Asia-Pacific Network for Global Change Research

Carbon Financial Markets, Rural Poverty, and Global Climate Change in SE Asia-Scoping Workshop, Training and Project Site Development

Final report for APN project: ARCP2007-09NSY

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Carbon Financial Markets, Rural Poverty, and Global Climate Change in Southeast Asia – Scoping Workshop, Training and Project Site Development

Project Reference Number: ARCP2007-09NSY

Final Report submitted to APN

Overview of project work and outcomes

Non-technical summary

Two of the greatest threats to planetary peace and prosperity are global climate change and extreme poverty. This project is based on the premise that both of these problems can be simultaneously addressed through a single intervention: The promotion of more carbon intensive, or "greener," forestry and agriculture in impoverished rural communities in developing countries. Aside from the combustion of fossil fuels, agriculture, and the conversion of forest to agricultural land, is the leading source of greenhouse gas production. For many small-holder farmers in developing countries, the only recourse to a reduction in productivity is to expand the surface area under production, leading to an increase in the clearing of forest lands and the release of more carbon into the atmosphere. We believe introducing locally appropriate land-use changes, and linking these to the rapidly growing external carbon financial markets, will create the necessary conditions for poverty reduction and greenhouse gas mitigation, while making environmental conservation a profitable undertaking and thereby introducing a new type of sustainability. In order to achieve the long-term objectives of linking carbon offsets from agroforestry and afforestation/reforestation activities at the community level with carbon financial markets, training and planning must take precedent. This project supports: (1) a training and project scoping workshop and (2) field site visits for validation and in situ biomass measurements.

Objectives

The main objectives of the project are:

1. Training and capacity building for participants from Cambodia, Lao PDR, Thailand, and Vietnam in carbon cycle science, carbon financial markets, and measuring, monitoring and managing forest-related carbon projects, and

2. Identifying potential sites in each in-region country to develop community carbon sequestration pilot projects.

Amount received and number years supported

2007/08: USD30,000.00

Activity undertaken

APN project **ARCP2007-09NSY** supported a training and project scoping workshop held in Vientiane, Lao PDR 14 – 16 January 2007 and field visits with preliminary data collection in Vietnam, Thailand, and Lao PDR.

Results

Capacity building materials specific to (1) Carbon Cycle Science, (2) Carbon Financial Markets, and (3) Measuring, Monitoring and Managing Forest-related Carbon Sequestration Projects were developed for workshop. Information material specific to potential carbon projects in Cambodia, Lao PDR, Thailand, and Vietnam were also developed for the workshop.

From the field site visits, introductions regarding carbon sequestration and carbon markets were made to local land-owners, community groups and local regional and national government officials and agencies. Initial data collections resulted in GPS field points and polygons, digital pictures, and in some sites the establishment of

permanent sample plots for collecting routine biometric data (e.g. height and diameter at breast height or dbh measurements).

Relevance to APN's Science Agenda and objectives

This project is cross-cutting relating to the APN priority topics of (1) climate, (2) ecosystems and land use, and (3) the use of resources for sustainable development. The project's relevance to the APN policy agenda is in its ultimate goal of enabling national policy, regional scientists, and local people in these countries to participate in emerging carbon markets; forest-related land-use management for carbon sequestration and poverty alleviation.

Self evaluation

The project collaborators were successful in meeting the first objective, the training and project scoping workshop. More than fifty (50) participants attend the workshop from Cambodia, Lao PDR, Thailand, the United States, and Vietnam. We have also met the goals of identifying the potential pilot projects areas in each of the four countries. There are two potential sites in Lao PDR: (1) small-holder *Tectona grandis* (teak) plantation in Luang Prabang Province and (2) the Model Training Forest of the Faculty of Forest, National University of Laos (FoF, NUOL) in Vientiane Province. There are three sites identified in Thailand: (1) agroforestry and small-holder plantations with the Inpang Community Network in five provinces in Northeast Thailand, (2) small-holder *Hevea brasiliensis* (Para rubber) plantations, intercropped *Hevea brasiliensis* plantations and fruit orchards with the Trat Agroforestry Research Station (TAFRS) of Kasetsart University in Trat Province, and (3) small-holder *Eucalyptus* plantations with the Institute of Science at Suranaree University of Technology in Nakhon Ratchasima Province. There are two sites identified in Vietnam both are in Luc Ngan District, Bac Giang Province approximately 120 kilometers northeast of Hanoi. The first area is Kien Lao Commune where there are large areas of *Litchi* orchards, with and without intercropping (e.g. maize, soybean, and cassava) and afforestation/reforestation with *Acacia*, *Acacia Hybrid*, and *Eucalyptus*. The second area is in Cam Son Commune which also includes afforestation/reforestation with *Acacia*, *Acacia Hybrid*, and *Eucalyptus*. In Cambodia a potential project site has been identified in Takeo Province, south of Phnom Penh in collaboration with a national NGO, Chamroeun Cheat Khmer.

Potential for further work

There is additional work required to see these community forest-carbon sequestration pilot projects fully realized. The project collaborators will continue to develop these projects with the goal of vetting project areas to ensure they meet the necessary requirements (e.g. non-forest or degraded forest in 1990) for carbon markets, in particular for the Chicago Climate Exchange (CCX), identifying and developing the end-to-end mechanisms by which financial transactions from carbon sequestration project are realized and money actually flows back to a farmer, household or community. Such activities will include (1) delevoping the institutional linkages from farmer to market which vary from country to country, (2) drafting project documents that shows project location, land eligibility, sub-area stratification, sample plots areas, model estimates of rates of sequestration, etc., and (3) proposing new protocols to the CCX, for such projects where established protocols do not exist. In addition, further work is required at each project site collecting biometric data and establishing permanent sample plots and in developing a web-enable registry database for projects and participants. While the one-year funding support from APN enabled our collaborators to understand better carbon markets and carbon sequestration projects and even gain a foothold in developing such projects, we are most likely another 6 – 9 months away from seeing one of these pilot projects through the complete process.

Publications

None to date.

References

None.

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CAMBODIA

Ministry of Environment

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Technical Report

Preface

Global climate change is increasingly recognized as the greatest threat facing humanity. For the majority of the world's population, the persistent problems of food insecurity, rural poverty, and the struggle to develop and sustain new sources of economic growth must now be considered against a backdrop of uncertainty and change in historical climatic patterns. With emerging carbon financial markets, however, it may be possible to address climate change mitigation and rural poverty alleviation with a single intervention – small-holder forestry plantations and agroforestry land use that link farmers, households, and communities with carbon financial markets. Our project aims to establish carbon sequestration pilot projects in Cambodia, Lao PDR, Thailand, and Vietnam.

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1.0 Introduction

The United Nations Scientific Experts Group on Climate Change and Sustainable Development recently concluded that "the human race…has never faced a greater challenge" (United Nations 2007) The authors observe that the world's poor will bear the heaviest burden of a changing climate, leading to the designation of a new type of refugee – environmental refugees – that will potentially number in the tens of millions. For the majority of the world's population, the persistent problems of food insecurity, rural poverty, and the struggle to develop and sustain new sources of economic growth must now be considered against a backdrop of uncertainty and change in historical climatic patterns. Separately and together, governments, and both international and domestic organizations not only need to continue responding to the immediate concerns of extreme poverty, environmental degradation and social unrest, but, in addition, must now begin to prepare communities and entire regions to adapt to uncertain future climatic regimes, as well as make tangible contributions in first slowing, and ultimately re-establishing a balance in greenhouse gas exchanges at a planetary scale. Under mounting time pressures, there is an urgent need to evolve win-win solutions that address both these immediate local and long-term global threats.

This project is based on the premise that both of these problems (rural poverty and climate change) can be simultaneously addressed through a single intervention: The promotion of more carbon intensive, or "greener," forestry and agriculture in impoverished rural communities in developing countries. Aside from the combustion of fossil fuels, agriculture, and the conversion of forest to agricultural land, is the leading source of greenhouse gas production. For many small-holder farmers in developing countries, the only recourse to a reduction in productivity is to expand the surface area underproduction, leading to an increase in the clearing of forest lands and the release of more carbon into the atmosphere. We believe introducing locally appropriate land-use changes, and linking these to the rapidly growing external carbon financial markets, will create the necessary conditions for poverty reduction and greenhouse gas mitigation, while making environmental conservation a profitable undertaking and thereby introducing a new type of sustainability. In order to achieve the long-term objectives of linking carbon offsets from agroforestry and afforestation/reforestation activities at the community level with carbon financial markets, training and planning must take precedent. This project supports: (1) a training and project scoping workshop and (2) field site visits for validation and in situ biomass measurements.

Carbon sequestration in agricultural soils, grasslands and woody perennials, and the transfer of carbon credits through market structures, represent one such win-win opportunity. Among the alternatives, tree planting offers perhaps the greatest potential. Trees grow in all but the most extreme conditions (e.g., deserts and arctic). Their physiology enables them to tolerate intra-annual climatic fluctuations of greater magnitude and duration than annual species, thus allowing them to mitigate risks to which annual crops are most vulnerable, and which with increased climatic change, will become increasingly common. Many tree species also yield additional high-value products – edible fruits and leaves, fodder for livestock, gums and oil-bearing nuts for human and industrial uses, including feedstock used in the manufacture of bio-fuels – that offer a perfect opportunity for creating a win-win situation through removing carbon from the atmosphere and providing new sources of income for farmers. The co-development of market value-chains for sequestered carbon and secondary products, we believe, is pivotal to enlisting the managerial skills and lands of tens of millions of farmers around the world in the struggle to slow and abate climate change.

Sequestered carbon is now a globally traded commodity. As a commodity with the ability to provide economic returns to land managers, carbon sequestration can serve as a new catalyst for improved forest management practices such as forest preservation, lengthening fallow periods and reduced impact forestry. Unlike traditional development models based on deferred and diffused benefit streams, the new carbon-market model offers an opportunity to directly link land management and natural resource conservation with specific and immediate market incentives. This market-driven approach will

stimulate growth and development of local social and technical infrastructure that is self-sustaining over the long term, with highly valued additional benefits such as enhanced land tenure and environmental quality.

In recent years opportunities for participation in carbon credit trading markets have been growing. The Chicago Climate Exchange (CCX) now boasts more than six million trades per month. A recent World Bank publication, *State and Trends of the Carbon Market 2008*, reports a rapid increase in corporate participation in the carbon market (Capoor and Ambrosi 2008). One opportunity lies in prospects for leveraging these growing carbon financial markets in the US and Europe to assist poor farmers in developing countries who could participate in tree planting or vegetation regeneration projects and earn revenues that can, in turn, catalyze economic development within their communities, increase rural incomes, enhance land tenure security, and stimulate natural resource conservation.

Most of the carbon market trade involves emission reduction credits but there is also growing interest in the use of trees and forests for absorbing carbon dioxide from the atmosphere. The Clean Development Mechanism (CDM) of the Kyoto Protocol and some voluntary carbon markets, such as the Chicago Climate Exchange, allow countries and companies to offset their carbon emissions by carrying out tree planting projects. There is also considerable evidence that forests and agroforestry in developing countries provide substantial benefits to rural dwellers, national economies, and the environment. Trees provide a range of products for home use such as food, timber, firewood, medicines, and fodder as well as products for sale, boosting farm incomes, rural economies, and national exports. Trees on farms and in forests can also provide a range of environmental services, such as conserving biodiversity, reduced soil erosion and sedimentation in rivers and lakes, and increased soil fertility. Moreover, what is often unrecognized is that while forested area is declining in developing countries, tree cover on farms is rapidly increasing, as farmers substitute for the tree products they formerly accessed from forests and seize market opportunities for selling tree products.

Sustainable development links natural resource management with tangible economic improvements in rural livelihoods. Approximately 3 billion people, half of the world's population, live below the ethical poverty line (EPL). The ethical poverty line is defined as the point at which life expectancy falls as rapidly as income, and above which life expectancy rises only slightly compared to income increases (Edwards, 2006). Currently, the global EPL is around $2.70/day. A vast majority of these individuals depend for their survival on the 400 million small-farms that are found throughout the developing world (Gates Foundation, 2006). If the appropriate markets can be created the cumulative human and natural resources that can be marshaled in reducing atmosphere carbon, and raising rural incomes are vast. Traditional approaches to reforestation and agroforestry, often fail because farmers are asked to make immediate investments of scarce land and labor to plant and protect trees with the uncertain hope that the trees will begin to produce benefits 5-15 years later. The ability to link tree planting with near-term payments through the emerging carbon financial markets, with additional payments from other tree products coming on-line in subsequent years, has the potential to positively impact millions of lives. Furthermore, once productive, the continued generation of high-value tree products (fruits, oil-bearing nuts) serves to protect the stored carbon from being harvested as fuel wood, burned and the re-released into the atmosphere. The fact that some oil-bearing nuts (e.g., jatropha) can be used in the manufacture of bio-diesel, thus reducing the use of fossil fuels and release of additional stored carbon, constitutes yet another positive gain of our approach to carbon sequestration.

In order to achieve the long-term objectives of linking carbon offsets from agroforestry and afforestation/reforestation activities at the community level with carbon financial markets, training and planning must take precedent. Therefore, the main objectives of the first year of this project, recognizing the project is longer term (2 – 3 years), included the following:

1. Training and capacity building for participants from Cambodia, Lao PDR, Thailand, and Vietnam in carbon cycle science, carbon financial markets, and measuring, monitoring and managing forest-related carbon projects, and

2. Identifying potential sites in each of the four countries to develop small-holder forestry and agroforestry community carbon sequestration pilot projects.

2.0 Methodology

Training and Project Scoping Workshop

The training and project scoping workshop was held at the Lao Plaza Hotel, Vientiane, Lao PDR, 14 – 16 January 2007 with the Faculty of Forestry, National University of Laos as the local host. More than fifty (50) participants from Cambodia, Thailand, the United States and Vietnam as well as from the host country attended the meeting (see participants list in the appendix section). The goals of the meeting were three-fold:

1. Provide capacity-building and training for national level ministry personnel, and collaborators on carbon cycle science, carbon financial markets, and techniques for measuring, monitoring, and managing carbon sequestration projects (see workshop agenda in the appendix section). The workshop materials can be accessed via the internet at:

   ftp://APN_ARCP2007_09_Workshop:trficftp@landsatftp.geo.msu.edu/

2. Provide country-specific information regarding current knowledge base regarding carbon offsets and developing carbon sequestration projects as well as expert knowledge on potential project areas based on the following criteria:

   a. Areas of at least 1000 ha (does not have to be a single area, can be non-contiguous areas that add up to 1000 or more ha).

   b. Areas that were non-forest in 1990 or in degraded forest condition within the past 17 years (since 1990).

   c. Areas that have had or are currently undergoing afforestation/reforestation, natural regeneration (e.g. shifting cultivation lands that are now in permanent fallow), plantation (e.g. rubber, teak, etc.), or agroforestry activities in the past 17 years (since 1990). Natural forest regeneration, single species plantation, and complex agroforestry systems are all possible.

3. Provide a venue and format for the sharing of knowledge and information specific to climate change, carbon cycle science, carbon financial markets (including the Kyoto Clean Development Mechanism or CDM), project implementation and the like.

In additional to the project collaborators from the Cambodian Ministry of Environment, the Faculty of Forestry, National University of Laos, the Vietnamese Ministry of Agriculture and Rural Development, and the various Thai Universities and the National Research Council of Thailand, we specifically solicited the participation at the workshop of the UNFCCC CDM Designated National Authority (DNA) for each of the countries. In response, participants included: Dr. Jesada Luangjame from the Thai Royal Forestry Department and a member of the Thai UNFCCC Climate Change committee, Ms. Le Anh Ngoc from the International Cooperation Department, Ministry of Natural Resources and Environment (MONRE) in Vietnam, Mr. Sum Thy Cheif of the Climate Change Office, Ministry of Environment in Cambodia, and Mr. Syamphone Sengchandala, Director of the International Environment Division of the of the Prime Minister's Office, Science, Technology and Environment Agency (STEA), Lao PDR.

Field Site Visits and Initial Fieldwork

As our collaborative teams have identified potential pilot project sites, we have scheduled field visits that include: meetings with National level UNFCCC CDM DNA's, and appropriate ministries and agencies at national, regional and local levels, meetings and trainings with local communities, collected initial site data (GPS, digital pictures, general land use/cover histories, etc.) and also established permanent plots in small-holder plantations and agroforestry fields within project sites collecting forest biometric data (tree species, planting density, age, db, height, etc.). In addition to the capacity-building between the project collaborators, there is a great need for establishing formal and informal agreements within each country at the various institutional levels with agencies who are responsible for responding to national climate change commitments and who are actively involved in participating in developing and managing such projects as those initiated under our collective efforts. Our early efforts in each country and with all the currently identified pilot projects have first centered on capacity building and knowledge sharing with partners at the national to local levels.

In addition to the initial field data collection we are identifying and acquiring multi-temporal satellite remote sensing data sets for each pilot project site. These data include Landsat MSS, Landsat TM, Landsat ETM+, ASTER VNIR, and in some cases, where available, IKONOS, QuickBird, and/or SPOT data. These data will be used to map the land use and land cover changes of the project areas to determine eligibility based on non-forest or degraded forest classification in 1990. They will also serve as the primary data for developing advanced carbon measurement tools using remotely-sensed Earth-observation satellite data.

The following table shows the progression in each country from initial meetings with CDM-DNA authorities and national agencies and institutions (January 2007 for Thailand, Vietnam, and Lao PDR) to field visits and initial field data collection periods to date. Projects in Vietnam and Thailand have come along at a faster pace than those in Lao PDR and Cambodia, though we have made recent progress this year (2008) in Lao PDR and expect to see the pilot project in Cambodia move forward later this year. Also note that we will be collaborating on a carbon workshop meeting in Indonesia with BPPT September 2008 with the goal of initiating projects there as well. In addition, we expect to hold a side meeting with the SEARRIN network at the NASA NEESPI/MAIRS joint meeting in January 2008 in Kohn Kaen, Thailand. At our SEARRIN meeting we will focus on these on-going carbon projects and discuss expand to new projects within each country, including the Philippines and Malaysia, strong SEARRIN partners who, due to limited funding, have yet to participate in these carbon projects.

Table 1: Country and pilot project site development paths

Dates	Country	Project Site	Data Collection	Meetings
January 2007	Vietnam	Hanoi - meetings	N/A	DoST-MARD, FIPI, MONRE (CDM-DNA)
March 2007	Vietnam	Bac Giang Province	GPS, Digital Pictures	DoST-MARD, Dept. of Forestry-MARD
August 2007	Vietnam	Kien Lao Commune, Luc Ngan Dist., Bac Giang Prov.	Permanent plots in 11 sites	DoST-MARD, Dept. of Forestry-MARD
October 2007	Vietnam	Hanoi – training workshop	N/A	DoST-MARD, FSIV, FIPI, MONRE (CDM-DNA),
January 2008	Vietnam	Kien Lao Commune, Luc Ngan District,	Permanent plots in 4 sites; Total 15.	DoST-MARD, Dept. of Forestry-MARD

Dates	Country	Project Site	Data Collection	Meetings
		Bac Giang Province		
June 2008	Vietnam	Cam Son Commune, Luc Ngan District, Bac Giang Province	GPS, Digital Pictures	DoST-MARD, FSIV, FIPI, MONRE (CDM-DNA), Bac Giang DARD (Department of Agriculture and Rural Development), Cam Son PFM Board
January 2007	Thailand	Bangkok – meetings and workshop	N/A	ONEP (CDM-DNA), RFD, LDD, NRCT, MSU-Thai, Mahidol U., Kasetsart U., Suranaree U.
April 2007	Thailand	Inpang, Northeast Thailand	N/A	Inpang, MSU-Thai, NRCT
August 2007	Thailand	Inpang, Northeast Thailand	Permanent plots in 4 sites	Inpang, MSU-Thai, NRCT
October 2007	Thailand	Inpang, Northeast Thailand	Questionnaire survey 2500 Inpang Households	Inpang, MSU-Thai, NRCT
January 2008	Thailand	Inpang, Northeast Thailand	Permanent plots in 5 sites; Total 9	Inpang, MSU-Thai, NRCT
June 2008	Thailand	Inpang, Northeast Thailand	Database development	MSU-Thai, NRCT
January 2008	Thailand	TAFRS, Trat Province	GPS, Digital pictures	TAFRS
April 2008	Thailand	TAFRS, Trat Province	Permanent plots in 17 sites	TAFRS
June 2008	Thailand	Nakhon Ratchasima – small-holder Eucalyptus	N/A	Suranaree University of Technology
January 2007	Lao PDR	Vientiane – meetings and workshop	N/A	STEA (CDM-DNA), FoF, NUOL
April 2008	Lao PDR	Luang Prabang – Teak plantations	Permanent plots in 12 sites	DOF
June 2008	Lao PDR	Luang Prabang – Teak plantations	N/A	PAFO & DOF, MAF
June 2008	Lao PDR	FoF, NUOL Model Training Forest	GPS, digital pictures	FoF, NUOL
* September	Cambodia	Phnom Penh &	TBD	Ministry of Environment; Local

Dates	Country	Project Site	Data Collection	Meetings
2008		Takeo Province		NGO Chamroeun Cheat Khmer
* September 2008	Indonesia	Jakarta – meetings and workshop	N/A	BPPT
* January 2009	SEARRIN Network	Kohn Kaen, Thailand - meetings	N/A	Side meeting at the NASA NEESPI/MAIRS meeting in Kohn Kean Thailand

* These are forthcoming activities which are scheduled to occur after the submission of this report.

