 to FY 2012

[5] Inoue Y., Kiyono Y., Asai H., Ochiai Y., Qi J., Olioso A., Shiraiwa T., Horie T., Saito K., and Dounagsavanh L (2010) Assessing land-use and carbon stock in slash-and-burn ecosystems in tropical mountain of Laos based on time-series satellite images. International Journal of Applied Earth Observation and Geoinformation, 12(4): 287-297



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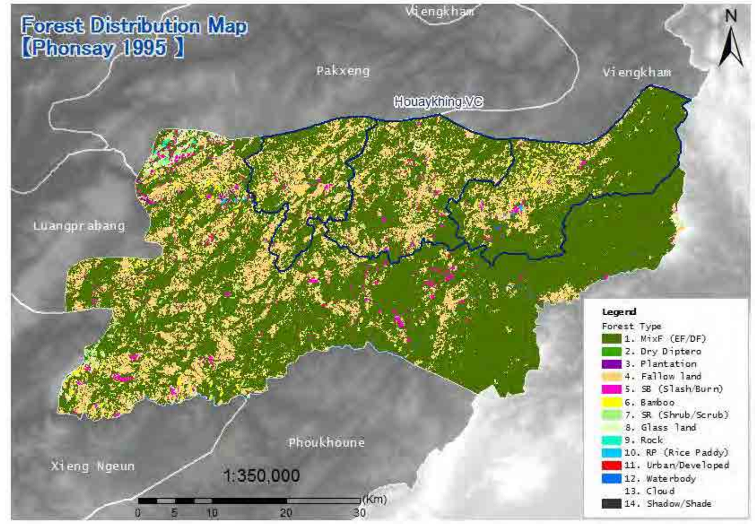

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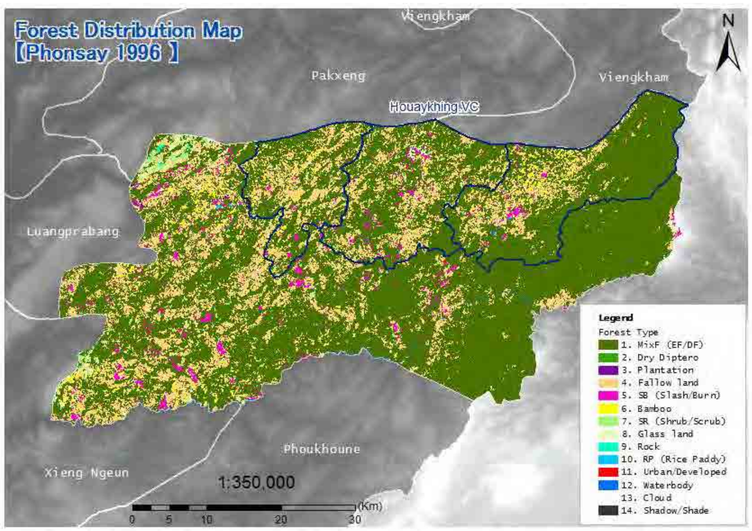

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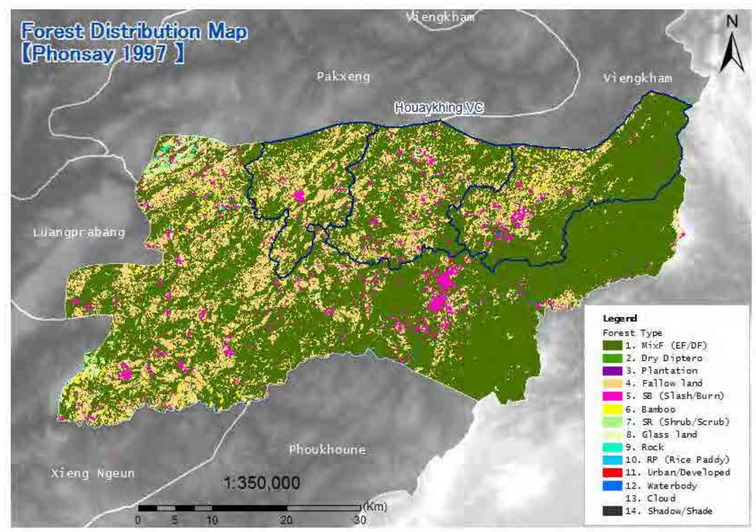
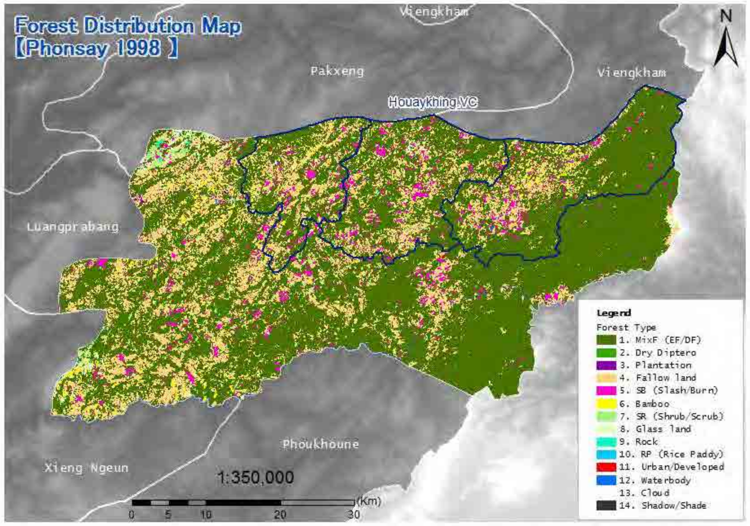


Year 1997

Figure 9 Land use dynamics in Phonsay District of Luang Prabang Province from 1994 to 2010 (Figures were improved)



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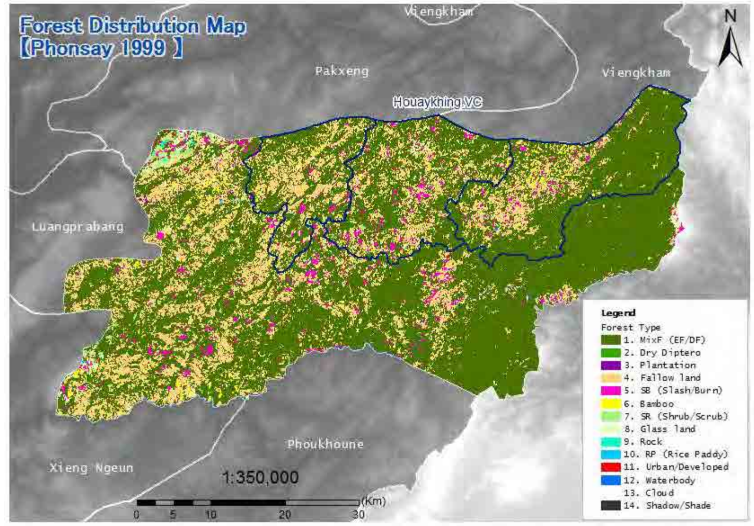

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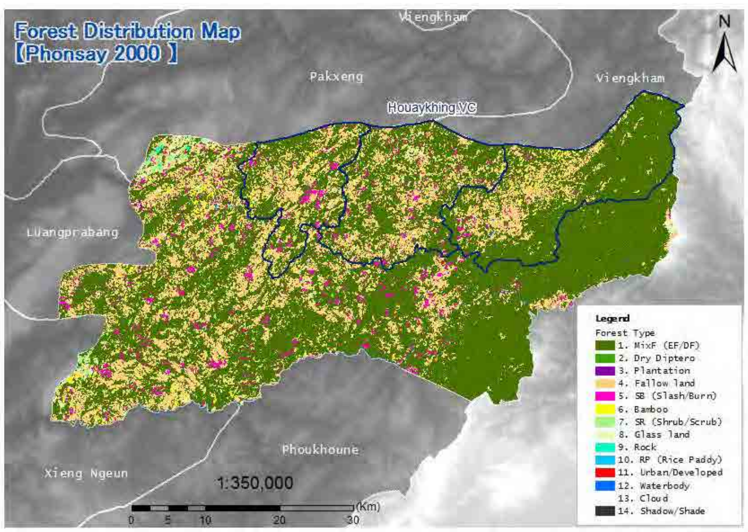

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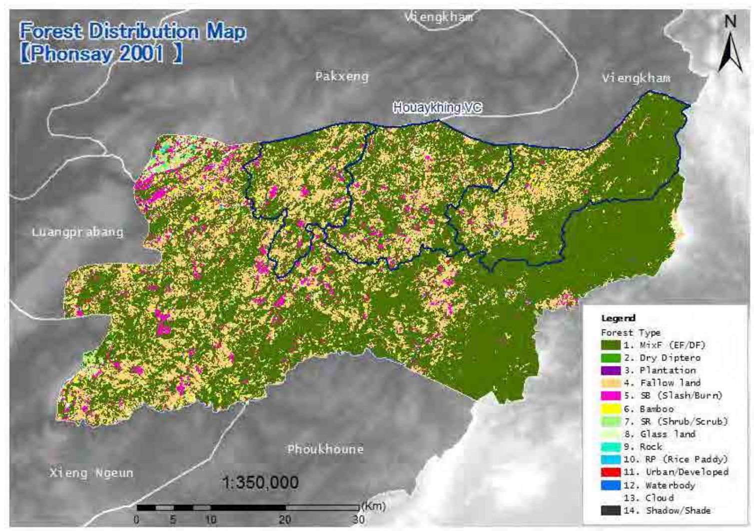

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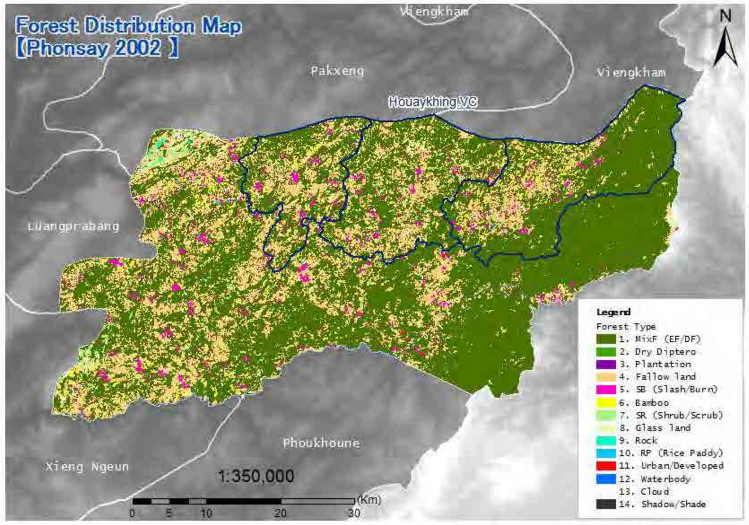
Figure *Continued* (Figures were improved)



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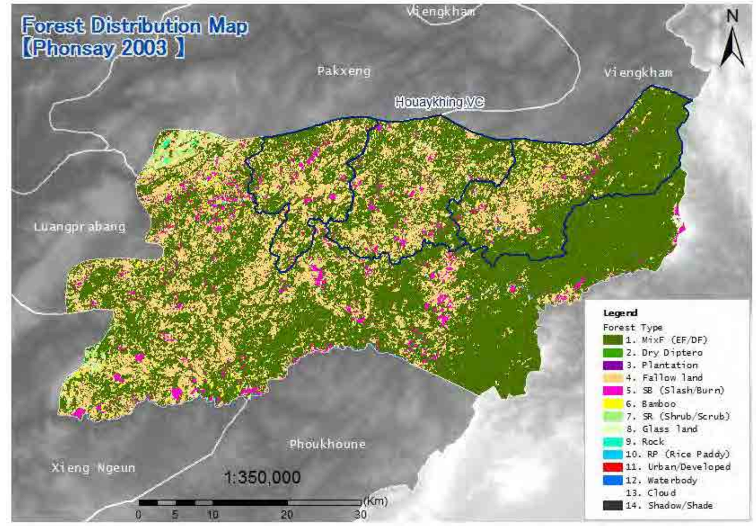

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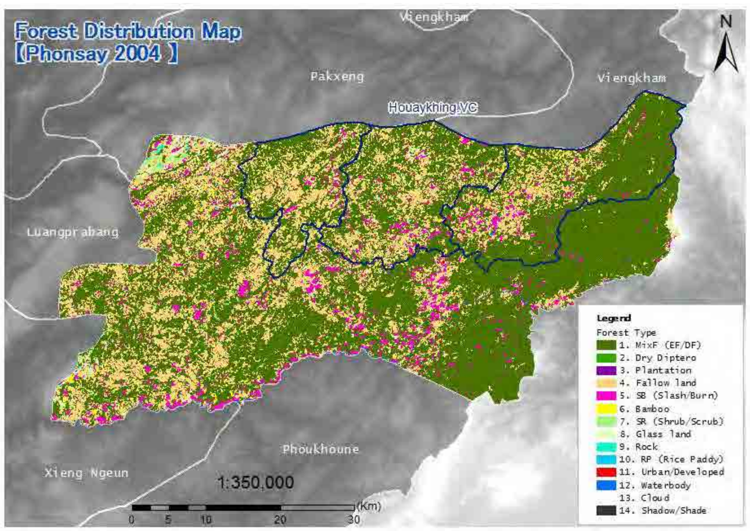

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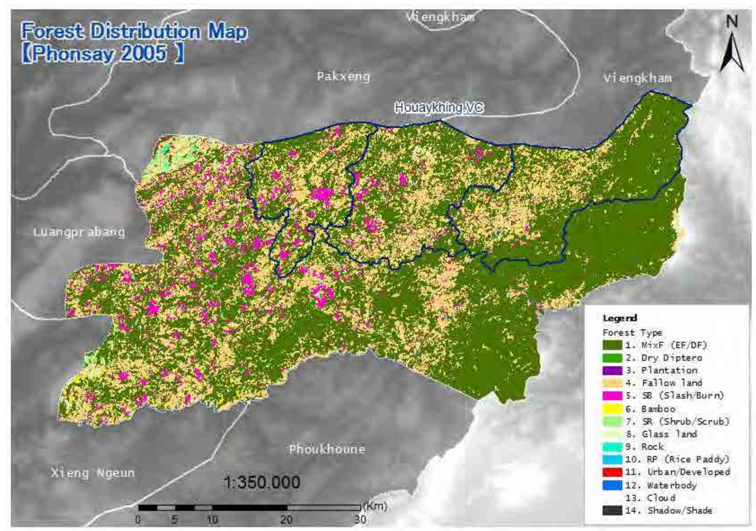
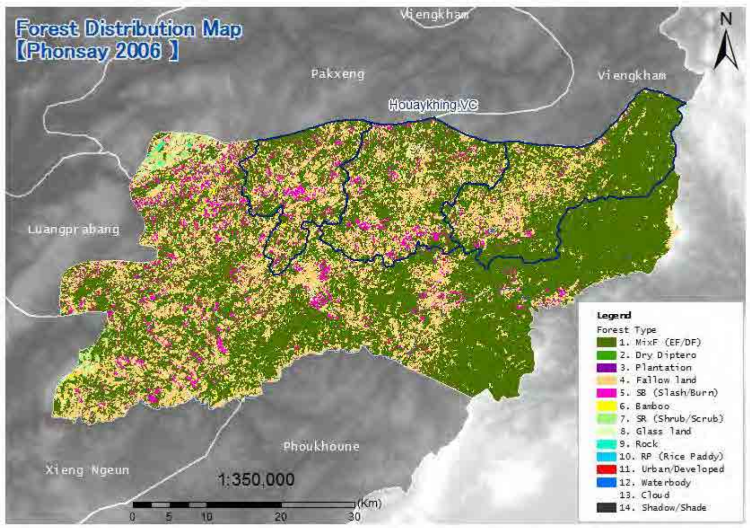


Year 2005

Figure *Continued* (Figures were improved)



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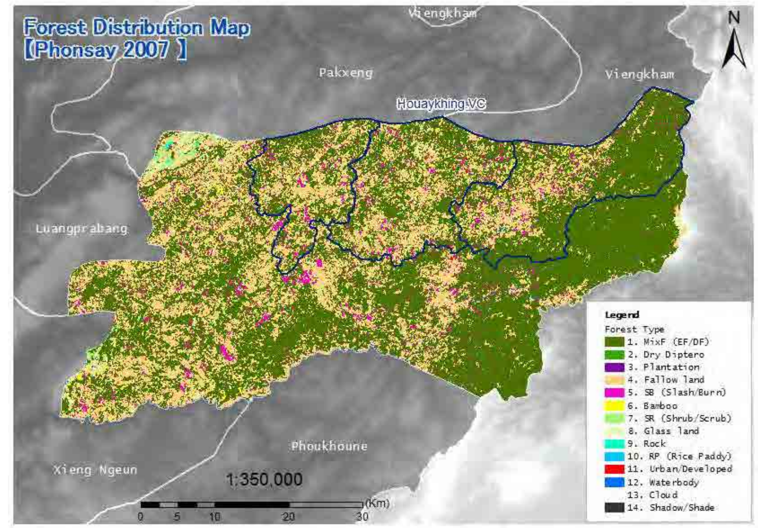

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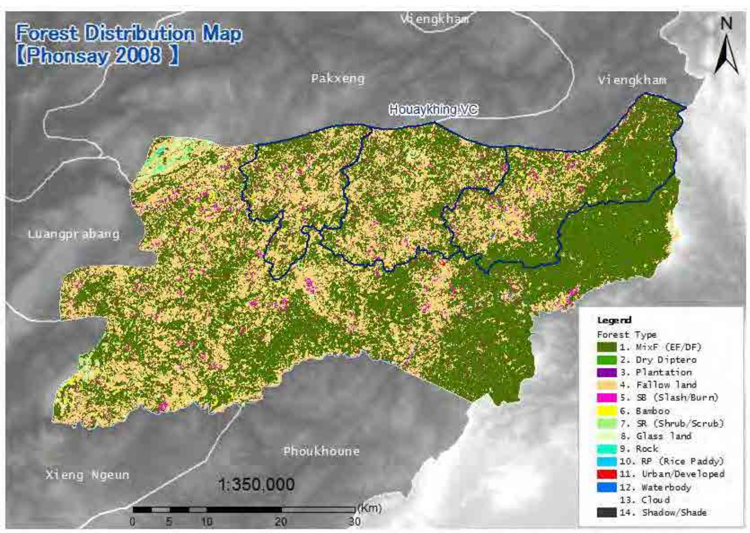

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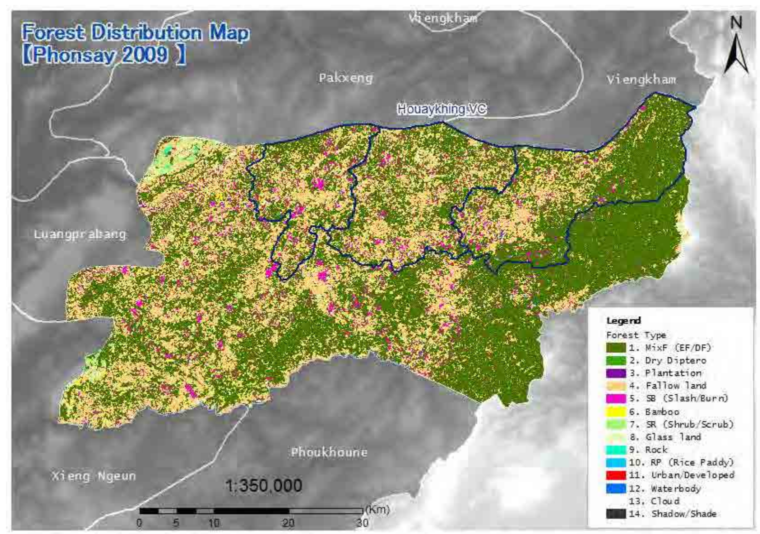
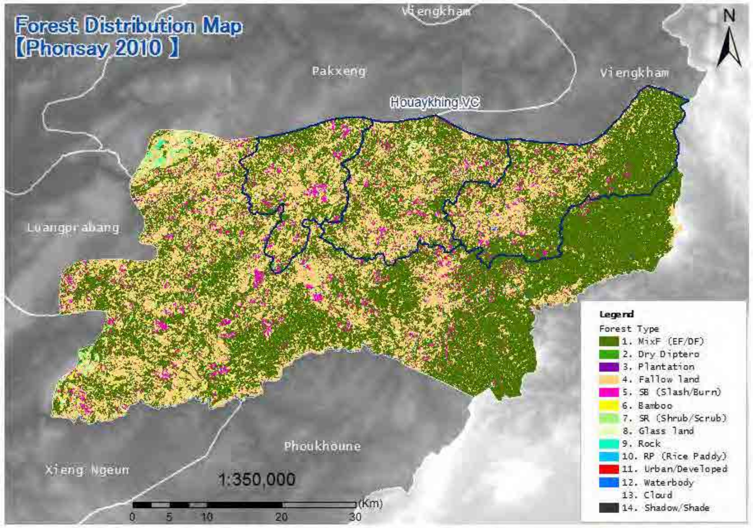


Year 2009

Figure *Continued* (Figures were improved)



Year 2010

Figure *Continued* <u>(Figures were improved)</u>

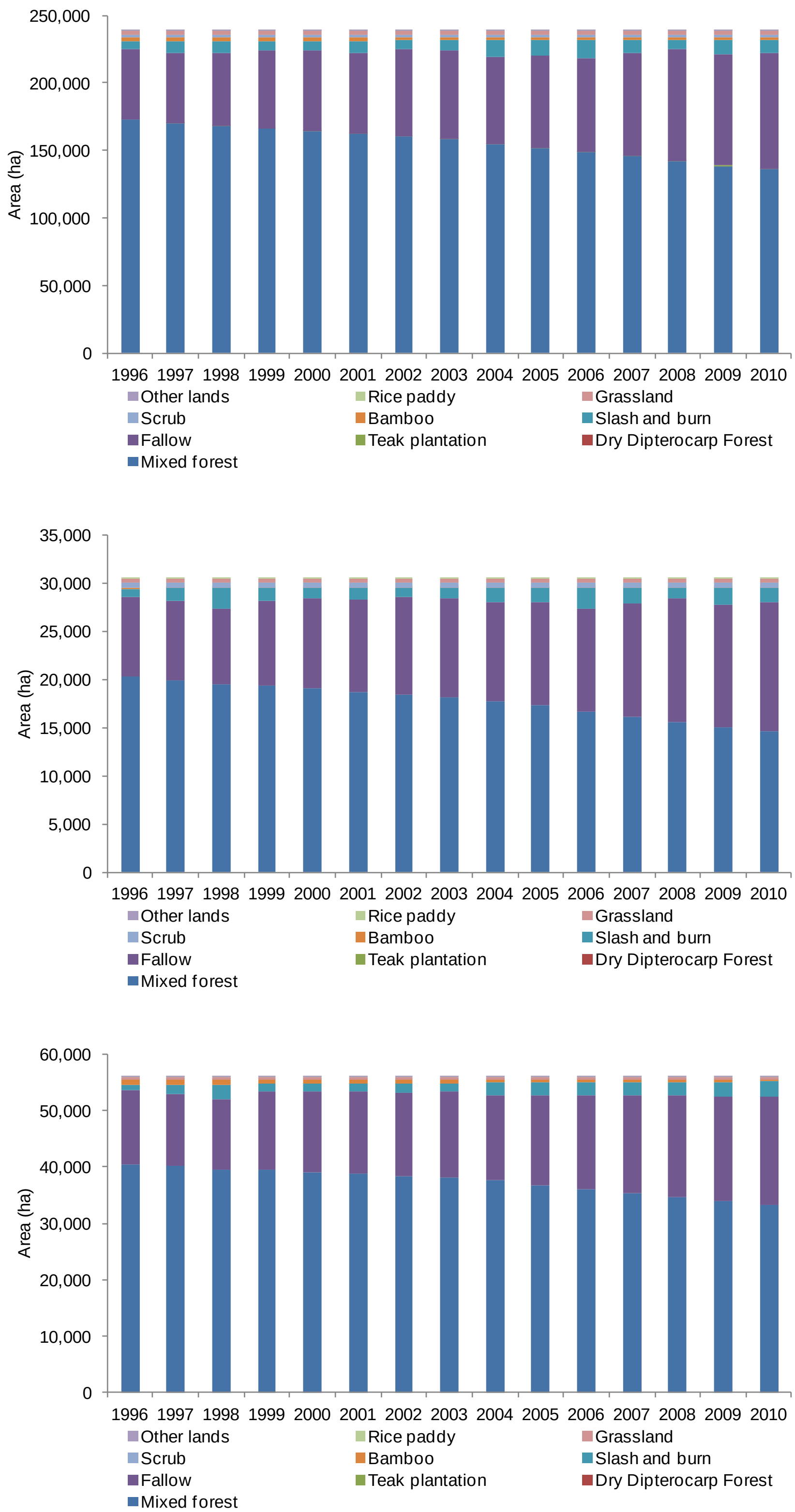


Figure 10 Dynamics of each type of forest area (above: reference region of Phonsay District, middle: project site of HH-VC, below: leakage belts of Soptia and Phonton VC)

2.5 Map accuracy assessment

The 2010 land cover classification developed by the methodology of this project was validated by ground truth data of 215 points within Luang P~~h~~rabang Province, which was acquired by FIM, FPP, and JICA PAREDD. The resulting confusion matrix for forest and non-forest is presented in Table 8. The overall accuracy was 94.4%, while the accuracy of forest and non-forest was above 90%. The resulting confusion matrix for forest types is presented in Table 9. The overall accuracy was 80.9%, while the accuracy of forest types was above 80%.

Table 8 Result of accuracy assessment for forest and non-forest (2010 land cover classification by this project's methodology)

		Ground Truth			
		F	NF	Total	U.A
Map	F	199	0	199	100.0%
	NF	12	4	16	25.0%
	Total	211	4	215	
	P.A	94.3%	100.0%		
Overall Accuracy		94.4%			

U.A : User's Accuracy
P.A : Producer's Accuracy

Table 9 Result of accuracy assessment for forest types (2010 land cover classification by this project's methodology)

		Ground Truth								
		MF	DD	PF	B	FL	SB	Other	Total	U.A
Map	MF	70	4	5	3	0	0	0	82	85.4%
	DD	1	7	0	0	0	0	0	8	87.5%
	PF	0	1	20	0	0	0	0	21	95.2%
	B	1	0	0	5	0	0	0	6	83.3%
	FL	4	3	7	0	68	0	0	82	82.9%
	SB	0	0	0	0	0	0	0	0	#DIV/0!
	Other	5	1	3	1	2	0	4	16	25.0%
	Total	81	16	35	9	70	0	4	215	
	P.A	86.4%	43.8%	57.1%	55.6%	97.1%	#DIV/0!	100.0%		
Overall Accuracy		80.9%								

U.A : User's Accuracy
P.A : Producer's Accuracy

Note: From the results of this project, land caver clarification in draft Forest Base Map developed by FIM was revised according to this project's methodology which considers how to monitor the area affected by shifting cultivation and to achieve high map accuracy for forest types more than 80%.

2.6 Preparation of a methodology annex to the PD

A detailed description of the remote sensing methodology and procedures used to classify satellite imagery based on the standard change detection method are closely followed JICA PAREDD's standard change detection methodology (*see* Appendix 3 for details). All process of satellite imagery analysis, especially for a) Data sources and pre-processing, b) Data classification and post-processing and c) Classification accuracy assessment should be conducted by methodology in Appendix 3 and documented. Also documentations will be submitted to validator in validation process/verifier in each verification process.

3 STEP 3: ANALYSIS OF AGENTS, DRIVERS AND UNDERLYING CAUSES OF DEFORESTATION AND THEIR LIKELY FUTURE DEVELOPMENT.

3.1 Identification of agents of deforestation

Main group/agent of deforestation was all of rural people who are conducting shifting cultivation as livelihood (*see* Appendix 1). Name of agent group is not specific (i.e. rural people group), and agent group's general information including population size and others are complied in Table 4 in PD. Most of attribution to deforestation in project area had been induced by rural people.

3.2 Identification of deforestation drivers

As explained in Appendix 1, deforestation drivers are expansion of shifting cultivation in project area. From results of satellite imagery analysis in past, area of slash-and-burn, i.e. slash-and-burn with short term rotation (rather than 3 years) area is increasing; 5,087 ha in 1996, 7,445 ha in 2000, 11,610 ha in 2005 and 9,839 ha in 2010. This was because that total population in project area had been increased and all villagers changed land-use (from forest to slash-and-burn area).

According to preliminary survey (*see* Appendix 1), risk of deforestation was not different in overall project site and reference region which were based on analysis of biophysical and socio-economic constraints. However, proximity to market for selling some products from agricultural activities was indicated as driver variable in project area. Most of rural people showed interests in proximity to market. From survey described in Appendix 1, proximity to market will have potential to change their livelihoods and how to address proximity to market will be one of the important aspect of implementing all of project activities.

3.3 Identification of underlying causes of deforestation

Underlying causes of deforestation in the project area were identified from the expert opinions gathered through a background analysis commissioned by the JICA to local partner PAFO/DAFO and participant rural appraisal (PRA), which included a review of existing socio-economic studies, interviews with local experts (such as government officials and community leaders), and was completed by participatory workshops (*see* Appendix 1). Basically, underlying causes of deforestation is system of land and forest management in project area. Therefore, as project activities in this project, land and forest management committee (LFMC) will be established to improve the system. All of project activities in this PD are expected to change and/or improve current system through implementing activities.

3.4 Analysis of chain of events leading to deforestation

As explained above, chain of events of leading deforestation is described; the main drivers~~factors~~ of deforestation in the project area are the expansion of area of pioneer shifting cultivation by rural people as agent group. Also shifting cultivation as main drivers is strongly related in limited livelihood in project area and related in poor land and forest management system (i.e. underlying causes). Such results of analysis of chain of events were quite a typical case in northern Lao PDR, and supported by PAFO/DAFO.

Therefore introduction of alternative livelihood will be essential to change their land and forest management system and ~~Therefore~~ this project decided to introduce alternative livelihood (in mainly Type 2 according to PAREDD Approach).

3.5 Conclusion

From the results of the interview survey to rural people (*see* Appendix 4 in PD), it was found that there is inclination to increase pioneer shifting cultivation land since increase in households of individual farmers resulted in expansion of food for family consumption. In addition, there were some cases of cultivating cash crops: gingers, corns, pineapples and so forth, to earn money.

As conclusive evidence, ~~Population~~ population in HK-VC have been increased since 2011 (project start period) and increased ratio is approximately 5 to 10% per year (in case of Houayking village, 205 households in 2012 and 220 in 2013), which was confirmed by JICA PAREDD. Therefore trend of deforestation will be continued (i.e. deforestation rate will be constant), and considering such situation, suitable project activities (i.e. introduction of alternative livelihood) can be required.

4 STEP 4: PROJECTION OF FUTURE DEFORESTATION

4.1 Projection of the quantity of future deforestation

The VM0015 methodology suggests stratifying the reference region according to the results from the analysis of agents and drivers of deforestation (Step 3 in above) (Table 10).

Table 10 Stratification of the reference region

Stratum ID		Description	Area at year (ha)			
ID$_i$	Name		1996	2000	2005	2010
1	Mixed forest	Mixed forest of deciduous and evergreen trees	172,435	164,025	151,942	136,239
2	Dry dipterocarp forest	Natural and semi-natural forest	0	0	0	0
3	Teak plantation	Plantation Forest	167	154	134	152
4	Fallow	After slash-and-burn area4	52,788	59,476	68,048	86,045
5	Slash-and-burn	Slash-and-burn with short term rotation (rather than 3 years) area. This land cover is identified as cropland according to IPCC Guidelines4	5,087	7,445	11,610	9,839
6	Bamboo	Bamboo dominated area. This land cover will be included in forest area, but carbon stock of bamboo is not estimated according to conservative approach	2,829	2,268	1,633	1,114
7	Scrub	Scrub area in constant. This land cover will be included in forest area, but carbon stock of bamboo is not estimated according to conservative approach	2,293	2,293	2,293	2,293
8	Grassland	Grassland in constant	2,927	2,927	2,927	2,927
9	Rice paddy	Rice paddy fields in constant	6	8	35	12
10	Other land uses	Including settlement and so on	622	558	533	533

4.1.1 Selection of the baseline approach

As described in above Step 3, shifting cultivation is the main economic activity for local communities/people and is the major driver of deforestation and forest degradation in the project area. Other drivers, such as conversion of forest to settlements and road construction, have no small effect on deforestation and forest degradation as they are all liked to shifting cultivation directly or indirectly. For example, rural people expand grazing area and so on.

According to the VM0015 methodology, if the deforestation rates measured in different historical sub-periods in the reference region reveal a clear trend and this trend is increasing, and if conclusive evidence emerges from the analysis of drivers and agents of deforestation explaining the increased trend and making it likely that this trend will continue in the future, then the project proponent should use approach "b" (time function approach), whereby the rate of baseline deforestation is estimated by extrapolating the historical trend observed within the reference region as a function of time using some regressions or any other statistically sound regression technique (*see* details in "7.1.2 *Ex-ante* estimation of carbon stock changes due to unavoidable unplanned deforestation within the project area").

The project mapped historical land-cover for several periods in the reference region in Figure 9. The analysis of historical deforestation showed a clear increasing trend between the historical reference periods of 1994-2000 and 2000-2010. In addition, conclusive evidence that this trend is likely to continue during the future periods emerged from the drivers and agents of deforestation analysis, as described in Step 3. Therefore, the project will use the time function approach (approach "b") to estimate the rate of baseline deforestation in the reference region.

According to results of activities of JICA PAREDD which had been promoted by JICA and PAFO/DAFO who manage the project site, all the forest within the reference region is under risks of deforestation and forest degradation based on the agents, drivers and underlying causes prevalent in the area and identified in our analyses;

4.1.2 Quantitative projection of future deforestation

4.1.2.1 Projection of the annual areas of baseline deforestation in the reference region

Annual areas of deforestation using satellite imagery

The target area of REDD+ is continuously being impacted by the significant population increase within and around its boundaries that rely heavily on forest conversion to cropland to sustain their income generation activities. Shifting cultivation, especially slash-and-burn in natural and/or secondary forests is the primary economic activity in the area. Such activities are identified by following methods a to d;

a) Image selection

LANDSAT Thematic Mapper (TM) images of different dates were compiled from the United States Geographical Survey (USGS). The dates of historic imagery were then plotted over a timeline (Appendix ~~2~~3) to demonstrate that on average they were distributed over the entire historical reference period, thus avoiding any bias in the image weights used to estimate the observation weights.

b) Observation points

The total number of observation points in the reference region was estimated based on the variance of small sample data. Initially 112 points were distributed over the reference region and classified according to the land cover observed in the satellite imagery above listed.

c) Land-cover classification

The state of forest of each point was then visually classified based on each LANDSAT and RapidEye covering the historical period. One of the following classes was assigned to each point; Forest, Non-Forest, Cloud/Shadow, Build-up, or no images. Consistency of the accuracy must be taking into account when carrying out forest classification using several points in time of satellite imagery. If the error of the classification at each point in time exceeds the amount of the change, the trend of the change would not be able to be delivered. Therefore, classification methodology, such as updating only changed land, is desirable while respecting the result of one time before the target time. So as to detect the monitoring target~~ shown in "3.1 Clarification of the monitoring target"~~, new slush-and-burn area is required to be extracted primarily as the amount of the change between two points in time. From this aspect, the project decided to extract only changed land from forest to non-forest through comparing two points in time while using the classification result of one time before at the land of not changed. Different method is used for the land changed from non-forest to forest, such as plantation (excluding teak plantation), since remote sensing is difficult to extract them. From the above points of view, flow of the classification methodology is shown as below Figure 11.

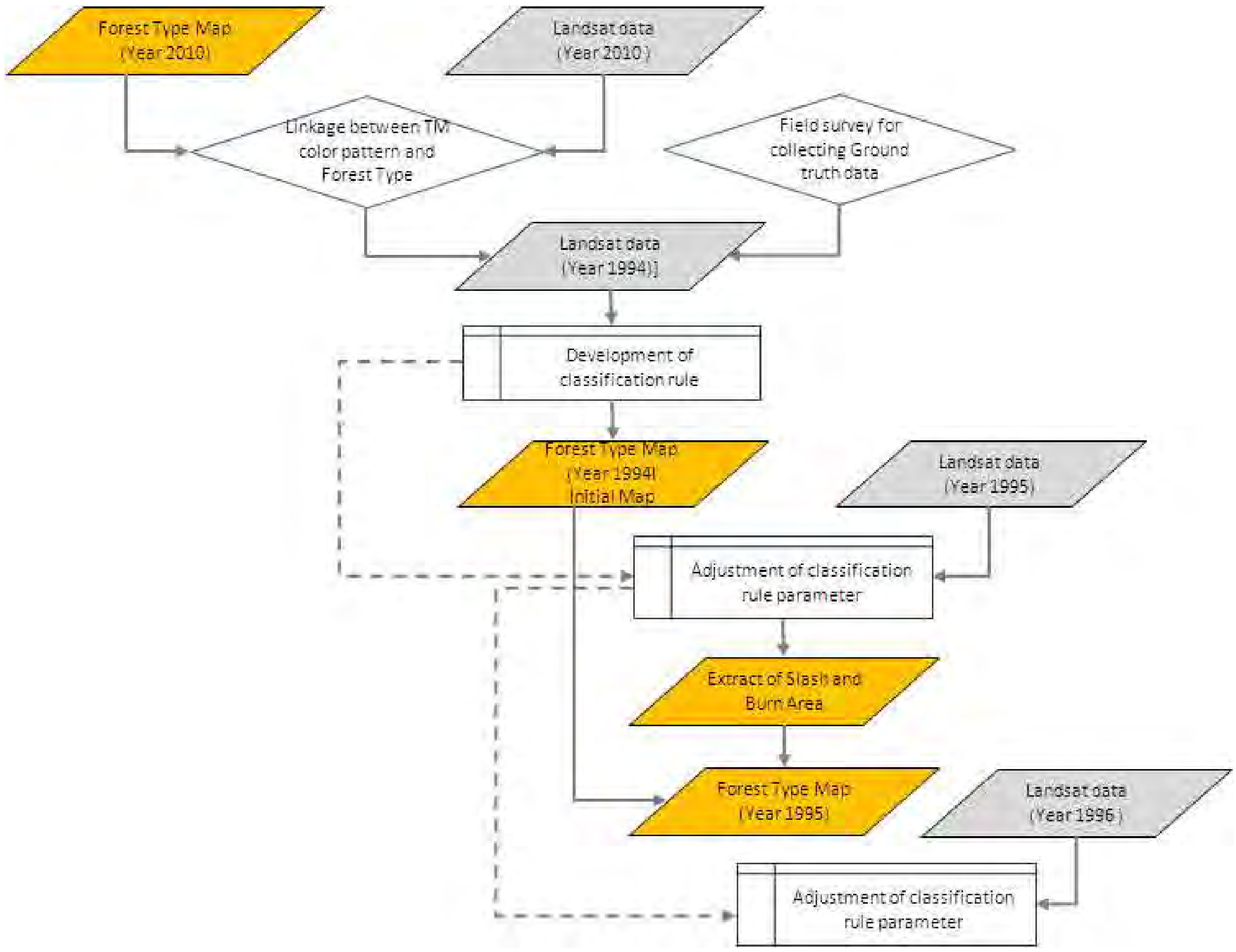


Figure 11 Classification Methodologies

d) Considering national / regional circumstances

As explained in above "4.1.1 Selection of the baseline approach", it is appropriate to use a time function approach (or approach "b") to estimate the rate of baseline deforestation and forest degradation in the area. In order to apply the time function approach, we applied historical trend of population, number of livestock (i.e. cow) (*see* details in "7.1.2 *Ex-ante* estimation of carbon stock changes due to unavoidable unplanned deforestation within the project area").

Calculation of *Aoptimal* and *Aaverage* under approach b

In northern Lao PDR, shifting cultivation, especially pioneer shifting cultivation is considered as the largest driver of deforestation and forest degradation. From results of preliminary survey in this study (*see* Appendix 1), it is clear that this project site is also under such situation. Land use constraints were explained by following two aspects (a and b) in project area and reference region.

a) Biophysical constraints

Deforestation and forest degradation was observed in the region. For instance, deforestation and forest degradation were observed in areas with slope and medium elevation. Likewise, forest loss occurred in such area in the project site. Therefore, no biophysical constraints are considered to limit the geographical area where deforestation agents could expand their land use activities within the reference region.

b) Socio-economic constraints

Historical evidence, validated through the analysis of agents and drivers of deforestation and forest degradation, also shows that no socio-economic constraints limit the geographical area where deforestation and forest degradation agents could expand their land use activities within the reference region. From preliminary survey (*see* Appendix 1), movement of rural people including immigration are related to accessibility (e.g. main road), however shifting cultivation or other human activities are not strongly limited by distance from main road. Rural people used to be able to access to remote area for shifting cultivation. Therefore, deforestation and forest deforestation in the both project area and the reference region will be happened not only in area near urban area but also remote area.

As there are no biophysical or socio-economic constraints to the expansion of deforestation and forest deforestation, the entire reference region is susceptible for conversion to the current land-uses in the baseline scenario.

From consideration of above constrains, maximum deforestation map will be drown as same as following Figure 16

4.1.2.2 Projection of the annual areas of baseline deforestation in the project area and leakage belt

The portion of the annual areas of baseline deforestation and forest degradation for each forest class within the project area and leakage belt was determined using satellite imagery analysis. The map of forest classes was overlaid with the projected yearly deforestation~~ and forest degradation~~ maps developed in "step 4.2 Projection of the location of future deforestation".

4.1.2.3 Summary of step 4.1.3

The results of this step are presented in Table 11

Table 11 Annual areas of baseline deforestation in reference region

Project year *t*	Stratum in the reference region (ha)				Total	
	Mixed forest $ABSLRR_{i,t}$ ha	Dry DF[1] $ABSLRR_{i,t}$ ha	TP[2] $ABSLRR_{i,t}$ Ha	Fallow $ABSLRR_{i,t}$ ha	Annual $ABSLRR_{i,t}$ ha	Cumulative $ABSLRR_{i,t}$ ha
2011	2,845	0	0	-2,538	307	307
2012	2,962	0	0	-2,852	110	417
2013	3,138	0	0	-2,964	174	591
2014	3,315	0	0	-3,122	192	783
2015	3,515	0	0	-3,296	220	1,002
2016	3,740	0	0	-3,491	249	1,252
2017	3,992	0	0	-3,709	283	1,534
2018	4,274	0	0	-3,954	320	1,855
2019	4,590	0	0	-4,228	362	2,217
2020	4,944	0	0	-4,535	410	2,627

1: Dry dipterocarp forest, 2: Teak plantation

Table 12 Annual areas of baseline deforestation in the project area

Project year *t*	Stratum in the reference region (ha)				Total	
	Mixed forest $ABSLRR_{i,t}$ ha	Dry DF[1] $ABSLRR_{i,t}$ ha	TP $ABSLRR_{i,t}$ ha	Fallow $ABSLRR_{i,t}$ ha	Annual $ABSLPR_{i,t}$ ha	Cumulative $ABSLPR_{i,t}$ ha
2011	281	0	0	-394	-113	-113
2012	277	0	0	-417	-141	-254
2013	275	0	0	-410	-135	-389
2014	272	0	0	-407	-135	-523
2015	268	0	0	-402	-134	-657
2016	264	0	0	-397	-133	-790
2017	260	0	0	-391	-132	-921
2018	255	0	0	-385	-130	-1,052
2019	249	0	0	-378	-129	-1,180
2020	243	0	0	-370	-127	-1,308

1: Dry dipterocarp forest, 2: Teak plantation

Table 13 Annual areas of baseline deforestation in the leakage belt

Project year *t*	Stratum in the reference region (ha)				Total	
	Mixed forest $ABSLRR_{i,t}$ ha	Dry DF[1] $ABSLRR_{i,t}$ ha	TP $ABSLRR_{i,t}$ Ha	Fallow $ABSLRR_{i,t}$ ha	Annual $ABSLLR_{i,t}$ ha	Cumulative $ABSLLR_{i,t}$ ha
2011	678	0	0	-567	111	111
2012	694	0	0	-620	74	185
2013	723	0	0	-628	95	280
2014	751	0	0	-645	106	386
2015	782	0	0	-662	120	507
2016	818	0	0	-682	136	643
2017	857	0	0	-704	154	796
2018	902	0	0	-728	173	970
2019	951	0	0	-756	195	1,165
2020	1,007	0	0	-787	220	1,385

1: Dry dipterocarp forest, 2: Teak plantation

4.2 Projection of the location of future deforestation

As mentioned in “4.1.~~1~~2.1 (especially for ~~Biophysical~~ biophysical constraints~~”~~ and ~~“4.1.1.2 Socio~~socio-economic constraints”, activities related to deforestation are not based on biophysical and socio-economic constraints. From preliminary survey (*see* Appendix 1), trend of pioneer shifting cultivation has been increasing and such tendency is supported by analysis of satellite imagery analysis (Figure 10).

4.2.1 Preparation of factor maps

According to preliminary survey (*see* Appendix 1), factors of deforestation are strongly related to abundance of natural and secondary forests (Mixed forest), which was identified and quantified by satellite imageries analysis. Also deforestation and forest degradation are not related in infrastructure, such road construction and others (*see* above “4.1.2.1 Projection of the annual areas of baseline deforestation in the reference region”).

In project area, there are no planed infrastructure (new road or railroad), and unplanned infrastructure (secondary roads) are not also known in proponent(s) in this PD. However, for applying ~~In this project,~~ empirical approach, distance map was prepared (Figure 12).

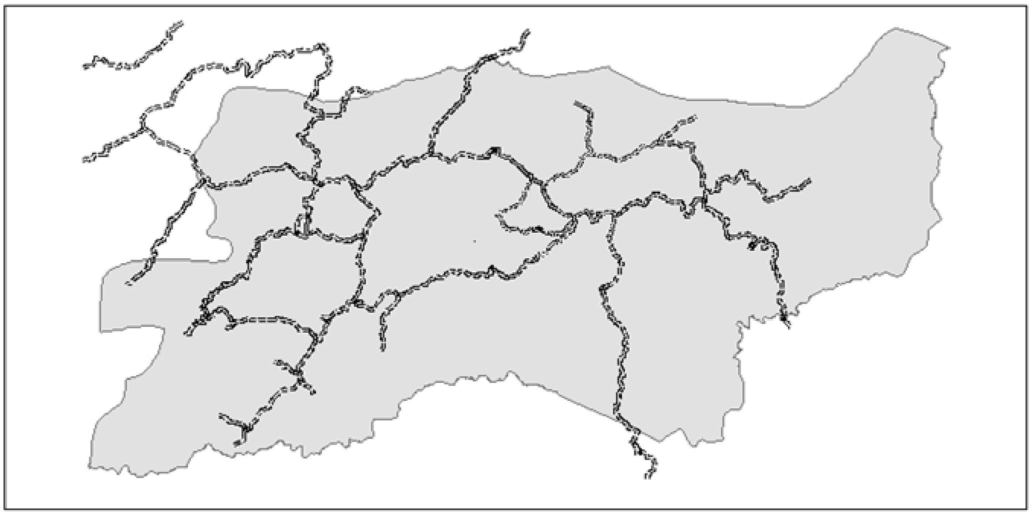


Figure 12 Road status in Phonsay District

By using above data, distance from road; until 100 m, until 500 m, until 1,000 m, until 5,000 m, until 10,000 m and until 20,000 m were identified (Figure 13), and allocated are according to distance from road and past deforestation was analyzed.

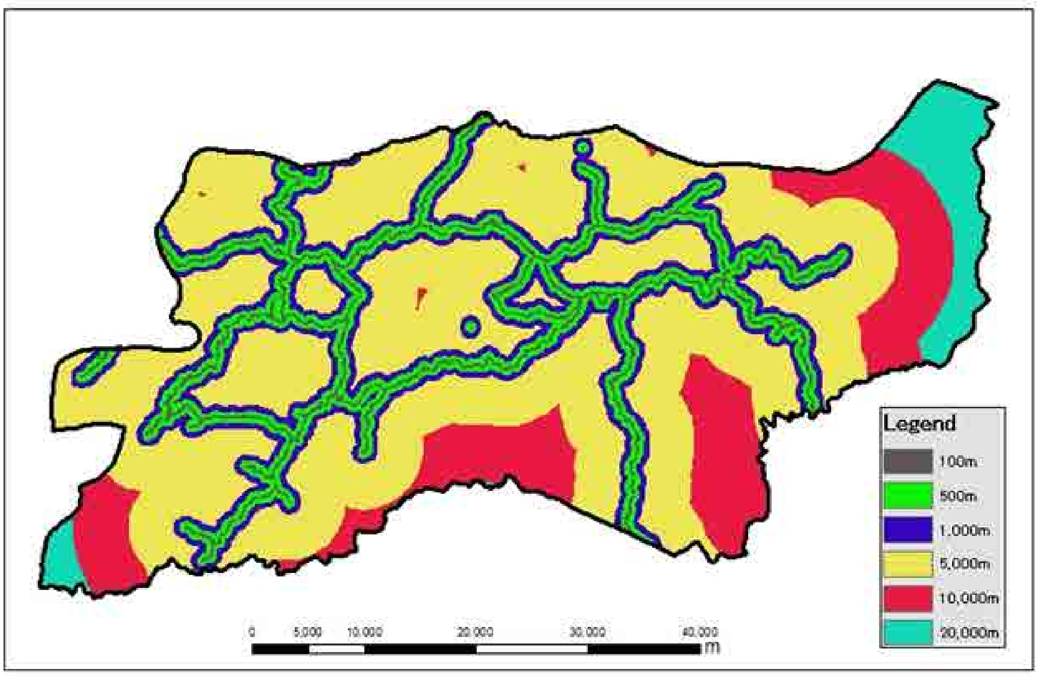


Figure 13 Distance from road in Phonsay District

However, from results of relationship between results of historical deforestation identified by satellite imageries analysis and distance from road, elevation, slope or some socio-economic insights~~ (e.g. distance from road)~~ of the project ~~site~~ area and reference region were insignificant (*see* historical deforestation and forest degradation in Figure 9). In addition, such results are supported by villager's activities of shifting cultivation which were analysed by preliminary survey.

4.2.2 Preparation of deforestation risk maps

Deforestation risk maps were prepared by land and forest classification map, and other information (Table 14 as following), which was identified and quantified by satellite imageries analysis, and flow-chart diagram for identifying Risk Map is in Figure 14.

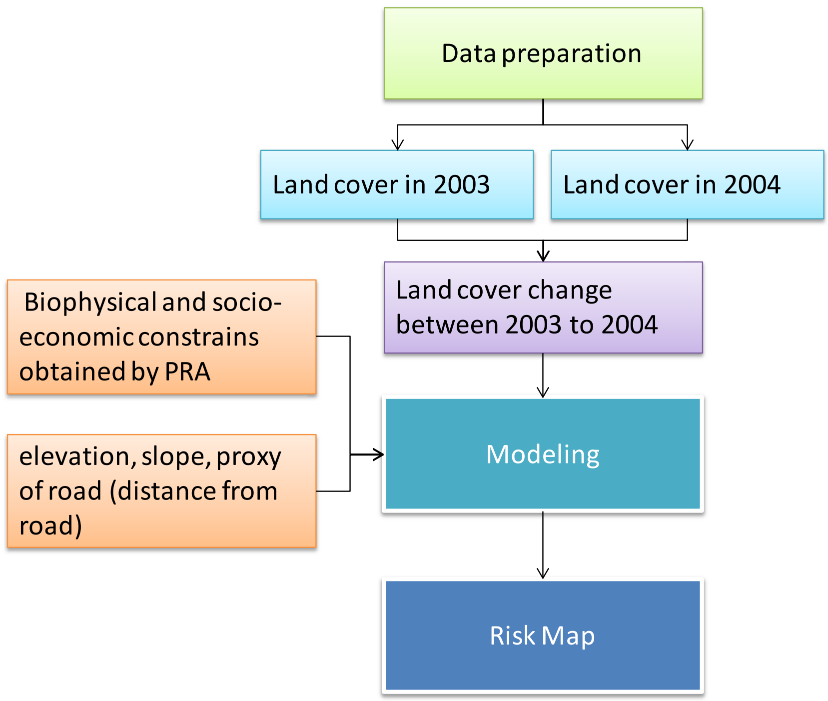


Figure 14 Flow-chart diagram for identifying Risk Map

Table 14 List of variables, maps and factor maps

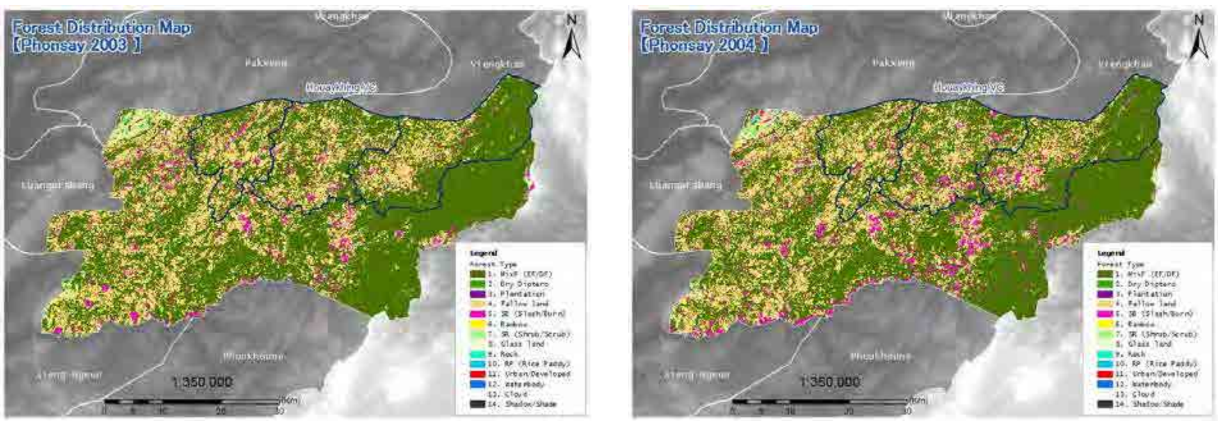
Factor Map		Source	Variable represented		Meaning of the categories or pixel value		Other Maps and Variables used to create the Factor Map		Algorithm or Equation used	Comments
ID	File Name		Unit	Description	Range	Meaning	ID	File Name		
1	Elevation	Aster - Global Digital Elevation Model	m, ABSL	-	324 - 2,106m	m	-	-	-	-
2	Slope	derived from elevation - Aster - Global Digital Elevation Model	degree	-	20.6 on average	degrees	-	-	-	-
3	Road map	field survey using GPS	km	-	-	km	-	-	Euclidean distance	-

According to preliminary survey (*see* Appendix 1), risk of deforestation was not different in overall project ~~site~~ area and reference region which were based on analysis of biophysical and socio-economic constraints (*see* above "4.1.2.1 Projection of the annual areas of baseline deforestation in the reference region").

However, using distance from main road, which will connect with the deforestation (human activities including pioneer shifting cultivation) rather than elevation and/or slope, was applied as parameter. Then, road status in Phonsay District was drawn using governmental road data and identified road by field survey for this PD (above Figure 12).

4.2.3 Selection of the most accurate deforestation risk map

For selecting most accurate deforestation risk map, forest dynamics in 2003 and in 2004 (Figure 15) was simulated using by the markov-chain model.



Year 2003 Year 2004

Figure 15 Forest area dynamics between 2003 and 2004

Polygon data in 2003 and in 2004 (resolution: 30 m) were converted into raster data (resolution: 30 m), and randomly and automatically 10,000 training data was identified. Next, by applying 10.000 training data, future deforestation was simulated using the markov-chain model (Table 15)。

Table 15 Results of future deforestation by the markov-chain model

Parameters	Values
Final learning rate	0.0001
Acceptable RMS	0.01
Training RMS	0.4312
Accuracy rate	27.38%

From results of Table 15, although 27.4% of accuracy in case of driver of road showed high values from comparison with values in case of driver of elevation and slope, the accuracy 27.4% do not have significant relationship between deforestation (human activities) and road status. Also such results are supported by results of preliminary survey (*see* Appendix 1). Such results were assessed by Land use Change Modeler (LCM) according to applied methodology.

4.2.4 Mapping of the locations of future deforestation

Deforestation (conversion from Mixed forest to Slash-and-burn area) map in 2030 was drawn in Figure 16, and simulated area in each land and forest type was in Table 16. For simulation of future deforestation, Land use Change Modeler (LCM) was applied according to applied methodology and analysis process was based on the methodology.