3.0 Results & Discussion

Owing to the great importance of immediate action to mitigate greenhouse gas emissions and affect rural poverty, and to the fact that few working models or road-maps, if any, existed for actualizing small-holder forestry and agroforestry carbon sequestration activities, this project initiated a general outline for *pathfinding* such activities in Southeast Asia with long-time collaborators active in natural resource management and sustainable development and who have significant knowledge of geospatial technologies and analysis. We began this project with the training and project scoping workshop in January 2008 aimed at overall capacity building and the sharing of cross-national experiences in understanding: (1) climate change, (2) carbon financial markets, and (3) developing small-holder forestry and agroforestry carbon sequestration projects. The results of this workshop have been a cross-fertilization of ideas, knowledge, and inputs from academics, local people, and institutional and agency professions. It is clear that while climate change is a generally understood concept among the participants, there is a great range of understanding regarding carbon financial markets and with developing small-holder forestry and agroforestry carbon sequestration projects. The workshop has succeeded in beginning the process of knowledge-building with respect to these later two components, but we recognize there is more to accomplish and the dissemination and clarification of these concepts is a priority and is on-going.

The results of our field visits are more easily reported here. Table 2 list the pilot project sites identified in the four countries. These are listed in chronological order of when the field site visits began. Figure 1 shows the general locations of these project sites at the regional scale.

Table 2: Pilot Project Sites

Country	Location	Carbon Type
Vietnam	Kien Lao Commune, Luc Ngan District, Bac Giang Province	1.Afforestation/reforestation (various species) 2. *Litchi* orchards w/ and w/o intercropping (annuals)
Thailand	Inpang Community Network, Northeast Thailand	1. Small-holder plantations (various species) 2. Simple to complex agroforestry
Thailand	Trat Province	1. *Hevea brasiliensis* plantations – monoculture 2. *Hevea brasiliensis* plantations – intercropped 3. Fruit orchards

Country	Location	Carbon Type
Lao PDR	Luang Prabang Province	1. Small-holder Plantations (*Tectona grandis*)
Lao PDR	Model Training Forest, Vientiane Province (FoF, NUOL)	1. Plantation (monoculture and intercrop) 2. Assisted natural regeneration
Vietnam	Cam Son Commune, Luc Ngan District, Bac Giang Province	1. Afforestation/reforestation (various species)
Thailand	Nakhon Ratchasima Province	1. Small-holder plantations (*Eucalyptus var.*)
*Cambodia	Takeo Province	1. Afforestation/reforestation
†Indonesia	TDB	TDB

* Cambodia site to be visited for the first time in September 2008.

† A possible pilot project site in Indonesia will be discussed with BPPT in September 2008

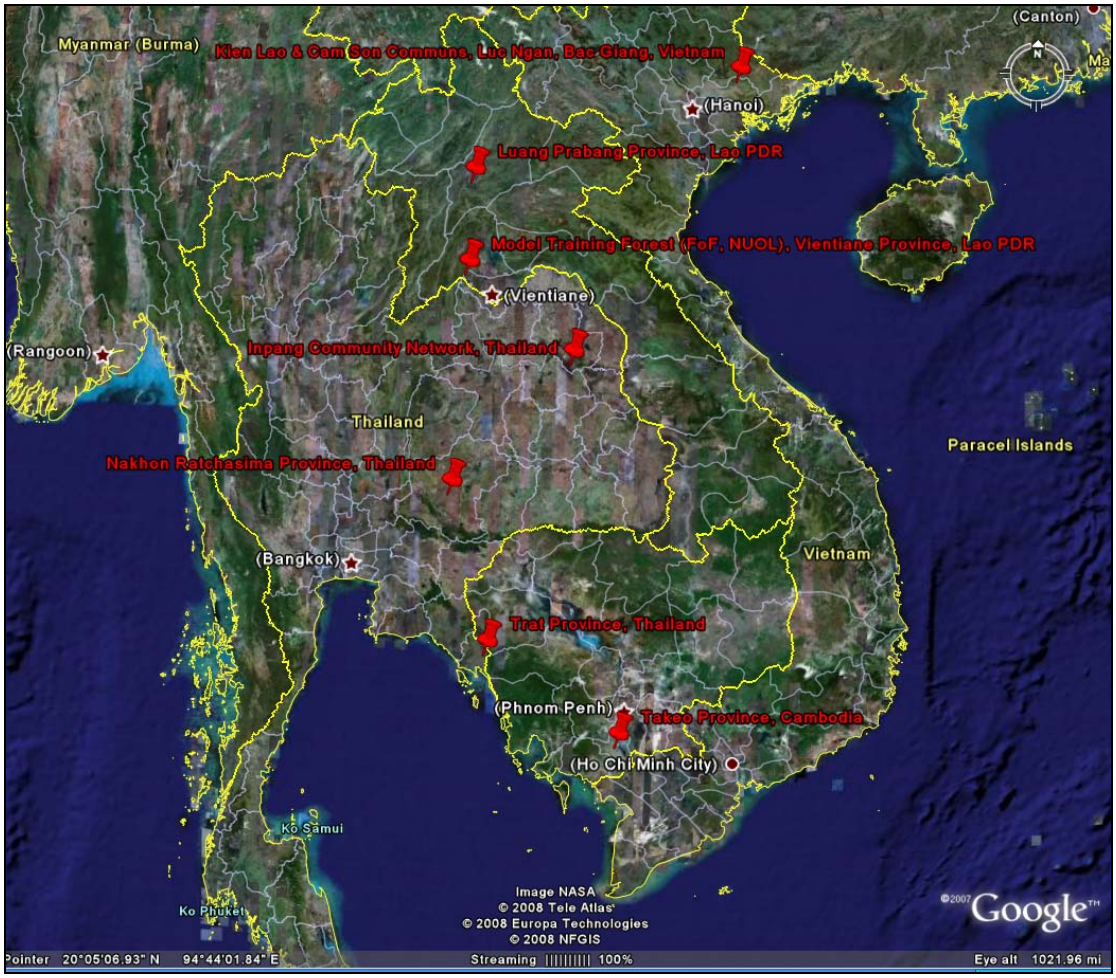

Figure 1: Location of eight (8) pilot project sites (regional view)

More detailed information on these pilot project sites including data collection follows.

Kien Lao Commune, Luc Ngan District, Bac Giang Province, Vietnam

Kien Lao Commune, Luc Ngan District, Bac Giang Province located 120 km northeast of Hanoi, Vietnam (Figure 2) The commune families have been participants in the 5 Million Hectare Reforestation Program – 5MHRP since 1993 (prior to 1998 the 5MHRP was known

as the “327 program”). The commune has 5,600 ha of natural land and 6,250 habitants. Under the 5MHRP, the commune has already planted 465 ha of forest - predominantly *Acacia (var. sp.)*, *Eucalyptus* and *Pinus* species.

In addition to the reforestation activities in the district, the area has undergone extensive land use change in the last fifteen to twenty years. Agricultural lands have been converted to *Litchi* gardens throughout the district and province. While there remain large tracts of irrigated rice as well as some cassava, soybean, and maize cultivation, the landscape of Luc Ngan is dominated by *Litchi* orchards, in response to market mechanism as well as to favorable geographic and climatic conditions. The current land use and land cover landscape, much of which has transitioned from annual crops (cassava, soybean, and maize) and bare land to permanent tree stands (*Litchi*, *Litchi* mixed with annual crops such as soybean and cassava, and forest plantations), now stores more carbon in biomass than it did under earlier conditions.

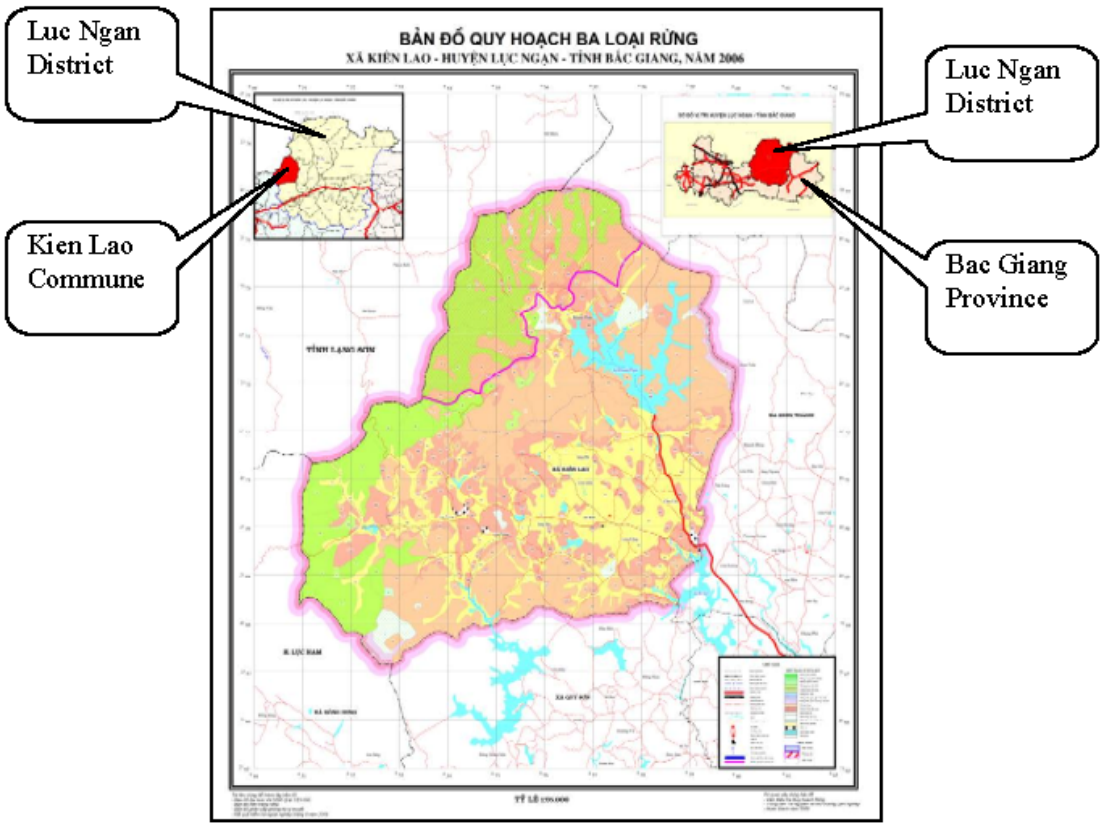

Figure 2: Kien Lao Commune, Luc Ngan District, Bac Giang Province, Vietnam (Source: Dr. Do Xuan Lan, Department of Science and Technology, Ministry of Agriculture and Rural Development, Vietnam)

An initial field visit was made in March 2007 (GPS points and digital pictures), which was followed by data collection efforts in August 2007 and January 2008. The August 2007 and January 2008 data collection included: GPS point and polygon areas, digital pictures, biometric data collection (*Litchi* orchards and afforestation/reforestation areas), and farmer interviews (ownership, land use/cover history, and management and planting schemes). Figures 3 - 14 shows the initial 15 project polygons where farmer interviews and biometric field data have been collected. In these graphics field polygon outlines are displayed on 15-meter resolution ASTER VNIR (e.g. Figure 4) and 1-meter panchromatic-sharpened IKONOS data (e.g. Figure 5). Below each graphic (figures 4 - 14) is ownership, area, planting and synthesized biometric data (average DBH, average height). Figure 15 shows a GIS registry of all of the afforestation and reforestation areas in Kien Lao Commune established from 1991 – 2007. These areas account for over 1000 individual parcels and 1200 hectares. Finally, figure 16 shows a sample of the ASTER Normalized Difference Vegetation Index (NDVI) for an image acquired 31-August-2002.

Multi-temporal NDVI data will be used to analyze the historic changes in land use and land cover and assist in identifying specifically areas that meet the 1990 non-forest or degraded forest criteria for any CCX forestry carbon offset project. We believe, that the NDVI data sets may also be used to measure carbon and rates of sequestration directly. However, more work is required to develop these algorithms. We have identified alometric equations for use in estimating the amount of CO_2 in the afforestation/reforestation biomass (e.g. *Acacia Hybrid*, *Eucalyptus*, etc.) however, we are still working to identify an appropriate equation or method for calculating CO_2 in the *Litchi* orchards, and may resort to destructive sampling methods in the near future. Further work also includes calculating the baseline 1990 CO_2 for these project polygons. Figures 17 and 18 shows the landscape of the project area - *Litchi* orchards (17) and *Acacia Hybrid* plantation sites (18).

The lead on this project is Dr. Do Xuan Lan, Department of Science and Technology, Ministry of Agriculture and Rural Development, Hanoi, Vietnam.

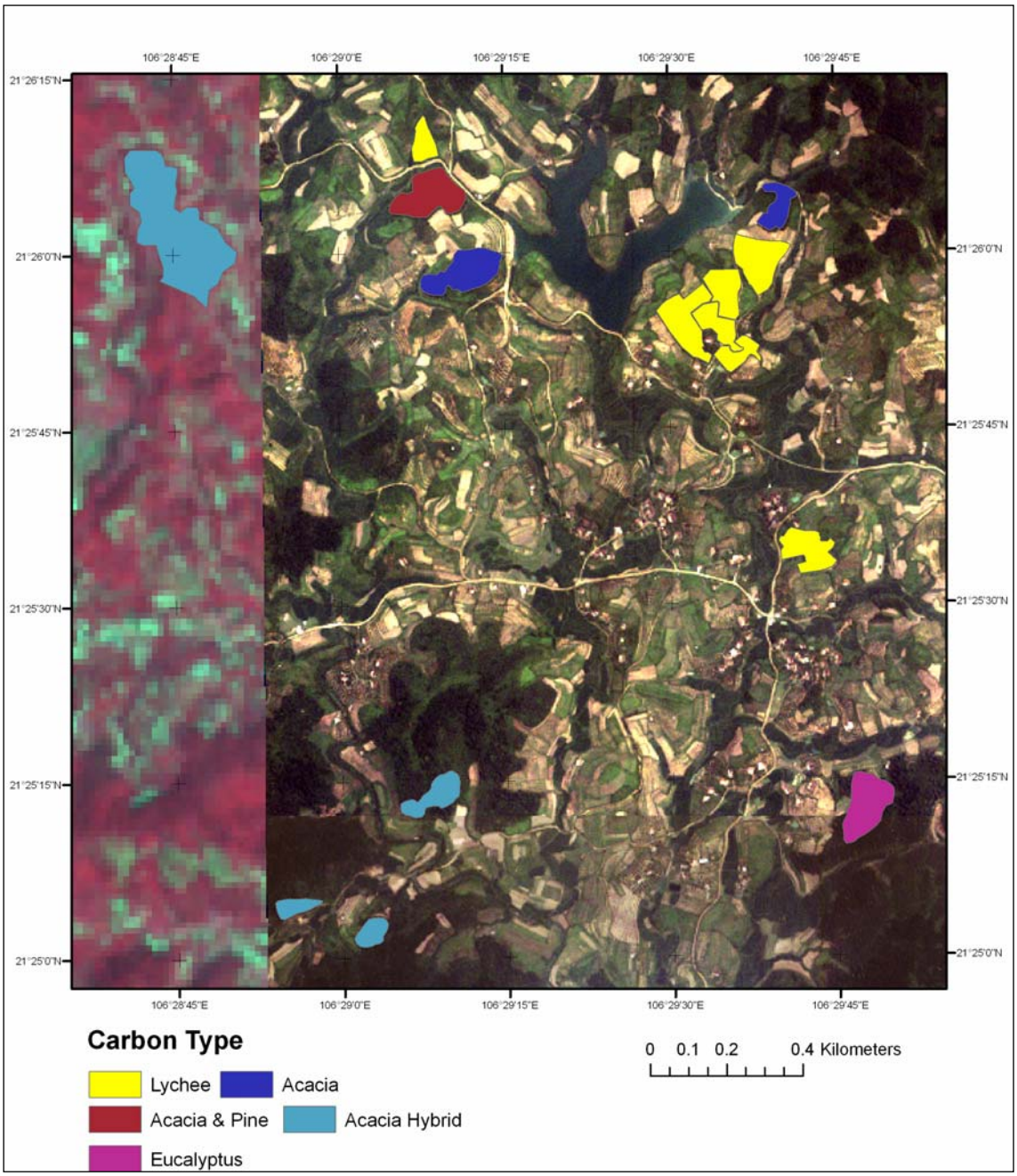

Figure 3: Fifteen (15) project sample sites; biometric data, ownership data, and land use history data have been collected for each polygon area. The total area of all polygons is 19.69 hectares.

Figures 4 – 14: Details of above 15 area polygons shown in figure 3.

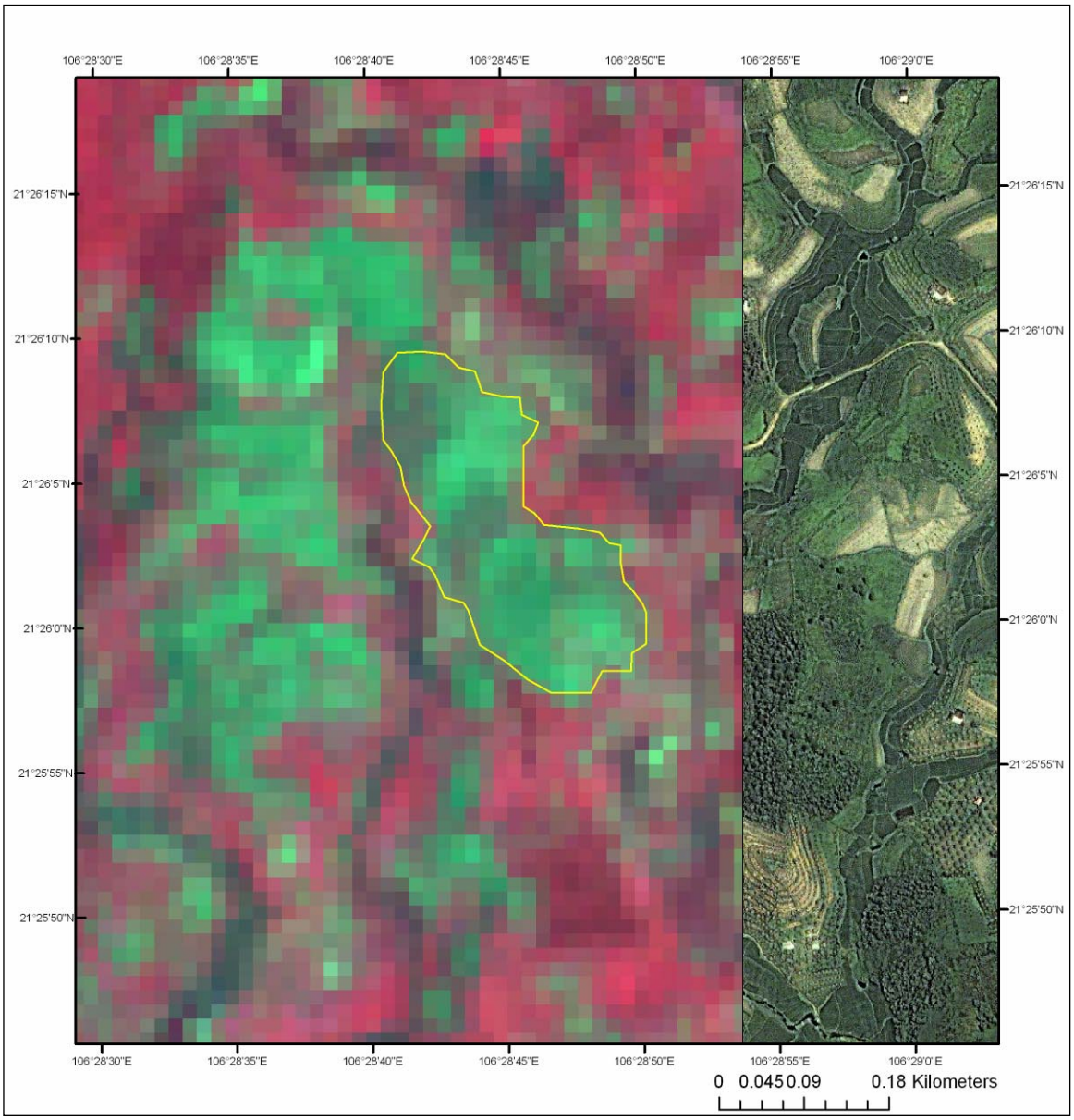

Figure 4

Carbon Type: A/R *Acacia Hybrid*
Owner: Ly Van Si
Area: 1.3 ha (polygon 5.3 ha)
Land Use History: *Acacia Hybrid* planted in 2002. Before 2002 Pine plantation.
Biometric Data: 25 m x 20 m plot (500 sq. m.); Planting 3 m x 3 m (1100 – 1500 trees / ha); 50 trees sampled – Average height = 13.1 m, Average DBH = 12.3 cm.