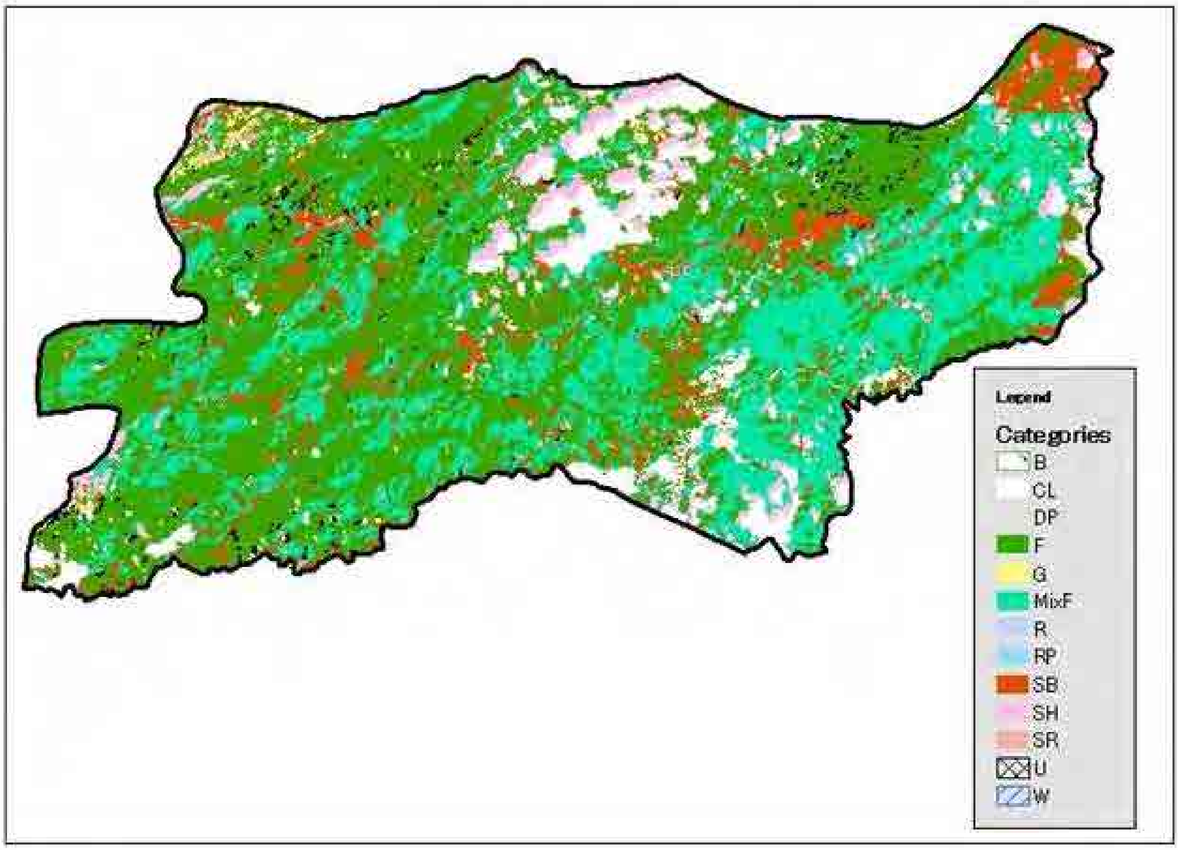


Figure 16 Simulated land and forest distribution in 2030 in Phonsay District

Table 16 Simulated land and forest types are in 2030 in Phonsay District

Land and forest type	Area (ha)	Ratio to total area
Mixed forest	67,638	28%
Teak forest	48	0%
Fallow	112,726	47%
Slash-and-burn	21,440	9%
Bamboo	2,805	1%
Scrub	1,793	1%
Grassland	2,353	1%
Rice paddy	962	0%
Other land use	30,586	13%

Simulated future slash-and-burn area (21,440 ha in 2030) was almost same as results of estimation by using econometric model in Step 7, which estimated future land and forest are using some parameters (number of livestock, area of rice paddy and number of population should be better). This showed that the results of selected deforestation risk map were applicable to estimate future deforestation (but not applicable for identification of deforestation location). Also, correspondence of the econometric model in Step 7 was applicable to estimate future land and forest dynamics.

5 STEP 5: DEFINITION OF THE LAND-USE AND LAND-COVER CHANGE COMPONENT OF THE BASELINE

5.1 Calculation of baseline activity data per forest class

In order to estimate the area in hectares of each forest class within the project area deforested and degraded under the baseline scenario, annual deforestation rate was applied for 2011-2020. The results are shown in Table 17.

Table 17 Annual areas deforested per forest class within the reference area in the baseline case (baseline activity data per forest class)

Area deforested per forest class within the project area					Total baseline deforestation in the project area	
ID	1	2	3	4	*ABSLPA$_t$*	*ABSLPA*
Name	Mixed forest	Dry DF[1]	TP	Fallow	annual	Cumulative
Project year *t*	ha	ha	ha	ha	ha	ha
2011	2,845	0	0	-2,538	307	307
2012	2,962	0	0	-2,852	110	417
2013	3,138	0	0	-2,964	174	591
2014	3,315	0	0	-3,122	192	783
2015	3,515	0	0	-3,296	220	1,002
2016	3,740	0	0	-3,491	249	1,252
2017	3,992	0	0	-3,709	283	1,534
2018	4,274	0	0	-3,954	320	1,855
2019	4,590	0	0	-4,228	362	2,217
2020	4,944	0	0	-4,535	410	2,627

1: Dry dipterocarp forest, 2: Teak plantation

Table 18 Annual areas deforested per forest class within the project area in the baseline case (baseline activity data per forest class)

Area deforested per forest class within the project area					Total baseline deforestation in the project area	
ID	1	2	3	4	*$ABSLPA_t$*	*ABSLPA*
Name	Mixed forest	Dry DF[1]	TP	Fallow	annual	Cumulative
Project year *t*	Ha	ha	ha	ha	ha	ha
2011	281	0	0	-394	-113	-113
2012	277	0	0	-417	-141	-254
2013	275	0	0	-410	-135	-389
2014	272	0	0	-407	-135	-523
2015	268	0	0	-402	-134	-657
2016	264	0	0	-397	-133	-790
2017	260	0	0	-391	-132	-921
2018	255	0	0	-385	-130	-1,052
2019	249	0	0	-378	-129	-1,180
2020	243	0	0	-370	-127	-1,308

1: Dry dipterocarp forest, 2: Teak plantation

Table 19 Annual areas deforested per forest class within the leakage belt in the baseline case (baseline activity data per forest class)

Area deforested per forest class within the project area					Total baseline deforestation in the project area	
ID	1	2	3	4	*$ABSLPA_t$*	*ABSLPA*
Name	Mixed forest	Dry DF[1]	TP	Fallow	annual	Cumulative
Project year *t*	ha	ha	ha	ha	ha	ha
2011	678	0	0	-567	111	111
2012	694	0	0	-620	74	185
2013	723	0	0	-628	95	280
2014	751	0	0	-645	106	386
2015	782	0	0	-662	120	507
2016	818	0	0	-682	136	643
2017	857	0	0	-704	154	796
2018	902	0	0	-728	173	970
2019	951	0	0	-756	195	1,165
2020	1,007	0	0	-787	220	1,385

1: Dry dipterocarp forest, 2: Teak plantation

5.2 Calculation of baseline activity data per post-deforestation forest class

Method 01 was used to calculate the baseline carbon stock change. The estimation of baseline activity data was analyzed using method in above – where historical land cover changes are assumed to be representative of future trends in all-over reference region. Therefore reference region is based on only one zone.

The land-cover map for the historical period was generated by interpreting LANDSAT and RapidEye imageries. These imageries have a spatial resolution of approximately 30 m and 5 m respectively, thus each type of forest and non-forest areas can be identified accurately.

5.3 Calculation of baseline activity data per LU/LC change category

Not applicable to the project.

6 STEP 6: ESTIMATION OF BASELINE CARBON STOCK CHANGES AND NON-CO_2

6.1 Estimation of baseline carbon stock changes

6.1.1 Estimation of the average carbon stocks of each LU/LC class

Average carbon stocks was estimated based on field measurements of forest classes present in the project area, as well as non-forest classes projected to exist in the project area under the baseline scenario.

The target area commissioned the collection of initial biomass data for the HK-VC by the project (collaborated with local partner PAFO/DAFO) in 2010, 2011 and 2012. A total of 112 plots were measured in the field, which sampling design was according to VM0015~~, a~~. All plots were located within forested areas in project area, reference region and some plots are located in outside of reference region (but from same forest type and vegetation) (Figure 17). Field measurements focused on above-ground biomass and below-ground biomass.

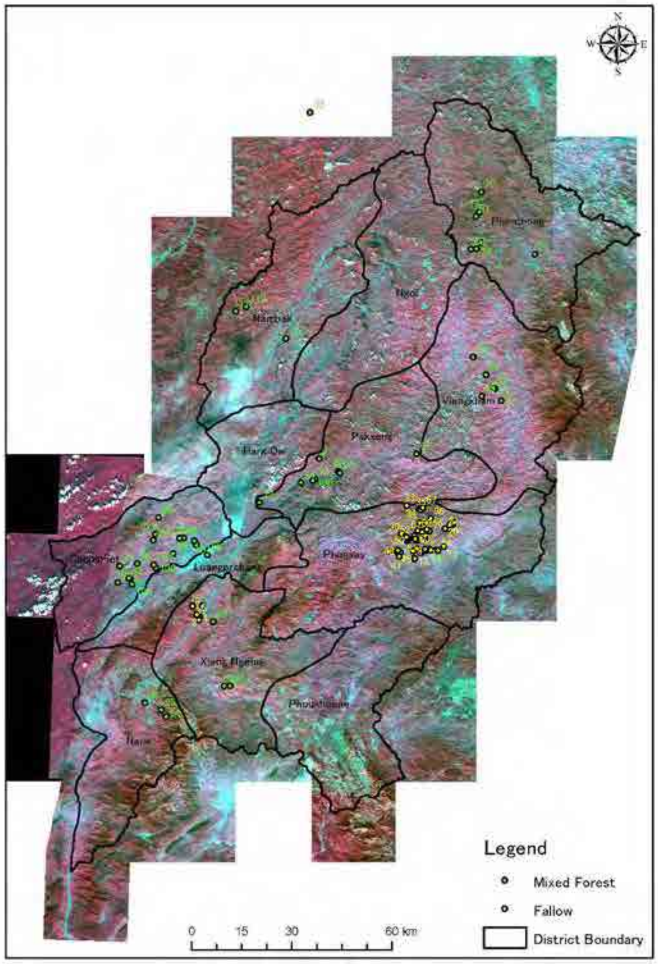


Figure 17 Location of plots in the field survey

Above-ground carbon stocks in Mixed forest, Dry dipterocarp forest, Teak plantation and Slash-and-burn Area:

To identify appropriate allometric equations, the project conducted field survey for developing site-specific allometric equations (Table 20) and an extensive literature review, and identified regionally-derived allometric equations specific to our forest types and appropriate for the conditions of our project area. Specifically, the equations used for Mixed forest are derived from site-specific equations. In addition, the equations chosen include wood density as one of the parameters, which were derived from IPCC EFDB. Similarly, allometric equations for Teak plantation was also derived from IPCC EFDB. The equations used are illustrated in Table 20 below; a copy of the original studies will be provided to the validator for review.

Table 20 Allometric equations identified for use in the area for estimating above-ground biomass and living biomass (above-ground and below-ground biomass)

Forest type/ species group	Organs	Equation and values		Source	Original location
Mixed forest	Trunk with bark	Biomass = $0.03566*D^{2.618}$, $R^2 = 0.771$	146.9 t ha^{-1} in living biomass (below-ground biomass (root) is 41.4 t ha^{-1})	in this study	HK-VC and neighbouring area
	Branch	Biomass = $3.162*D^{1.197}$, $R^2 = 0.485$		in this study	HK-VC and neighbouring area
	Leaf	Biomass = $0.2497*D^{1.281}$, $R^2 = 0.633$		in this study	HK-VC and neighbouring area
	Root	Biomass = $0.4908*D^{1.652}$, $R^2 = 0.855$		in this study	HK-VC and neighbouring area
Dry dipterocarp forest	-	-		-	-
Teak plantation	Above ground biomass	180.0 t ha^{-1}		IPCC EFDB	Tropical moist deciduous forest, Asia (continental)
Fallow	Living biomass (above-ground)	Figure 18 (above-ground)	Below-ground biomass is 27.3% to above-ground	in this study	HK-VC and neighbouring area
Slash-and-burn	Living biomass	16.1 t ha^{-1}		IPCC EFDB	Tropical - Moist & Wet
Bamboo	Living biomass	116.5 t ha^{-1}		Kiyono et al. (2007)	Northern Lao PDR
Scrub	Living biomass	84.0 t ha^{-1}		IPCC EFDB	Tropical scrubland, Asia (continental)
Grassland	Living biomass	16.1 t ha^{-1}		IPCC EFDB	Tropical - Moist & Wet
Rice paddy	Living biomass	0.0 t ha^{-1}		IPCC EFDB	Conservatively applied 0.0 t-CO_2/ha
Other land uses	Living biomass	0.0 t ha^{-1}		IPCC EFDB	Conservatively applied 0.0 t-CO_2/ha

Above-ground carbon stocks in Fallow:

The project decided to utilize the methodology of keeping consistency of classification accuracy by extracting pioneer shifting cultivation only by satellite imagery at each point in time while using former classification result at the land of not changed. Consequently, updating the map of changed land from forest to non-forest between two points in time is only required. Considering of the situation that shifting cultivation is the cause of the land change to non-forest in the project area, the methodology would be extracting pioneer shifting cultivation only from LANDSAT satellite imagery at each point in time, as a result. The effective way of extracting shifting cultivation land would be considered as the methodology of excluding each level of classification of other land cover/land use. Making such rule base and changing threshold into suitable value may result in keeping the consistency of the methodology of extraction.

While for carbon stock dynamics under cultivation, which is the distinct cause of deforestation and forest degradation in the northern part of Lao PDR, this project aimed at reducing expansion t of cultivation into the natural forests and secondary forests, and increasing the quantity of average carbon stock by lengthening the fallow period. So we developed our own model to fix the quantity of carbon stock in the shifting cultivation (Figure 18).

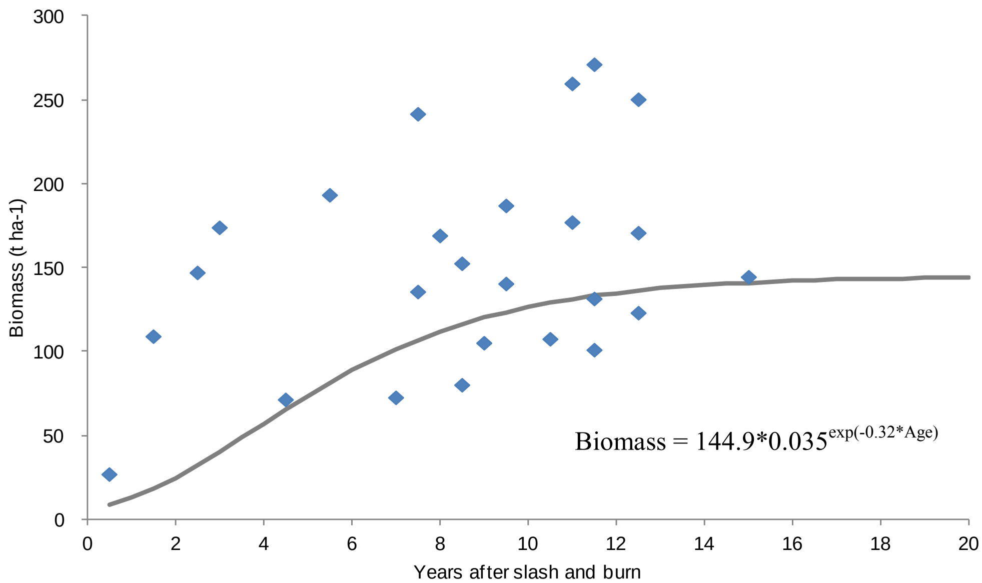


Figure 18 Growth curve of living biomass (above- and below-ground biomass) in fallow area

Below-ground carbon stocks:

Below-ground carbon stocks of forest classes were estimated based on root-to-shoot ratios provided by IPCC EFDB (Table 21).

Table 21 Applied root-to-shoot ratios in each type of forest

Forest type/ species group	root-to-shoot ratios	Uncertainty	Applied values	Source	Original location
Mixed forest	*See* Table 20	-	-	-	-
Dry dipterocarp forest	-	-	-	-	-
Teak plantation	0.24	Maximum in case of using default value	0.159	IPCC EFDB	Tropical moist deciduous forest
Fallow	*See* Table 20	-	-	-	-

Note: below-ground biomass of other specific groups was estimated by using living biomass values.

In the baseline scenario, the carbon stocks and boundaries of the forest classes within the project area is assumed to remain constant. It is not expected that areas will lose carbon due to degradation, logging for timber, charcoal production or fuel wood collection.

The project estimates carbon stock increases in fallow land after shifting cultivation which will be calculated by years after slash-and-burn activities (in Figure 18). From concept of accurate estimation, this project estimates carbon stock in fallow by using model in Figure 18, but the carbon stock in fallow in the future is assumed to be remained constant at beginning of the project from conservative manner.

A complete description of the sampling design and field measurements are provided to the validator, if necessary. The average carbon content in all LU/LC classes as well as the 90% confidence intervals are reported in Table 22.

Table 22 Carbon stocks per hectare of initial forest classes (including specific groups) existing in the project area and leakage belt

LU/LC class		Average carbon stock per hectare + 90% CI					
		Cab					
ID_{cl}	Name	average stock t CO_2e ha^{-1}	+ 90% CI t CO_2e ha^{-1}	average stock t CO_2e ha^{-1}	+ 90% CI t CO_2e ha^{-1}	average stock t CO_2e ha^{-1}	+ 90% CI t CO_2e ha^{-1}
1	Mixed forest	291.8	38.6	79.6	8.2	371.4	46.5
2	Dry dipterocarp forest	-	-	-	-	-	-
3	Teak plantation	310.2	93.1	74.4	22.3	384.6	115.4
4	Fallow	-	-	-	-	Figure 18	-
5	Slash-and-burn	27.7	8.3	-	-	27.7	8.3
6	Bamboo	200.8	60.2	-	-	200.8	60.2
7	Scrub	144.8	43.4	-	-	144.8	43.4
8	Grassland	27.7	8.3	-	-	27.7	8.3
9	Rice paddy	0.0	0.0	-	-	0.0	0.0
10	Other land uses	0.0	0.0	-	-	0.0	0.0

Cab_{cl}: Average carbon stock per hectare in the above-ground biomass carbon pool of class *cl*; tCO_2-e ha^{-1}
Cbb_{cl}: Average carbon stock per hectare in the below-ground biomass carbon pool of class *cl*; tCO_2-e ha^{-1}
$Ctot_{cl}$ Average carbon stock per hectare n all accounted carbon pools *cl*; tCO_2-e ha^{-1}

Table 23 Values to be used after discounts for uncertainties

LU/LC class		Average carbon stock per hectare + 90% CI					
		Cab_{cl}		Cbb_{cl}		$Ctot_{cl}$	
ID_{cl}	Name	*C* stock t CO_2e ha^{-1}	*C* stock change t CO_2e ha^{-1}	average stock t CO_2e ha^{-1}	*C* stock change t CO_2e ha^{-1}	average stock t CO_2e ha^{-1}	*C* stock change t CO_2e ha^{-1}
1	Mixed forest	253.2	-	76.0	-	329.1	-
2	Dry dipterocarp forest	-	-	-	-	-	-
3	Teak plantation	217.1	-	52.1	-	269.3	-
4	Fallow	-	-	-	-	Figure 18	-
5	Slash-and-burn	19.4	-	-	-	19.4	-
6	Bamboo	140.6	-	-	-	140.6	-
7	Scrub	101.3	-	-	-	101.3	-
8	Grassland	19.4	-	-	-	19.4	-
9	Rice paddy	0.0	-	-	-	0.0	-
10	Other land uses	0.0	-	-	-	0.0	-

Cab_{cl}: Average carbon stock per hectare in the above-ground biomass carbon pool of class *cl*; tCO_2-e ha^{-1}
Cbb_{cl}: Average carbon stock per hectare in the below-ground biomass carbon pool of class *cl*; tCO_2-e ha^{-1}
$Ctot_{cl}$ Average carbon stock per hectare n all accounted carbon pools *cl*; tCO_2-e ha^{-1}
Note: Average carbon stock per hectare is as same in each ID_{cl} for in all years.

Carbon stock in post-deforestation class was assumed as slash-and-burn area (SB) and applied as 19.4 t CO_2e ha^{-1} from conservative manner (Table 24).

Table 24 Long-term (20-years) average carbon stocks per hectare of post-deforestation LU/LC classes present in the reference region

Project year *t*	Average carbon stock per hectare + 90% CI					
	Cab		*Cbb*		*Ctot*	
	C stock t CO_2e ha^{-1}	±90% CI t CO_2e ha^{-1}	*C stock* t CO_2e ha^{-1}	±90% CI t CO_2e ha^{-1}	*C stock* t CO_2e ha^{-1}	±90% CI t CO_2e ha^{-1}
Value from conservative manner	-	-	-	-	19.4	-

As mentioned before the Project assumes only one Zone and one post-deforestation land-use class that is slash-and-burn area (Table 25).

Table 25 Long-term (20-years) area weighted average carbon stock per zone~~Long-term (20-years) average carbon stocks per hectare of post-deforestation LU/LC classes present in the reference region~~

Name	Post – deforestation LU/LC & class grassland”				Area weighted long term (20 years average carbon stocks per zone)		
	Cab		*Cbb*		*Cab*	*Cbb*	*Ctot*
	C stock t CO_2e ha^{-1}	±90% CI t CO_2e ha^{-1}	*C stock* t CO_2e ha^{-1}	±90% CI t CO_2e ha^{-1}	*C stock* t CO_2e ha^{-1}	*C stock* t CO_2e ha^{-1}	*C stock* t CO_2e ha^{-1}
1	-	-	-	-	-	-	19.4

As a result, the net emissions per ha from LULC-change in case of from Mixed forest in Project Area is 432.6 tCO_2e/ha,

6.1.2 Calculation of carbon stock change factors

Carbon stock changes factors calculated with Method 01 are presented above Table 22 and Table 23.

6.1.3 Calculation of baseline carbon stock changes

Carbon stock changes factors calculated with Method 1 are presented below (Table 26 and Table 27).

Table 26a Carbon stock change factors for initial forest classes (Mixed forest) (Method 1)

Year after deforestation		Mixed forest					
		⊿Cab	*⊿Cbb*	*⊿Cdw*	*⊿Cl*	*⊿Csoc*	*⊿Cwp*
1	t*	69.0	2.07	-	-	-	-
2	t*+1	0	2.07	-	-	-	-
3	t*+2	0	2.07	-	-	-	-
4	t*+3	0	2.07	-	-	-	-
5	t*+4	0	2.07	-	-	-	-
6	t*+5	0	2.07	-	-	-	-
7	t*+6	0	2.07	-	-	-	-
8	t*+7	0	2.07	-	-	-	-
9	t*+8	0	2.07	-	-	-	-
10	t*+9	0	2.07	-	-	-	-
11	t*+10	0	2.07	-	-	-	-
12	t*+11	0	0	-	-	-	-
13	t*+12	0	0	-	-	-	-
14	t*+13	0	0	-	-	-	-
15	t*+14	0	0	-	-	-	-
16	t*+15	0	0	-	-	-	-
17	t*+16	0	0	-	-	-	-
18	t*+17	0	0	-	-	-	-
19	t*+18	0	0	-	-	-	-
20	t*+19	0	0	-	-	-	-
20-T	t*+20…	0	0	-	-	-	-

Table 26b Carbon stock change factors for initial forest classes (Teak Plantation) (Method 1)

Year after deforestation		Teak plantation					
		⊿Cab	*⊿Cbb*	*⊿Cdw*	*⊿Cl*	*⊿Csoc*	*⊿Cwp*
1	t*	59.2	1.42	-	-	-	-
2	t*+1	0	1.42	-	-	-	-
3	t*+2	0	1.42	-	-	-	-
4	t*+3	0	1.42	-	-	-	-
5	t*+4	0	1.42	-	-	-	-
6	t*+5	0	1.42	-	-	-	-
7	t*+6	0	1.42	-	-	-	-
8	t*+7	0	1.42	-	-	-	-
9	t*+8	0	1.42	-	-	-	-
10	t*+9	0	1.42	-	-	-	-
11	t*+10	0	1.42	-	-	-	-
12	t*+11	0	0	-	-	-	-
13	t*+12	0	0	-	-	-	-
14	t*+13	0	0	-	-	-	-
15	t*+14	0	0	-	-	-	-
16	t*+15	0	0	-	-	-	-
17	t*+16	0	0	-	-	-	-
18	t*+17	0	0	-	-	-	-
19	t*+18	0	0	-	-	-	-
20	t*+19	0	0	-	-	-	-
20-T	t*+20…	0	0	-	-	-	-

Table 26c Carbon stock change factors for initial forest classes (Fallow) (Method 1)

Year after deforestation		Fallow					
		⊿Cab	*⊿Cbb*	*⊿Cdw*	*⊿Cl*	*⊿Csoc*	*⊿Cwp*
1	t*	According to year after slash-and-burn	According to year after slash-and-burn	-	-	-	-
2	t*+1	0	*ditto*	-	-	-	-
3	t*+2	0	*ditto*	-	-	-	-
4	t*+3	0	*ditto*	-	-	-	-
5	t*+4	0	*ditto*	-	-	-	-
6	t*+5	0	*ditto*	-	-	-	-
7	t*+6	0	*ditto*	-	-	-	-
8	t*+7	0	*ditto*	-	-	-	-
9	t*+8	0	*ditto*	-	-	-	-
10	t*+9	0	*ditto*	-	-	-	-
11	t*+10	0	*ditto*	-	-	-	-
12	t*+11	0	0	-	-	-	-
13	t*+12	0	0	-	-	-	-
14	t*+13	0	0	-	-	-	-
15	t*+14	0	0	-	-	-	-
16	t*+15	0	0	-	-	-	-
17	t*+16	0	0	-	-	-	-
18	t*+17	0	0	-	-	-	-
19	t*+18	0	0	-	-	-	-
20	t*+19	0	0	-	-	-	-
20-T	t*+20…	0	0	-	-	-	-

Table 27 Carbon stock change factors for final classes (Slash-and-burn) (Method 1)

Year after deforestation		Slash-and-burn					
		⊿Cab	*⊿Cbb*	*⊿Cdw*	*⊿Cl*	*⊿Csoc*	*⊿Cwp*
1	t*	19.4	0	-	-	-	-
2	t*+1	19.4	0	-	-	-	-
3	t*+2	19.4	0	-	-	-	-
4	t*+3	19.4	0	-	-	-	-
5	t*+4	19.4	0	-	-	-	-
6	t*+5	19.4	0	-	-	-	-
7	t*+6	19.4	0	-	-	-	-
8	t*+7	19.4	0	-	-	-	-
9	t*+8	19.4	0	-	-	-	-
10	t*+9	19.4	0	-	-	-	-
11	t*+10	-	-	-	-	-	-
12	t*+11	-	-	-	-	-	-
13	t*+12	-	-	-	-	-	-
14	t*+13	-	-	-	-	-	-
15	t*+14	-	-	-	-	-	-
16	t*+15	-	-	-	-	-	-
17	t*+16	-	-	-	-	-	-
18	t*+17	-	-	-	-	-	-
19	t*+18	-	-	-	-	-	-
20	t*+19	-	-	-	-	-	-
20-T	t*+20…	-	-	-	-	-	-

Method 01 was used to calculate the baseline carbon stock change (Table 28to Table 33).