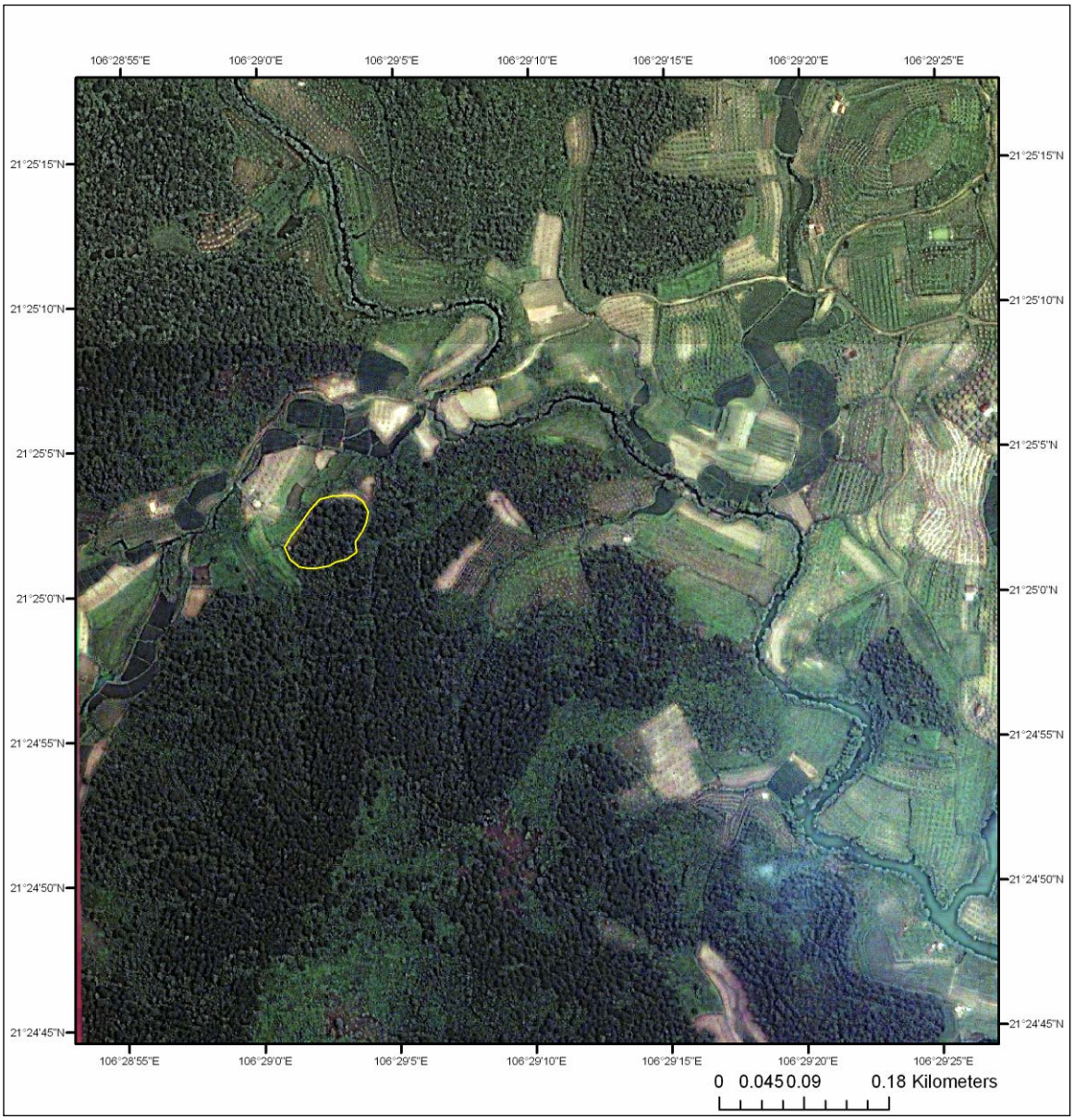

Figure 5

Carbon Type: A/R *Acacia Hybrid*
Owner: Dien
Area: 0.47 ha
Land Use History: *Acacia Hybrid* planted in 2004. Pine plantation in 1980, partially degraded.
Biometric Data: 25 m x 20 m plot (500 sq. m.); Planting 2.5 m x 2.5 m to 3 m x 3 m (~1200 trees / ha); 61 trees sampled – Average height = 11 m, Average DBH = 10.5 cm.

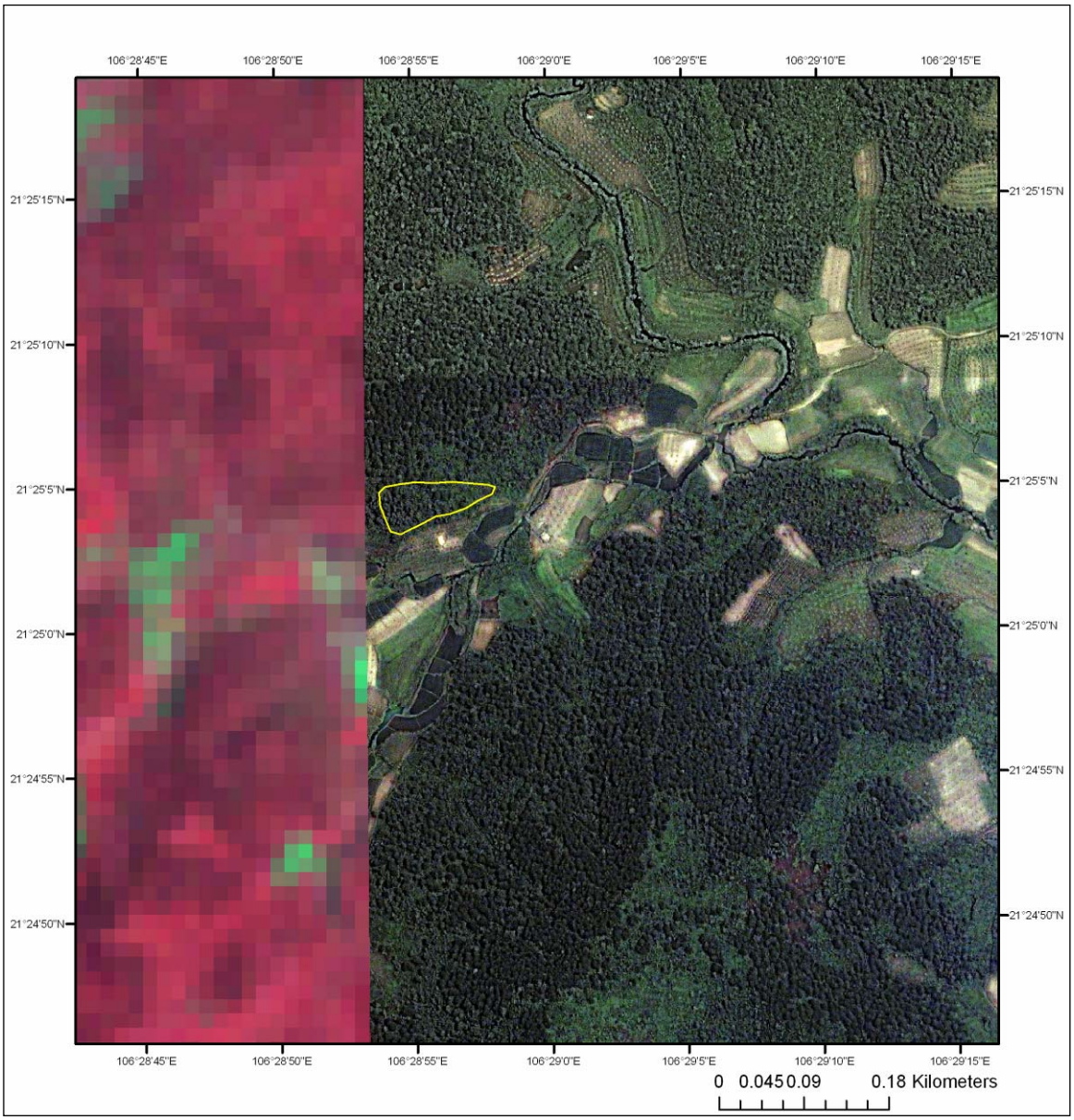

Figure 6

Carbon Type: A/R *Acacia Hybrid*
Owner: Bingh
Area: 0.47 ha
Land Use History: *Acacia Hybrid* planted in 2006.
Biometric Data: 25 m x 20 m plot (500 sq. m.); Planting 2.5 m x 2.5 m to 3 m x 3 m (~1200 trees / ha); 61 trees sampled –Average DBH = 8.3 cm.

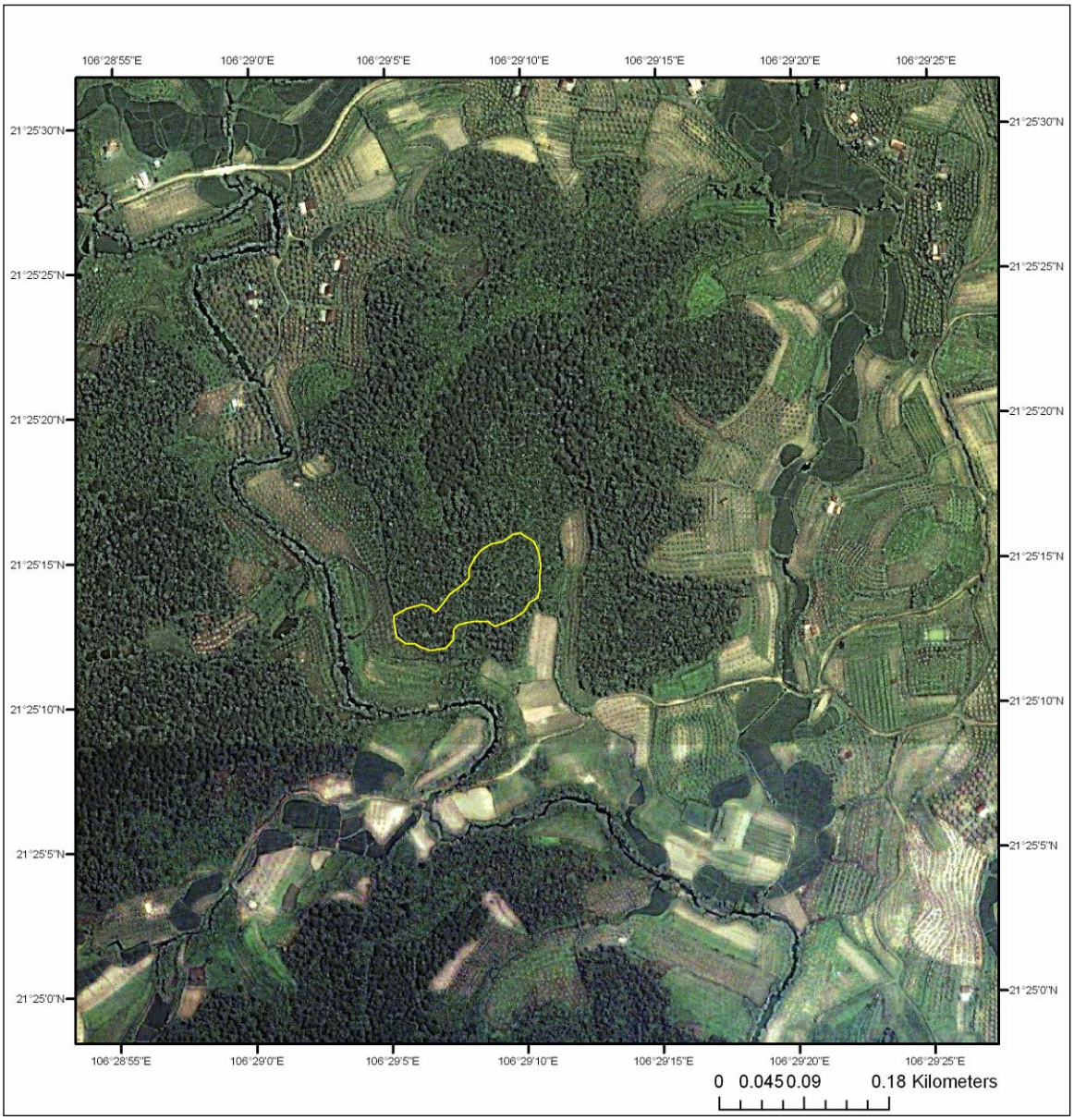

Figure 7

Carbon Type: A/R *Acacia Hybrid*
Owner: see Mr. Ky
Area: 0.91 ha
Land Use History: *Acacia Hybrid* planted in 2007. Previously *Pinus* plantation.
Biometric Data: 25 m x 20 m plot (500 sq. m.); Planting 2.5 m x 2.5 m (~1200 - 1500 trees / ha); Observed: Average height = 2 m, Average DBH = 3 cm.

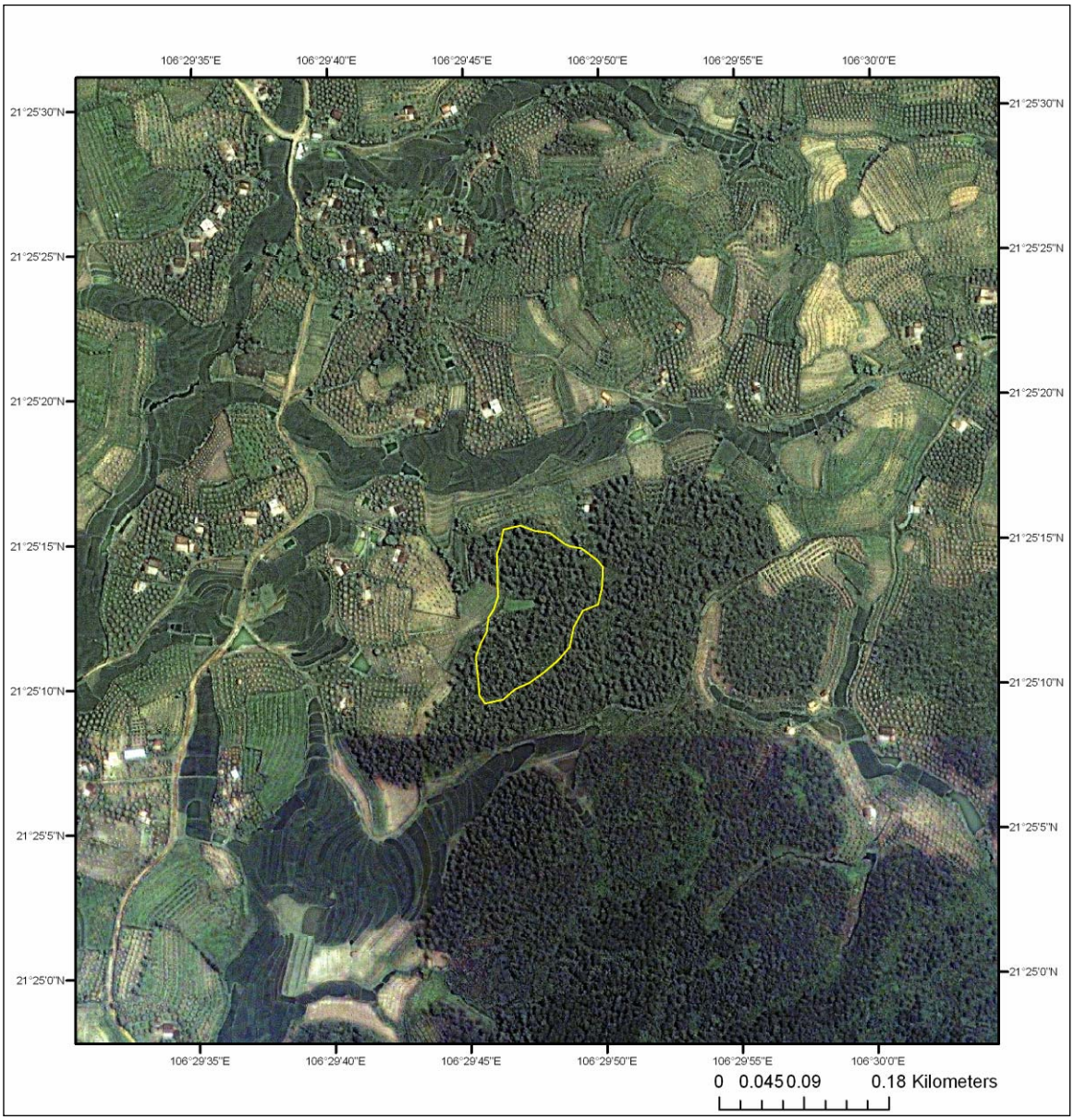

Figure 8

Carbon Type: A/R *Eucalyptus*
Owner: Tham
Area: 1.2 ha (polygon 1.56 ha)
Land Use History: *Eucalyptus* planted in April 2005. Second rotation.
Biometric Data: 25 m x 20 m plot (500 sq. m.); Planting 2.5 m x 2.5 m to 5 m x 4 m (~700 to 1600 trees / ha); 105 trees sampled (2 sub-plots: 69 trees and 36 trees): Average height = 10.5 m, Average DBH = 9.2 cm.

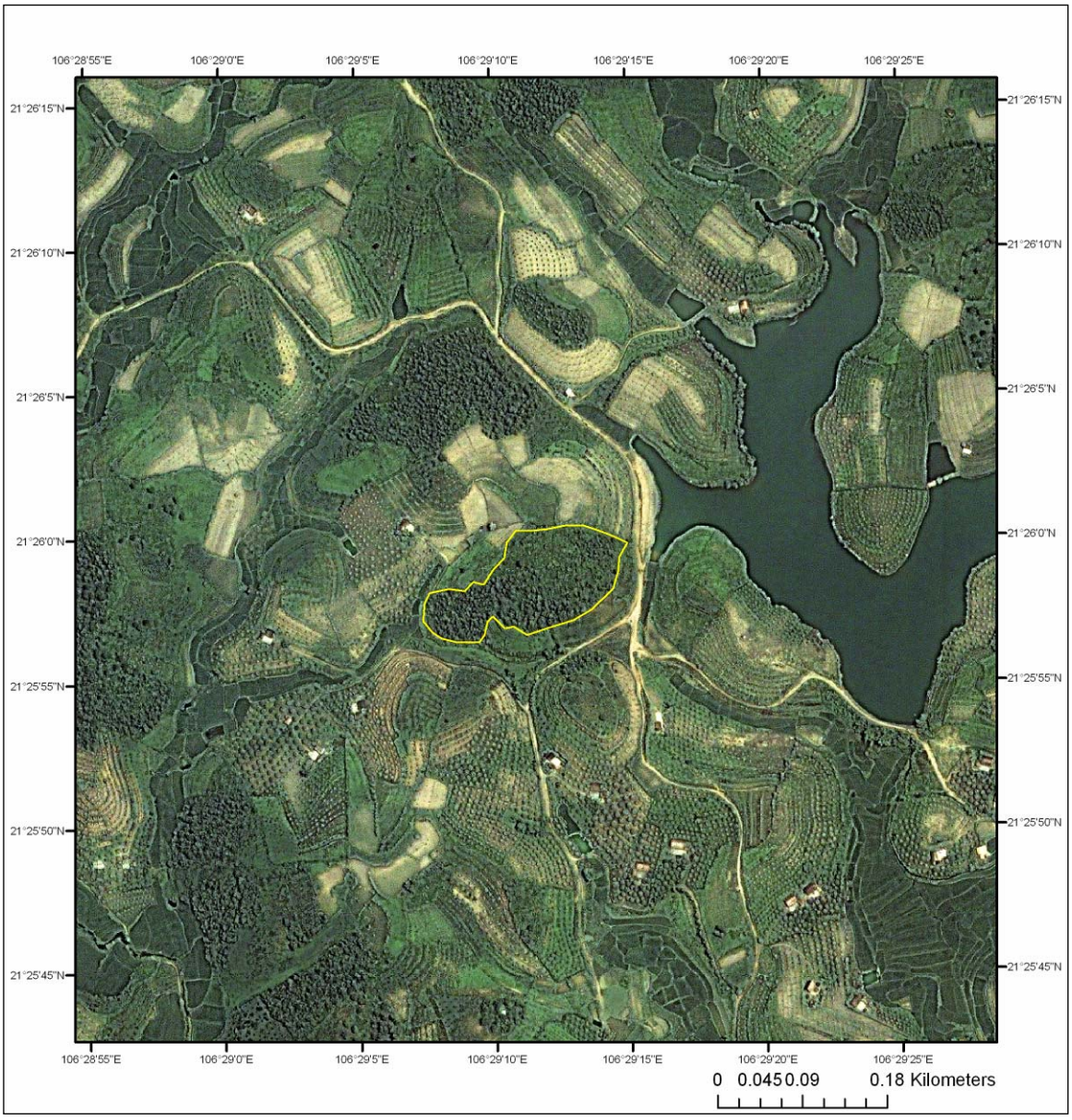

Figure 9

Carbon Type: A/R *Acacia*
Owner: Lam Van Loi
Area: 1.59 ha
Land Use History: *Acacia* planted in 1994. Previously *Pinus* plantation.
Biometric Data: 25 m x 20 m plot (500 sq. m.); Planting density (~ 420 trees / ha); 21 trees sampled: Average height = 12.6 m, Average DBH = 17.9 cm.

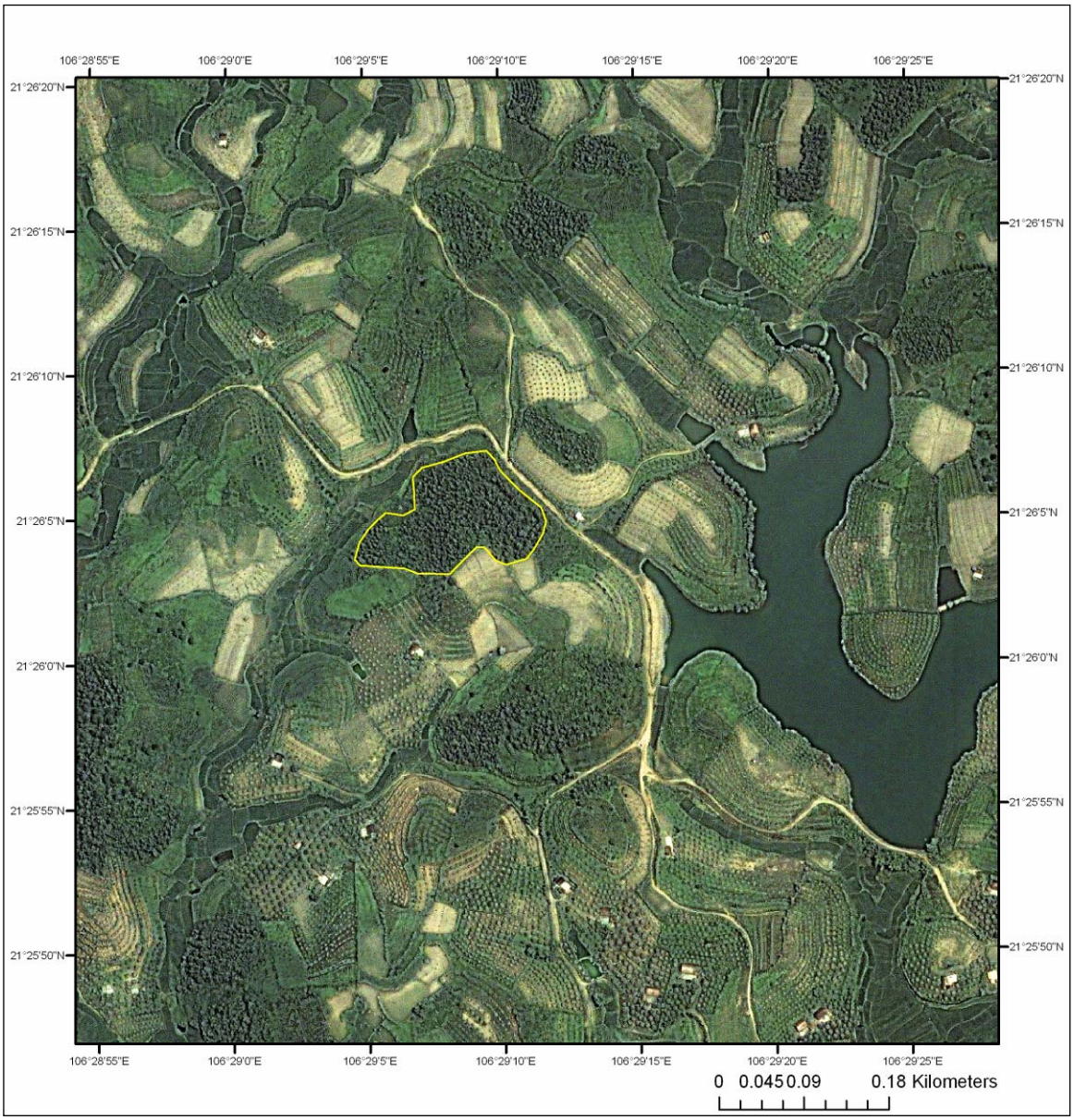

Figure 10

Carbon Type: A/R *Acacia* with *Pinus*
Owner: Ly Thi Keo
Area: 1.63
Land Use History: *Acacia* with *Pinus* planted in 1997.
Biometric Data: Observed: Estimated 1400 trees total; Average height = 11 m, Average DBH = 111 cm.

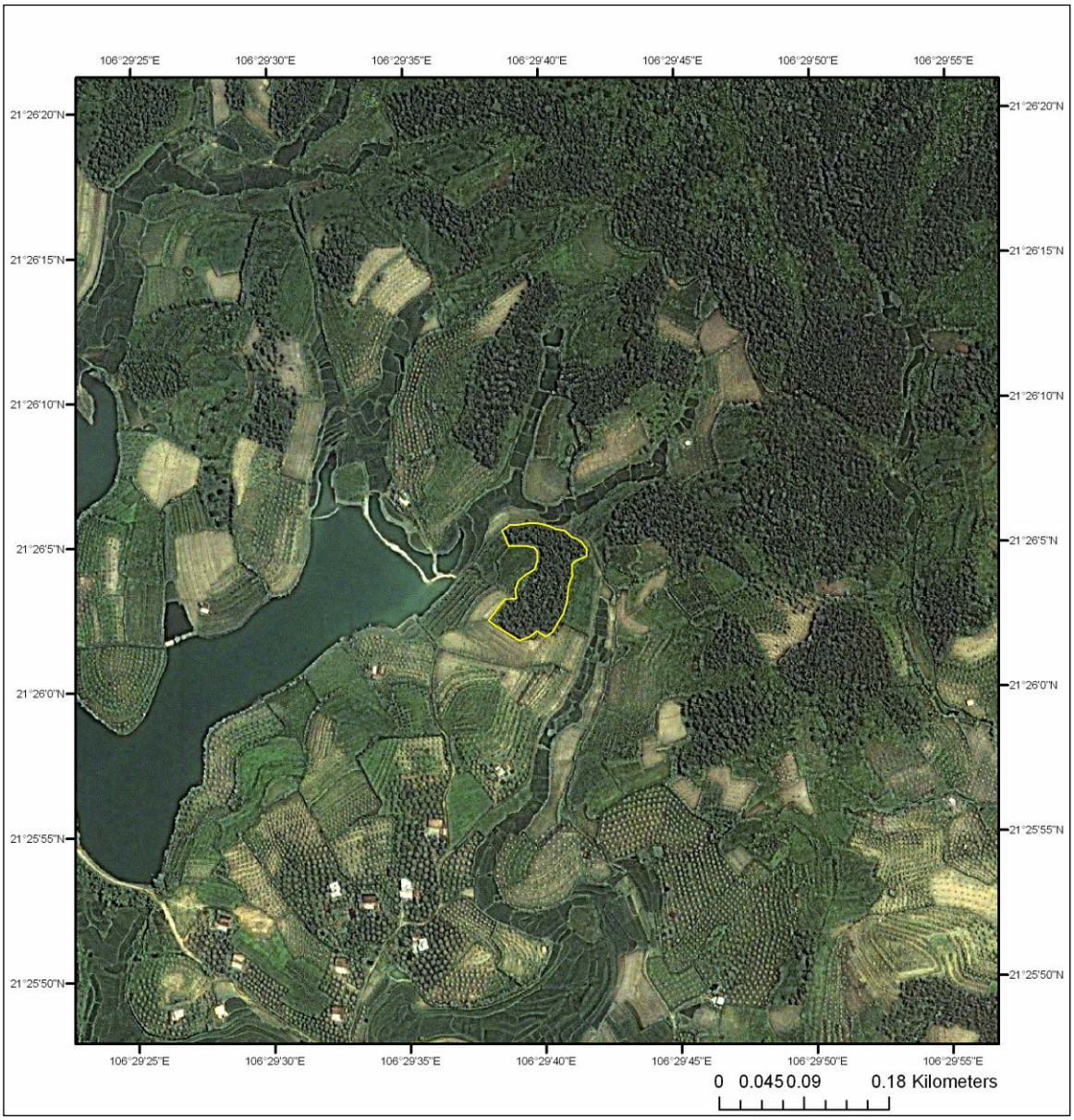

Figure 11

Carbon Type: A/R *Acacia* (few *Pinus*)
Owner: La Van manh
Area: 0.69
Land Use History: *Acacia* (few *Pinus*) planted in 1997.
Biometric Data: m x 20 m plot (500 sq. m.); Planting density (~ 420 trees / ha); 57 trees sampled: Average height = 11.6 m, Average DBH = 11.4 cm.

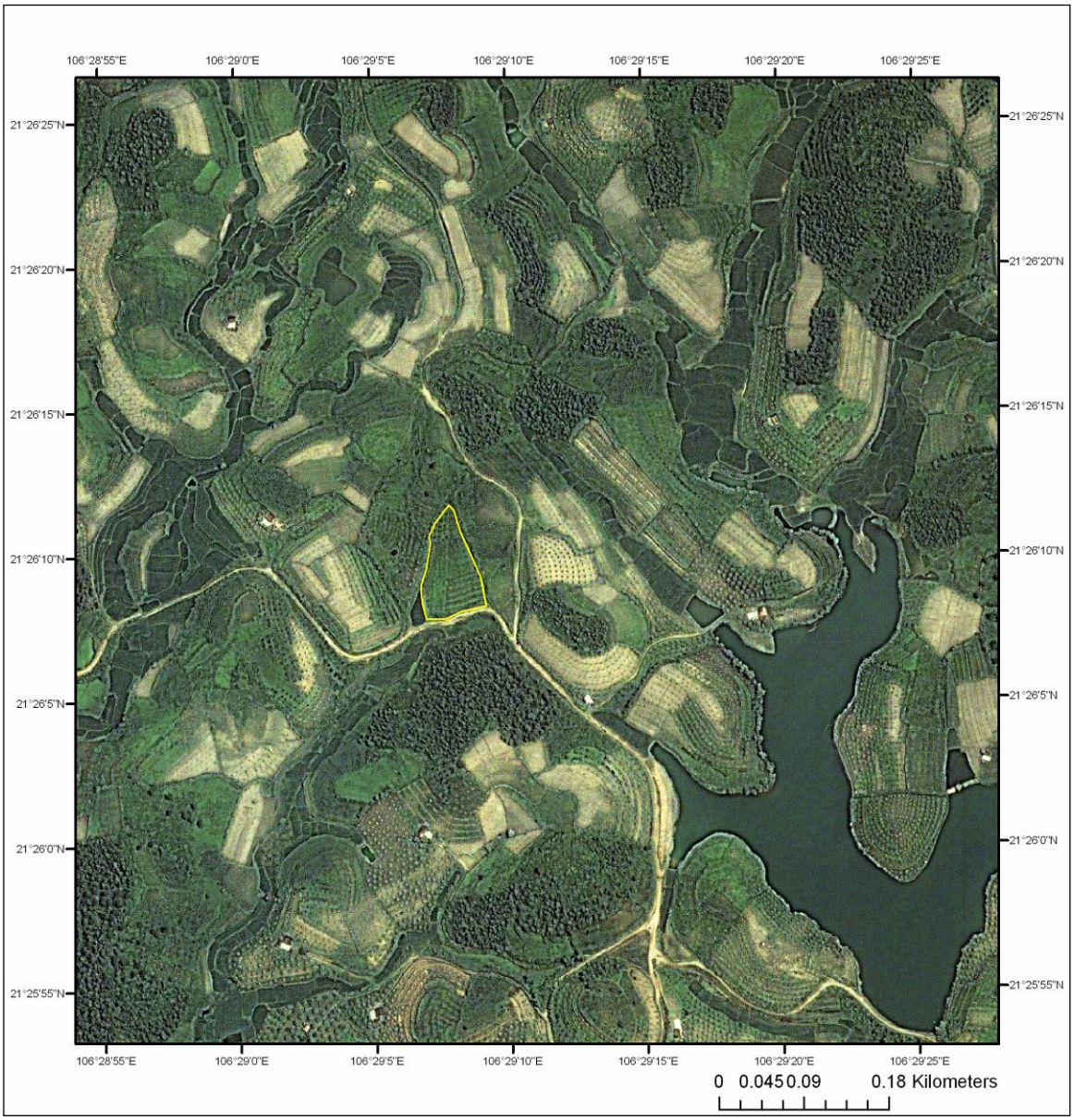

Figure 12

Carbon Type: Ag-f – *Litchi* intercropped with soybean
Owner: Ly Thi Keo
Area: 1.63
Land Use History: *Litchi* planted in 1997. August 2007 intercropped with soybean.

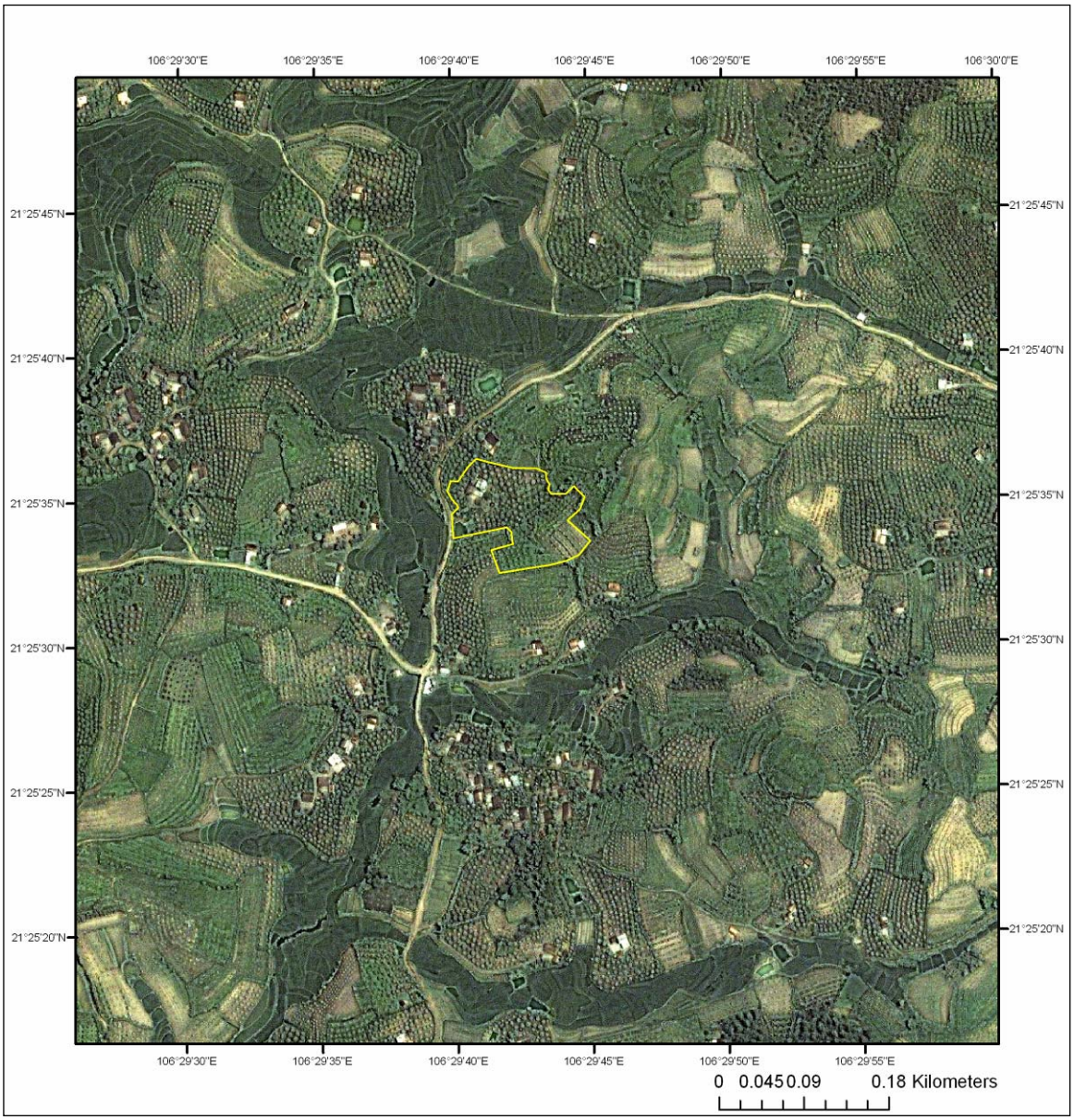

Figure 13

Carbon Type: Ag-f – *Litchi*
Owner: Ly Thi Keo
Area: 1.14
Land Use History: *Litchi* planted in 1995 – 2006 surrounding house.