Table 28 Baseline carbon stock change in the above-ground biomass in reference region

Project year *t*	Carbon stock changes in the above-ground biomass per initial forest classes								Total carbon stock change in the above-ground biomass of the initial forest classes in the reference region	
	Mixed forest		Dry dipterocarp forest		Teak plantation		Fallow		annual	cumulative
	$ABSLPA_{icl,t}$	$Ctot_{icl,t}$	$ABSLPA_{icl,t}$	$Ctot_{icl,t}$	$ABSLPA_{icl,t}$	$Ctot_{icl,t}$	$ABSLPA_{icl,t}$	$Ctot_{icl,t}$	$CBSLPAi_t$	$CBSLPAi_t$
	ha	tCO_2-e ha^{-1}	ha	tCO_2-e ha^{-1}	ha	tCO_2-e ha^{-1}	ha	tCO_2-e ha^{-1}	tCO_2-e	tCO_2-e
2011	2,845	253.2	-	-	0	217.1	-2,538	102.8	459,337	459,337
2012	2,962	253.2	-	-	0	217.1	-2,852	106.3	446,825	906,162
2013	3,138	253.2	-	-	0	217.1	-2,964	109.0	471,373	1,377,536
2014	3,315	253.2	-	-	0	217.1	-3,122	111.0	492,490	1,870,026
2015	3,515	253.2	-	-	0	217.1	-3,296	112.5	519,298	2,389,324
2016	3,740	253.2	-	-	0	217.1	-3,491	113.5	550,610	2,939,935
2017	3,992	253.2	-	-	0	217.1	-3,709	114.3	586,874	3,526,809
2018	4,274	253.2	-	-	0	217.1	-3,954	114.7	628,626	4,155,434
2019	4,590	253.2	-	-	0	217.1	-4,228	115.0	676,169	4,831,603
2020	4,944	253.2	-	-	0	217.1	-4,535	115.1	729,881	5,561,485

Table 29 Baseline carbon stock change in the below-ground biomass in reference region

Project year *t*	Carbon stock changes in the below-ground biomass per initial forest classes								Total carbon stock change in the below-ground biomass of the initial forest classes in the reference region	
	Mixed forest		Dry dipterocarp forest		Teak plantation		Fallow		annual	cumulative
	$ABSLPA_{icl,t}$	$Ctot_{icl,t}$	$ABSLPA_{icl,t}$	$Ctot_{icl,t}$	$ABSLPA_{icl,t}$	$Ctot_{icl,t}$	$ABSLPA_{icl,t}$	$Ctot_{icl,t}$	$CBSLPAi_t$	$CBSLPAi_t$
	ha	tCO_2-e ha^{-1}	ha	tCO_2-e ha^{-1}	ha	tCO_2-e ha^{-1}	ha	tCO_2-e ha^{-1}	tCO_2-e	tCO_2-e
2011	2,845	76.0	-	-	0	52.1	-2,538	38.6	118,201	118,201
2012	2,962	76.0	-	-	0	52.1	-2,852	39.9	111,281	229,482
2013	3,138	76.0	-	-	0	52.1	-2,964	40.9	117,141	346,623
2014	3,315	76.0	-	-	0	52.1	-3,122	41.7	121,695	468,318
2015	3,515	76.0	-	-	0	52.1	-3,296	42.2	127,930	596,247
2016	3,740	76.0	-	-	0	52.1	-3,491	42.6	135,401	731,648
2017	3,992	76.0	-	-	0	52.1	-3,709	42.9	144,214	875,863
2018	4,274	76.0	-	-	0	52.1	-3,954	43.1	154,509	1,030,372
2019	4,590	76.0	-	-	0	52.1	-4,228	43.2	166,330	1,196,702
2020	4,944	76.0	-	-	0	52.1	-4,535	43.2	179,740	1,376,443

Table 30 Baseline carbon stock change in the above-ground biomass in project area

Project year *t*	Carbon stock changes in the above-ground biomass per initial forest classes								Total carbon stock change in the above-ground biomass of the initial forest classes in the project area	
	Mixed forest		Dry dipterocarp forest		Teak plantation		Fallow		annual	cumulative
	$ABSLPA_{icl,t}$ ha	$Ctot_{icl,t}$ tCO_2-e ha^{-1}	$ABSLPA_{icl,t}$ ha	$Ctot_{icl,t}$ tCO_2-e ha^{-1}	$ABSLPA_{icl,t}$ ha	$Ctot_{icl,t}$ tCO_2-e ha^{-1}	$ABSLPA_{icl,t}$ ha	$Ctot_{icl,t}$ tCO_2-e ha^{-1}	$CBSLPAi_t$ tCO_2-e	$CBSLPAi_t$ tCO_2-e
2011	281	253.2	-	-	0	217.1	-394	109.7	34,103	34,103
2012	277	253.2	-	-	0	217.1	-417	112.1	30,870	64,973
2013	275	253.2	-	-	0	217.1	-410	114.0	32,821	97,794
2014	272	253.2	-	-	0	217.1	-407	115.5	34,103	131,897
2015	268	253.2	-	-	0	217.1	-402	116.5	35,921	167,818
2016	264	253.2	-	-	0	217.1	-397	117.2	38,119	205,937
2017	260	253.2	-	-	0	217.1	-391	117.7	40,709	246,646
2018	255	253.2	-	-	0	217.1	-385	118.0	43,738	290,385
2019	249	253.2	-	-	0	217.1	-378	118.1	47,213	337,597
2020	243	253.2	-	-	0	217.1	-370	118.2	51,166	388,763

Table 31 Baseline carbon stock change in the below-ground biomass in project area

Project year *t*	Carbon stock changes in the below-ground biomass per initial forest classes								Total carbon stock change in the below-ground biomass of the initial forest classes in the project area	
	Mixed forest		Dry dipterocarp forest		Teak plantation		Fallow		annual	cumulative
	$ABSLPA_{icl,t}$ ha	$Ctot_{icl,t}$ tCO_2-e ha^{-1}	$ABSLPA_{icl,t}$ ha	$Ctot_{icl,t}$ tCO_2-e ha^{-1}	$ABSLPA_{icl,t}$ ha	$Ctot_{icl,t}$ tCO_2-e ha^{-1}	$ABSLPA_{icl,t}$ ha	$Ctot_{icl,t}$ tCO_2-e ha^{-1}	$CBSLPAi_t$ tCO_2-e	$CBSLPAi_t$ tCO_2-e
2011	281	76.0	-	-	0	52.1	-394	41.2	6,980	6,980
2012	277	76.0	-	-	0	52.1	-417	42.1	5,528	12,508
2013	275	76.0	-	-	0	52.1	-410	42.8	5,900	18,408
2014	272	76.0	-	-	0	52.1	-407	43.4	6,019	24,427
2015	268	76.0	-	-	0	52.1	-402	43.8	6,291	30,718
2016	264	76.0	-	-	0	52.1	-397	44.0	6,656	37,374
2017	260	76.0	-	-	0	52.1	-391	44.2	7,113	44,486
2018	255	76.0	-	-	0	52.1	-385	44.3	7,673	52,159
2019	249	76.0	-	-	0	52.1	-378	44.4	8,330	60,489
2020	243	76.0	-	-	0	52.1	-370	44.4	9,089	69,578

Table 32 Baseline carbon stock change in the above-ground biomass in leakage belt area

Project year *t*	Carbon stock changes in the above-ground biomass per initial forest classes								Total carbon stock change in the above-ground biomass of the initial forest classes in the in leakage belt area	
	Mixed forest		Dry dipterocarp forest		Teak plantation		Fallow		annual	cumulative
	$ABSLPA_{icl,t}$	$Ctot_{icl,t}$	$ABSLPA_{icl,t}$	$Ctot_{icl,t}$	$ABSLPA_{icl,t}$	$Ctot_{icl,t}$	$ABSLPA_{icl,t}$	$Ctot_{icl,t}$	$CBSLPAi_t$	$CBSLPAi_t$
	ha	tCO_2-e ha^{-1}	ha	tCO_2-e ha^{-1}	ha	tCO_2-e ha^{-1}	ha	tCO_2-e ha^{-1}	tCO_2-e	tCO_2-e
2011	678	253.2	-	-	0	217.1	-567	99.9	466,715	466,715
2012	694	253.2	-	-	0	217.1	-620	101.5	460,443	927,158
2013	723	253.2	-	-	0	217.1	-628	102.8	489,835	1,416,993
2014	751	253.2	-	-	0	217.1	-645	103.8	515,201	1,932,194
2015	782	253.2	-	-	0	217.1	-662	104.4	545,970	2,478,164
2016	818	253.2	-	-	0	217.1	-682	104.9	580,897	3,059,061
2017	857	253.2	-	-	0	217.1	-704	105.2	620,665	3,679,726
2018	902	253.2	-	-	0	217.1	-728	105.4	665,648	4,345,374
2019	951	253.2	-	-	0	217.1	-756	105.4	716,601	5,061,975
2020	1,007	253.2	-	-	0	217.1	-787	105.4	774,038	5,836,013

Table 33 Baseline carbon stock change in the below-ground biomass in leakage belt area

Project year *t*	Carbon stock changes in the below-ground biomass per initial forest classes								Total carbon stock change in the below-ground biomass of the initial forest classes in the leakage belt area	
	Mixed forest		Dry dipterocarp forest		Teak plantation		Fallow		annual	cumulative
	$ABSLPA_{icl,t}$	$Ctot_{icl,t}$	$ABSLPA_{icl,t}$	$Ctot_{icl,t}$	$ABSLPA_{icl,t}$	$Ctot_{icl,t}$	$ABSLPA_{icl,t}$	$Ctot_{icl,t}$	$CBSLPAi_t$	$CBSLPAi_t$
	ha	tCO_2-e ha^{-1}	ha	tCO_2-e ha^{-1}	ha	tCO_2-e ha^{-1}	ha	tCO_2-e ha^{-1}	tCO_2-e	tCO_2-e
2011	678	76.0	-	-	0	52.1	-567	37.5	120,971	120,971
2012	694	76.0	-	-	0	52.1	-620	38.1	116,395	237,366
2013	723	76.0	-	-	0	52.1	-628	38.6	124,074	361,440
2014	751	76.0	-	-	0	52.1	-645	39.0	130,223	491,663
2015	782	76.0	-	-	0	52.1	-662	39.2	137,945	629,608
2016	818	76.0	-	-	0	52.1	-682	39.4	146,774	776,382
2017	857	76.0	-	-	0	52.1	-704	39.5	156,903	933,286
2018	902	76.0	-	-	0	52.1	-728	39.6	168,412	1,101,697
2019	951	76.0	-	-	0	52.1	-756	39.6	181,513	1,283,210
2020	1,007	76.0	-	-	0	52.1	-787	39.6	196,322	1,479,532

6.2 Baseline non-CO_2 from forest fires

GHG emission from forest fires (biomass burning) used as a tool for shifting cultivation in the project area was estimated according to methodology VM0015.

The leakage prevention activities are not associated with other registered project activities under VCS or UNFCCC. In addition, the consumption of fossil fuels, as a result of the project activity, is considered always insignificant by the methodology; however, it is not considered in this project.

Table 34 Parameters used to calculate non-CO_2 emissions from forest fire

Project year *t*	% Fburnt	$t\text{-}CO_2e\ ha^{-1}$ Cab	$t\text{-}CO_2e\ ha^{-1}$ Cdw	$t\text{-}CO_2e\ ha^{-1}$ Cl	% Pburnt ab	% Pburnt dw	% Pburnt l	% CE ab	% CE dw	% CE l	$t\text{-}CO_2e\ ha^{-1}$ ECO_2-ab	$t\text{-}CO_2e\ ha^{-1}$ ECO_2-dw	$t\text{-}CO_2e\ ha^{-1}$ ECO_2-l	$t\text{-}CO_2e\ ha^{-1}$ $EBBCO_2$	$t\text{-}CO_2e\ ha^{-1}$ $EBBnN_2O$	$t\text{-}CO_2e\ ha^{-1}$ $EBBnCH_4$	$t\text{-}CO_2e\ ha^{-1}$ EBBtot
2011	10.9	101	0	0	100	100	100	55	55	55	6.0	0	0	6.03	1.83	0.80	8.66
2012	11.1	101	0	0	100	100	100	55	55	55	6.2	0	0	6.15	1.87	0.81	8.83
2013	11.3	101	0	0	100	100	100	55	55	55	6.3	0	0	6.30	1.91	0.83	9.04
2014	11.6	101	0	0	100	100	100	55	55	55	6.4	0	0	6.44	1.96	0.85	9.25
2015	11.9	101	0	0	100	100	100	55	55	55	6.6	0	0	6.59	2.00	0.87	9.46
2016	12.1	101	0	0	100	100	100	55	55	55	6.7	0	0	6.73	2.05	0.89	9.67
2017	12.4	101	0	0	100	100	100	55	55	55	6.9	0	0	6.88	2.09	0.91	9.87
2018	12.6	101	0	0	100	100	100	55	55	55	7.0	0	0	7.02	2.13	0.93	10.07
2019	12.9	101	0	0	100	100	100	55	55	55	7.2	0	0	7.15	2.17	0.94	10.27
2020	13.1	101	0	0	100	100	100	55	55	55	7.3	0	0	7.28	2.21	0.96	10.46

Table 35 Baseline non-CO_2 emissions from forest fires in the project area

Project year *t*	Emissions of non-CO2 gasses from baseline forest fires								Total *ex-ante* estimated actual non-CO_2 emissions from forest fires in the project area	
	Mixed forest		Dry dipterocarp forest		Teak plantation		Fallow		Annual	Cumulative
	ABSLPA	EBBBSLtot	ABSLPA	EBBBSLtot	ABSLPA	EBBBSLtot	ABSLPA	EBBBSLtot	*$EBBBSLPA_t$* t-CO_2e	*EBBBSLPA* t-CO_2e
	ha	tCO_2-e ha^{-1}	ha	tCO_2-e ha^{-1}	ha	tCO_2-e ha^{-1}	ha	tCO_2-e ha^{-1}	tCO_2-e ha^{-1}	tCO_2-e ha^{-1}
2011	289.9	8.66	-	-	-	-	-	-	2,510	2,510
2012	296.8	8.83	-	-	-	-	-	-	2,621	5,131
2013	305.8	9.04	-	-	-	-	-	-	2,765	7,896
2014	315.5	9.25	-	-	-	-	-	-	2,919	10,814
2015	326.3	9.46	-	-	-	-	-	-	3,087	13,901
2016	338.2	9.67	-	-	-	-	-	-	3,271	17,172
2017	351.4	9.87	-	-	-	-	-	-	3,469	20,641
2018	366.1	10.07	-	-	-	-	-	-	3,686	24,327
2019	382.3	10.27	-	-	-	-	-	-	3,926	28,253
2020	400.3	10.46	-	-	-	-	-	-	4,188	32,441

7 STEP 7: *EX-ANTE* ESTIMATION OF ACTUAL CARBON STOCK CHANGES AND NON-CO_2

7.1 *Ex-ante* estimation of actual carbon stock change emissions in the project area

7.1.1 *Ex-ante* estimation of actual carbon stock changes due to planned activities

According to the methodology, the project proponent should account for changes in the carbon stocks in the project area due to planned project activities.

The reduction in carbon and non-CO_2 emissions inside the HK-VC generated by the project are based on assumed reductions in the deforestation rate that will occur throughout the project area. Project activities to achieve those reductions will not lead to any change in carbon stocks. Planned deforestation or forest degradation as a result of infrastructure implementation, timber logging, or charcoal production for example, are not being considered as part of the project's activities.

7.1.2 *Ex-ante* estimation of carbon stock changes due to unavoidable unplanned deforestation within the project area

The actual GHG emissions reductions generated by the project will be determined through *ex-post* measurements of project results based on its monitoring plan. Here, under the assumption of project effectiveness and following the methodology requirements, the *ex-ante* carbon stock changes within the project area are estimated by multiplying the annual total baseline carbon stock change by the factor (1-EI), where (EI) is an Effectiveness Index ranging from 0 (no effectiveness) to 1 (maximum effectiveness).

The EI was estimated based on the demonstration of project activities. We also assume that higher effectiveness rate will be achieved. We assume that in the effectiveness rate will be 100%.

Under the assumption of project, the *ex-ante* carbon stock changes within the project area are estimated by future scenario;

Table 36 Assumption of project

Factor	Assumption
Population	Population dynamics is according to historical trend
Number of livestock (i.e. cow)	Number of cow is expected to increase to 2.5 times larger by 2030, compared to that in 2010.
Alternative livelihood from introduced by project activities. In this case, area of Paddy Field as used as alternative livelihood	Area of Paddy Field is expected to increase to 2.5 times larger by 2030, compared to that in 2010.

In this project, according to baseline scenario described in "2.4 Baseline Scenario" of PD, GHG emission in the future (up to 2030) is estimated by developed econometric model, which uses some parameters in Table 36. The components of the econometric model to estimate a reference level are presented as below. More specifically, drivers of deforestation and forest degradation identified by preliminary survey (*see* Appendix 1) are applied into econometric model.

The results of the model showed a satisfactorily high projection level. In the model, it is interpreted that as population increased and activities of shifting cultivation increased, slash-and-burn Area was likely to have expanded. This means that as more economic demand was placed on the activities of shifting cultivation, slash-and-burn area was assumed to have increased, while the improvement of productivity (by introduced alternative livelihoods; livestock management or paddy field management) was likely to have reduced such pressure on shifting cultivation.

$$ForArea_t = 0.0207 \times ForArea_{t-1} - 0.937 \times FA_t - 0.930 \times SBA_t + 223{,}371$$
$$FA = 0.982 \times FA_{t-1} + 0.661 \times SBA_{t-1} - 2{,}390 \quad \text{.....................Econometric model}$$
$$SBA = 0.235 \times FA_{t-1} - 235 \times PF + 0.337 \times POP - 0.434 \times Cow - 10{,}494$$

where;

$ForArea_t$	Total forest area of Mixed forest, Dry dipterocarp forest and Teak plantation within the reference region at year *t*; ha
FA_t	Area of fallow at time *t* within the reference region; ha
SBA_t	Area of slash-and-burn at time *t* within the reference region; ha
PF_t	Area of paddy field at time *t* within the reference region; ha
POP_t	Population of within the reference region at time *t*
Cow_t	Number of cow as livestock at time *t* within the reference region
t	1, 2, 3 … *T*, a year of the proposed crediting period; dimensionless

Also, for estimation of GHG emission in project scenario, some parameters which are assumed by implementing effects of project activities (i.e. improvement of livestock management and expansion of paddy field as alternative livelihood) are applied in equation 2.

7.1.3 *Ex-ante* estimated net actual carbon stock changes in the project area

The results of the previous step are summarized in Table 37.

Table 37 *Ex-ante* estimated net carbon stock change in the project area under the project scenario

Project year *t*	Total carbon stock decrease due to planned activities		Total carbon stock increase due to planned activities		Total carbon stock decrease due to unavoided unplanned deforestation		Total carbon stock change in the project case	
	Annual	Cumulative	Annual	Cumulative	Annual	Cumulative	Annual	Cumulative
	$CBAdPA_t$	*CBAdPA*	$CBAiPA_t$	*CBAiPA*	$CUDdPA_t$	*CUDdPA*	$CBSPA_t$	*CBSPA*
	t-CO_2e	t-CO_2e	t-CO_2e	t-CO_2e	t-CO_2e	t-CO_2e	t-CO_2e	t-CO_2e
2011	0	0	0	0	114,914	114,914	114,914	114,914
2012	0	0	0	0	112,925	227,839	112,925	227,839
2013	0	0	0	0	109,938	337,777	109,938	337,777
2014	0	0	0	0	106,535	444,311	106,535	444,311
2015	0	0	0	0	102,967	547,278	102,967	547,278
2016	0	0	0	0	99,313	646,591	99,313	646,591
2017	0	0	0	0	95,112	741,703	95,112	741,703
2018	0	0	0	0	90,701	832,404	90,701	832,404
2019	0	0	0	0	85,854	918,258	85,854	918,258
2020	0	0	0	0	80,254	998,511	80,254	998,511

7.2 *Ex-ante* estimation of actual non-CO_2 emission from forest fires

GHG emission from forest fires used as a tool for shifting cultivation in the project area was estimated according to methodology VM0015.

Table 38 Total *ex-ante* estimated actual emissions of non-CO_2 gasses due to forest fires (biomass burning) in the project area

Project year *t*	Total ex-ante estimated actual non-CO_2 emissions from forest fires in the project area	
	EBBPSPA$_t$ t-CO_2e	*EBBPSPA* t-CO_2e
2011	7,020	7,020
2012	6,970	13,990
2013	6,970	20,960
2014	6,954	27,914
2015	6,930	34,844
2016	6,895	41,740
2017	6,850	48,589
2018	6,791	55,380
2019	6,718	62,098
2020	6,629	68,727

7.3 Total *ex-ante* estimations for the project area

The total *ex-ante* estimation of GHG emissions for the project area is reported in Table 39.

Table 39 Total *ex-ante* estimated actual net carbon stock changes and emissions of non-CO_2 gasses in the project area

Project year *t*	Total *ex-ante* carbon stock decrease due to planned activities		Total *ex-ante* carbon stock increase due to planned activities		Total *ex-ante* carbon stock decrease due to unavoided unplanned deforestation		Total *ex-ante* net carbon stock change		Total *ex-ante* estimated actual non-CO_2 emissions from forest fires in the project area	
	Annual	Cumulative	Annual	Cumulative	Annual	Cumulative	Annual	Cumulative	Annual	Cumulative
	$CPAdPA_t$	*CPAdPA*	$CBAiPA_t$	*CBAiPA*	$CUDdPA_t$	*CUDdPA*	$CBSPA_t$	*CBSPA*	$EBBPSPA_t$	*EBBPSPA*
	t-CO_2e	t-CO_2e	t-CO_2e	t-CO_2e	t-CO_2e	t-CO_2e	t-CO_2e	t-CO_2e	t-CO_2e	t-CO_2e
2011	0	0	0	0	114,914	114,914	114,914	114,914	7,020	7,020
2012	0	0	0	0	112,925	227,839	112,925	227,839	6,970	13,990
2013	0	0	0	0	109,938	337,777	109,938	337,777	6,970	20,960
2014	0	0	0	0	106,535	444,311	106,535	444,311	6,954	27,914
2015	0	0	0	0	102,967	547,278	102,967	547,278	6,930	34,844
2016	0	0	0	0	99,313	646,591	99,313	646,591	6,895	41,740
2017	0	0	0	0	95,112	741,703	95,112	741,703	6,850	48,589
2018	0	0	0	0	90,701	832,404	90,701	832,404	6,791	55,380
2019	0	0	0	0	85,854	918,258	85,854	918,258	6,718	62,098
2020	0	0	0	0	80,254	998,511	80,254	998,511	6,629	68,727

8 STEP 8: *EX-ANTE* ESTIMATION OF LEAKAGE

8.1 *Ex-ante* estimation of the decrease in carbon stocks and increase in GHG emissions due to leakage prevention measures

8.1.1 Carbon stock changes due to activities implemented in leakage management areas

Leakage prevention activities in these areas in the project scenario include the introduction of alternative livelihoods, through the use of new agriculture techniques (*see* PD). Carbon stocks in the project area in the project scenario are thus expected to increase compared to the baseline. However, we conservatively assume that they will remain non-forest land, and the carbon stock in the project area will consequently remain unchanged throughout the project period.

8.1.2 *Ex-ante* estimation of CH_4 and N_2O emissions from grazing animals

Project activities associated with leakage prevention do not include significant livestock management, therefore emissions as result of grazing are not considered. Also activities for expanding paddy fields do not include significant non-CO_2 emissions, therefore emissions are not considered.

8.1.3 Total *ex-ante* estimated carbon stock changes and increases in GHG emissions due to leakage prevention measures

The results of the previous step are summarized (Table 40)~~ in above~~.

Table 40 *Ex-ante* estimated total emissions above the baseline from leakage prevention activities

Project year *t*	Carbon stock decrease due to leakage prevention measures		Total *ex-ante* GHG emissions from increased grazing activities		Total *ex-ante* increase in GHG emissions due to leakage prevention measures	
	Annual $\Delta CLPMLK_t$ t-CO_2e	Cumulative $\Delta CLPMLK$ t-CO_2e	Annual $EgLK_t$ t-CO_2e	Cumulative $EgLK$ t-CO_2e	Annual $ELPMLK_t$ t-CO_2e	Cumulative $ELPMLK$ t-CO_2e
2011	0	0	0	0	0	0
2012	0	0	0	0	0	0
2013	0	0	0	0	0	0
2014	0	0	0	0	0	0
2015	0	0	0	0	0	0
2016	0	0	0	0	0	0
2017	0	0	0	0	0	0
2018	0	0	0	0	0	0
2019	0	0	0	0	0	0
2020	0	0	0	0	0	0

8.2 *Ex-ante* estimation of the decrease in carbon stocks and increase in GHG emissions due to activity displacement leakage

In order to conservatively estimate, it was assumed that 5% of the deforestation within the project area in the baseline case will be displaced to the leakage belt in the first 3 years of the project and will continuously decrease until reaching 0% in 2020. The calculation process of 5% to be displaced will be provided to the project validator in validation process

Table 41 *Ex-ante* estimated leakage due to activity displacement

Project year *t*	Total *ex-ante* estimated decrease in carbon stocks due to displaced deforestation		Total *ex-ante* estimated increase in GHG emissions due to displaced forest fires	
	Annual $\Delta CADLK_t$ t-CO_2e	Cumulative $\Delta CADLK$ t-CO_2e	Annual $EADLK_t$ t-CO_2e	Cumulative $EADLK$ t-CO_2e
2011	3,736	3,736	187	187
2012	3,892	7,628	192	379
2013	4,063	11,691	197	576
2014	3,482	15,173	169	745
2015	2,902	18,075	141	886
2016	2,322	20,397	113	999
2017	1,741	22,138	85	1,083
2018	1,161	23,299	56	1,140
2019	580	23,879	28	1,168
2020	0	23,879	0	1,168

8.3 *Ex-ante* estimation of total leakage

The total *ex-ante* leakage estimation is reported in Table 42.

Table 42 *Ex-ante* estimated total leakage

Project year *t*	Total *ex-ante* GHG emissions from increased grazing activities		Total *ex-ante* increase in GHG emissions due to displaced forest fires		Total *ex-ante* decrease in carbon stocks due to displaced deforestation		Carbon stock decrease or non-CO_2 emissions due to leakage prevention measures		Total *ex-ante* decrease in carbon stocks due to displaced deforestation		Total net increase in emissions due to leakage	
	Annual $EgLK_t$ t-CO_2e	Cumulative $EgLK$ t-CO_2e	Annual $EADLK_t$ t-CO_2e	Cumulative $EADLK$ t-CO_2e	Annual $\Delta CADLK_t$ t-CO_2e	Cumulative $\Delta CADLK$ t-CO_2e	Annual $\Delta CLPMLK_t$ t-CO_2e	Cumulative $\Delta CLPMLK$ t-CO_2e	Annual ΔCLK_t t-CO_2e	Cumulative ΔCLK t-CO_2e	Annual ΔELK_t t-CO_2e	Cumulative ΔELK t-CO_2e
2011	-	-	187	187	3,736	3,736	-	-	3,923	3,923	3,923	3,923
2012	-	-	192	379	3,892	7,628	-	-	4,084	8,007	4,084	8,007
2013	-	-	197	576	4,063	11,691	-	-	4,260	12,267	4,260	12,267
2014	-	-	169	745	3,482	15,173	-	-	3,651	15,919	3,651	15,919
2015	-	-	141	886	2,902	18,075	-	-	3,043	18,962	3,043	18,962
2016	-	-	113	999	2,322	20,397	-	-	2,434	21,396	2,434	21,396
2017	-	-	85	1,083	1,741	22,138	-	-	1,826	23,222	1,826	23,222
2018	-	-	56	1,140	1,161	23,299	-	-	1,217	24,439	1,217	24,439
2019	-	-	28	1,168	580	23,879	-	-	609	25,047	609	25,047
2020	-	-	0	1,168	0	23,879	-	-	0	25,047	0	25,047

9 STEP 9: *EX-ANTE* TOTAL NET ANTHROPOGENIC GHG EMISSION REDUCTIONS

9.1 Significance assessment

The carbon stored in the above and below ground biomass pools were considered by the project. While the above-ground pool is mandatory, the below-ground pool is optional but recommended by the methodology, since it represents around ~~50~~15-30% of the carbon stored in above-ground biomass, and is therefore a significant pool. Root-to-shoot ratios and data to estimate the carbon stocks in the below-ground biomass pool were sourced from regional literature in accordance with IPCC (2006) guidance. Non-CO_2 emission from forest fire (i.e. results of shifting cultivation practice) was also considered in this project.

On the other hand, ~~Harvested~~ harvested wood products were excluded as significant timber removal is not associated with the baseline scenario. This is because that there were no logging activities in project area and reference region and there were not so much harvest wood products to be accounted.

~~Non-CO_2 emission from forest fire (i.e. results of shifting cultivation practice) was also considered in this project.~~

9.2 Calculation of *ex-ante* estimation of total net GHG emissions reductions ~~and~~

The *ex-ante* estimation of total net GHG emissions reductions ~~and the calculation of *ex-ante* Verified Carbon Units (VCUs)~~ to be generated through the proposed AUD project activity are calculated.

$$\Delta REDD_t = (\Delta CBSLPA_t + EBBBPSPA_t) - (\Delta CPSPA_t + EBBPSPA_t) - (\Delta CLK_t + ELK_t) \quad \text{.............Equation 1}$$

where;

$\Delta REDD_t$	*Ex-ante* estimated net anthropogenic GHG reduction attributable to the AUD project activity at year *t*; tCO_2e
$\Delta CBSLPA_t$	Sum of baseline carbon stock changes in the project area at year *t*; tCO_2e
$EBBBSLPA_t$	Sum of baseline emissions from biomass burning in the project area at year *t*; tCO_2e
$\Delta CPSPA_t$	Sum of ex post estimated actual carbon stock changes in the project area at year *t*; tCO_2e
$EBBPSPA_t$	Sum of (*ex-ante* estimated) actual emissions from biomass burning in the project area at year *t*; tCO_2e
ΔCLK_t	Sum of ex post estimated leakage net carbon stock changes at year *t*; tCO_2e
ELK_t	Sum of ex post estimated leakage emissions at year *t*; tCO_2e
t	1, 2, 3 … *t*, a year of the proposed crediting period; dimensionless

Ex-ante buffer credits are calculated based on a 14% risk factor estimated through the VCS non-permanence risk tool (as attached).

9.3 Calculation of *ex-ante* Verified Carbon Units (VCUs)

~~The ex-ante estimation of total net GHG emissions reductions and t~~The calculation of *ex-ante* Verified Carbon Units (VCUs) to be generated through the proposed AUD project activity are summarized in Table

43. *Ex-ante* buffer credits are calculated based on a 14% risk factor estimated through the VCS non-permanence risk tool.

Table 43 *Ex-ante* estimated net anthropogenic GHG emission reductions ($\Delta REDD_t$) and Voluntary Carbon Units (VCU_t)

Project year *t*	Baseline carbon stock changes		Baseline GHG emissions		*Ex-ante* project carbon stock changes		*Ex-ante* project GHG emissions		*Ex-ante* leakage carbon stock changes		*Ex-ante* leakage GHG emissions		*Ex-ante* net anthropogenic GHG emission reductions		*Ex-ante* VCUs tradable		*Ex-ante* buffer credits	
	Ann. C_t t-CO_2e	Cum. C t-CO_2e	Ann. $EBBB_t$ t-CO_2e	Cum. $EBBB$ t-CO_2e	Ann. $CPSPA_t$ t-CO_2e	Cum. $CPSPA$ t-CO_2e	Ann. EBB_t t-CO_2e	Cum. EBB t-CO_2e	Ann. CLK_t t-CO_2e	Cum. CLK t-CO_2e	Ann. ELK t-CO_2e	Cum. ELK t-CO_2e	Ann. $REDD_t$ t-CO_2e	Cum. $REDD$ t-CO_2e	Ann. VCU_t t-CO_2e	Cum. VCU t-CO_2e	Ann. VBC_t t-CO_2e	Cum. VBC t-CO_2e
2011	124,536	124,536	130,772	130,772	114,914	114,914	121,934	121,934	3,923	3,923	3,923	3,923	12,761	12,761	10,975	10,975	1,787	1,787
2012	129,747	254,283	136,131	266,903	112,925	227,839	119,895	241,829	4,084	8,007	4,084	8,007	20,320	33,081	17,475	28,450	2,845	4,631
2013	135,423	389,706	142,002	408,905	109,938	337,777	116,908	358,737	4,260	12,267	4,260	12,267	29,354	62,435	25,244	53,694	4,110	8,741
2014	141,838	531,544	148,626	557,530	106,535	444,311	113,489	472,225	3,651	15,919	3,651	15,919	38,788	101,224	33,358	87,052	5,430	14,171
2015	149,454	680,998	156,474	714,004	102,967	547,278	109,897	582,123	3,043	18,962	3,043	18,962	49,619	150,843	42,673	129,725	6,947	21,118
2016	158,486	839,483	165,762	879,766	99,313	646,591	106,209	688,331	2,434	21,396	2,434	21,396	61,987	212,830	53,309	183,034	8,678	29,796
2017	168,632	1,008,115	176,192	1,055,958	95,112	741,703	101,961	790,292	1,826	23,222	1,826	23,222	76,056	288,887	65,409	248,443	10,648	40,444
2018	180,401	1,188,516	188,276	1,244,233	90,701	832,404	97,492	887,784	1,217	24,439	1,217	24,439	92,001	380,888	79,121	327,564	12,880	53,324
2019	193,762	1,382,278	201,986	1,446,220	85,854	918,258	92,572	980,356	609	25,047	609	25,047	110,023	490,911	94,620	422,184	15,403	68,728
2020	208,627	1,590,906	217,239	1,663,459	80,254	998,511	86,882	1,067,238	0	25,047	0	25,047	130,357	621,268	112,107	534,290	18,250	86,978

C: CBSLPA, EBBB: EBBBSLPA, EBB: EBBPSP

Note: *Ex-ante* buffer credits are calculated based on a 14% Risk Factor (RF) estimated through the VCS non-permanence risk tool.

PART 3 – METHODOLOGY FOR MONITORING AND RE-VALIDATION OF THE BASELINE

1 TASK 1: MONITORING OF CARBON STOCK CHANGES AND GHG EMISSIONS FOR PERIODICAL VERIFICATIONS

1.1 Monitoring of actual carbon stock changes and GHG emissions within the project area

1.1.1 Monitoring of project implementation

Monitoring of the HK-VC project implementation is conducted through different components that together form an integrated monitoring system. Quarterly reports will be available describing the progress of the activities listed in the management plans. The project will keep a copy of all spatial and tabular data, maps, reports and any relevant documentation, securely backed-up. This information will be available to verifiers for inspection. The project will also be responsible for monitoring project activities to be implemented by local partners. *See* section "4.3 Description of the Monitoring Plan" of the PD for a detailed description of the HK-VC data management plan.

1.1.2 Monitoring of land-use and land-cover change within the project area

As of the date of validation no regional, national or jurisdictional monitoring system of land-cover change was in place. Therefore, the project proponent will be responsible for developing the land-cover change component of the monitoring plan for the project area. The analysis will cover the monitoring of forest land converted to non-forest. The land cover and change maps will be produced following the technical steps described below, including quality assurance procedures.

The project proponent will complete the following technical steps:

1. Acquire appropriate LANDSAT images with minimal cloud cover from multiple sources. Multiple images will be used in the verification to fill areas obscured by clouds;

2. Atmospherically correct images;

3. Orthorectify images to within one pixel using a single base image (generally a GeoCover image, or similar image, used to generate the forest benchmark map);

4. In areas where no-data values exist in the base image (due to clouds, cloud shadows and so on), composited images will be generated using the base image and multiple gap-filling images. A cloud and cloud shadow will first be generated and gap-filling scenes identified to fill the mask of the base image. Temporal and gap extent criteria will be used to select the gap-filling scenes; scenes with similar acquisition dates will be given preference, as well as minimal cloud and cloud shadow.

1.1.3 Monitoring of carbon stock changes and non-CO_2

<u>Monitoring of carbon stock changes emissions from forest fires</u>

Within the project area:

The *ex-ante* estimated average carbon stocks per in Mixed forest is not expected to change during the fixed baseline period. There are no areas subject to significant carbon stock decrease due to controlled deforestation and planned harvest activities (e.g. planned logging, fuel-wood collection and charcoal production activities) in the project scenario. Similarly, no areas subject to significant unplanned carbon stock decrease e.g. due to uncontrolled forest fires or other catastrophic events were identified. Although protection of forest by the project will likely lead to an increase in carbon stocks, monitoring of increases in carbon stocks are conservatively omitted because the project does not intend to claim credits for this category. Therefore, carbon stocks will not be monitored within the project area.

Within leakage management areas (LMAs):

No areas will be subject to planned and significant carbon stock decrease in the project scenario in the LMAs according to the *ex-ante* assessment. On the contrary, carbon stocks are expected to increase in LMAs but are conservatively omitted from project accounting. Therefore, carbon stocks will not be monitored within LMAs.

Within the leakage belt:

Carbon stocks will not be monitored within the leakage belt as this is optional.

Monitoring of non-CO_2 emissions form forest fires

Emissions from forest fires were estimated.

1.1.4 Monitoring of impacts of natural disturbances and other catastrophic events

Natural disasters that might affect the carbon stocks (i.e. hurricanes, volcanic eruptions, flooding, severe droughts, earthquakes) in the project area are uncommon and do not represent a significant risk for the project area as assessed in the Non-Permanence Risk Report. However, the project proponent will use medium-resolution satellite images to monitor catastrophic events, applying the methodology described in Appendix 2~~Supporting Information 1~~.

1.1.5 Total ex post estimated actual net carbon stock changes and GHG emissions in the project area

Relevant tables will be updated using the new measurements of changes in carbon stocks and GHG emissions in each monitoring period. The results will be summarized: Total ex-post estimated actual net changes in carbon stocks and emissions of GHG in the project area.

1.2 Monitoring of leakage

1.2.1 Monitoring of carbon stock changes and GHG emissions associated to leakage prevention activities

The major leakage prevention activity to be implemented is the capacity building and technical assistance for alternative livelihoods. No planned deforestation or degradation is expected to occur as part of leakage prevention activities, and no changes in carbon stocks are expected to occur according to the *ex-ante* analysis.

1.2.2 Monitoring of carbon stock decrease and increases in GHG emissions due to activity displacement leakage

Deforestation in the leakage belt will be monitored. Any deforestation above the baseline in the leakage belt will be discounted from the carbon emissions avoided to due to project activities. If emissions in the leakage belt are higher than the baseline due to activities not attributed to the project, the project proponent will collect robust evidence to justify that the deforestation is not linked to project activities.

Emissions from forest fires are included in the baseline therefore increases in GHG emissions will be monitored in the leakage belt.

1.2.3 Total ex post estimated leakage

The results of all ex-post estimations of leakage through monitoring will be summarized using the same table format used in the *ex-ante* assessment and will be reported.

1.3 Ex post net anthropogenic GHG emission reductions

The calculation of ex-post net anthropogenic emission reductions will be estimated similarly to the *ex-ante* calculation using the equation below:

$$\Delta REDD_t = \Delta CBSLPA_t - \Delta CPSPA_t - (\Delta CLK_t + ELK_t) \quad \text{Equation 2}$$

where;

$\Delta REDD_t$	Ex-post estimated net anthropogenic GHG reduction attributable to the AUD project activity at year t; tCO_2e
$\Delta CBSLPA_t$	Sum of baseline carbon stock changes in the project area at year t; tCO_2e
$\Delta CPSPA_t$	Sum of ex post estimated actual carbon stock changes in the project area at year t; tCO_2e
ΔCLK_t	Sum of ex post estimated leakage net carbon stock changes at year t; tCO_2e
ELK_t	Sum of ex post estimated leakage emissions at year t; tCO_2e
t	1, 2, 3 … T, a year of the proposed crediting period; dimensionless

2 TASK 2 REVISITING THE BASELINE PROJECTIONS FOR FUTURE FIXED BASELINE PERIOD

The baseline proposed for the project will be revised in 2020. If by this date no regional, national or jurisdictional baseline has been developed, the project proponent will revisit and update the baseline.

2.1 Update information on agents, drivers and underlying causes of deforestation

Information on drivers and agents of deforestation in the reference region will be collected periodically. Prior to 2020, a workshop will be organized with local representatives, experts and stakeholders to validate the information collected and discuss strategies to mitigate the drivers of deforestation.

2.2 Adjustment of the land-use and land-cover change component of the baseline

2.2.1 Adjustment of the annual areas of baseline deforestation

As more information becomes available on land-cover change and the causes of deforestation, the annual rates of deforestation will be re-estimated. If conclusive information on historical deforestation is available to project deforestation rates for the next baseline period, approach ”b” (time function) will be used. The methods used will follow steps 3 and 4 of part 02 of the VCS VM0015 methodology. If an applicable sub-national or national baseline becomes available during the fixed baseline period, it will be used for the subsequent period.

2.2.2 Adjustment of the location of the projected baseline deforestation

Using the adjusted annual deforestation rate, the location will be spatially distributed. New factor maps and a risk map will be produced for the project and leakage belt. The leakage belt will be revised and its boundary delineated based on a mobility analysis, unless the agents and drivers of deforestation have changed substantially and another method for defining the boundary of the leakage is more suitable.

2.3 Adjustment of the carbon component of the baseline

The project will use the carbon stock measurements for the entire project crediting period, unless more accurate data is available and covering all the carbon pools considered by the project.

APPENDIX 1: SOCIO-ECONOMIC ANALYSIS

1 OUTLINE OF SURVEY

Within the framework of the project scope, the main goal of the preliminary survey was to assess the current socio-economic situation and natural and human resources of the Houay Khing village as typical village in the target site and to develop alternative livelihood strategies to reduce deforestation. Also this preliminary study comprehend an aspect of mobility analysis (Option II: Mobility Analysis for identifying Leakage belt according to the applied methodology).

The project applied “capability approach” to assess and develop the approach (project activities). Specifically, the assessments were based on natural resources potential such as land use and productivity and human resources potentials such as technique, knowledge and interesting for livelihood.

2 SURVEY METHODS

Participatory method was applied to collect information from the village. The data collection involved villagers throughout the process. The information was collected in three steps i.e. workshop, group discussion and individual interview were conducted from October 2012 to February 2013.

As for workshop and group discussion, a total of 21 participants from four villages (Houay Khing village, Phak Bong village, Houay Ha village, Houay Tho village) attended the workshop and group discussion representing both gender and ethnicity. The workshop primarily focused on assessing the interests and capacities of the participants to adopt alternative livelihood options. In the final stage of the study, group discussions were carried out with specific interest groups who were willing to adopt changes in their agricultural practices and livelihood options in the future.

Workshop in the village

Workshop in the village

The interviews were applied for all households (208 households) in Houay Khing village (except for households of going away for work), and mostly focused on assessing current livelihood activities, problems related to current livelihood activities and forestry situation, and then suggesting alternative livelihood options.

	
Interview to villager	Interview to villager

Based on the interviews, a list of alternative livelihood options was prepared, in which the results of the workshops and group discussions were added.

3 SURVEY RESULTS

Expansion of shifting cultivation because of rack of opportunities to start new livelihoods, low skill of livestock management (e.g. expansion of grazing land converted from forest) and no accessibility to the market were found to be the major causes of deforestation in the village. The study found that shifting cultivation is not an isolated problem but is associated with many social and economic development issues in the region. Traditional cultural practice, lack of knowledge of improved agricultural system and permanent agriculture, lack of irrigation facility, lack of clear land tenure policy, and lack of technical inputs from concerned organization were found to be major reasons for such practice. As a result of preliminary survey, it was found there were three main problems in each sector; forestry sector, agricultural sector, and market system.

3.1 Forestry Sector

Forest management activity didn't exist in the village. In the most cases, villagers had free access to forest to collect forest products as they were required or much as they wanted, which are without strict regulations. Besides shifting cultivation practice, forest encroachment was also common in the village to expand cropland (i.e. pioneer shifting cultivation).

Recently land and forest zoning system has been applied and implemented in the village on a trial basis. However, during the survey, the majority of villagers indicated that they have heard about the zoning enforcement in the village and the most of the respondents implicitly said that zoning regulations were not followed strictly as forest products were still being collected from other forests and shifting cultivation practices were still continuing in utilization and other forests.

People who have followed the zoning regulations have suffered severely as they have been restricted to three plots of shifting cultivation, but this regulation was causes of increasing months of rice deficiency. Furthermore, most of the villagers indicated there were no opportunities to start new livelihoods alternative by shifting cultivation, although they have interests and hope to start them. It was indicated overlay on shifting cultivation is a fundamental cause of deforestation. This is the reason why the project decided to apply demonstration of alternative livelihoods (e.g. nursery management system or weaving production system) and introduce them in the village as project activities.

The forest has rich NTFPs resources and the local people collect many species of NTFPs for both domestic consumption and sale. The common NTFPs are bamboo, doukdua (elephant yam), wild mushroom, rattan and many types of wild herbs. NTFPs have good markets in the nearby cities with their ultimate destination to China, Thailand and Vietnam.

3.2 Agricultural sector; shifting cultivation, paddy farming, livestock management

Almost all of the villagers depend on their livelihood by shifting cultivation. They said they had 3 plots for cultivation supposedly of village level regulation; however, the preliminary survey revealed that they have more than 5 plots. Despite considerable size of land holding, more than 50% of villagers indicated they had not have enough rice for 12 months and majority of them were from Khmu community (56%) (Table 44). If the regulation becomes strict in the future, it will be more difficult to get enough rice production for villagers.

Table 44 Agricultural land and production in Houay Khing village

	Khmu	Hmong	Lao loum	Total
Total number of plots (by each ethnic group)	352	294	15	661
Average number of plots (by each ethnic group)	3	3	1.4	2.97
Number of paddy field owners	16	31	1	48
Total size of paddy fields	11 ha	24.1 ha	0.5ha	35.6 ha
Number of families with rice sufficiency (12 months or more)	51 (44%)	81 (84%)	8 (73%)	140
Number of families with rice deficiency	65 (56%)	8 (8.3%)	3 (28%)	76
Number of families with rice deficiency more than three months	47 (40%)	2 (2.1%)	1 (9%)	50

Beside shifting cultivation, a limited number of farmers own paddy field, especially those famers whose lands were located close to the permanent water sources. The sizes of these paddy fields were generally very small, ranging from 0.3 ha to 2.0 ha. However, they were not being managed and utilized to its full capacity because of lack of technique and system of group activities among farmer.

Livestock is an important part of economy of the village which has a promising existing market with growing market price. About half of the villagers own large size cattle (cow and buffalo) and about 60% of them own pig and goat and more than 80% of them own chicken and ducks. However, livestock raising technique was very primitive and unscientific. Large size cattle (cow and buffalo) were raised freely in the forest significantly contributing to deforestation and/or forest degradation. Uncontrolled and free grazing in the forest has also caused higher mortality of cattle due to possible contamination with the diseased wild animals. This is the reason why the project provided training of grazing management including vaccine administration.

3.3 Market System

One of the obvious constraints of income generation in the Houay Khing village was the lack of market system for agriculture and forestry products. Although the village had very high potential to commercially produce vegetables, livestock, fruits, NTFPs and many other cash crops, there was no existing market or direct linkage with market system to sell these products. Villagers largely depend upon middlemen to sell their products, who control both demand and price of the products. The market uncertainty has also discouraged people to grow cash crops in large quantity. This is the reason why the project decided to apply demonstration of village market.

In spite of various issues and problems in agriculture and natural resources sector, so much useful knowledge and expertise exist in the village. It was observed that the most of the villagers had traditional knowledge on growing fruits and vegetables, though mostly they did domestic consumption. The majority of Khmu people were adept in bamboo crafting and weaving. Hmong people were skilful in embroidering, sewing and iron works. Some of them had knowledge on coffee plantation, traditional medicine, terrace making etc. Such local knowledge could be promoted and transferred locally through proper extension education activities. This is the reason why the project decided to apply demonstration of weaving production system.

4 CONCLUSION

For designing the strategy of demonstration for reducing deforestation, problems were analysed. The analysis shown that development of agricultural market system, provision of technical and financial assistance on improved agricultural system, community awareness programmes and introduction of community forestry for the better management of forest are crucial both for providing better livelihood options and to reduce the deforestation. During the preliminary survey, villagers also indicated their interests in various options that they would like to adopt to improve their livelihood. The livelihood activities, which were demonstrated in the village, were evaluated during the workshop. The villagers showed their interests especially in terrace paddy, coffee plantation and weaving. From the survey, it was found that these activities comply with potential in the village and market potential is also high in Luang Prabang city.

APPENDIX 2: INFLUENCE OF SHIFTING CULTIVATION FOR SOIL CARBON

1 ABSTRACT

In order to analyse soil carbon dynamics under the land conversion from forest to cropland and/or land use of shifting cultivation which means land use of “reference level” in this project, we reviewed some published scientific literatures.

Murty et al. (2002[6]) reported that, in general, the land conversion from forest to cropland tended to decrease soil carbon over time. That is land use under the reference scenario results in soil carbon decrease and land use under the project activities will result in soil carbon increase compared with reference scenario. In addition, other literatures reported that the soil carbon under the shifting cultivation showed lower carbon contents compared with conserved forest (Chaplot et al., 2010[7]; Wairiu and Lal 2003[8]).

From results mentioned in above, it indicated that soil carbon in land under the project activities does not decrease compared to reference scenario (which is under shifting cultivation). Therefore, it should be in accordance with conservative manner to exclude carbon pool of soil carbon.

*Above mentioned basic information. Following section”1.2 Results” gives supplemental information.

2 RESULTS

Detail information of those 3 literatures was mentioned as follows. Each literature was arranged with the topic of Summary, Area / Climate zone, Landscape, Vegetation, and Soil, and showed the result about soil carbon of slash-and-burn land.

[6] Murty D, Kirschbaum MF, McMurtrie RE, McGilvray H (2002) Does conversion of forest to agricultural land change soil carbon and nitrogen? A review of literature. Global Change Biology, 8, 105–123.Wairiu M and Lal R (2003) Soil organic carbon in relation to cultivation and topsoil removal on sloping lands of Kolombangara, Solomon Islands. Soil and Tillage Research, 70, 19–27.

[7] Chaplot V, Bouahom B and Valentin C (2010) Soil organic carbon stocks in Laos: spatial variations and controlling factors. Global Change Biology, 16: 1380–1393

[8] Wairiu M and Lal R (2003) Soil organic carbon in relation to cultivation and topsoil removal on sloping lands of Kolombangara, Solomon Islands. Soil and Tillage Research, 70, 19–27.

2.1 Supplemental information from Murty et al. (2002)

Summary	Reviewed more than 50 study reports.
Area / Climate zone	Mainly tropical area (There was few studies in south-east Asia and no study in Lao PDR)
Landscape	-
Vegetation	-
Soil	-
Result	Most studies mentioned the soil carbon after land conversion from forest to agricultural land was reduced 0-60%. Feature and amount of crop residue influenced on soil carbon after land conversion.

2.2 Supplemental information from Chaplot et al. (2010)

Summary	Measured and compared soil carbon in forest land, slash-and-burn land and agricultural land in overall Lao PDR. Slash-and-burn land was divided 2types with fallow period (less than 5 years or more than 5 years). Effective data plot for analysis was 1,407.
Area / Climate zone	Overall Lao PDR / Tropical rainforest area
Landscape	-
Vegetation	-
Soil	Acrisol (Weathered is occurred by acidity. More than 70% of overall Lao PDR is acrisol land.)
Others	Sample plots were settled in overall Lao PDR based on expert's judgement
Result	Soil carbon (the 0-30cm depth) in slash-and-burn land was decreased around 2.5% compared to forest land.

2.3 Supplemental information from Wairiu and Lal (2003)

Summary	Compared to soil carbon between agricultural land (sweet potato field), which was slashed and burned, and nearby natural forest land. Sample soil survey was done 3 years after the forest was slashed and burned.
Area / Climate zone	Kolombangar, Solomon Islands/ Tropical rainforest area
Landscape	Slope land
Vegetation	Secondary forest was predominantly. Patches of primary forest was remained in lowland on steep slopes.
Soil	Weathered soil (low activity clays was cumulated by weathered)
Result	Soil carbon (the 0-30cm depth) in slash-and-burn land was decreased around 52% compared to natural forest land. Soil carbon with depth, especially the decreasing range in surface soil (the 0-15 cm depth) was large and it was decreased around 60% compared natural forest.

APPENDIX 3: PROCEDURES OF SATELITE IMAGERY ANALYSIS

1 INTRODUCTION

- Detection of land cover changes is implemented in comparison among imageries of different time points so that the historical trend of the detection of deforestation such as tree-clearing and wild fire or forest degradation can be created.

- There are two types of automatic detection as follows; (i) method to detect the change by creating forest type classification maps on a time point-by-time point basis; (ii) method to directly detect the change between imagery of two time points in figures.

- And for automatic classification, pixel-based or object-based image analysis is used in general. In this project, we used object-based analysis with supervised classification by creating forest distribution maps on a time point-by-time point basis to detect the changes.

- For extraction of the temporal changes, continuous time-series maps form 1994 to 2010 were made. The Map of 2010 was made for base map using high resolution satellite imagery. Based on this map, forest distribution maps were made from 1994 to 2009.

- It is difficult to classify old fallow land as fallow land by optical satellite imagery, because old fallow has similar spectral characteristics of forested area.

- Therefore it has been utilized classified data to get more high classification accuracy, i.e. the area where classified as SB was decided as fallow land after for next 15 years.

- From a viewpoint of the effectiveness, classification of all land cover types was done for 1994 and 2010, and the area of slash-and-burn and cloud/shade were extracted for from 1994 to 2009 satellite imageries.

2 SATELLITE IMAGERY

2.1 LANDSAT (1994 to 2004)

From 1994 to 2004, two types sensor of satellite imageries, Thematic Mapper (TM) mounted on LANDSAT 5 and The Enhanced Thematic Mapper Plus (ETM+) mounted on LANDSAT 7, were used for detecting time-series changes. Basic specification of both sensors and satellites was shown in the following Table 45.

Table 45 Basic specification of LANDSAT 5 and 7

Specification	LANDSAT 5	LANDSAT 7
Launch Date	March 1, 1984	April 15, 1999 (operational despite Scan Line Corrector (SLC) failure May 31, 2003)
Altitude	705 km	705 km
Inclination	98.2°	98.2°
Orbit	polar, sun-synchronous	polar, sun-synchronous
Sensors	TM, MSS	ETM+
Spatial Resolution	30 m (120 m - thermal)	30 m (60 m - thermal, 15-m pan)
Temporal Resolution	16 days	16 days
Image Size	185 km X 172 km	183 km X 170 km

HTTP://LANDSAT.GSFC.NASA.GOV/

LANDSAT TM has seven bands as follows: Visible, three bands (red, green, and blue); Near-infrared, one band; Short-wavelength infrared, two bands; and Thermal infrared, one band. A panchromatic band with a ground resolution of 15 meters is added to LANDSAT ETM+.

As a major feature, short-wavelength infrared bands (Bands 5 and 7) are provided. These wavelength bands are located in the wavelength for absorption of green leaves and moisture, thus, these are impacted by the amount of moisture in leaves (Table 46). Therefore, it is effective for the quantitative analysis of forest.

Table 46 Spectral range of each band

Band		LANDSAT TM		LANDSAT ETM+	
		µm	Resolution	µm	Resolution
1	Blue	0.45-0.52	30 m	0.45-0.515	30 m
2	Green	0.52-0.60	30 m	0.525-0.605	30 m
3	Red	0.63-0.69	30 m	0.63-0.69	30 m
4	Near Infrared	0.76-0.90	30 m	0.75-0.90	30 m
5	Short Wave Infrared	1.55-1.75	30 m	1.55-1.75	30 m
6	Thermal	10.4-12.5	120 m	10.4-12.5	60 m
7	Short-wave Infrared	2.08-2.35	30 m	2.09-2.35	30 m
8	Panchromatic	-	-	0.52-0.9	15 m

HTTP://LANDSAT.GSFC.NASA.GOV/

2.2 SPOT

For 2005, HRVIR-X sensor (MSS) mounted on SPOT 5, was used for detecting time-series changes. Basic specification of sensor and satellite was shown in the following Table 47.

Table 47 Basic specification of SPOT 5 MSS

Specification	SPOT 5 MSS
Launch Date	May 3, 2002
Altitude	822 km
Inclination	98.7°
Orbit	polar, sun-synchronous
Sensors	HRVIR-X (MSS)
Spatial Resolution	10 m (MSS)
Temporal Resolution	26 days
Image Size	60 km X 60 km

HTTP://WWW.SATIMAGINGCORP.COM/SATELLITE-SENSORS/SPOT-5.HTML

SPOT5 HRVIR-X sensor (MSS) has four bands as follows: Visible, two bands (red and green); Near-infrared, one band; Short-wavelength infrared, one band.

As a major feature, short-wavelength infrared band (Bands 4) is provided. This wavelength bands is located in the wavelength for absorption of green leaves and moisture, thus, this is impacted by the amount of moisture in leaves (Table 48). Therefore, it is effective for the quantitative analysis of forest.

Table 48 Spectral range of each band

Band		SPOT 5 MSS	
		µm	Resolution
1	Green	0.48-0.59	10 m
2	Red	0.61-0.68	10 m
3	Near Infrared	0.78-0.89	10 m
4	Short Wave Infrared	1.58-1.75	20 m

HTTP://WWW.SATIMAGINGCORP.COM/SATELLITE-SENSORS/SPOT-5.HTML

2.3 Rapid eye

For 2010, Multi-spectral sensor (MSS) mounted on RapidEye was used for detecting time-series changes. Basic specification of sensor and satellite was shown in the following Table 49.