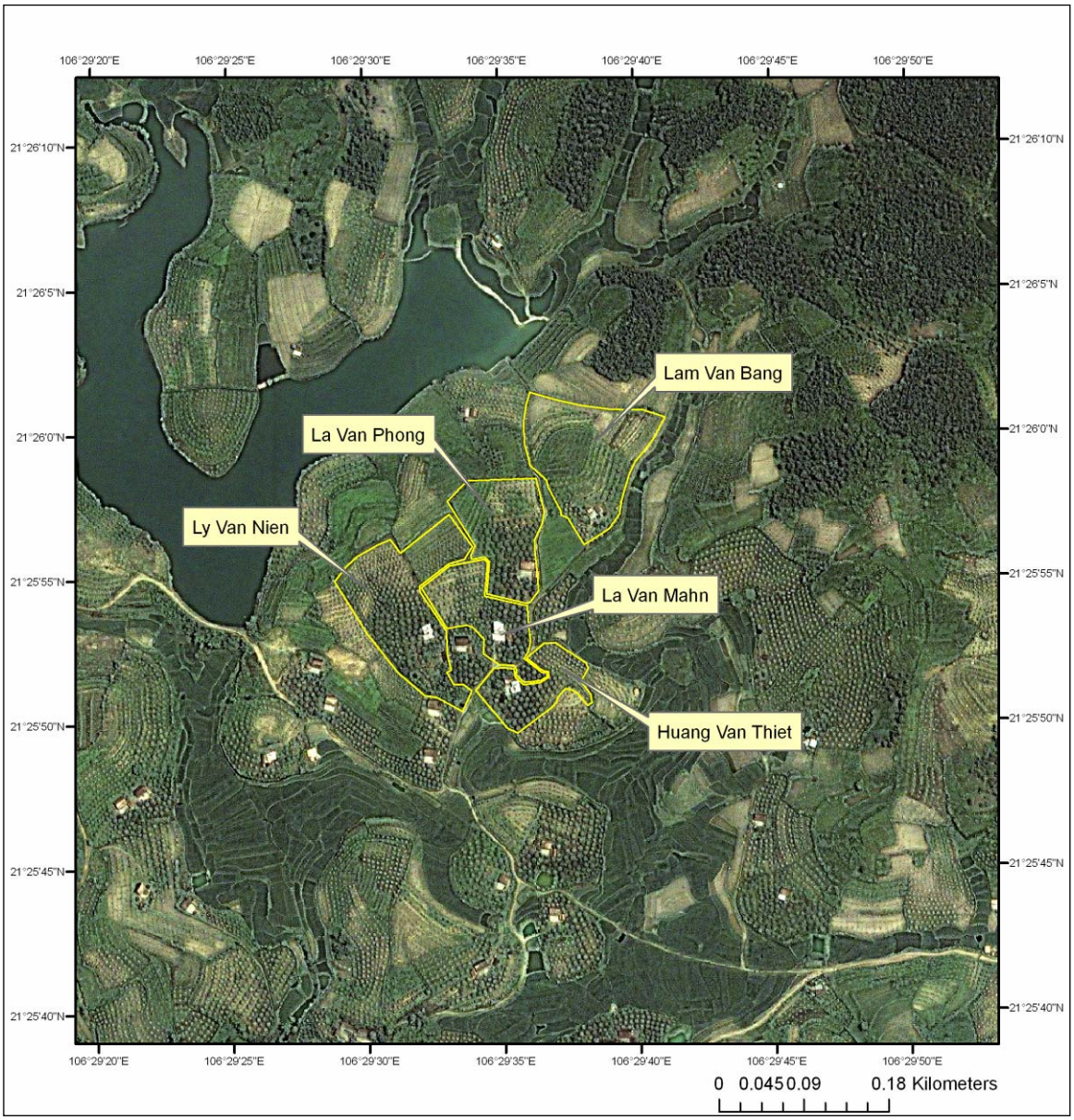

Figure 14

Carbon Type: Ag-f – *Litchi* and *Litchi* intercropped

Owner	**Area (ha)**	**Year(s) Planted**
La Van Manh	0.73	1991
La Van Phong	0.91	1990 - 1998
Ly Van Nien	1.43	1991 & 1995/6
Lam Van Bang	1.38	1995 & 2003
Huang Van Theit	0.57	1990 - 1998

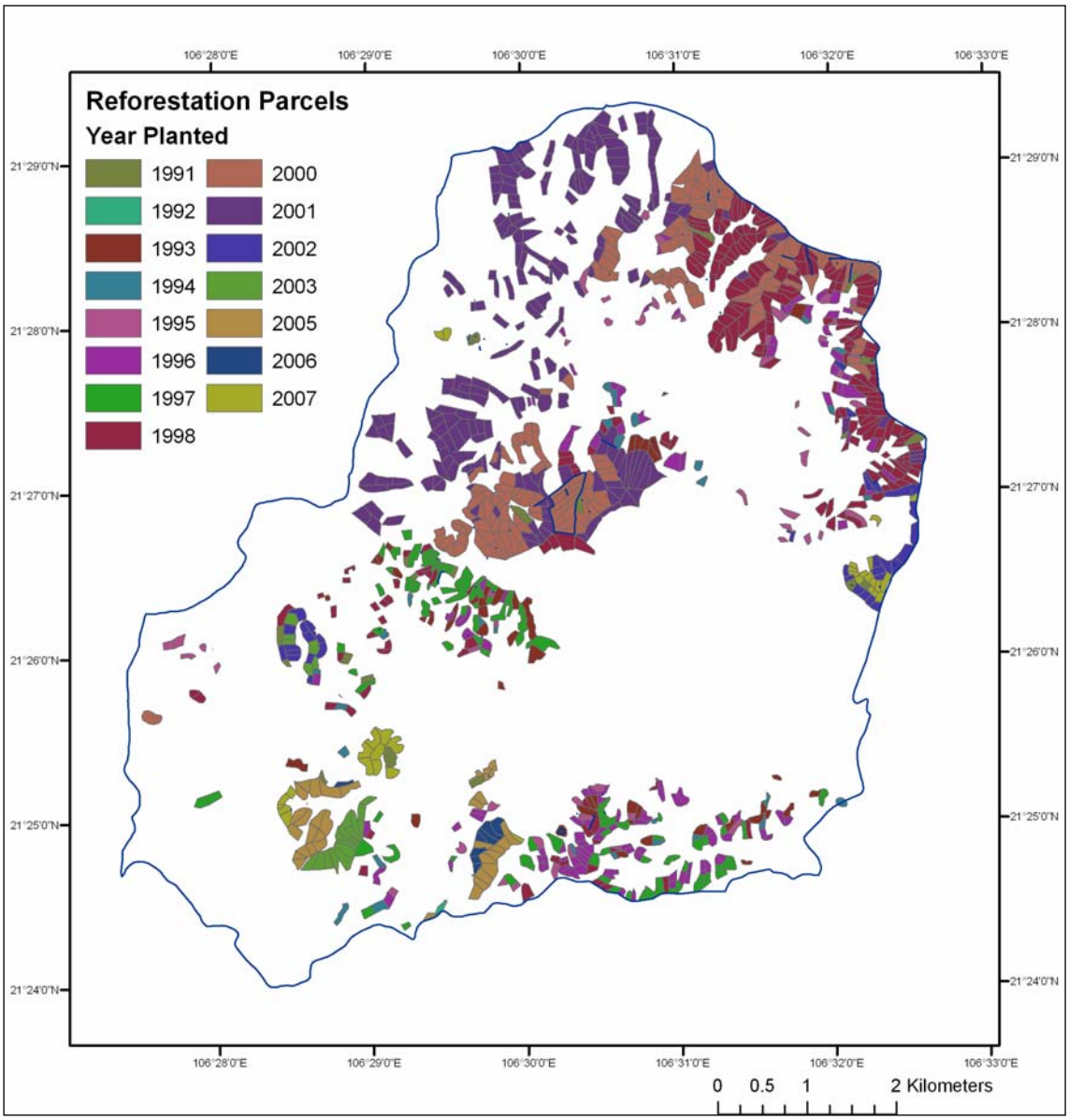

Figure 15: Reforestation Parcels Kien Lao Commune

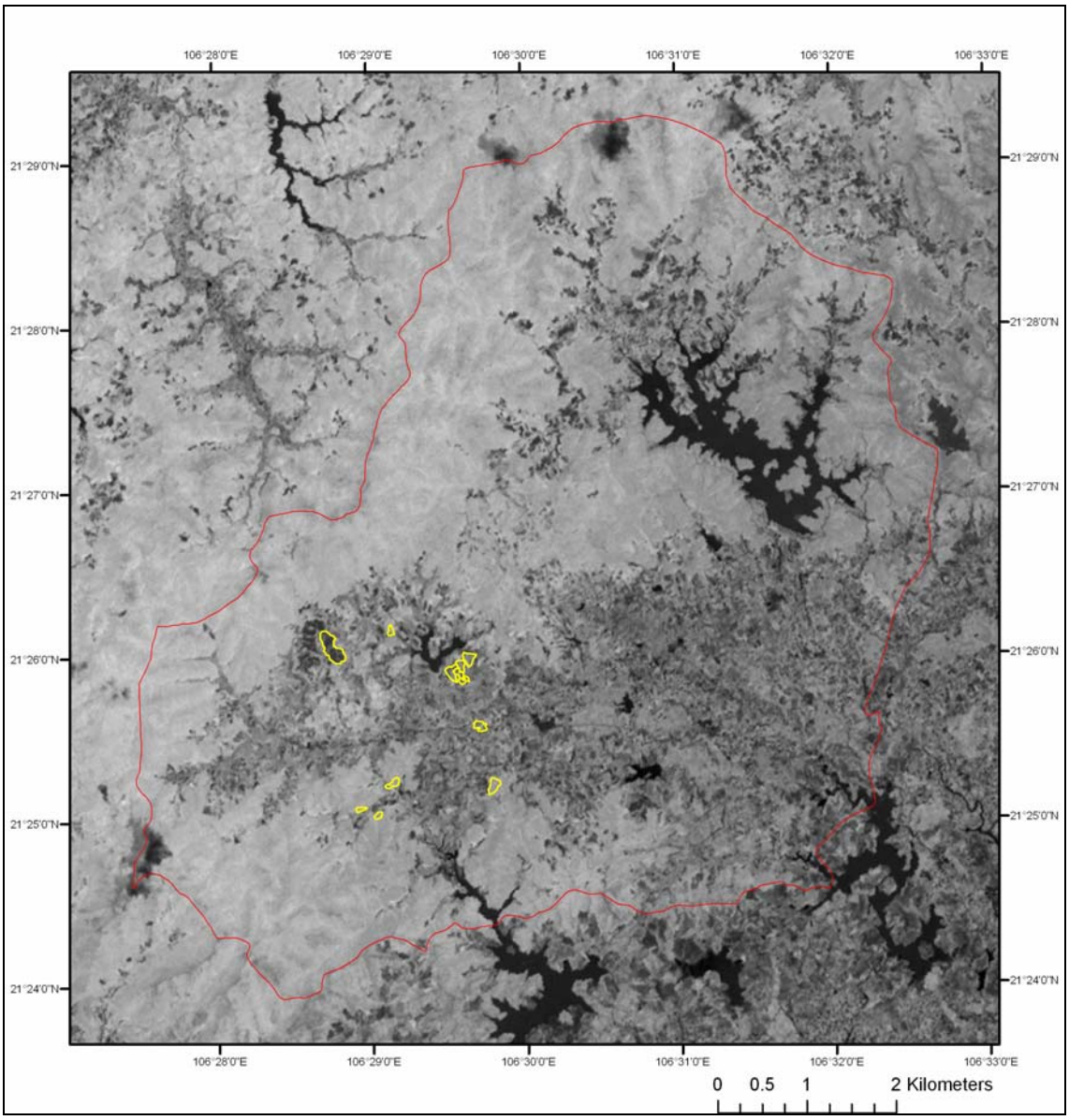

Figure 16: 31-Aug-2002 ASTER NDVI data set with polygon of Kien Lao Commune (red) and initial 15 project area polygons (yellow)

Figure 17: *Litchi* along hillside above rice paddies

Figure 18: *Acacia Hybrid* plantation

Inpang Community Network, Northeast Thailand

The first field visit to the Inpang (sometimes spelled *Inpaeng*) Community Network was April 2007 to discuss the possibility of developing a carbon sequestration project with the members of the Inpang Community Network, a network which began in 1987 and now boasts a membership of over 4000 households from five provinces in Northeast Thailand. Inpang members are devoted to the concepts embodied in "Sufficiency Economy" (UNDP 2007). As such, they have transformed much of the landscape they occupy from simple single cash crop systems (like farming cassava) to complex agro-forest farms that include rice, fish ponds, fruit trees, rattan, timber trees and the like. The Inpang Network likened the idea of carbon sequestration to a "carbon bank" and expressed interest in developing the project further. Subsequent follow-up trainings and field collection trips took place in August 2007, October 2007, and January 2008. The Inpang Community Youth group has been most active and instrumental in data collection. A database registry has been developed that includes ownership and parcel information, tree species planted data (age, number of trees, uses, average DBH and height measurements), and location data. The database reveals that the community members are planting a wide variety of tree species (table 3) for a number of uses. These fields range from simple small-holder plantations of *Tectona grandis* (teak), *Hevea brasiliensis* (Para rubber), and fruit trees, to complex agro-forest farms with sometimes more than 100 species occupying a few hectares or less. We are currently in the process of stratifying these areas from simple single (or few) species fields to the complex multi-species, multi-age fields in order to use appropriate methods for estimating carbon.

Figure 19 shows the location of the Inpang Network members in the five provinces (Udon Thani, Sakhon Nakhon, Kalasin, Mukdahan, and Nakhon Phanom) in Northeast Thailand. Figures 20 - 26 show the fieldwork polygons of nine (9) project sites where permanent plots have been established for collecting biometric data. The polygon outlines are displayed on 0.6-meter resolution QuickBird multi-spectral satellite data (e.g. Figure 20) and 15-meter ASTER VNIR multi-spectral satellite data (e.g. Figure 23). We continue to refine the database and are continuing to collect field GPS boundaries.

The leads on this project are Dr. Usa Klinhom, Mr. Teerawong Laosuwan, and Mr. Pornchai Uttaruk from Mahasalakham University, Maha Salakham, Thailand; and Mr. Tawatchai Kulwong from the Inpang Community Network, Kud Bak, Sakhon Nakhon, Thailand.

Table 3: List of species planted or managed by members of the Inpang Community Network

Common Name	Species	Households (HH)	*Max # Trees by HH	Total # of Trees Planted	Age Range
Chik, Teng, Siamese sal, Thitya	Shorea obtusa	246	5000	139760	2-36
Kung	Dipterocarpus tuberculatus	208	12100	123808	2-130
Daeng, Iron Wood	Xylia xylocarpa	169	5000	86426	2-115
Pra du	Pterocarpus macrocarpus	103	5000	72727	2-32
Eucalyptus	Eucalyptus	45	7000	58459	1-10
Rung	Shorea siamensis	97	8636	46888	4-36
Mango	Mangifera indica	54	5000	33770	2-34
Tio	Cratoxylum formosum	41	3000	18425	2-30
Lamyai	Dimocarpus longan	35	2500	15501	3-16
Pueai, Ta baek	Lagerstroemia floribunda	15	10000	14400	5-25
Ma khamong	Afzelia xylocarpa	21	5000	11560	3-36
Plao yai	Croton argyrtus	23	2000	11355	2-30
Tamarind	Tamarindus indica	43	800	11347	2-57
Cheuk	Terminalia alata	28	4000	11014	3-30

Common Name	Species	Households (HH)	*Max # Trees by HH	Total # of Trees Planted	Age Range
Sat	Dipterocarpus obtusifolius	25	1705	10757	3-28
Mueat yai	Aporosa villosa	23	2000	10251	1-30
Krabok	Irvingia malayana	6	5300	7350	18-30
Arang	Peltophorum dasyrachis	11	2000	6877	3-36
Kha	Cinnamomum ilicioides	5	2000	4400	1-10
Kwao	Haldina cordifolia	12	1000	4320	5-25
Sugar Apple	Annona squamosa	15	600	4206	1-15
Thum	Mitragyna hirsuta	11	800	3264	2-28
Sabu dam	Jatropha curcas	8	1000	3082	0-5
Makok liam	Canarium subulatum	7	1000	3074	10-32
Wa	Syzygium cumini	10	800	2524	3-30
Ma pok	Parinari anamense	8	1180	2430	5-32
Kra thin	Leucaena leucocephala	3	1100	2246	3-30
Yang na	Dipterocarpus alatus	10	500	2230	1-100
Thong leang	Berrya mollis	4	1000	2100	3-15
Takhrai	Litsea cubeba	3	1500	2100	1-5
Nam kiang	Semecarpus cochinchinensis	7	530	1680	10-25
Plao noi	Croton joufra	1	1600	1600	20-20
Khemdong	Ixora finlaysoniana	1	1590	1590	15-15
Tum ka	Strychnos nux-blanda	4	1000	1355	9-30
Ma Ngeaw	Nephelium hypoleucum	2	1230	1330	10-20
Phayom	Shorea roxburghii	1	1300	1300	20-20
Mao yai	Antidesma	5	400	1110	6-10
Cham cha	Samanea saman	9	200	1080	10-20
Khanun, Jack Fruit	Artocarpus heterophyllus	4	300	1050	3-5
Mek	Syzygium gratum	3	700	1050	10-20
Ching chan	Dalbergia oliveri	1	1000	1000	36-36
Ta ko	Schleichera oleosa	1	1000	1000	15-15
Sadao (Neem)	Azadirachta indica	4	500	800	0-70
Phang, Sa Phang	Caesalpinia sappan	2	500	800	5-20
Samo thai	Terminalia chebula	2	700	800	10-10
Hua ling	Hymenocardia wallichii	2	600	700	3-20
Makok	Spondias bipinnata	3	300	650	7-36
Tangerine	Citrus reticulata	2	500	650	7-8
Velvet tamarind	Dialium cochinchinense	2	500	650	10-30
Phai	Bambusa spp.	4	200	500	4-25
Khilek	Senna siamea	1	500	500	36-36
Ko	Castanopsis fissa	4	180	480	5-20
Khae foi	Stereospermum cylindricum	2	350	450	15-18
Yo pa	Morinda coreia	4	105	405	5-23
Sakae	Combretum quadrangulare	2	300	400	10-10
Phan sat	Erythrophleum succirubrum	2	300	400	10-18
Guava	Psidium guajava	2	200	400	1-2
Ma khatae	Sindora siamensis	2	300	400	15-15
Hang num	Bridelia retusa	1	300	300	10-10
Lamut, Nasebery, Sapodilla plum	Manilkara zapota	1	300	300	12-12

Common Name	Species	Households (HH)	*Max # Trees by HH	Total # of Trees Planted	Age Range
Mafai	Baccaurea ramiflora	2	150	250	20-25
Mun pla	Fagraea fragrans	2	150	250	20-20
Oil palm	Elaeis guineensis	1	250	250	2-2
Sathon	Millettia leucantha	1	230	230	13-13
Ma tong	Sandoricum koetjape	2	115	215	12-12
Som siao	Bauhinia malabarica	2	100	200	8-15
Nun	Bombax ceiba	2	100	200	10-10
Tummy-wood, Patana oak	Careya sphaerica (arborea?)	2	100	200	16-20
Pak wanpa	Champereia manillana	2	100	200	5-10
Ben	Flacourtia indica	2	100	200	1-10
Tab tao	Neonauclea sessilifolia	2	100	200	5-10
Emblic myrabolan, Malacca tree	Phyllanthus emblica	2	100	200	10-15
Satang	Xylopia vielana	2	100	200	10-12
Kritsana	Aquilaria crassna	1	200	200	5-5
Ma duea pong	Ficus hispida	1	200	200	5-5
Tab tim, pomegranate	Punica granatum	1	200	200	5-5
Ma kong	Ziziphus cambodiana	1	200	200	20-20
Kok kan	Lannea coromandelica	1	180	180	16-16
Ngo, rambutan	Nephelium lappaceum	1	180	180	12-12
Kumbog	Crateva adansonii	1	150	150	5-5
Kan lueang	Gonocaryum lobbianum	1	145	145	7-7
Siamese Rosewood	Dalbergia cochinchinensis	1	130	130	20-20
Pomelo	Citrus maxima	1	120	120	10-10
Sang	Xanthophyllum lanceatum	1	120	120	30-30
Ma hat	Artocarpus lacucha	1	110	110	20-20
Thon	Albizia procera	1	100	100	5-5
Khang hung	Albizia lebbeck	1	100	100	15-15
Bak	Anisoptera costata	1	100	100	10-10
Nam taeng	Catunaregam spathulifolia (*tomentosa*?)	1	100	100	12-12
Ma phrao, coconut	Cocos nucifera	1	100	100	20-20
Khao khwai	Dalbergia cultrata	1	100	100	12-12
Pra dong	Dalbergia	1	100	100	15-15
Mui dang	Dioecrescis erythroclada	1	100	100	15-15
Heat kwang	Diospyros ehretioides	1	100	100	20-20
Mi	Litsea glutinosa	1	100	100	13-13
Romkhom	Microcos tomentosa	1	100	100	10-10
Chang nao	Ochna integerrima	1	100	100	10-10
Yang bong	Persea kurzii	1	100	100	15-15
Ta kai	Salacia chinensis	1	100	100	15-15
Ta kwang	Salacia verrucosa	1	100	100	15-15
Khrai nun	Salix tetrasperma	1	100	100	5-5
Som hong	Sterculia foetida	1	100	100	10-10
Siamese rough bush, Tooth brush tree	Streblus asper	1	100	100	10-10

* Min number trees = 100

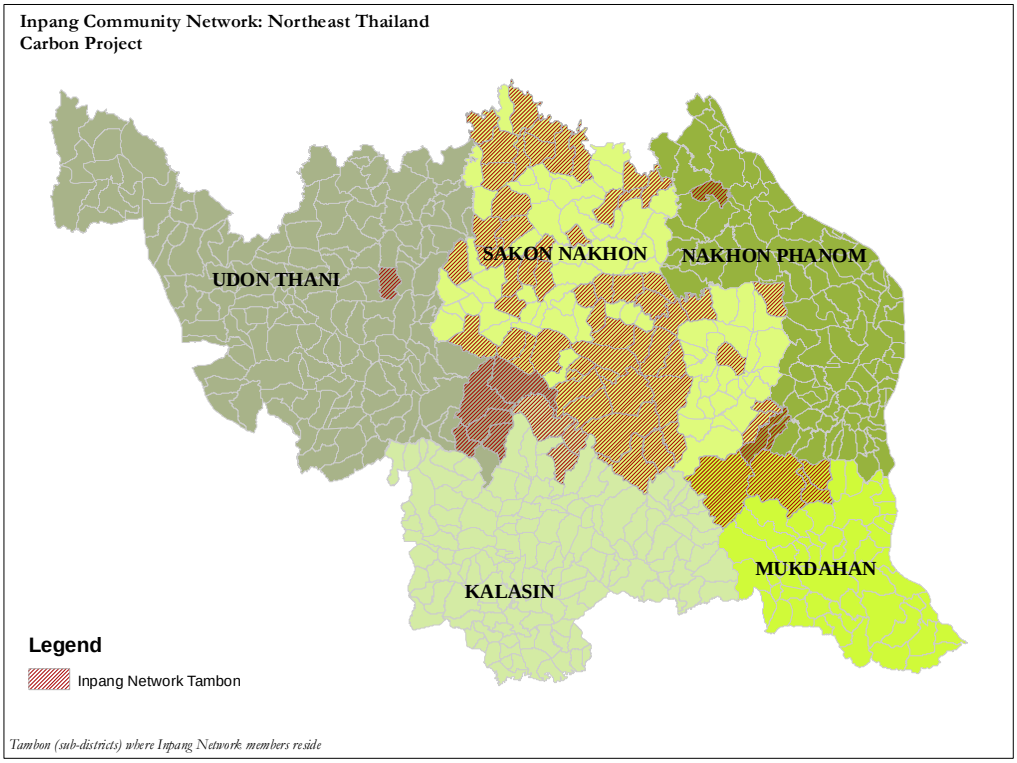

Figure 19: Map showing locations (by Tambon) of Inpang Network members in five provinces in Northeast Thailand

Comment	Plot_ID	Carb_Type	Owner	Carbon	Value	Hectares
1990 - 97	ip_001	Agro-f Dipt alatus, Hopea odorata	Sawing Kudwongkaew	0	0	1.195403
1989-2008	ip_002	Agro-f multiple	Serm Udomna	0	0	2.797676
2008	ip_003	Agro-f Dipterocarpus (Teak?)	Serm Udomna	0	0	0.434785
1987-2001	ip_004	Agro-f Shorea obtusa, Xylia xylocarpa	Kosin Dablaum	0	0	1.775102
1981-2004	ip_005	Agro-f Tectona grandis, Mangafera Indic	Thanakorn Promburom	0	0	15.469914
1993	ip_006	A / R Para rubber	Louchai Ratchakhum	0	0	3.305884
2004	ip_007	A / R Para rubber	Kaew Khamsri	0	0	12.629548
1984	ip_008	A / R Para rubber	Sangkhom Kheawkhom	0	0	2.414095
1994	ip_009	A / R Teak	Khumkan	0	0	2.33353

Figure 20

Comment	Plot_ID	Carb_Type	Owner	Carbon	Value	Hectares
1990 - 97	ip_001	Agro-f Dipt alatus, Hopea odorata	Sawing Kudwongkaew	0	0	1.195403
1989-2008	ip_002	Agro-f multiple	Serm Udomna	0	0	2.797676
2008	ip_003	Agro-f Dipterocarpus (Teak?)	Serm Udomna	0	0	0.434785
1987-2001	ip_004	Agro-f Shorea obtusa, Xylia xylocarpa	Kosin Dablaum	0	0	1.775102
1981-2004	ip_005	Agro-f Tectona grandis, Mangafera Indic	Thanakorn Promburom	0	0	15.469914
1993	ip_006	A / R Para rubber	Louchai Ratchakhum	0	0	3.305884
2004	ip_007	A / R Para rubber	Kaew Khamsri	0	0	12.629548
1984	ip_008	A / R Para rubber	Sangkhom Kheawkhom	0	0	2.414095
1994	ip_009	A / R Teak	Khumkan	0	0	2.33353

Figure 21

Comment	Plot_ID	Carb_Type	Owner	Carbon	Value	Hectares
1990 - 97	ip_001	Agro-f Dipt alatus, Hopea odorata	Sawing Kudwongkaew	0	0	1.195403
1989-2008	ip_002	Agro-f multiple	Serm Udomna	0	0	2.797676
2008	ip_003	Agro-f Dipterocarpus (Teak?)	Serm Udomna	0	0	0.434785
1987-2001	ip_004	Agro-f Shorea obtusa, Xylia xylocarpa	Kosin Dablaum	0	0	1.775102
1981-2004	ip_005	Agro-f Tectona grandis, Mangafera Indic	Thanakorn Promburom	0	0	15.469914
1993	ip_006	A / R Para rubber	Louchai Ratchakhum	0	0	3.305884
2004	ip_007	A / R Para rubber	Kaew Khamsri	0	0	12.629548
1984	ip_008	A / R Para rubber	Sangkhom Kheawkhom	0	0	2.414095
1994	ip_009	A / R Teak	Khumkan	0	0	2.33353

Figure 22

Comment	Plot_ID	Carb_Type	Owner	Carbon	Value	Hectares
1990 - 97	ip_001	Agro-f Dipt alatus, Hopea odorata	Sawing Kudwongkaew	0	0	1.195403
1989-2008	ip_002	Agro-f multiple	Serm Udomna	0	0	2.797676
2008	ip_003	Agro-f Dipterocarpus (Teak?)	Serm Udomna	0	0	0.434785
1987-2001	ip_004	Agro-f Shorea obtusa, Xylia xylocarpa	Kosin Dablaum	0	0	1.775102
1981-2004	ip_005	Agro-f Tectona grandis, Mangafera Indic	Thanakorn Promburom	0	0	15.469914
1993	ip_006	A / R Para rubber	Louchai Ratchakhum	0	0	3.305884
2004	ip_007	A / R Para rubber	Kaew Khamsri	0	0	12.629548
1984	ip_008	A / R Para rubber	Sangkhom Kheawkhom	0	0	2.414095
1994	ip_009	A / R Teak	Khumkan	0	0	2.33353

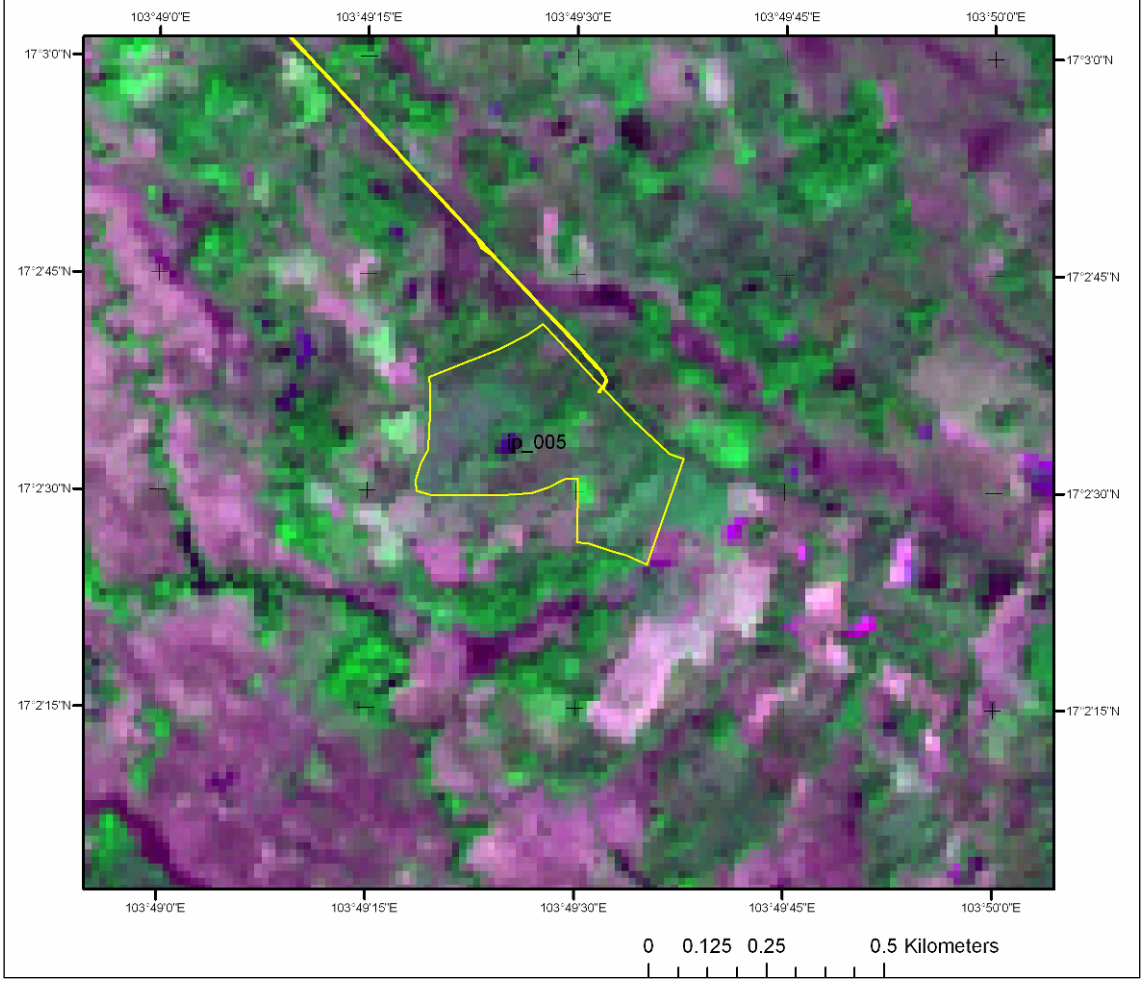

Figure 23

Comment	Plot_ID	Carb_Type	Owner	Carbon	Value	Hectares
1990 - 97	ip_001	Agro-f Dipt alatus, Hopea odorata	Sawing Kudwongkaew	0	0	1.195403
1989-2008	ip_002	Agro-f multiple	Serm Udomna	0	0	2.797676
2008	ip_003	Agro-f Dipterocarpus (Teak?)	Serm Udomna	0	0	0.434785
1987-2001	ip_004	Agro-f Shorea obtusa, Xylia xylocarpa	Kosin Dablaum	0	0	1.775102
1981-2004	ip_005	Agro-f Tectona grandis, Mangafera Indic	Thanakorn Promburom	0	0	15.469914
1993	ip_006	A / R Para rubber	Louchai Ratchakhum	0	0	3.305884
2004	ip_007	A / R Para rubber	Kaew Khamsri	0	0	12.629548
1984	ip_008	A / R Para rubber	Sangkhom Kheawkhom	0	0	2.414095
1994	ip_009	A / R Teak	Khumkan	0	0	2.33353

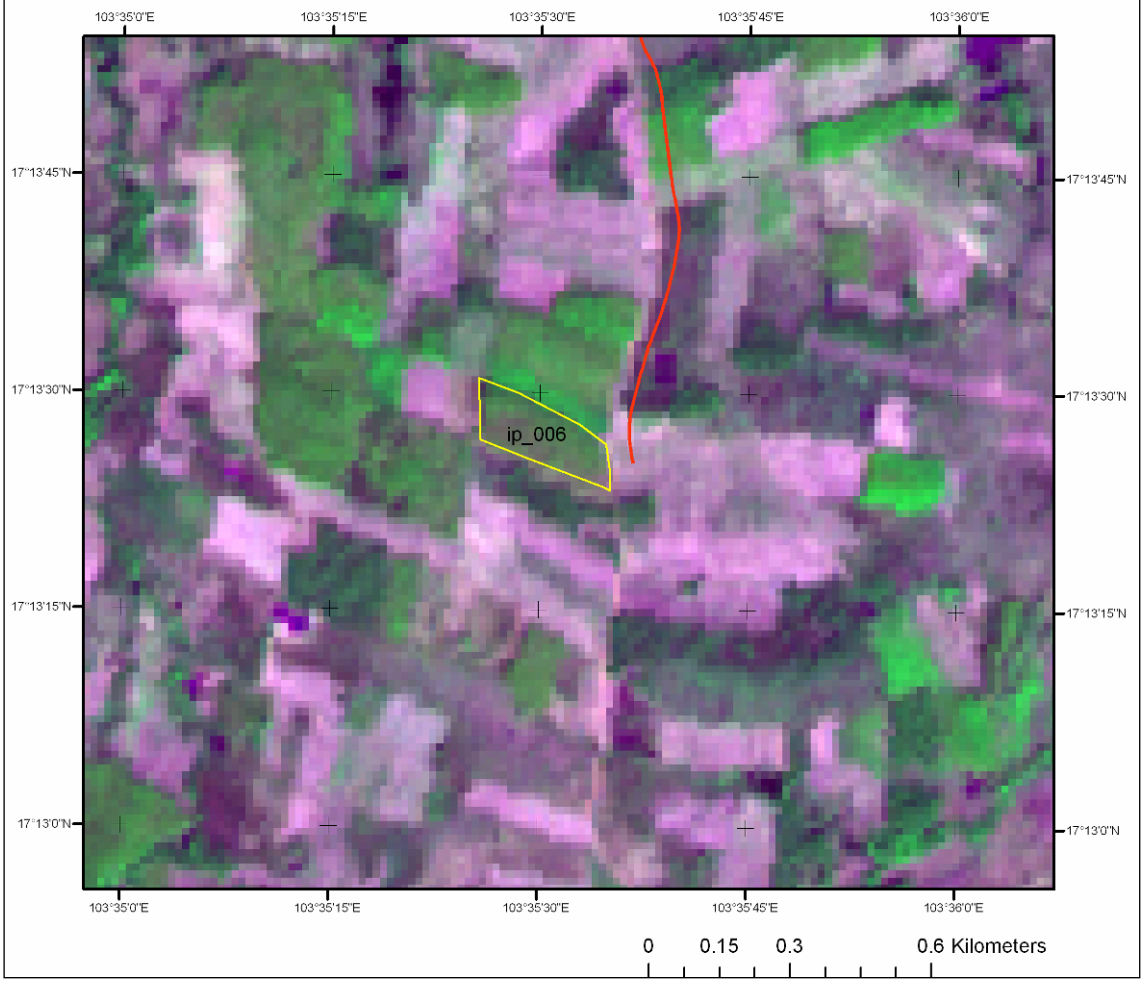

Figure 24

Comment	Plot_ID	Carb_Type	Owner	Carbon	Value	Hectares
1990 - 97	ip_001	Agro-f Dipt alatus, Hopea odorata	Sawing Kudwongkaew	0	0	1.195403
1989-2008	ip_002	Agro-f multiple	Serm Udomna	0	0	2.797676
2008	ip_003	Agro-f Dipterocarpus (Teak?)	Serm Udomna	0	0	0.434785
1987-2001	ip_004	Agro-f Shorea obtusa, Xylia xylocarpa	Kosin Dablaum	0	0	1.775102
1981-2004	ip_005	Agro-f Tectona grandis, Mangafera Indic	Thanakorn Promburom	0	0	15.469914
1993	ip_006	A / R Para rubber	Louchai Ratchakhum	0	0	3.305884
2004	ip_007	A / R Para rubber	Kaew Khamsri	0	0	12.629548
1984	ip_008	A / R Para rubber	Sangkhom Kheawkhom	0	0	2.414095
1994	ip_009	A / R Teak	Khumkan	0	0	2.33353

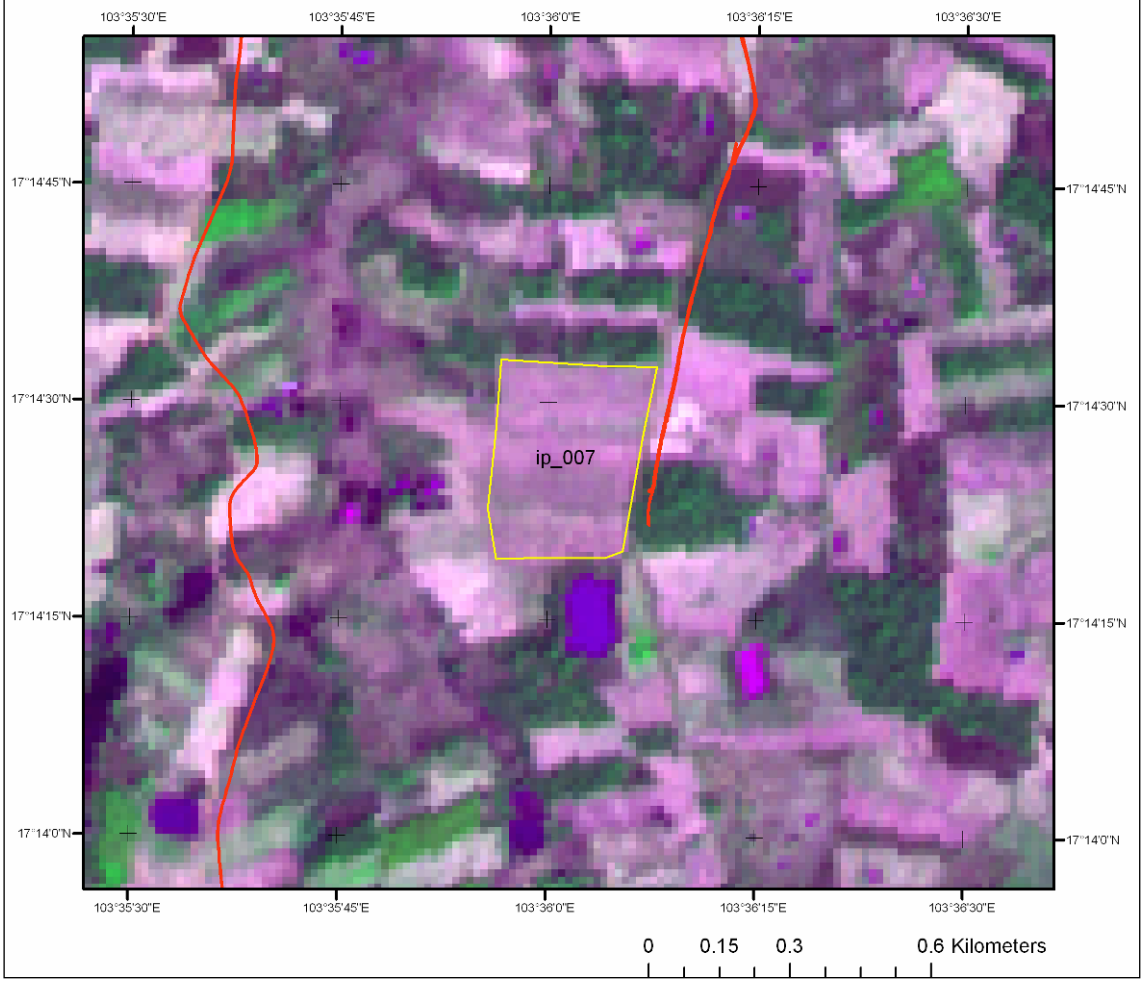

Figure 25

Comment	Plot_ID	Carb_Type	Owner	Carbon	Value	Hectares
1990 - 97	ip_001	Agro-f Dipt alatus, Hopea odorata	Sawing Kudwongkaew	0	0	1.195403
1989-2008	ip_002	Agro-f multiple	Serm Udomna	0	0	2.797676
2008	ip_003	Agro-f Dipterocarpus (Teak?)	Serm Udomna	0	0	0.434785
1987-2001	ip_004	Agro-f Shorea obtusa, Xylia xylocarpa	Kosin Dablaum	0	0	1.775102
1981-2004	ip_005	Agro-f Tectona grandis, Mangafera Indic	Thanakorn Promburom	0	0	15.469914
1993	ip_006	A / R Para rubber	Louchai Ratchakhum	0	0	3.305884
2004	ip_007	A / R Para rubber	Kaew Khamsri	0	0	12.629548
1984	ip_008	A / R Para rubber	Sangkhom Kheawkhom	0	0	2.414095
1994	ip_009	A / R Teak	Khumkan	0	0	2.33353