Table 49 Basic specification of RapidEye

Specification	RapidEye
Launch Date	August 29, 2008 -
Altitude	630 km
Inclination	97.8°
Orbit	polar, sun-synchronous
Sensors	MSS
Spatial Resolution	6.5 m
Temporal Resolution	Daily(off-nadir) / 5.5 days(at nadir)
Image Size	77 km X 1,500 km (Tile Size: 25km X 25km)

HTTP://WWW.RAPIDEYE.COM/UPLOAD/RE_PRODUCT_SPECIFICATIONS_ENG.PDF

RapidEye has five bands as follows: Visible, three bands (red, green, and blue); Red Edge, one band; Near-infrared, one band.

As a major feature, Red Edge band (Bands 4) is provided. This band is located in the wavelength between red and near-infrared. Therefore, this band is effective for describing a deference of vegetation types (Table 50).

Table 50 Spectral range of each band

Band		RapideEye		LANDSAT ETM+	
		µm	Resolution	µm	Resolution
1	Blue	0.44-0.51	6.5 m	0.45-0.515	30 m
2	Green	0.52-0.59	6.5 m	0.525-0.605	30 m
3	Red	0.63-0.69	6.5 m	0.63-0.69	30 m
4	Red Edge	0.69-0.73	6.5 m	0.75-0.90	30 m
5	Near Infrared	0.76-0.85	6.5 m	1.55-1.75	30 m

HTTP://WWW.RAPIDEYE.COM/UPLOAD/RE_PRODUCT_SPECIFICATIONS_ENG.PDF

2.4 PALSAR

From 2006 to 2009, PALSAR mounted on ALOS was used for detecting time-series changes. Basic specification of sensor and satellite was shown in the following Table 51. In this project, spatial resolution was re-sampled to 10m spatial resolution.

Table 51 Basic specification of ALOS/PALSAR

Specification	ALSO/PALSAR
Launch Date	January 24, 2006
Altitude	692 km
Inclination	98.16°
Orbit	polar, sun-synchronous
Sensors	PALSAR (SAR)
Spatial Resolution	7-44 m (Fine mode)
Temporal Resolution	46 days
Image Size	70 km X 70 km

HTTP://LANDSAT.GSFC.NASA.GOV/

PALSAR has L band with a spatial resolution of 4 to 44 meters.

As a major feature, L band is provided. This band can go through green leaves though, can be reflected on branches or trunks of trees. Therefore, this band is suitable for extracting a difference between forest and non-forest (Table 52).

Table 52 Center frequency of band

Band		PALSAR	
		MHz (L-band)	Resolution
1	L	1270	10 m

HTTP://LANDSAT.GSFC.NASA.GOV/

3 CLASSIFICATION PROCESSING

3.1 Optical Sensor

3.1.1 LANDSAT TM and ETM+ (1994-2004)

3.1.1.1 Preprocessing of satellite imagery

In the classification processing, satellite imagery was firstly made forest distribution map and then change was detected by these maps.

For pre-processing of satellite imagery, following steps were conducted.

i. mosaic for imageries that acquired same date,

ii. subset to extract area of Luang Prabang Province of Lao PDR with 1km buffer,

iii. geometric correction by GCP

iv. atmospheric path-radiance correction by to subtract the minimum value from the histogram of imagery,

v. calculation of normalized differential vegetation index (NDVI) and analysis of principal component (PCA), and

vi. acquisition of training area for supervised classification

On pre-processing, image analysis software, Erdas Imagine (Intergraph Corporation), was used.

3.1.1.2 Classification process

Classification method is object-based image analysis. This is the method to conduct classification in terms of the object which is a gathering of pixels generated by domain division (segmentation). Compared with the pixel-based classification, the object can be assigned to one forest stand as an object, and can also have the texture information, not only spectral information.

After the object is generated using segmentation, the classification is conducted based on information such as tone or texture of the object. At that time, all of the classifications are not conducted at a time, but each of them is classified in a phased manner with the use of the decision-tree method to classify into each class. At the end of classification process, it was adjusted by manual classification for classification results.

As mentioned before, we prepare two kinds of maps, by full classification and slash-and-burn extraction, to set the time-series forest distribution map. The former is for map of 1994 and the latter for 1995 to 2004, classified using LANDSAT imageries.

Layers which are visible, near infrared and short wave infrared bands, NDVI, PCA, aspect and curvature, after pre-processing, were used for making map.

Firstly, these layers were processed segmentation, by image analysis software, eCognition developer 8.7 (Trimble Navigation Limited). Parameters for segmentation were three; scale parameter is 10, shape is 0.1, and compactness is 0.5.

After segmentation, decision-tree for each mosaic scene was made by statistical analysis using training area objects and then each object was applied to the land cover class from the decision-tree conditions.

3.1.2 SPOT (2005)

3.1.2.1 Pre-processing of satellite imagery

For pre-processing of satellite imagery, following steps were conducted.

i. mosaic for imageries that acquired same date,

ii. subset to extract area of Luang Prabang Province of Lao PDR,

iii. geometric correction by RPC file

iv. atmospheric path-radiance correction by to subtract the minimum value from the histogram of imagery,

v. calculation of normalized differential vegetation index (NDVI) and

vi. acquisition of training area for supervised classification

On pre-processing, image analysis software, Erdas Imagine (Intergraph Corporation), was used.

3.1.2.2 Classification process

Classification method is object-based image analysis. After the object is generated using segmentation, the classification is conducted based on information such as tone or texture of the object. At that time, all of the classifications are not conducted at a time, but each of them is classified in a phased manner with the use of the decision-tree method to classify into each class. At the end of classification process, it was adjusted by manual classification for classification results.

We extracted slash-and-burn land and rice paddy by SPOT imagery in 2005 to set 2005 forest distribution map by overlapping with 2004 forest distribution map.

Layers which are visible, near infrared and short wave infrared bands, NDVI and slope, after pre-processing, were used for making map.

Firstly, these layers were processed segmentation, by image analysis software, eCognition developer 8.7 (Trimble Navigation Limited). Parameters for segmentation were three; scale parameter is 15, shape is 0.1, and compactness is 0.5.

After segmentation, decision-tree for each mosaic scene was made by statistical analysis using training area objects and then each object was applied to the land cover class from the decision-tree conditions.

3.1.3 RapidEye (2010)

3.1.3.1 Pre-processing of satellite imagery

For pre-processing of satellite imagery, following steps were conducted. (RapidEye 3B products, which has already been ortho-rectified by GCP, is used)

i. mosaic for imageries that acquired same date,

ii. subset to extract area of Luang Prabang Province of Lao PDR,

iii. calculation of normalized differential vegetation index(NDVI) and

iv. acquisition of training area for supervised classification

On pre-processing, image analysis software, Erdas Imagine (Intergraph Corporation), was used.

3.1.3.2 Classification process

Classification method is object-based image analysis. After the object is generated using segmentation, the classification is conducted based on information such as tone or texture of the object. At that time, all of the classifications are not conducted at a time, but each of them is classified in a phased manner with the use of the decision-tree method to classify into each class. At the end of classification process, it was adjusted by manual classification for classification results.

We developed 2010 forest distribution map by overlapping a part of full classification in 2010 as above with 2009 forest distribution map.

Layers which are visible, near infrared band, NDVI and slope, after pre-processing, were used for making map.

Firstly, these layers were processed segmentation, by image analysis software, eCognition developer 8.7 (Trimble Navigation Limited). Parameters for segmentation were three; scale parameter is 200, shape is 0.1, and compactness is 0.5.

After segmentation, decision-tree for each mosaic scene was made by statistical analysis using training area objects and then each object was applied to the land cover class from the decision-tree conditions.

3.2 SAR

3.2.1 PALSAR (2006-2009)

3.2.1.1 Pre-processing of satellite imagery

For pre-processing of satellite imagery, following steps were conducted.

i. multi-look process is conducted,

ii. co-registration between scenes are observed in difference year,

iii. noises in scenes are filtered by refine lee methodology,

iv. generate backscatter coefficient imagery and some by products by conducting recoding process,

v. composite imagery is created by layer-stack process for neighbouring years,

vi. subset to extract area of Luang Prabang Province of Lao PDR,

On pre-processing, image analysis software, ENVI (Exelis Visual Information Solutions) and Erdas Imagine (Intergraph Corporation), were used.

3.2.1.2 Classification process

Classification method is object-based image analysis. After the object is generated using segmentation, the classification is conducted based on information backscatter coefficient, especially deference of backscatter coefficient between neighbouring years. At the end of classification process, it was adjusted by manual classification for classification results.

We extracted slash-and-burn land by PALSAR imagery from 2006 to 2009 to set 2006 to 2009 forest distribution maps by overlapping with 2005 forest distribution map.

Backscatter coefficient, after pre-processing, was used for making map.

Firstly, this layer was processed segmentation, by image analysis software, eCognition developer 8.7 (Trimble Navigation Limited). Parameters for segmentation were three; scale parameter is 15, shape is 0.1, and compactness is 0.5.

After segmentation, threshold of extracting slash-and-burn land is adjusted based on ground truth data acquired during 2006 to 2009.

4 POST PROCESSING USING GIS

4.1 How to extract Slash-and-burn and Fallow

Generally speaking, it is difficult to distinguish Mixed forest and fallow, especially old one by satellite imagery classification even with high resolution imagery. On the other hand, slash-and-burn patches (hereinafter S/B patches for short) in each year are much likely to be easy to extract compared to fallow vegetation. Focusing on this point, epoch-making methodology was developed in this project to extract fallow using S/B patches in each year. See following Figure 19 on how to extract fallow based on S/B patches, making better use of GIS overlay function (UNION command).

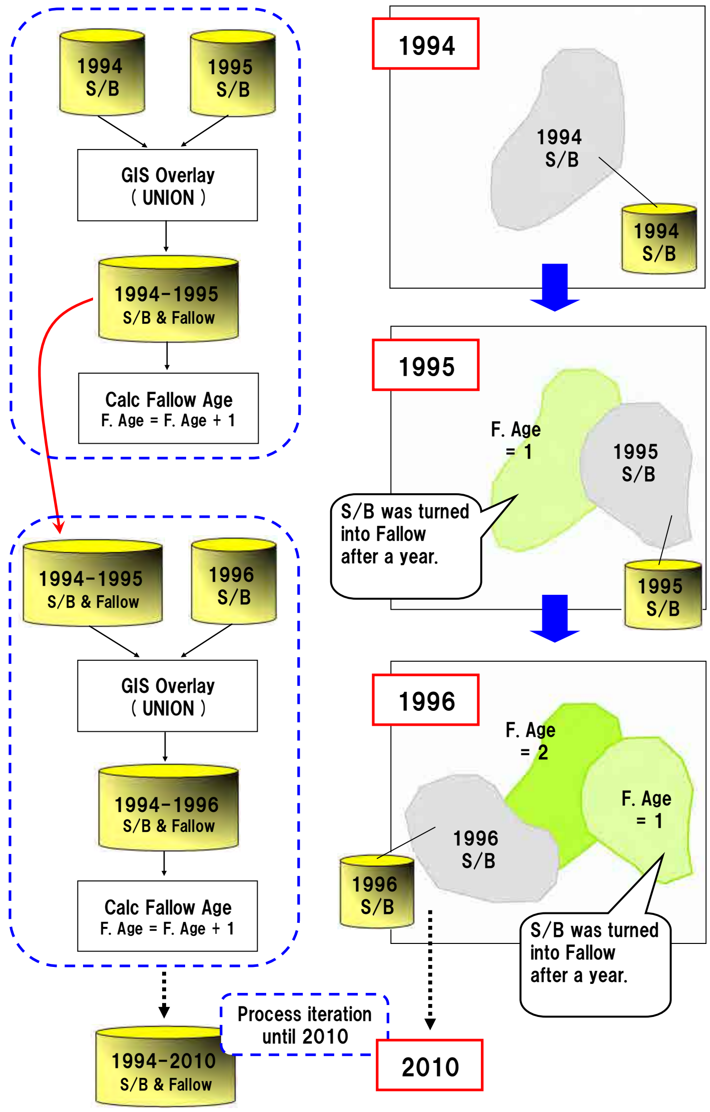


Figure 19 How to create time series S/B and Fallow polygon data

This methodology is based on an idea that S/B patches would turn into fallow next year with the age of it would be one year. And the fallow age would be incremented as time goes by. Applying this methodology to entire Luang Prabang province for year 1994 to 2010, complete S/B and fallow polygon dataset was created in this project.

4.2 How to create time-series FDM (Forest Distribution Maps)

As mentioned in "2. Satellite imagery" chapter, S/B patches for 1995 to 2004 were classified and extracted using LANDSAT imagery. (For 2005 to 2010, SPOT imagery, Rapid Eye imagery or ALOS-PALSAR imagery was utilized.) Cloud, Shadow, Shade polygons (and Rice paddy polygons) were also classified and extracted applying the same procedures as S/B extraction. Prior to creating FDM in each year, FDM1994 classified map was corrected using Mask dataset of Mixed forest which was derived from FDM2010, since classified fallow data in FDM1994 was thought to include mis-classified Mixed forest. And we regarded this corrected FDM1994 as the base map for creating FDM1995 to FDM2009. FDM in each year was created based on FDM1994 with overlaying each year's dataset for S/B and fallow, Cloud, Shadow, Shade polygons as following Figure 20. For polygon data overlay, GIS "UPDATE" function was used.

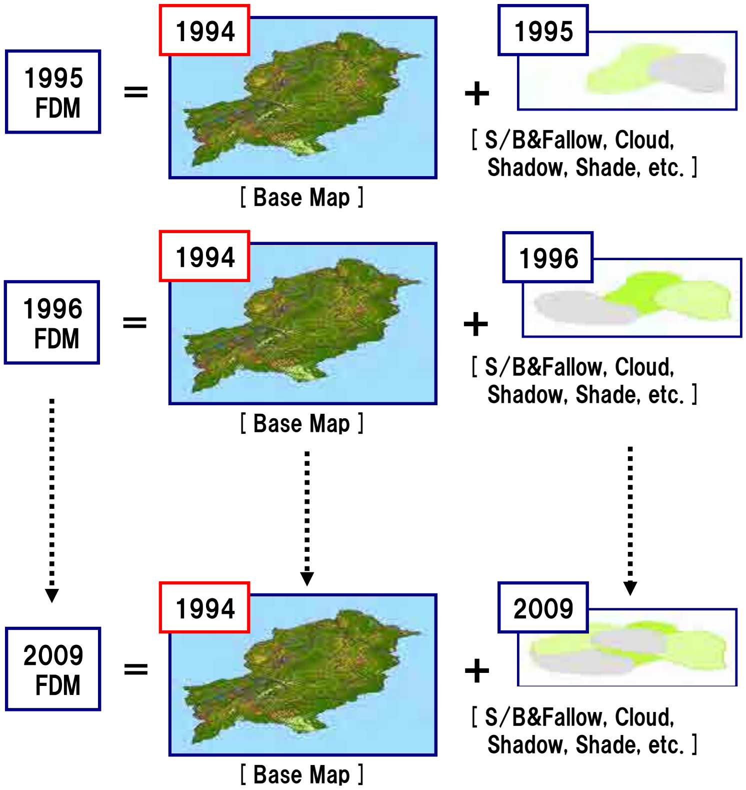


Figure 20　How to create time-series Forest Distribution Maps

APPENDIX ~~2~~4: SATELLITE IMAGERY LIST

fiscal year	Acquisition date (DD/MM/YYYY)	Satellite *	Scene identifier	
			Path	Row
1994	03/11/1994	LANDSAT 5	128	46
1994	25/10/1994	LANDSAT 5	129	46
1995	08/12/1995	LANDSAT 5	128	46
1995	16/01/1996	LANDSAT 5	129	46
1996	26/12/1996	LANDSAT 5	128	46
1996	03/02/1997	LANDSAT 5	129	46
1997	14/01/1998	LANDSAT 5	128	46
1997	02/11/1997	LANDSAT 5	129	46
1998	18/02/1999	LANDSAT 5	128	46
1998	05/11/1998	LANDSAT 5	129	46
1999	27/12/1999	LANDSAT 7	128	46
1999	26/12/1999	LANDSAT 5	129	46
2000	26/10/2000	LANDSAT 7	128	46
2000	02/11/2000	LANDSAT 7	129	46
2001	30/11/2001	LANDSAT 7	128	46
2001	23/12/2001	LANDSAT 7	129	46
2002	16/10/2002	LANDSAT 7	128	46
2002	08/11/2002	LANDSAT 7	129	46
2003	15/12/2003	LANDSAT 5	128	46
2003	05/12/2003	LANDSAT 5	129	46
2004	14/11/2004	LANDSAT 5	128	46
2004	07/12/2004	LANDSAT 5	129	46
2005	07/04/2005	SPOT4/5	263	308
2005	31/10/2006	SPOT4/5	264	309
2006	26/01/2007	ALOS/PALSAR	480	39
2006	26/01/2007	ALOS/PALSAR	480	40
2006	28/12/2006	ALOS/PALSAR	481	38
2006	28/12/2006	ALOS/PALSAR	481	39
2007	14/12/2007	ALOS/PALSAR	480	39
2007	14/12/2007	ALOS/PALSAR	480	40
2007	15/11/2007	ALOS/PALSAR	481	38
2007	15/11/2007	ALOS/PALSAR	481	39
2008	16/12/2008	ALOS/PALSAR	480	39
2008	16/12/2008	ALOS/PALSAR	480	40
2008	02/01/2009	ALOS/PALSAR	481	38
2008	02/01/2009	ALOS/PALSAR	481	39
2009	03/11/2009	ALOS/PALSAR	480	39
2009	03/11/2009	ALOS/PALSAR	480	40
2009	05/01/2010	ALOS/PALSAR	481	38
2009	05/01/2010	ALOS/PALSAR	481	39
2010	06/11/2010	ALOS/PALSAR	480	39
2010	06/11/2010	ALOS/PALSAR	480	40
2010	23/11/2010	ALOS/PALSAR	481	38
2010	23/11/2010	ALOS/PALSAR	481	39
2010	08/11/2010	RapidEye	4848204	
2010	08/11/2010	RapidEye	4848205	
2010	08/11/2010	RapidEye	4848305	
2010	14/11/2010	RapidEye	4848204	
2010	14/11/2010	RapidEye	4848304	
2010	04/12/2010	RapidEye	4848304	

* Specifications

satellite	sensor	Spatial resolution	Spectral resolution	Image size	Number of band	Temporal Resolution
		(m)	(μm)	(km)		(day)
LANDSAT 5	Thematic Mapper	30	0.45-12.5	185 X 172	7	16
LANDSAT 7	Enhanced Thematic Mapper Plus	30	0.45-12.5	183 X 170	8	16
SPOT4/5	HRVIR-X	20/10	0.5-1.75	60 X 60	4	26
ALOS	PALSAR	10	L-band, HH	70 X 70	1	46
RapidEye	MSS	6.5	0.44-0.88	25 X 25	5	1

PARTICIPATORY LAND AND FOREST MANAGEMENT PROJECT IN NORTHERN LAO PDR

Developed by the Japan International Cooperation Agency (JICA)

for

XXVV Co., Ltd. (a Japan-based private venture)
and
The Luang Prabang Provincial Agriculture and Forestry Office (PAFO)

with supports from
The Department of Forestry (DOF) under the Ministry of Agriculture and Forestry,
The Department of Forestry Resource Management (DFRM) under the Ministry of Natural Resource and Environment (MONRE),

Project Title	Participatory Land and Forest Management Project in northern LAO PDR
Version	Version 0.1
Date of Issue	31st August 2014
Project ID	
Monitoring Period	
Prepared By	*XXVV Co., Ltd. (a Japan-based private venture)*
Contact	*Under discussion*

Table of Contents

1 INTERNAL RISK

1.1 Project Management

- This project is categorised as “Type of Activity: Avoid Unplanned Deforestation (AUD)” and target site do not have much planted forests.
- This project aims to involve rural people into all project activities, and Land and Forest Management Committee (LFMC) consist of representatives of rural people implement and manage all project activities. Please see “1.3 Project Proponent” in PD.
- Officials of REDD+ Office and other Governments give advises to support the project management. Additionally, members of LFMC and local consultant have enough experiences and knowledge for implementing project activities. Please see “1.3 Project Proponent” in PD.
- Management team have enough knowledge regarding forest management system in Lao PDR and also have experiences of forest conservation project. Please see “1.3 Project Proponent” in PD.
- The management system is adaptive in the project area. It is because the system is based on ideas of rural people and regional governments (PAFO/DAFO). Please see “1.8 Description of the Project Activity” in PD.

1.2 Financial Viability

- Cash flow was analyzed before project start. It is clear to manage budget for 5 years after project start.
- The project proponents stored about 50% of project implementing budget before project start.

1.3 Opportunity Cost

- A net present value (NPV) from the most profitable land use activities in the HK-VC is not so much. It is estimated about 50% of project activities.
- Project proponents who conduct all activities in HK-VC are non profit organization. Please see “1.3 Project Proponent” in PD.
- All project activities are implemented after consultation process with PAFO/DAFO, and then they are according to low of Lao PDR. Please see “1.8 Description of the Project Activity” in PD.

1.4 Project Longevity

- This project is scheduled to implement activities for 40 years, which is from results of consultation with Lao REDD+ Office. Please see “1.6 Project Crediting Period” in PD.

2 EXTERNAL RISK

2.1 Land Tenure and Resource Access Impacts

- Ownership and resource access/use right are hold by same entity. Please see “13.4 Ownership and Other Programs” in PD.
- Land tenure and ownership in the project are clear. Please see “13.4 Ownership and Other Programs” in PD.

2.2 Community Engagement

- Almost 100% of households in project area relay on activities in project area.
- Project activities should bring positive impacts in the project area. Please see “17 ENVIRONMENTAL IMPACT” and “STAKEHOLDER COMMENTS” in PD.

2.3 Political Risk

- According to procedure in the "AFOLU Non-Permanence Risk Tool", the score is -0.91 which was based on World Bank Institute's Worldwide Governance Indicators (WGI)[1].

3 NATURAL RISK

3.1 Natural Risk

3.1.1 Significance

See attached MS-excel sheet. Values are estimated by past evidence and stakeholders experiences and comments.

3.1.2 Likelihood

See attached MS-excel sheet. Values are estimated by past evidence and stakeholders experiences and comments.

3.1.3 Score (LS)

See attached MS-excel sheet.

3.1.4 Mitigation

See attached MS-excel sheet.

[1] The World Bank Institute Worldwide Governance Indicators are available at: http://info.worldbank.org/governance/wgi/index.asp

STEP 1: RISK ANALYSIS

1 INTERNAL RISK

Project Management		
a)	Species planted (where applicable) associated with more than 25% of the stocks on which GHG credits have previously been issued are not native or proven to be adapted to the same or similar agro-ecological zone(s) in which the project is located.	0
b)	Ongoing enforcement to prevent encroachment by outside actors is required to protect more than 50% of stocks on which GHG credits have previously been issued.	0
c)	Management team does not include individuals with significant experience in all skills necessary to successfully undertake all project activities (ie, any area of required experience is not covered by at least one individual with at least 5 years experience in the area).	0
d)	Management team does not maintain a presence in the country or is located more than a day of travel from the project site, considering all parcels or polygons in the project area.	0
e)	**Mitigation:** Management team includes individuals with significant experience Management team includes individuals with significant experience in AFOLU project design and implementation, carbon accounting and reporting (eg, individuals who have successfully managed projects through validation, verification and issuance of GHG credits) under the VCS Program or other approved GHG programs.	0
f)	**Mitigation:** Adaptive management plan in place	0
Total Project Management [a + b + c + d + e + f]		0

Note: When a risk factor does not apply to the project, the score shall be zero for such factor

Financial Viability		
Q	How many years does it take for the cumulative cashflow to break even?	c)
Q	What percentage of funding is needed to cover the total cash out before the project breaks even has been secured?	g)
a)	Project cash flow breakeven point is greater than 10 years from the current risk assessment	0
b)	Project cash flow breakeven point is between 7 and up to less than 10 years from the current risk assessment	0
c)	Project cash flow breakeven point between 4 and up to less than 7 years from the current risk assessment	1
d)	Project cash flow breakeven point is less than 4 years from the current risk assessment	0
e)	Project has secured less than 15% of funding needed to cover the total cash out before the project reaches breakeven	0
f)	Project has secured 15% to less than 40% of funding needed to cover the total cash out required before the project reaches breakeven	0
g)	Project has secured 40% to less than 80% of funding needed to cover the total cash out required before the project reaches breakeven	1
h)	Project has secured 80% or more of funding needed to cover the total cash out before the project reaches breakeven	0
i)	**Mitigation:** Project has available as callable financial resources at least 50% of total cash out before project reaches breakeven	0
Total Financial Viability [(a, b, c or d) + (e, f, g or h) + i]		2
Note: When a risk factor does not apply to the project, the score shall be zero for such factor		

Opportunity Cost		
Q	What is the NPV from the most profitable alternative land use activity compared to NPV of project activity?	c)
a)	NPV from the most profitable alternative land use activity is expected to be at least 100% more than that associated with project activities; or where baseline activities are subsistence-driven, net positive community impacts are not demonstrated	0
b)	NPV from the most profitable alternative land use activity is expected to be between 50% and up to100% more than from project activities	0
c)	NPV from the most profitable alternative land use activity is expected to be between 20% and up to 50% more than from project activities	4
d)	NPV from the most profitable alternative land use activity is expected to be between 20% more than and up to 20% less than from project activities; or where baseline activities are subsistence-driven, net positive community impacts are demonstrated	0
e)	NPV from project activities is expected to be between 20% and up to 50% more profitable than the most profitable alternative land use activity	0
f)	NPV from project activities is expected to be at least 50% more profitable than the most profitable alternative land use activity	0
g)	**Mitigation:** Project proponent is a non-profit organization	-2
h)	**Mitigation:** Project is protected by legally binding commitment to continue management practices that protect the credited carbon stocks over the length of the project crediting period (see project longevity)	0
i)	**Mitigation:** Project is protected by legally binding commitment to continue management practices that protect the credited carbon stocks over at least 100 years (see project longevity)	-8
Total Opportunity Cost [(a, b, c, d, e or f) + (g + h or i)]		0
Note: When a risk factor does not apply to the project, the score shall be zero for such factor Total may not be less than zero		

Project Longevity		
Q	Does the project have a legally binding agreement that covers at least a 100 year period from the project start date?	No
Q	What is the project Longevity in years?	40
Q	Legal Agreement or requirement to continue management practice?	Yes
a)	Without legal agreement or requirement to continue the management practice	0
b)	With legal agreement or requirement to continue the management practice	10
Total Project Longevity		10
Note: Total may not be less than zero. Any project with a legally binding agreement that covers at least a 100 year period from the project start date will be assigned a score of zero. Any project with a project longevity of less than 30 years fails the risk assessment		
Total Internal Risk (PM + FV + OC + PL)		**12**
Note: Total may not be less than zero		

2 EXTERNAL RISK

Land and resource tenure		
Q	Are the ownership and resource access/use rights held by the same of different entities?	Different
a)	Ownership and resource access/use rights are held by same entity(s)	0
b)	Ownership and resource access/use rights are held by different entity(s) (eg, land is government owned and the project proponent holds a lease or concession)	2
c)	In more than 5% of the project area, there exist disputes over land tenure or ownership	0
d)	There exist disputes over access/use rights (or overlapping rights)	0
e)	WRC projects unable to demonstrate that potential upstream and sea impacts that could undermine issued credits in the next 10 years are irrelevant or expected to be insignificant, or that there is a plan in place for effectively mitigating such impacts	0
f)	**Mitigation:** Project area is protected by legally binding commitment (eg, a conservation easement or protected area) to continue management practices that protect carbon stocks over the length of the project crediting period	0
g)	**Mitigation:** Where disputes over land tenure, ownership or access/use rights exist, documented evidence is provided that projects have implemented activities to resolve the disputes or clarify overlapping claims	0
Total Land Tenure [(a or b) + c + d + e + f +g)]		**2**
Note: When a risk factor does not apply to the project, the score shall be zero for such factor Total may not be less than zero		

Community Engagement		
a)	Less than 50 percent of households living within the project area who are reliant on the project area, have been consulted	0
b)	Less than 20 percent of households living within 20 km of the project boundary outside the project area, and who are reliant on the project area, have been consulted	0
c)	**Mitigation:** The project generates net positive impacts on the social and economic well- being of the local communities who derive livelihoods from the project area	-5
Total Community Engagement [a + b + c]		**-5**
Note: When a risk factor does not apply to the project, the score shall be zero for such factor Total may be less than zero		

Political Risk		
Q	What is the country's calculated Governance score?	−0.91
a)	Governance score of less than −0.79	6
b)	Governance score of −0.79 to less than −0.32	0
c)	Governance score of −0.32 to less than 0.19	0
d)	Governance score of 0.19 to less than 0.82	0
e)	Governance score of 0.82 or higher	0
f)	**Mitigation:** Country implementing REDD+ Readiness or other activities such as: a) The country is receiving REDD+ Readiness funding from the FCPF, UN-REDD or other bilateral or multilateral donors b) The country is participating in the CCBA/CARE REDD+ Social and Environmental Standards Initiative c) The jurisdiction in which the project is located is participating in the Governors' Climate and Forest Taskforce d) The country has an established national FSC or PEFC standards body e) The country has an established DNA under the CDM and has at least one registered CDM A/R project	−2
Total Political [(a, b, c, d or e) + f)]		**4**
Note: When a risk factor does not apply to the project, the score shall be zero for such factor Total may not be less than zero		

Total External Risk (LT + CE +PC)	**1**
Note: Total may not be less than zero	

3 NATURAL RISK

Risk Category Factors		LS Value	Mitigation	Risk Rating
a)	Fire (F)	1	0.25	0.25
b)	Pest and Disease Outbreaks (PD)	0	0.25	0.00
c)	Extreme Weather (W)	1	0.25	0.25
d)	Geological Risk (G)	0	0.25	0.00
e)	Other natural risk (ON1)	0	0.25	0.00
f)	Other natural risk (ON2)	0	0.25	0.00
g)	Other natural risk (ON3)	0	0.25	0.00

Total Natural Risk [F + PD + W + G + ON]	0.50
Note: When a risk factor does not apply to the project, the score shall be zero for such factor	
Risk rating is determined by [LS x M]	

Total Natural Risk (F + PD + W + G + ON)	**0.50**
Note: Total may not be less than zero	
If the Total Natural Risk is above 35 then the project fails the entire risk analysis	

STEP 2: OVERALL NON-PERMANENCE RISK RATING AND BUFFER DETERMINATION

Risk Category		Rating
a)	Internal risk	12.00
b)	External risk	1.00
c)	Natural Risk	0.50
Overall risk rating (a + b + c)		**14**
Note: Overall risk rating shall be rounded up to the nearest whole percentage		
The minimum risk rating shall be 10, regardless of the risk rating calculated		
If the overall risk rating is over 60 then the project fails the entire risk analysis		
Total Risk Assessment		**14%**
Net change in the project's carbon stocks		53429
TOTAL NUMBER OF CREDITS TO BE DEPOSITED IN THE AFOLU POOLED BUFFER ACCOUNT		7480

Validation and Registration of the Project on REDD plus through Participatory Land and Forest Management for Avoiding Deforestation in Lao PDR

Technical Cooperation Report

- Manual of Participatory Forest Carbon Monitoring -

October 2014

Japan International Cooperation Agency (JICA)

Mitsubishi UFJ Research and Consulting

Japan Forest Technology Association

Implementation Manual for Participatory Forest Monitoring

1. Background

Global warming affects human security worldwide, and the international community is taking action to tackle this. Especially, averting deforestation and forest degradation in developing countries is considered to be an effective countermeasure. In addition, sustainable forest management can help not only mitigate global warming but also contribute to sustainable development of local communities. Success of sustainable forest management comes from collecting forest resources and feeding back this information to forest management planning. For forest monitoring, it is important to develop a participatory framework for local communities. The rationale of this is that most drivers of deforestation and forest degradation are linked to local communities, so the participation of local communities is needed to avert these drivers. Such activities make local people aware of the importance of forest management.

【What is REDD+?】

"Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries"

【Why REDD+?】

"As a result of recent policy developments under the United Nations Framework Convention on Climate Change (UNFCCC), a large market for carbon credits from tropical forests is likely to open up soon.

If developing countries are able to decrease their rates of deforestation and forest degradation, the resulting reduction of emissions of greenhouse gases may be credited and compensated either directly through a market or via a global fund."

2. Objectives of the Manual

This manual is applicable to forest resources monitoring under slash and burn agriculture areas in LAO P.D.R. Especially, careful attention is given to monitoring of regeneration process after slash and burn activity. Also, collaborative work with local officials and local communities is mentioned. In principle, the target of monitoring is defined as forest area and volume.

2.1. Why the Participatory Approach?

Most rural communities depend in part on forest products and practice a form of cyclical shifting cultivation.

The loss of forest biomass tends to be linked to exploitation of forest products by local communities in areas where natural regeneration capacity of the forest is overwhelmed. The forest starts to degrade, gradually losing biomass stock and thus also carbon.

These trends can often be reversed through improved management at the community level. Forest monitoring functions are shared among stakeholders, and local people work together with forestry professionals to develop and implement monitoring systems.

2.2. What is PFM?

PFM is not a specific methodology or monitoring protocol, but a multifaceted approach that encompasses a range of forest monitoring activities, from carbon stock changes and biodiversity to social impacts of REDD+.

2.3. The Merits of PFM

The idea of PFM is to introduce a form of decentralized sustainable management.
The success of PFM leads to the following benefits.

- The community gains by no longer living in conflict with forest officials, and by increasing the health and productivity of the forest.
- The state gains because this kind of management is often quite effective, and much cheaper and easier than protecting the forest by force.

3. Overall Methodology of Forest Monitoring

As mentioned earlier, this manual focuses on forest monitoring of slash and burn agricultural areas. Therefore, it is important to clarify the cycle of slash and burn agriculture and apply appropriate methodology for each stage. The following figure shows the cycle of forest status changes in context with slash and burn agricultural areas.

Stage-1 means just after slash and burn and applies the boundary measurement of burned area by GPS.

Threshold of 16 years means the point where scrub land becomes forest land with tree height of 5 meters, which is defined as category of forest in Lao P.D.R.

In Stage-2, small trees are dense and it is difficult to conduct circle shape plot survey. Therefore, rectangular shape plots should be applied.

After Stage-2, several high trees appear and this stage is defined as Stage-3. At this stage, understory vegetation is reduced and it is easy to walk around inside the forest. Circle shape plots are appropriate to conduct forest monitoring at this stage.

Normally, fallow land is reused for slash and burn again. But in some cases, such as spiritual areas or newly designated national parks, fallow land is protected and is not reused for slash and burn agriculture. This case is defined as Stage-4 and the circle shape plot is applied. In this circle shape plot, we need to secure an appropriate survey area to collect forest information. Therefore, radius of circle plot becomes longer than Stage-3 and it is difficult for local people to implement. For this reason, forest monitoring of Stage-4 is conducted by local officers and/or outsourced experts.

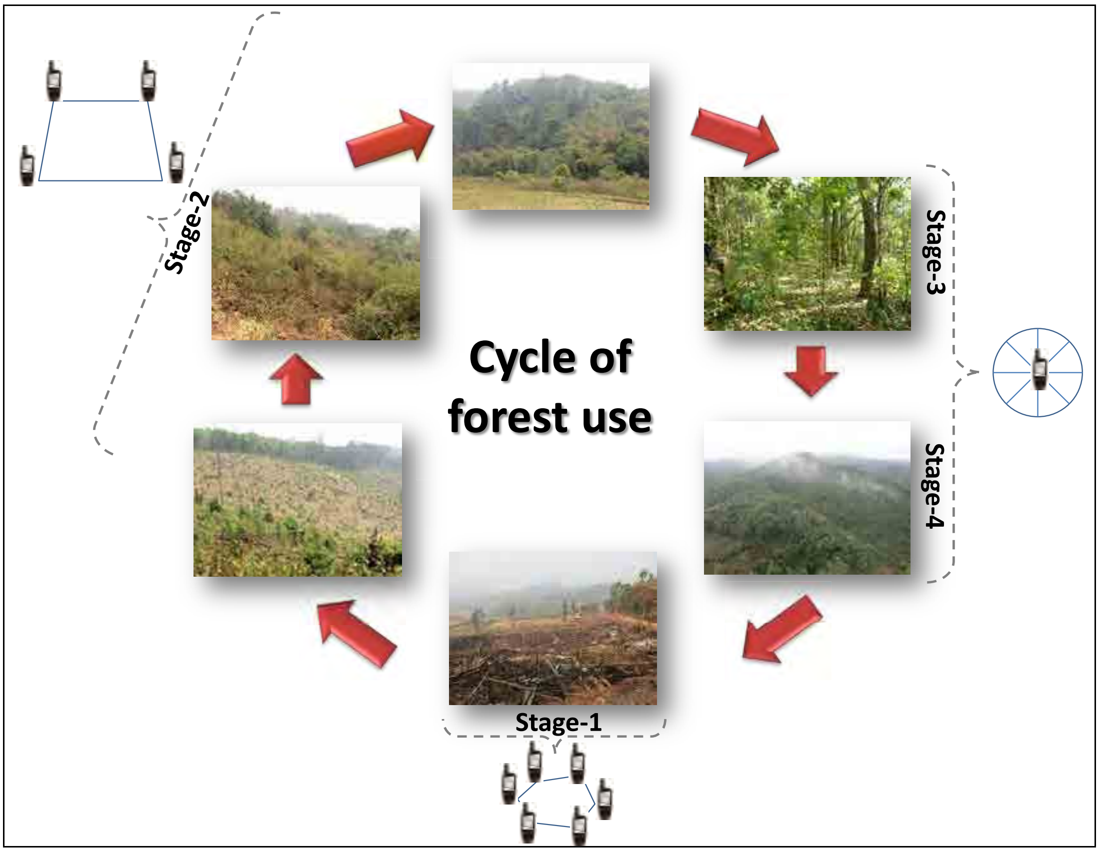


Fig-1 Stages of forest use related to slash and burn cultivation

Table-1 shows monitoring targets in different stages and also identifies responsibilities for conducting forest monitoring.

Table-1 Monitoring targets and responsibilities

Stage	Subjects	Responsibilities	Methods
Stage-1	Boundary delineation of S/B	Villagers/NGO	Boundary measurement by GPS
Stage-2	Growth monitoring of fallow land (less than 16 years)	Villagers/NGO	Rectangular plot survey in the field
Stage-3	Growth monitoring of fallow lands (16 years and above)	Villagers/NGO	Circular plot survey in the field
Stage-4	Growth monitoring of natural forest	PAFO/DAFO	Circular plot survey in the field

4. Responsibility of relevant stack holders

4.1. General

In the process of assessment to identify forest change dynamism under slash and burn agriculture area, relevant official such as DAFO and PFAO is designated to key player. In addition, local community and individual house hold is also important stakeholder. Participation of local community is necessary to success land use planning and management of their own forest. Forest monitoring activities could raise awareness of local people and improve ownership.

In this session describes institutional arrangement on forest monitoring. Experts from PAFO and DAFO could nominate officials to conduct forest status surveys. But due to limited human resources as local officials, covering huge forest area is impossible and corroborative work with local community is indispensable.

In addition, as mentioned above, implementation of participatory forest monitoring makes people more aware.

On a technical level, forest monitoring on the individual household level seems difficult. For this reason, village groups that have conducted land use planning could play an important role in forest monitoring activities. Involving local consultants and/or NGOs into these village groups and working together with individual households might be a realistic and ideal framework.

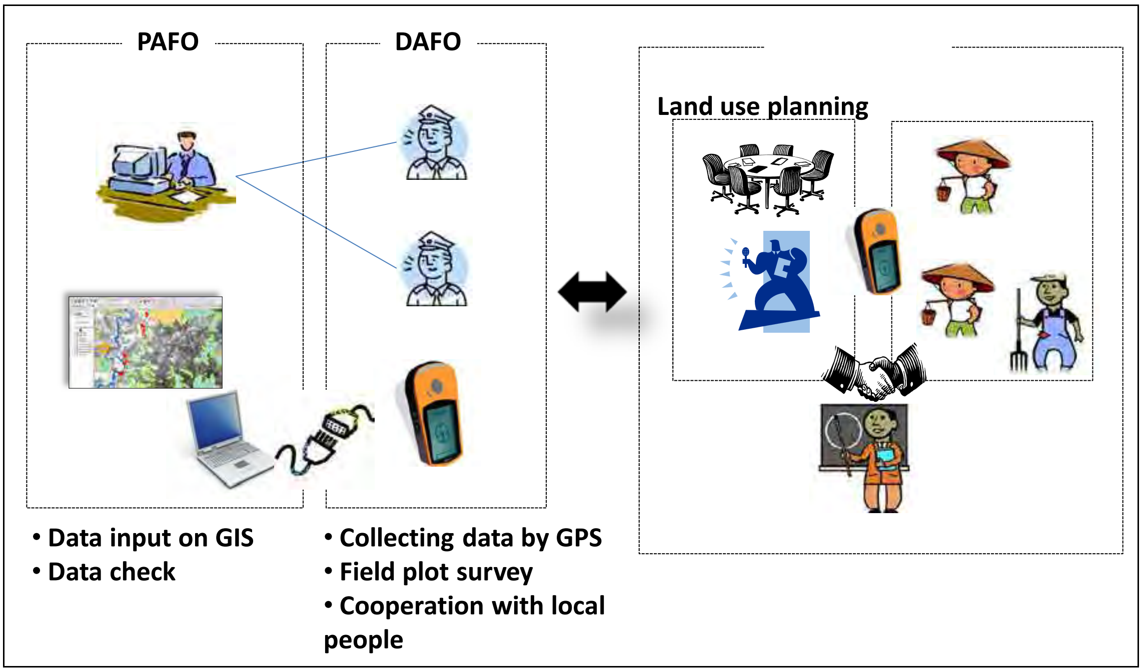


Fig-2 Collaborative work with local officers and local communities

4.2. Responsibility of each stakeholder

4.2.1. PAFO/DAFO

Technical staffs of PAFO and DAFO obtain high skill and expertise to conduct forest monitoring. As mentioned in table-1 above, growth monitoring in natural forest shall be conducted by PAFO/DAFO due to large size of sampling plot. In this monitoring, plot setting required high skill of measurement. Not only about plot sampling, but also data collection and aggregation is important mandate for PAFO/DAFO. Input data could categories two types. One is plot sampling data and the other is geographical information such as forest change boundary. Boundary delineation shall conduct by local people and/or group of villager but data input into GIS required high skill and equipment. Therefore, data input process work allocate to PAFO with the cooperation of DAFO.

Another important function of PAFO/DAFO is technical support to relevant stakeholders. For example, local community could not maintain forest monitoring technique from one generation to next generation. Maintain quality of information about forest monitoring, regular capacity build is necessary. In that occasion, PAFO/DAFO technical staff could be a trainer to develop capacity of local community.

4.2.2. Individual house hold and village group

Based on land use planning, individual house hold cultivates their land and mostly used to slash and burn activity. In principally, individual house hold shall measure and report forest change to relevant officer. But due to lack of technical skill, it is ideal to organize forest monitoring team under village group. In the process of PAREDD (Participatory Approach for Reduce Deforestation and Deforestation), village group shall be developed and group leading land use plan making and livelihood management for income generation. Utilizing village group framework, it is ideal to launch forest monitoring team and operate forest change monitoring when change event has happen.

4.2.3. NGO

Function of NGO is intermediate PAFO/DAFO and village group. As mentioned above, PAFO/DAFO shall conduct technical support and develop capacity of local community. But due to limitation of human resource, PAFO/DAFO could not cover whole activity and area belongs to. In this case, NOG could play supplementary work to support PAFO/DAFO.

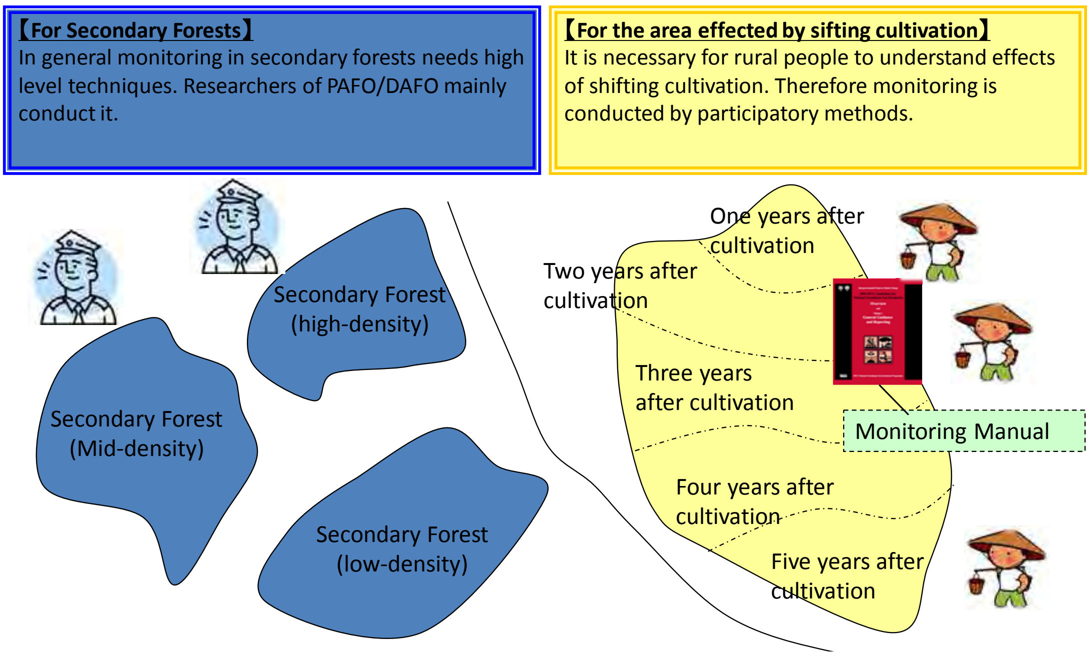


Fig-3 Demarcation by forest growth stages and implementers

Manual for Stage- 1

Stage	Subjects	Responsibilities	Methods
Stage-1	Boundary delineation of S/B	Villagers	Boundary measurement by GPS
Stage-2	Growth monitoring of fallow lands (less than 16 years)	Villagers	Rectangular plot survey in the field
Stage-3	Growth monitoring of fallow lands (16 years and above)	Villagers	Circular plot survey in the field
Stage-4	Growth monitoring of natural forest	PAFO/ DAFO	Circular plot survey in the field

1. Stage-1(Slash and burn area)

1.1. General

Just before burning, all trees are cut and felled clear. In this survey, boundary of clear cutting area is measured by GPS and store location, shape and area information. Individual corners of boundary should be measured by geographical coordination for the purpose of identifying shape of the slash and burn area.

Photo-1 Just after burning

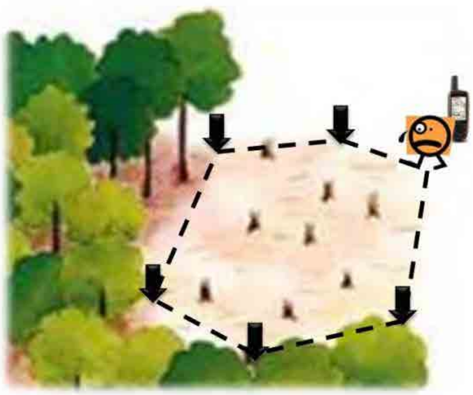


Fig-4 Individual corner measuring by GPS

1.2. Implementers

It is effective to conduct corroborative work with individual households and the village land use planning group to conduct forest monitoring for Stage-1. Collected information is provided to related government offices through the village group.

1.3. Survey method and items to be collected

Owner of area, Last fallow years, Forest types before use, Planning agricultural products, Area of slash and burn (calculated after survey), Land use categories (Protection, Production, etc.).

1.4. Survey sheets

Below mentioned documents describe survey sheet of Stage-1.

AREA MEASUREMENT

AREA ID#	:	Page - (1)	Date	:	/ / 20
District	:		Start time	:	:
Village	:		End time	:	:
Crew chief	:		Total time	:	m
Data recorded by	:				
# peopele in crew	:				

General Information

1) Owner of the Area;

2) Distance from residence (Approximately)

3) Planting Products; Stick rice, Maize, Corn, Others ( )

4) Fallow years of this Area;

5) Previous forest type;

6) Slashed and Burned year;

7) Total Area(ha) *<- Result from GPS measurement*;

Plot location Center

GPS :	X	
	Y	

Field Photo

Sketch of Boundary

Manual for Stage-2

Stage	Subjects	Responsibilities	Methods
Stage-1	Boundary delineation of S/B	Villagers	Boundary measurement by GPS
Stage-2	Growth monitoring of fallow lands (less than 16 years)	Villagers	Rectangular plot survey in the field
Stage-3	Growth monitoring of fallow lands (16 years and above)	Villagers	Circular plot survey in the field
Stage-4	Growth monitoring of natural forest	PAFO/ DAFO	Circular plot survey in the field

2. Stage-2 (Fallow land; less than 16 years after slash and burn)

2.1. General

Small trees appear in fallow land within 16 years. It is also difficult to set a large size survey plot. Therefore, initial survey is conducted over rectangular plot measuring approximately 7.5m by 7.5m and every tree with DHB larger than 1cm is measured.

In this initial survey, four corners of geographic coordinates are measured by GPS. On the next repeat monitoring, these coordinates are referenced to construct same plot shape and to re-measure all standing trees.

Photo-2 Field survey on fallow land (4 years)

Fig-5 Four corners measurement by GPS

2.2. Implementers

Work is conducted together with the forest monitoring team established within the village group and technical support is sought from PAFO and DAFO if necessary.

2.3. Survey method and items to be collected

Owner of the area, Survey year, Year of fallow land, Area, Total number of standing trees, Number of standing trees by hectare and geographical coordination of four corners.

2.4. Survey sheets

Below documents describe survey sheets of Stage-2 (fall land less than 16 years).

<table>
<tr><td>Objective</td><td>To set up plots in which measurements will be taken</td></tr>
<tr><td>Result</td><td>Random sample plots located</td></tr>
<tr><td>Responsibility</td><td>PFM team</td></tr>
<tr><td>Materials/ equipment</td><td>For making Square Plots for temporary sampling plot

GPS
Tape measure (50m)
Binding materials (substitution of rope)
Stakes (use fallen branches at the field)
Compass
Spray ink
Tape for marking the way to go
</td></tr>
<tr><td>Implementation</td><td>Establishing the plot

Navigate to predetermined latitude and longitude using a GPS.
The sampling plots are located at random locations in the forest.
Care should be taken to use representative locations (i.e. neither too dense nor too open, flat versus slope, etc.).
The slope of the plot is recorded using the clinometer.

The dimension of the plot is dependent on the type and condition of the forest.
<table>
<tr><td>Type</td><td>Condition</td><td></td><td>Size (radius)</td></tr>
<tr><td rowspan="7">Natural</td><td colspan="2">10 or more trees with DBH >5cm</td><td>500m2 (12.62m)</td></tr>
<tr><td rowspan="2">Less than 10 trees with DBH >5cm</td><td>25 or more trees with DBH <5cm</td><td>500m2 (12.62m)</td></tr>
<tr><td>Less than 25 trees with DBH <5cm</td><td>1,000m2 (17.84m)</td></tr>
<tr><td colspan="2">No trees with DBH >5cm</td><td>500m2 (12.62m)</td></tr>
<tr><td colspan="2">Bamboo</td><td>100m2 (5.64m)</td></tr>
<tr><td rowspan="2">Mixed forest</td><td>Tree – bamboo</td><td>500m2 (12.62m)</td></tr>
<tr><td>Bamboo – tree</td><td>100m2 (5.64m)</td></tr>
<tr><td rowspan="2">Plantation</td><td colspan="2">Irregularly spaced</td><td>As above for trees or bamboo</td></tr>
<tr><td colspan="2">Regularly spaced</td><td>5 rows x 5 trees</td></tr>
</table>

The stake with attached rope is driven into the ground in the center of the plot (except for the regularly spaced plantation).
Depending on the plot size, a knot is made in the rope to indicate the limit of the plot (this can also be prepared by the facilitators in the office; use colored bands to indicate the distance).
</td></tr>
</table>

PLOT SETTING

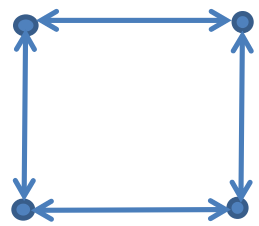
Plot ID#	:	Page – (1)	Date	: / / 2(
District	:		Start time	: :
Village	:		End time	: :
Crew chief	:		Total time	: mi
Data recorded by	:			
# peopele in crew	:			

Plot location (rectanglar)

GPS :

point	[1]	[2]	[3]	[4]
X				
Y				

GPS [2] GPS [3]



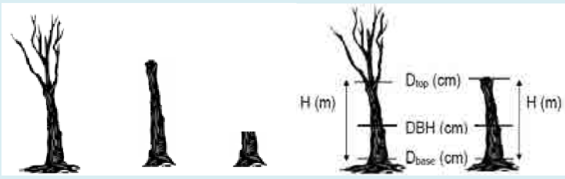
GPS [1] GPS [4]

Fallow land

year after S/B : 1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 –10 – 11 –12 – 13– 14– 15

Select the environmental situation:
near the the road
near the river

Objective	Measure the standing of trees and bamboo
Result	Forest properties measured for plot-wise above-ground biomass calculation
Responsibility	PFM team
Materials/ equipment	· Tree poles (Use bamboo of 1.5m and mark DBH at 1.3m) · Diameter tape · Chalk sticks · Writing board with paper forms
Implementation	① Assign one person to record the data and make him/her stand in the center. All others should be measuring and marking trees. ② Start measuring from North and the first trees. After the measuring, a chalk mark should be placed around each tree so that it can be seen from any direction. <The case for natural forests with trees> ③ Measure the DBH of every tree with DBH >5cm using the diameter tape. (If the tree is on the edge of the plot, only record it if the center is inside the plot.) ④ Record the BDS in centimeters. ⑤ Record the name of the tree if it can be identified(based on tree naming system developed prior to field data collection) ⑥ If the tree is on a slope, forked, leaning, etc. use the appropriate height for measurement from the figure on the next page. ⑦ Tally every tree that has DBH <5cm (i.e. count the total number of small trees in the plot; do not measure them). ⑧ Repeat until the first marked tree is encountered. <Other cases if necessary> For natural forests with bamboo : · Bamboo is measured by age and average height, if possible. Age of bamboo can be determined using the information in the annex. · If the bamboo is monopodial (single stem), DBH is measured as for trees. · If the bamboo is growing sympodial (in a culm), DBH of 10 individual stems in each culm (spread out over the culm) is taken, as well as the DBH of the entire culm For mixed forests: · Use the approach for trees and bamboo as specified above. · Use separate forms for the trees and bamboo (monopodial or sympodial). For plantations, regularly spaced: · Record the distance between the rows and between trees within rows. · Record the DBH of 5 trees in 5 adjacent rows in centimeters. · Record the height of these trees where possible. · Record the species.

Objective	To take measurements of the standing dead wood
Result	Standing dead wood measured
Responsibility	PFM team
Materials/ equipment	· Poles · Measuring tape · Clinometer
Implementation	・“Standing dead wood” refers to trees that have died but are still upright. ・Measurement of standing dead wood takes place concurrently with live tree measurements. ・There are 2 classes of trees for standing dead wood. <Class1>  Dead tree with branches and twigs that resembles a live tree except for absence of leaves ・Measure DBH (same as measuring live trees) ・Write as “Dead” on datasheet. <Class 2>  Trees ranging from those containing small and large branches to those with bole only. ・Measure DBH using methods for live trees ・Measure diameter at the base of the tree ・Measure diameter at the top (cm) , if possible. Alternatively, do not take a measurement at the top and write “None” on datasheet.