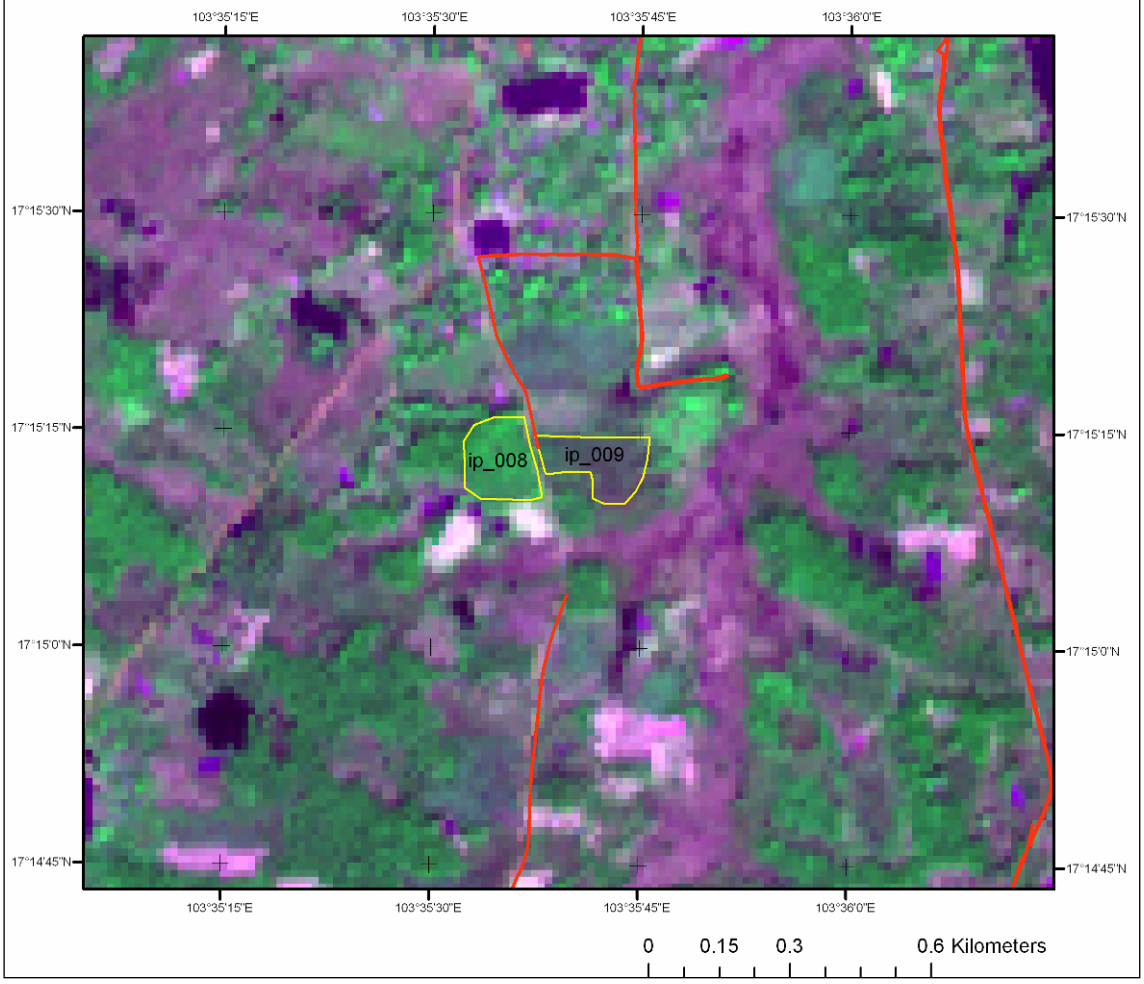

Figure 26

Trat Province, Thailand

The first field visit to the Trat Province project area in Thailand was in January 2008. An information workshop was held at the Trat Agroforestry Research Station (TAFRS), of the Kasetsart University Research and Development Institute (KURDI) with TAFRS staff and five members of the local community agroforestry network. These are families who participate in the TAFRS outreach program which centers on developing sustainable agroforestry models in this region of Thailand. Trat Province has a growing number of *Hevea brasiliensis* plantations and TAFRS is conducting practical research and applications for intercropping with *Hevea brasiliensis* as well as other commercial tree species. The province also has many fruit tree plantations. At the January 2008 visit we collected some field data at one of the agroforestry community member's farm which contained a range of "treed" landscapes: *Hevea brasiliensis* (monoculture), *Hevea brasiliensis* intercropped (e.g. w/ banana, *Dimocarpus longan* or longan, and/or *Salacca magnifica* or sala fuit), *Garcinia mangostana* (Mangosteen), *Nephelium lappaceum* (Rambutan), *Dimocarpus longan* (Longan) plantations. In April 2008 additional field data

were collected and permanent plots established multi-aged stands of small-holder *Hevea brasiliensis* as well as in a selection fruit tree plantations.

Figure 27 shows the locations of the carbon project polygons for the Trat Province pilot project. Figures 28 and 29 are location maps of a number of the fields where the permanent plots are established. Figures 30 – 32 are ground pictures of three-year old *Hevea brasiliensis* intercropped with *Ananas comosus* (pineapple), fourteen-year old *Hevea brasiliensis* plantation, and twenty-year old *Nephelium lappaceum* orchard respectively. These are the sites where permanent plots have been established. The field data are in the process of being analyzed.

The lead coordinators for the Trat Province carbon sequestration project are Dr. Prateep Duengkae, Chief, and Mr. Nathawat Khlangsap, Assistant Chief, of the Trat Agroforestry Research Station; and Dr. Sura Pattanakiat and Dr. Charlie Navanugraha of the Faculty of Environment and Resource Studies, Mahidol University.

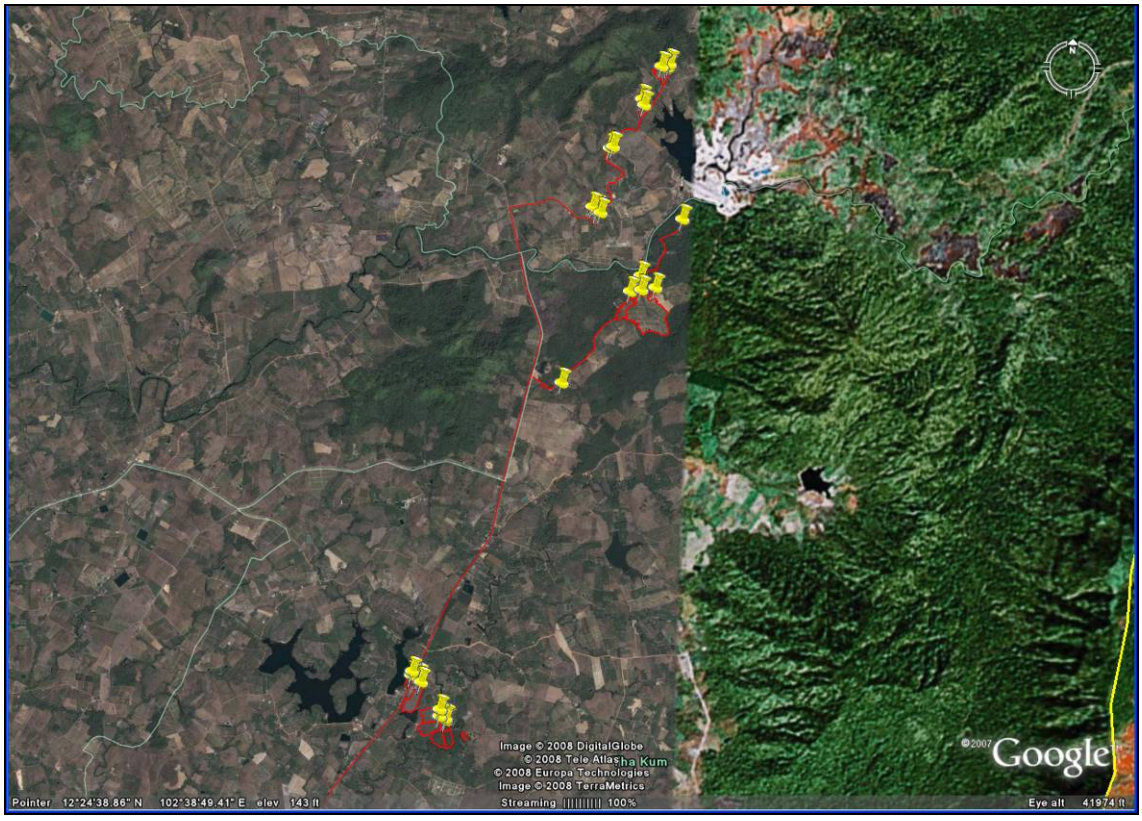

Figure 27: GPS Point and Polygon Locations of 17 Permanent Plots for Trat Province Project

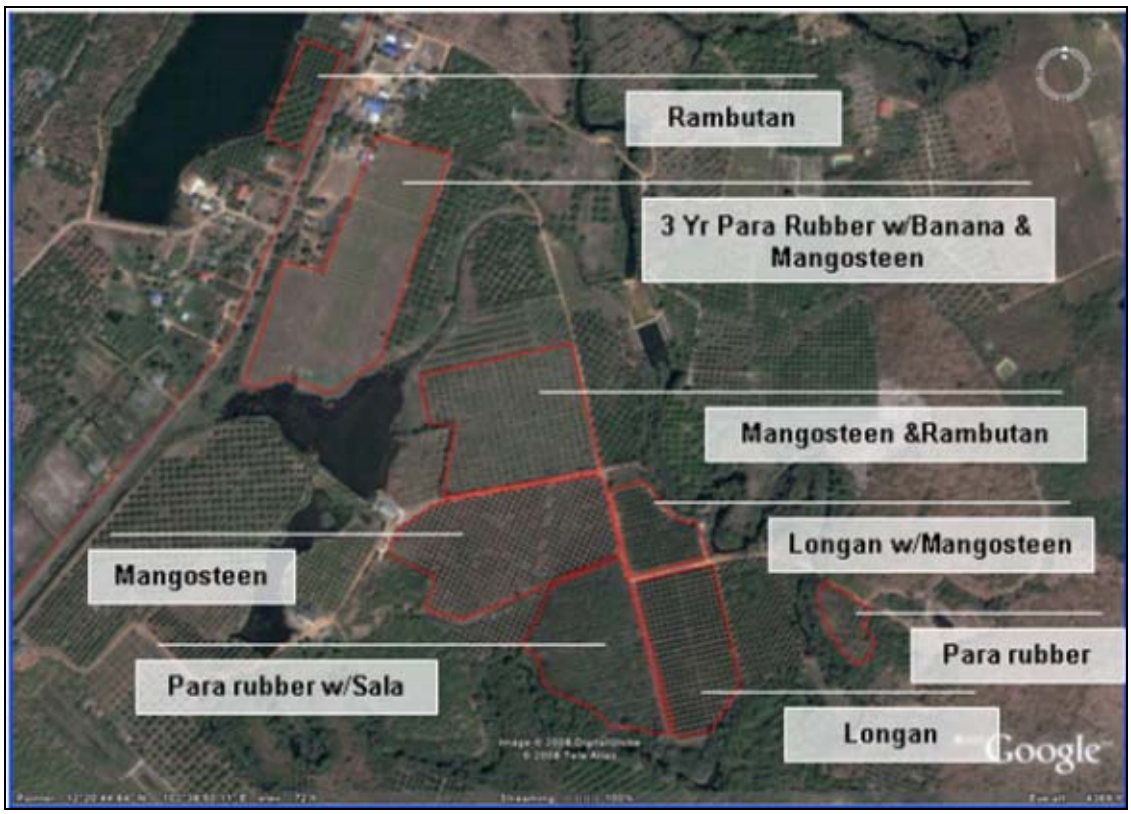

Figure 28: *Hevea brasiliensis* and fruit orchard fields

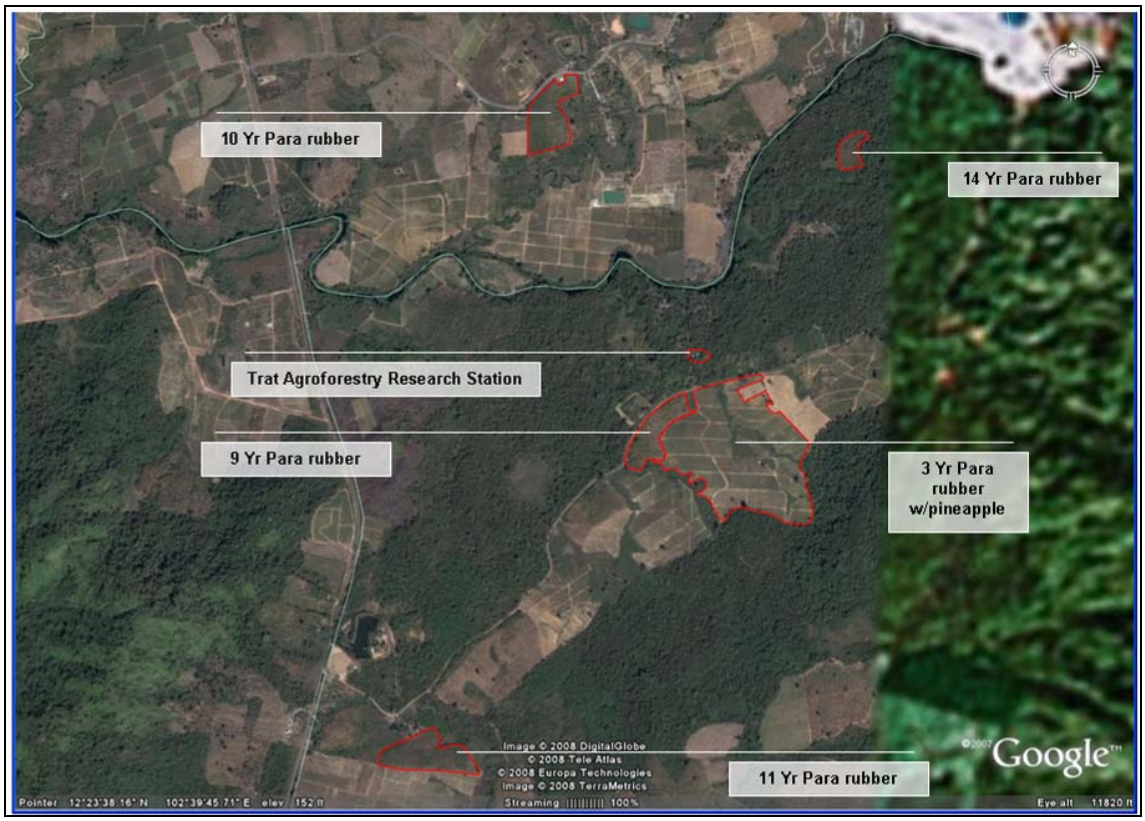

Figure 29: Chronosequence of *Hevea brasiliensis* plots

Figure 30: Three year old *Hevea brasiliensis* intercropped with *Ananas comosus*

Figure 31: Fourteen year old *Hevea brasiliensis* plantation

Figure 32: Twenty year old *Nephelium lappaceum* orchard

Luang Prabang Province, Lao PDR

In April 2008 we made a first field visit to Luang Prabang Province and established twelve permanent plots in a chronosequesence of small holder plantations of *Tectona grandis*, commonly known as teak. At a follow-up visit in June 2008 we meet formally with the Director General of the Luang Prabang Provincial Agriculture and Forestry Office and also gave a training workshop to the staff from the Provincial Department of Forestry Office in Luang Prabang Province. The field data are in the process of being analyzed.

Figure 33 shows the field data points, some of which are permanent plot locations, for the April 2008 site visit. Figure 34 shows an overlay of teak field areas and data points where a permanent plot has been established. Figures 35 and 36 are digital photos of three-year and thirteen-year old teak plantations respectively.

The lead coordinators for the small-holder *Tectona grandis* plantation carbon project in Luang Prabang are Dr. Sithong Thongmanivong and Mr. Houngphet Chantavong of the Faculty of Forestry, National University of Laos.