TREE MEASUREMENT （Live Tree）

Plot ID# :	page-( )	Date	: / / 2013
Data recorded by :		Start time	: :

Live Tree measurements （DBH>5cm）

Tree #	Species	E/D	DBH (cm)	remarks	Tree #	Species	EG/DD	DBH (cm)
1		E/D			51		E/D	
2		E/D			52		E/D	
3		E/D			53		E/D	
4		E/D			54		E/D	
5		E/D			55		E/D	
6		E/D			56		E/D	
7		E/D			57		E/D	
8		E/D			58		E/D	
9		E/D			59		E/D	
10		E/D			60		E/D	
11		E/D			61		E/D	
12		E/D			62		E/D	
13		E/D			63		E/D	
14		E/D			64		E/D	
15		E/D			65		E/D	
16		E/D			66		E/D	
17		E/D			67		E/D	
18		E/D			68		E/D	
19		E/D			69		E/D	
20		E/D			70		E/D	
21		E/D			71		E/D	
22		E/D			72		E/D	
23		E/D			73		E/D	
24		E/D			74		E/D	
25		E/D			75		E/D	
26		E/D			76		E/D	
27		E/D			77		E/D	
28		E/D			78		E/D	
29		E/D			79		E/D	
30		E/D			80		E/D	
31		E/D			81		E/D	
32		E/D			82		E/D	
33		E/D			83		E/D	
34		E/D			84		E/D	
35		E/D			85		E/D	
36		E/D			86		E/D	
37		E/D			87		E/D	
38		E/D			88		E/D	
39		E/D			89		E/D	
40		E/D			90		E/D	
41		E/D			91		E/D	
42		E/D			92		E/D	
43		E/D			93		E/D	
44		E/D			94		E/D	
45		E/D			95		E/D	
46		E/D			96		E/D	
47		E/D			97		E/D	
48		E/D			98		E/D	
49		E/D			99		E/D	
50		E/D			100		E/D	

Dead wood measurement

	Species	S/F	DBH (1.3m)		Species	S/F	DBH (1
1		S/F		6		S/F	
2		S/F		7		S/F	
3		S/F		8		S/F	
4		S/F		9		S/F	
5		S/F		10		S/F	

S: stand
F: fallen

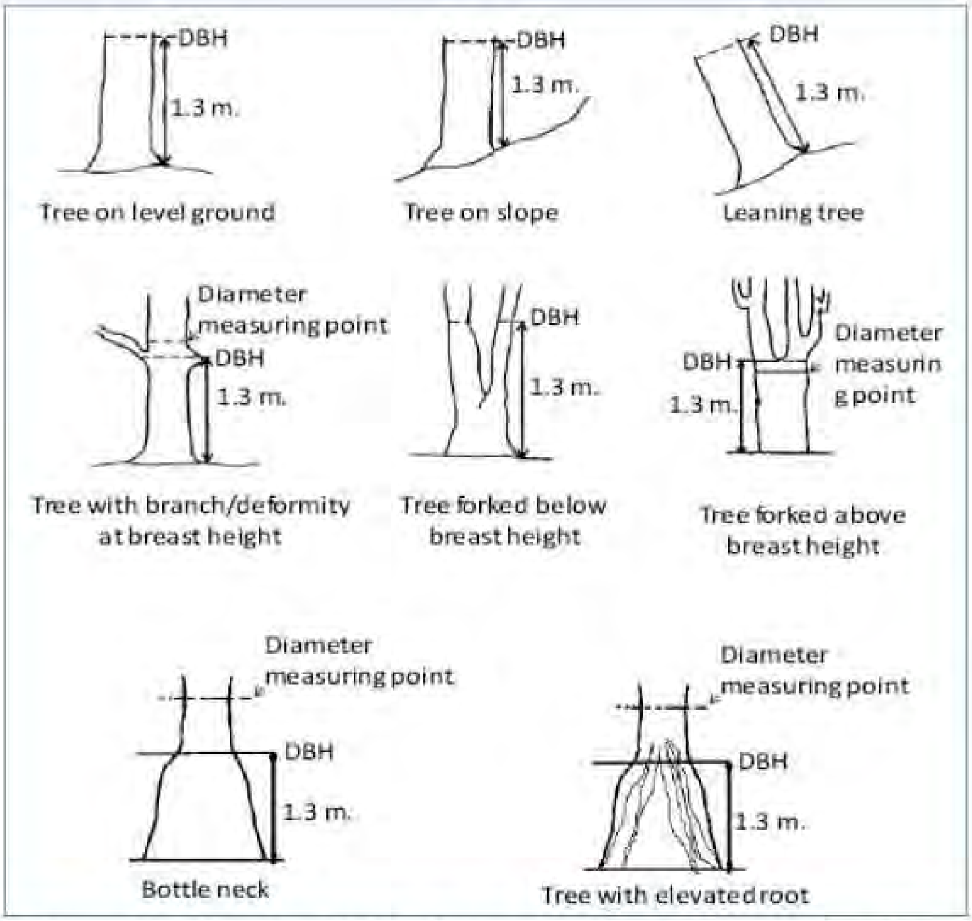


Figure 1: Measuring DBH of trees. (Source: Bhishma et al, 2010)

Manual for Stage-3

Stage	Subjects	Responsibilities	Methods
Stage-1	Boundary delineation of S/B	Villagers	Boundary measurement by GPS
Stage-2	Growth monitoring of fallow lands (less than 16 years)	Villagers	Rectangular plot survey in the field
Stage-3	Growth monitoring of fallow lands (16 years and above)	Villagers	Circular plot survey in the field
Stage-4	Growth monitoring of natural forest	PAFO/ DAFO	Circular plot survey in the field

3. Stage-3 (Fallow land; 16 years and above after slash and burn)

3.1. General

Circular shape plot survey is adapted to fallow land over 16 years. In these years, high trees comprise developed forest. Therefore, to secure accurate measurement, large area survey is required but setting of large rectangular area needs high expertise. Setting circular survey area by rope is a unique and effective way of plot setting.

Photo-3 Fallow land after 16 years

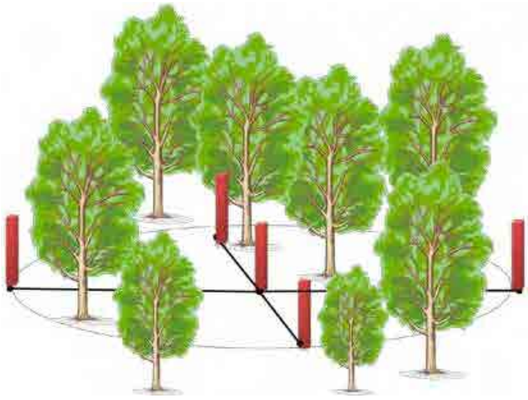


Fig-6 Forest survey by circular shape plot

3.2. Implementers

Work is conducted together with the forest monitoring team established within the village group and technical support is sought from PAFO and DAFO if necessary.

3.3. Survey method and items to be collected

Owner of the area, Survey year, Years of fallow land, Area, Total number of standing trees, Number of standing trees by hectare, and geographical coordination of four corners.

3.4. Survey sheets

Below documents describe survey sheets of Stage-3 land that has been fallow for 16 years or more.

<table>
<tr><td>Objective</td><td>To set up plots in which measurements will be taken</td></tr>
<tr><td>Result</td><td>Random sample plots located</td></tr>
<tr><td>Responsibility</td><td>PFM team</td></tr>
<tr><td>Materials/ equipment</td><td>For making Square Plots for temporary sampling plot
・ GPS
・ Tape measure (50m)
・ Binding materials (substitution of rope)
・ Stakes (use fallen branches at the field)
・ Compass
・ Spray ink
・ Tape for marking the way to go</td></tr>
<tr><td>Implementation</td><td>Establishing the plot
・ Navigate to predetermined latitude and longitude using a GPS.
・ The sampling plots are located at random locations in the forest.
・ Care should be taken to use representative locations (i.e. neither too dense nor too open, flat versus slope, etc.).
・ The slope of the plot is recorded using the clinometer.

The dimension of the plot is dependent on the type and condition of the forest.

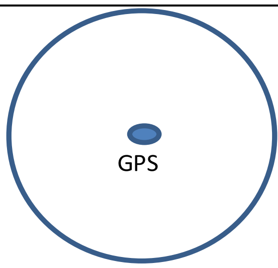
<table>
<tr><th>Type</th><th>Condition</th><th></th><th>Size (radius)</th></tr>
<tr><td rowspan="7">Natural</td><td colspan="2">10 or more trees with DBH >5cm</td><td>500m2 (12.62m)</td></tr>
<tr><td rowspan="2">Less than 10 trees with DBH >5cm</td><td>25 or more trees with DBH <5cm</td><td>500m2 (12.62m)</td></tr>
<tr><td>Less than 25 trees with DBH <5cm</td><td>1,000m2 (17.84m)</td></tr>
<tr><td colspan="2">No trees with DBH >5cm</td><td>500m2 (12.62m)</td></tr>
<tr><td colspan="2">Bamboo</td><td>100m2 (5.64m)</td></tr>
<tr><td rowspan="2">Mixed forest</td><td>Tree – bamboo</td><td>500m2 (12.62m)</td></tr>
<tr><td>Bamboo – tree</td><td>100m2 (5.64m)</td></tr>
<tr><td rowspan="2">Plantation</td><td colspan="2">Irregularly spaced</td><td>As above for trees or bamboo</td></tr>
<tr><td colspan="2">Regularly spaced</td><td>5 rows x 5 trees</td></tr>
</table>
・ The stake with attached rope is driven into the ground in the center of the plot (except for the regularly spaced plantation).
・ Depending on the plot size, a knot is made in the rope to indicate the limit of the plot (this can also be prepared by the facilitators in the office; use colored bands to indicate the distance).</td></tr>
</table>

PLOT SETTING

Plot ID#	:	Page – (1)	Date	: / / 2
District	:		Start time	: :
Village	:		End time	: :
Crew chief	:		Total time	: mi
Data recorded by	:			
# peopele in crew	:			

Plot location

GPS :	X	
	Y	



Plot setting

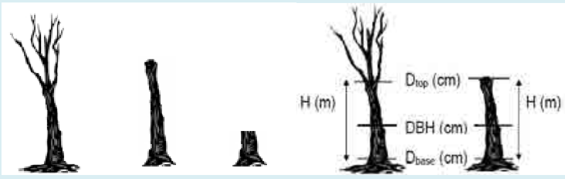
radius	: 5 / 7.5 / 10 / 15	m
area	:	m2
Slope	:	degree

Forest

Forest Type : Evergreen Forest / Decidius Forest

Select the environmental situation:
near the the road
near the river

Objective	Measure the standing of trees and bamboo
Result	Forest properties measured for plot-wise above-ground biomass calculation
Responsibility	PFM team
Materials/ equipment	· Tree Poles (Use bamboo of 1.5m and mark DBH at 1.3m) · Diameter tape · Chalk sticks · Writing board with paper forms
Implementation	⑨ Assign one person to record the data and make him/her stand in the center. All others should be measuring and marking trees. ⑩ Start measuring from North and the first trees. After the measuring, a chalk mark should be placed around each tree so that it can be seen from any direction. <The case for natural forests with trees> ⑪ Measure the DBH of every tree with DBH >5cm using the diameter tape. (If the tree is on the edge of the plot, only record it if the center is inside the plot.) ⑫ Record the BDS in centimeters. ⑬ Record the name of the tree if it can be identified (based on tree naming system developed prior to field data collection) ⑭ If the tree is on a slope, forked, leaning, etc. use the appropriate height for measurement from the figure on the next page. ⑮ Tally every tree that has a DBH <5cm (i.e. count the total number of small trees in the plot; do not measure them). ⑯ Repeat until the first marked tree is encountered. <Other cases if necessary> For natural forests with bamboo : · Bamboo is measured by age and average height, if possible. Age of bamboo can be determined using the information in the annex. · If the bamboo is monopodial (single stem), DBH is measured as for trees. · If the bamboo is growing sympodial (in a culm), DBH of 10 individual stems in each culm (spread out over the culm) is taken, as well as the DBH of the entire culm For mixed forests: · Use the approach for trees and bamboo as specified above. · Use separate forms for the trees and bamboo (monopodial or sympodial). For plantations, regularly spaced: · Record the distance between the rows and between trees within rows. · Record the DBH of 5 trees in 5 adjacent rows in centimeters. · Record the height of these trees where possible. · Record the species.

Objective	To take measurements of the standing dead wood
Result	Standing dead wood measured
Responsibility	PFM team
Materials/ equipment	· Poles · Measuring tape · Clinometer
Implementation	・“Standing dead wood” refers to trees that have died but are still upright. ・Measurement of standing dead wood takes place concurrently with live tree measurements. ・There are 2 classes of trees for standing dead wood. <Class1>  Dead tree with branches and twigs that resembles a live tree except for absence of leaves ・Measure DBH (same as measuring live trees) ・Write as “Dead” on datasheet. <Class 2>  Trees ranging from those containing small and large branches to those with bole only. ・Measure DBH using methods for live trees ・Measure diameter at the base of the tree ・Measure diameter at the top (cm) , if possible. Alternatively, do not take a measurement at the top and write “None” on datasheet.

TREE MEASUREMENT (Live Tree)

Plot ID#	:	page-( )	Date	: / / 2013
Data recorded by	:		Start time	: :

Live Tree measurements (DBH>5cm)

Tree #	Species	E/D	DBH (cm)	remarks	Tree #	Species	EG/DD	DBH (cm)
1		E/D			51		E/D	
2		E/D			52		E/D	
3		E/D			53		E/D	
4		E/D			54		E/D	
5		E/D			55		E/D	
6		E/D			56		E/D	
7		E/D			57		E/D	
8		E/D			58		E/D	
9		E/D			59		E/D	
10		E/D			60		E/D	
11		E/D			61		E/D	
12		E/D			62		E/D	
13		E/D			63		E/D	
14		E/D			64		E/D	
15		E/D			65		E/D	
16		E/D			66		E/D	
17		E/D			67		E/D	
18		E/D			68		E/D	
19		E/D			69		E/D	
20		E/D			70		E/D	
21		E/D			71		E/D	
22		E/D			72		E/D	
23		E/D			73		E/D	
24		E/D			74		E/D	
25		E/D			75		E/D	
26		E/D			76		E/D	
27		E/D			77		E/D	
28		E/D			78		E/D	
29		E/D			79		E/D	
30		E/D			80		E/D	
31		E/D			81		E/D	
32		E/D			82		E/D	
33		E/D			83		E/D	
34		E/D			84		E/D	
35		E/D			85		E/D	
36		E/D			86		E/D	
37		E/D			87		E/D	
38		E/D			88		E/D	
39		E/D			89		E/D	
40		E/D			90		E/D	
41		E/D			91		E/D	
42		E/D			92		E/D	
43		E/D			93		E/D	
44		E/D			94		E/D	
45		E/D			95		E/D	
46		E/D			96		E/D	
47		E/D			97		E/D	
48		E/D			98		E/D	
49		E/D			99		E/D	
50		E/D			100		E/D	

Dead wood measurement

	Species	S/F	DBH (1.3m)		Species	S/F	DBH (1
1		S/F		6		S/F	
2		S/F		7		S/F	
3		S/F		8		S/F	
4		S/F		9		S/F	
5		S/F		10		S/F	

S: stand
F: fallen

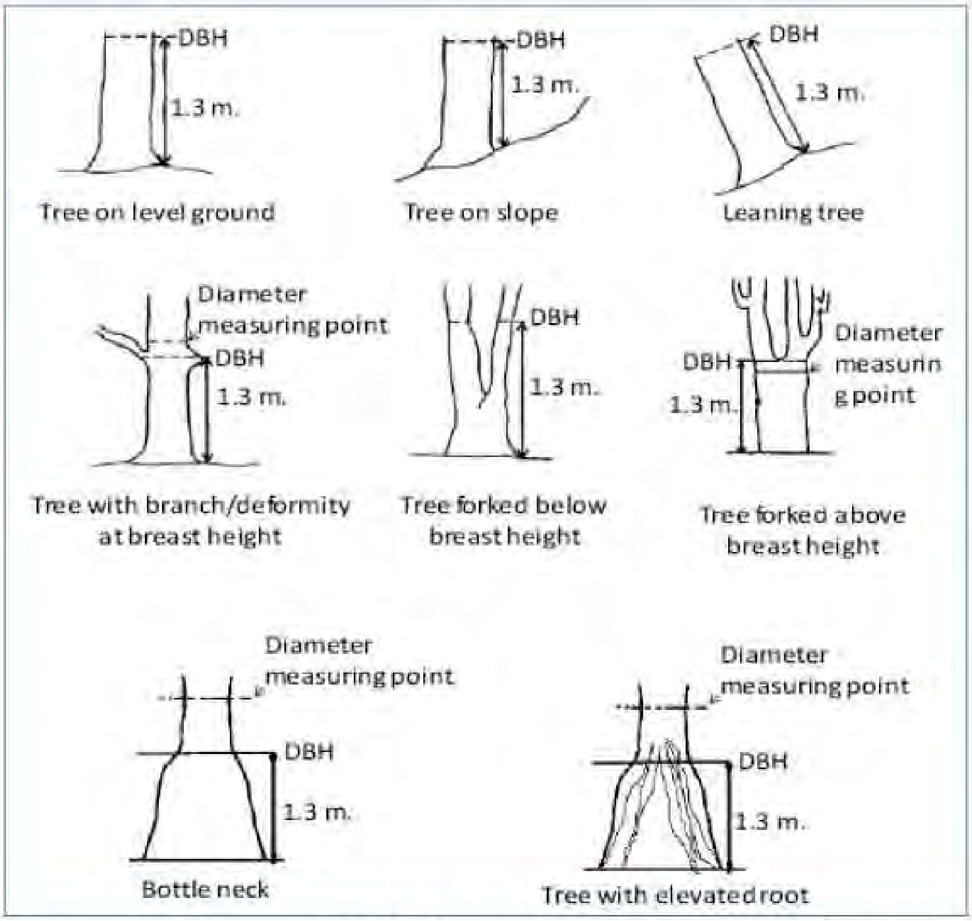


Figure 1: Measuring DBH of trees. (Source: Bhishma et al, 2010)

Manual for Stage-4

Stage	Subjects	Responsibilities	Methods
Stage-1	Boundary delineation of S/B	Villagers	Boundary measurement by GPS
Stage-2	Growth monitoring of fallow lands (less than 16 years)	Villagers	Rectangular plot survey in the field
Stage-3	Growth monitoring of fallow lands (16 years and above)	Villagers	Circular plot survey in the field
Stage-4	Growth monitoring of natural forest	PAFO/ DAFO	Circular plot survey in the field

4. Stage-4 (Growth monitoring of Natural Forest)

4.1. General

Stage-1 to Stage-3 describe forest monitoring under the cycles of slash and burn agriculture. In contrast, Stage-4 describes forest monitoring of protected area that is outside of the cycle of slash and burn agriculture. Areas inside national parks and spiritual forests could be candidates for these areas. Measured subjects such as individual DBH become bigger and a relatively large size plot is required.

4.2. Survey method and items to be collected

Land use types, Survey year, Year of fallow land, Area, total number of standing trees, Number of standing trees per hectare and geographical location plot center.

4.3. Survey sheets

Below documents describe survey sheets of Stage-4 for protected forest

<table>
<tr><td>Objective</td><td>To set up plots in which measurements will be taken</td></tr>
<tr><td>Result</td><td>Random sample plots located</td></tr>
<tr><td>Responsibility</td><td>PAFO/DAFO</td></tr>
<tr><td>Materials/ equipment</td><td>For making Square Plots for temporary sampling
・ GPS
・ Tape measure (50m)
・ Binding materials (substitution of rope)
・ Stakes (use fallen branches at the field)
・ Compass
・ Spray ink
・ Tape for marking the way to go</td></tr>
<tr><td>Implementation</td><td>Establishing the plot
• Navigate to predetermined latitude and longitude using a GPS.
• The sampling plots are located at random locations in the forest.
• Care should be taken to use representative locations (i.e. neither too dense nor too open, flat versus slope, etc.).
• The slope of the plot is recorded using the clinometer.

The dimension of the plot is dependent on the type and condition of the forest.
<table>
<tr><th>Type</th><th>Condition</th><th></th><th>Size (radius)</th></tr>
<tr><td rowspan="7">Natural</td><td colspan="2">10 or more trees with DBH >5cm</td><td>500m2 (12.62m)</td></tr>
<tr><td rowspan="2">Less than 10 trees with DBH >5cm</td><td>25 or more trees with DBH <5cm</td><td>500m2 (12.62m)</td></tr>
<tr><td>Less than 25 trees with DBH <5cm</td><td>1,000m2 (17.84m)</td></tr>
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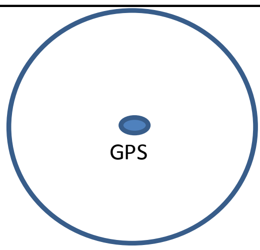
<tr><td>Bamboo – tree</td><td>100m2 (5.64m)</td></tr>
<tr><td rowspan="2">Plantation</td><td colspan="2">Irregularly spaced</td><td>As above for trees or bamboo</td></tr>
<tr><td colspan="2">Regularly spaced</td><td>5 rows x 5 trees</td></tr>
</table>
• The stake with attached rope is driven into the ground in the center of the plot (except for the regularly spaced plantation).
• Depending on the plot size, a knot is made in the rope to indicate the limit of the plot (this can also be prepared by the facilitators in the office; use colored bands to indicate the distance).</td></tr>
</table>

PLOT SETTING

Plot ID#	:	Page – (1)	Date	:	/ / 20
District	:		Start time	:	:
Village	:		End time	:	:
Crew chief	:		Total time	:	m
Data recorded by	:				
# peopele in crew	:				

Plot location

GPS :	X	
	Y	



Plot setting

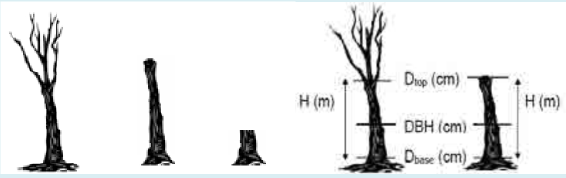
radius	: 5 / 7.5 / 10 / 15	m
area	:	m2
Slope	:	degree

Forest

Forest Type : Evergreen Forest / Decidius Forest

Select the environmental situation:
near the the road
near the river

Objective	Measure the standing of trees and bamboo
Result	Forest properties measured for plot-wise above-ground biomass calculation
Responsibility	PAFO/DAFO
Materials/ equipment	· Tree poles (Use bamboo of 1.5m and mark DBH at 1.3m) · Diameter tape · Chalk sticks · Writing board with paper forms
Implementation	⑰ Assign one person to record the data and make him/her stand in the center. All others should be measuring and marking trees. ⑱ Start measuring from North and the first trees. After the measuring, a chalk mark should be placed around each tree so that it can be seen from any direction. <The case for natural forests with trees> ⑲ Measure the DBH of every tree with DBH >5cm using the diameter tape. (If the tree is on the edge of the plot, only record it if the center is inside the plot.) ⑳ Record the BDS in centimeters. 21 Record the name of the tree if it can be identified (based on tree naming system developed prior to field data collection) 22 If the tree is on a slope, forked, leaning, etc. use the appropriate height for measurement from the figure on the next page. 23 Tally every tree that has a DBH <5cm (i.e. count the total number of small trees in the plot; do not measure them). 24 Repeat until the first marked tree is encountered. <Other cases if necessary> For natural forests with bamboo : · Bamboo is measured by age and average height, if possible. Age of bamboo can be determined using the information in the annex. · If the bamboo is monopodial (single stem), DBH is measured as for trees. · If the bamboo is growing sympodial (in a culm), DBH of 10 individual stems in each culm (spread out over the culm) is taken, as well as the DBH of the entire culm For mixed forests: · Use the approach for trees and bamboo as specified above. · Use separate forms for the trees and bamboo (monopodial or sympodial). For plantations, regularly spaced: · Record the distance between the rows and between trees within rows. · Record the DBH of 5 trees in 5 adjacent rows in centimeter. · Record the height of these trees where possible. · Record the species.

Objective	To take measurements of the standing dead wood
Result	Standing dead wood measured
Responsibility	PAFO/DAFO
Materials/ equipment	· Poles · Measuring tape · Clinometer
Implementation	・"Standing dead wood" refers to trees that have died but are still upright. ・Measurement of standing dead wood takes place concurrently with live tree measurements. ・There are 2 classes of trees for standing dead wood. <Class1>  Dead tree with branches and twigs that resembles a live tree except for absence of leaves ・Measure DBH (same as measuring live trees) ・Write as "Dead" on datasheet. <Class 2>  Trees ranging from those containing small and large branches to those with bole only. ・Measure DBH using methods for live trees ・Measure diameter at the base of the tree ・Measure diameter at the top (cm) , if possible. Alternatively, do not take a measurement at the top and write "None" on datasheet.

TREE MEASUREMENT (Live Tree)

Plot ID# : page-( ) Date : / / 2013

Data recorded by : Start time : :

Live Tree measurements (DBH>5cm)

Tree #	Species	E/D	DBH (cm)	remarks	Tree #	Species	EG/DD	DBH (cm)
1		E/D			51		E/D	
2		E/D			52		E/D	
3		E/D			53		E/D	
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5		E/D			55		E/D	
6		E/D			56		E/D	
7		E/D			57		E/D	
8		E/D			58		E/D	
9		E/D			59		E/D	
10		E/D			60		E/D	
11		E/D			61		E/D	
12		E/D			62		E/D	
13		E/D			63		E/D	
14		E/D			64		E/D	
15		E/D			65		E/D	
16		E/D			66		E/D	
17		E/D			67		E/D	
18		E/D			68		E/D	
19		E/D			69		E/D	
20		E/D			70		E/D	
21		E/D			71		E/D	
22		E/D			72		E/D	
23		E/D			73		E/D	
24		E/D			74		E/D	
25		E/D			75		E/D	
26		E/D			76		E/D	
27		E/D			77		E/D	
28		E/D			78		E/D	
29		E/D			79		E/D	
30		E/D			80		E/D	
31		E/D			81		E/D	
32		E/D			82		E/D	
33		E/D			83		E/D	
34		E/D			84		E/D	
35		E/D			85		E/D	
36		E/D			86		E/D	
37		E/D			87		E/D	
38		E/D			88		E/D	
39		E/D			89		E/D	
40		E/D			90		E/D	
41		E/D			91		E/D	
42		E/D			92		E/D	
43		E/D			93		E/D	
44		E/D			94		E/D	
45		E/D			95		E/D	
46		E/D			96		E/D	
47		E/D			97		E/D	
48		E/D			98		E/D	
49		E/D			99		E/D	
50		E/D			100		E/D	

Dead wood measurement

	Species	S/F	DBH (1.3m)		Species	S/F	DBH (1
1		S/F		6		S/F	
2		S/F		7		S/F	
3		S/F		8		S/F	
4		S/F		9		S/F	
5		S/F		10		S/F	

S: stand
F: fallen

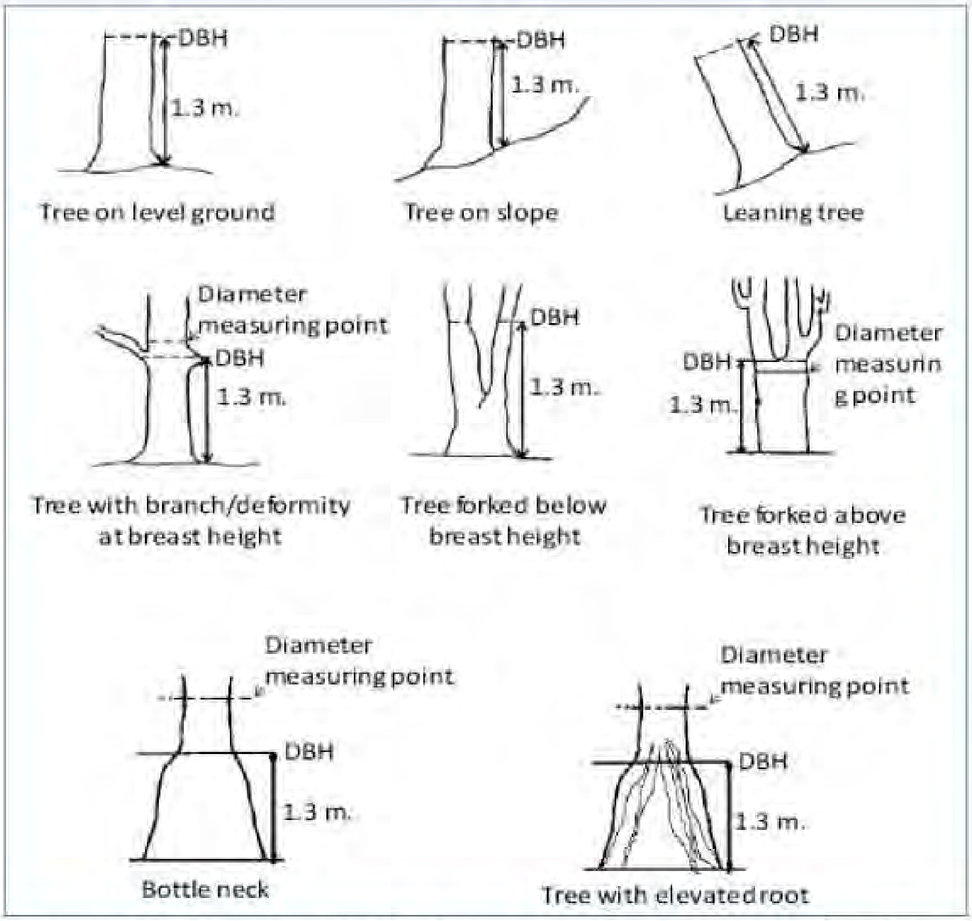

Figure 1: Measuring DBH of trees. (Source: Bhishma et al, 2010)