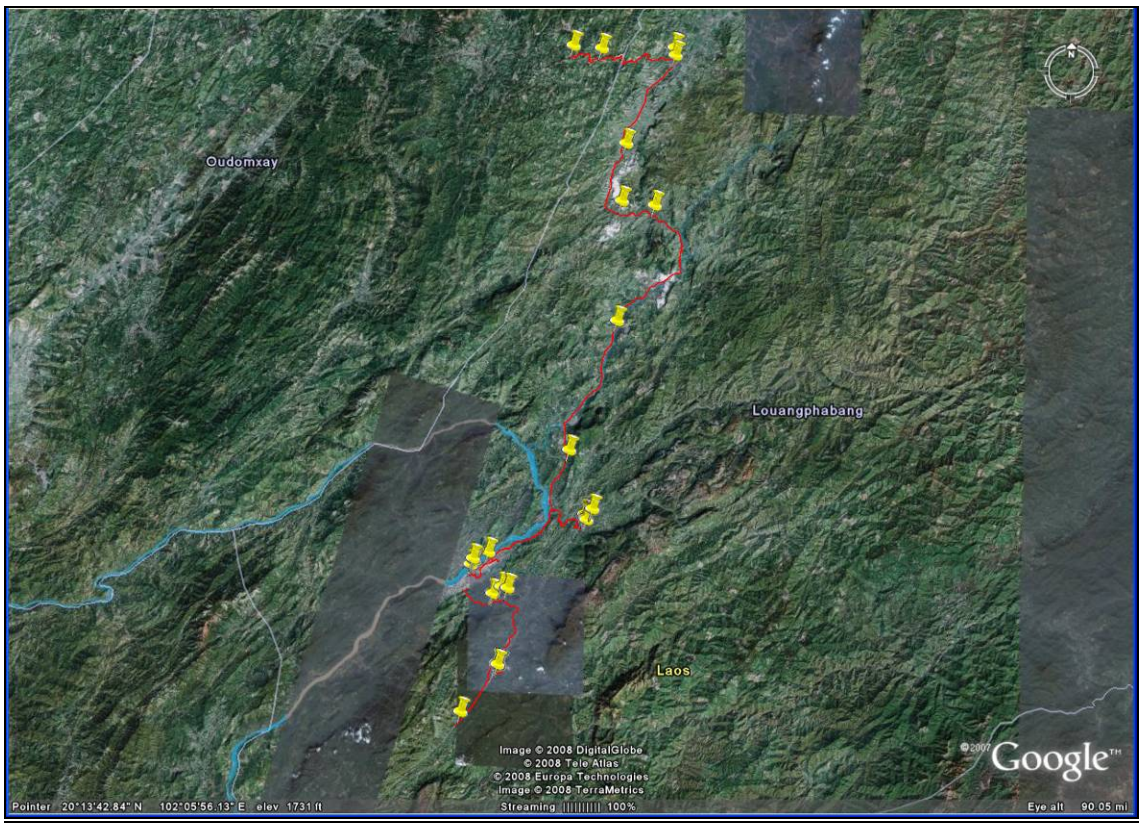

Figure 33: Data points for April 2008 fieldwork

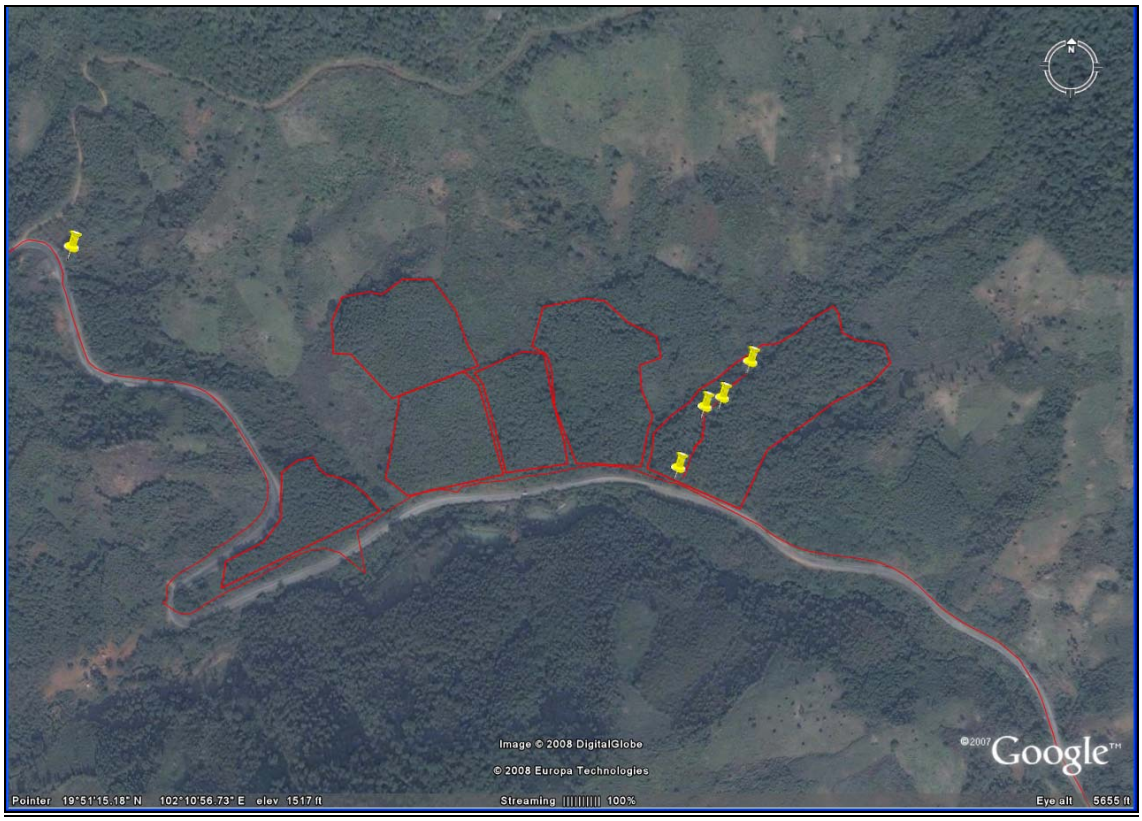

Figure 34: *Tectona grandis* compartments and sample points for permanent plot

Figure 35: Measuring DBH in three year old *Tectona grandis* plantation

Figure 36: Biomass measurements in thirteen year old *Tectona grandis* plantation

Model Training Forest (FoF, NUOL), Vientiane Province, Lao PDR

The Model Training Forest project site was visited in June 2008. GPS data points and digital pictures were acquired for a few areas. More detailed field work will be required for this pilot project site. There are twenty-nine permanent "treatment" plots each 100 ha in size. Figure 37 shows sample points within a section of the Model Training Forest.

The lead coordinators for the FoF, NUOL Model Training Forest carbon project in Vientiane Province are Dr. Sithong Thongmanivong and Mr. Houngphet Chantavong of the Faculty of Forestry, National University of Laos.

Figure 37: Sample points in Model Training Forest from field visit in June 2008

Cam Son Commune, Luc Ngan District, Bac Giang Province, Vietnam

The Cam Son Commune project site was visited in June 2008. GPS data points and digital pictures were acquired for a few areas. More detailed field work will be required for this pilot project site. The area has a large number of afforestation/reforestation sites, primarily with *Acacia Hybrid* and *Eucalyptus* species. Figure 38 shows sample points from the June 2008 site visit and figure 39 shows the landscape of the project site (reforestation area in *Acacia Hybrid*).

The lead on this project is Dr. Do Xuan Lan, Department of Science and Technology, Ministry of Agriculture and Rural Development, Hanoi, Vietnam

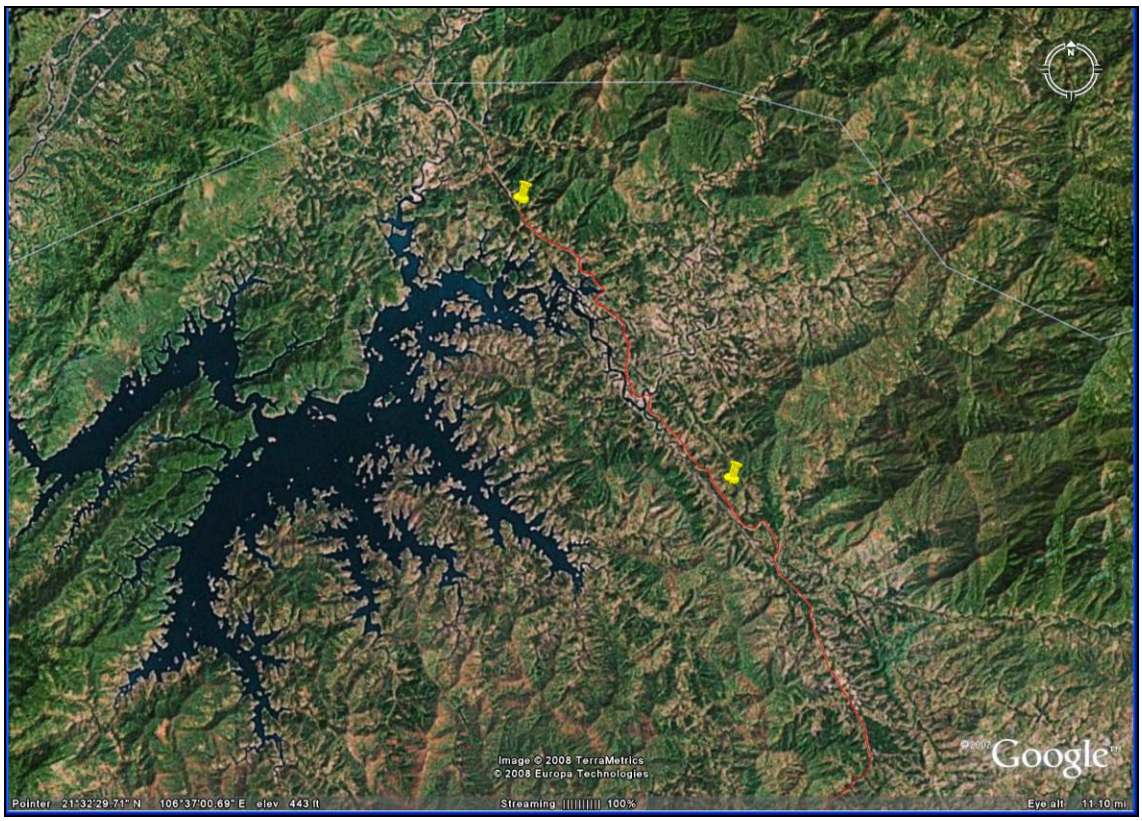

Figure 38: Cam Son Commune June 2008 field visit sample points

Figure 39: Cam Son Commune reforestation area (*Acacia Hybrid*)

Nakhon Ratchasima Province, Thailand and Takeo Province, Cambodia

The project site in Nakhon Ratchasima Province, Thailand has only recently (as of July 2008) been initiated with Dr. Suwit Ongsomwang from the School of Remote Sensing, Institute of Science, Suranaree University of Technology in Nakhon Ratchasima, Thailand. The province as a whole is seeing an increase in small holder *Eucalyptus* plantations. Our task will be to identify areas currently in *Eucalyptus* that were non-forest in 1990 using remote sensing data and archival records and develop a project design document for these areas for the CCX.

The first visit to the potential pilot project site in Takao Province, Cambodia will be in September 2008 (after this report is submitted). The area has been identified by Mr. Sum Thy, Chief of Climate Change Office, Ministry of Environment in Cambodia and a local non-governmental organization, Chamroeun Cheat Khmer, who are interested in developing a 2000 hectare community forestry project.

4.0 Conclusions

Our long-term objectives are to link carbon offsets from small-holder, agroforestry and afforestation/reforestation activities at the community level with carbon financial markets. The main objectives of this first year of our long-term project have been focused on:

1. Training and capacity building for participants from Cambodia, Lao PDR, Thailand, and Vietnam in carbon cycle science, carbon financial markets, and measuring, monitoring and managing forest-related carbon projects, and

2. Identifying potential sites in each of the four countries to develop small-holder forestry and agroforestry community carbon sequestration pilot projects.

We have held a successful regional meeting in January 2008 attended by more than fifty individuals from five countries and held many other formal, and informal, training sessions over the past 18 months at national, regional, and local levels providing information specific to climate change and carbon cycle science, carbon financial markets, and developing and implementing carbon sequestration projects.

Through collaboration and dialogue we have been able to identify a number of pilot project sites with the four Southeast Asian countries that represent a suite of small-holder farming and land management systems. The variation in landscapes and management systems pose challenges to developing measurement and monitoring methods for carbon sequestration and also opportunities to develop new protocols for approval in the nascent carbon markets, such as the Chicago Climate Exchange.

5.0 Future Directions

Fully realizing these carbon sequestration projects will likely take between six months and two years. The shorter time frame for sites that are less complex landscapes, such as the monoculture plantation areas, and where approved protocols are already exist. The longer time period will be required where sites are complex agroforestry systems and where new protocols will have to be developed and approved (such as the case with the *Litchi* orchards in Kien Lao Commune, Luc Ngan District, Bac Giang Province, Vietnam). Each of these projects sites is in the early stages of development. The initial efforts for this project have focused in capacity building, training, and establishing linkages with the appropriate authorities beginning with the country DNA's all the way down to the community households. We have collected some field level data sets as well as acquired multi-temporal satellite remote sensing data for the project sites (additional high resolution QuickBird, IKONOS, and/or SPOT data will also be acquired in the near future). Some project sites still need additional permanent plots established. Our next steps are

to calculate the above and below-ground carbon and estimate rates of sequestration for the project sites, develop specific project design documents and new protocols, where needed, to be submitted to the Chicago Climate Exchange.

Additional R & D will be devoted to testing new remote sensing algorithms for assessing carbon with remote sensing data. The backbone of a new accounting system is the use of high resolution satellite imagery and remote sensing analysis. We envision using a large archive of current and historical satellite imagery to provide the spatial database for locating participating land areas, conducting baseline carbon assessments, and measuring and monitoring changes in land use and carbon stocks over time. Remote sensing data will also be used to set parameters in the carbon models. There are recent advances in the use of remote sensing to directly parameterize models for carbon accounting and enable detection of: a) area changes, rates and extent of tree plantings, b) changes in stand density and percent cover, c) leaf area index, d) vegetation strata, and e) other important parameters related to total carbon assessment. Data on land use and forestry measurements will be obtained from a combination of satellite remote sensing assets (Aster, Landsat and MODIS sensors) and commercial satellites providing very high resolution imagery (Quickbird <1m data).

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Appendix

Conferences / Symposia / Workshops

WORKSHOP AGENDA

CARBON FINANCIAL MARKETS, RURAL POVERTY, AND GLOBAL CLIMATE CHANGE IN SOUTHEAST ASIA: TRAINING AND SCOPING WORKSHOP

JANUARY 14 – 16, 2008

LAO PLAZA HOTEL: VIENTIANE, LAO PDR

ASIA-PACIFIC NETWORK FOR GLOBAL CHANGE RESEARCH (APN)
ARCP2007-09NSY-SKOLE

FACULTY OF FORESTRY, NATIONAL UNIVERSITY OF LAOS, LAO PDR

GLOBAL OBSERVATORY FOR ECOSYSTEM SERVICES, DEPT. OF FORESTRY, MICHIGAN ST. UNIVERSITY, USA

MINISTRY OF ENVIRONMENT, CAMBODIA

DEPT. OF SCIENCE & TECHNOLOGY, MINISTRY OF AGRICULTURE & RURAL DEVELOPMENT, VIETNAM

Monday, January 14, 2008	
8:00 – 8:30	Registration
8.30 – 8:45	Welcome and opening workshop – President of National University of Laos
8:45 – 9:00	Opening Remarks – Dr. D. L. Skole, Michigan State Univ.
9:00 – 10:00	Workshop Overview – Jay Samek, Michigan State Univ.
10:00 – 10:30	*Coffee / tea break*
10:30 – 11:30	Carbon Cycle Science – Dr. D. L. Skole, Michigan State Univ.
11:30 – 12:00	Carbon as a Commodity: PES – Jay Samek, Michigan State Univ.
12:00 – 1:30	*Lunch*
1:30 – 2:30	Carbon Financial Markets – Dr. D. L. Skole, Michigan State Univ.
2:30 – 3:15	Carbon Project Criteria – Jay H. Samek, Michigan State Univ.
3:15 – 3:45	*Coffee / tea break*
3:45 – 4:15	Inpang Community Network – Dr. Usa Klinhom, Mahasalakham Univ.
4:15 – 4:45	Luc Ngan Dist., Bac Giang, Vietnam – Dr. Do Xuan Lan, Department of Science and Tech., Ministry of Ag. and Rural Development
4:45 – 5:00	Day 1 wrap up
5:30	*Reception Dinner (meet in lobby to walk over to Khua Lao Restaurant)*

Tuesday, January 15, 2008	
8:15 – 8:30	Overview of Day 2 – Jay Samek, Michigan State Univ.
8:30 – 10:00	Measuring and Monitoring Carbon: D. L. Skole and Jay Samek
10:00 – 10:30	*Coffee / tea break*
10:30 – 11:00	* Potential Carbon Project Sites in Lao PDR: Dr. Thatheva, Ministry of Agriculture and Forestry, Lao PDR
11:00 – 11:30	* Potential Carbon Project Sites in Cambodia: Mr. Sum Thy, Cambodian Climate Change Office, Ministry of Environment
11:30 – 12:00	* Potential Carbon Project Sites in Thailand: Dr. Jesada Luangjame, Royal Forest Department, Thailand
12:00 – 1:30	*Lunch*
1:30 – 2:00	* Potential Carbon Project Sites in Vietnam: Dr. Nguyen Phu Hung, Forest Inventory and Planning Institution, Ministry of Ag and Rural Development, Vietnam
2:00 – 2:30	Discussion: Forming of breakout groups
2:30 – 3:30	Break out groups: 3 or 4
3:30 – 3:45	*Coffee / tea break*
3:45 – 4:30	Report back from break out groups
4:30 – 5:00	Discussion – Dr. D. L. Skole, Michigan State Univ.
Dinner on your own.	

* Presentations would focus on potential carbon project sites in each respective country based on the following criteria:

1. Areas of at least 1000 ha (does not have to be a single area, can be non-contiguous areas that add up to 1000 or more ha).
2. Areas that were non-forest in 1990 or in degraded forest condition within the past 17 years (since 1990).
3. Areas that have had or are currently undergoing reforestation/afforestation, natural regeneration (e.g. shifting cultivation lands that are now in permanent fallow), plantation (e.g. rubber, teak, etc.), or agroforestry activities in the past 17 years (since 1990). Natural forest regeneration, single species plantation, and complex agroforestry systems are all possible.

Wednesday, January 16, 2008	
8:30 – 8:45	Overview of Day 3 – Jay Samek, Michigan State Univ.
8:45 – 10:00	Open Discussion of Project Identification
10:00 – 10:30	*Coffee / tea break*
10:30 – 11:15	Carbon Projects - steps for implementation
11:15 – 11:45	Wrap - up
11:45 – 12:00	Closing workshop – President of National University of Laos

All presentations from the workshop as well as background material and carbon models can be accessed at:
ftp://APN_ARCP2007_09_Workshop:trficftp@landsatftp.geo.msu.edu/

Carbon Financial Markets, Rural Poverty, and Global Climate Change in Southeast Asia: Training and Scoping Workshop

January 14 – 16, 2008 Lao Plaza Hotel: Vientiane, Lao PDR

Participants List

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11	Mr.	Bouaphan Phanthavong	Lao PDR	Department of Forestry, MAF	
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15	Mr.	Somchay Samounty	Lao PDR	Department of Forestry, MAF	
16	Dr.	Thongphath Vongmany	Lao PDR	Department of Forestry, MAF	
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21	Mr.	Souphab Khouangvichit	Lao PDR	Environment and Development Study Centre, NUOL	
22	Mr.	Chitana Phomphila	Lao PDR	Faculty of Forestry, NUOL	
23	Mr.	Khamtan Phonetip	Lao PDR	Faculty of Forestry, NUOL	
24	Ms.	Somvilay Chanthalounnavong	Lao PDR	Faculty of Forestry, NUOL	somvilaych@hotmail.com
25	Mr.	Thavisack Chittakoun	Lao PDR	Faculty of Forestry, NUOL	phandin_tor@hotmail.com
26	Mr.	Vasana Keomany	Lao PDR	Faculty of Forestry, NUOL	

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32	Mr.	Amalin Phanvilay	Lao PDR	Research and Post Graduate Division, Faculty of Forestry, NUOL	
33	Dr.	Horst Weyerhaeuser	Lao PDR	Research Management Advisor, URDP, NAFRI	horstweyerhaeuser@fastmail.fm
34	Mr.	Olot Sitaheanghung	Lao PDR	Soil and Water Research Centre, NAFRI	
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Glossary of Terms

APFED	Asia-Pacific Forum for Environment and Development
ASTER VNIR	A Japanese optical remote sensing satellite – Visible and Near-Infrared wavelength bands
BPPT	Agency for Assessment and Application of Technology, Indonesia
CCX	Chicago Climate Exchange
CDM	Clean Development Mechanism
DARD	Department of Agriculture and Rural Development (Provincial Authority), Vietnam
DNA	Designated National Authority (of the UNFCCC CDM)
DOF	Department of Forestry, Lao PDR
DoST-MARD	Dept. of Science and Technology, Ministry of Agriculture and Rural Development
FIPI	Forest Inventory and Planning Institute, Vietnam
FoF, NUOL	Faculty of Forestry, National University of Laos
FSIV	Forest Science Institute of Vietnam
KURDI	Kasetsart University Research and Development Institute
Landsat ETM+	A U.S. optical remote sensing sensor on board the Landsat 7 satellite - Enhanced Thematic Mapper Plus Sensor
Landsat MSS	A U.S. optical remote sensing sensor on board Landsats 1 – 3 satellites - Multi-spectral scanner
Landsat TM	A U.S. optical remote sensing sensor on board the Landsat 4 and 5 satellites - Thematic Mapper sensor
LDD	Land Development Department, Thailand
MAF	Ministry of Agriculture and Forestry, Lao PDR
MAIRS	Monsoon Asia Integrated Regional Study
MONRE	Ministry of Natural Resources and Environment, Vietnam
MSU-Thai	Mahaslakham University, Thailand
NEESPI	Northern Eurasian Earth Science Partnership Initiative
NRCT	National Research Council of Thailand
ONEP	Office of Natural Resources and Environmental Policy and Planning, Thailand
PAFO	Provincial Agriculture and Forestry Office, Lao PDR
RFD	Royal Forest Department, Thailand
SEARRIN	Southeast Asia Regional Research and Information Network
STEA	Science, Technology, and Environment Agency, Prime Minister's Office, Lao PDR
TAFRS	Trat Agroforestry Research Station, Kasetsart University Research and Development Institute, Thailand
UNFCCC	United Nations Framework Convention on Climate Change