Understanding the Contemporary Environmental Matters in Mainland Southeast Asia

March 2011
Nagoya University, Japan
This volume is a record of the workshop entitled "Understanding the Contemporary Environmental Matters in Mainland Southeast Asia", held on December 5, 2009, at Nagoya University. The workshop was organized as part of the Nagoya University Global COE program, which is called “From Earth System Science to Basic and Clinical Environmental Studies”. Global COE, the abbreviation for Global Centre of Excellence, was established by the Japanese government to train and enhance the education and research functions of graduate schools to foster highly creative young researchers who will go on to become world leaders in their respective fields.

The Nagoya University Global COE program “From Earth System Science to Basic and Clinical Environmental Studies” started in 2009. The process of tackling environmental problems has analogies with the ways in which medical science tackles disease. In this COE program we aim to develop a new field of Clinical Environmental Studies and we believe that appropriate diagnosis and treatment of environmental problems is most effectively achieved through area-specific On-site Research Training (ORT). One of the key regions we have selected for ORT is Mainland Southeast Asia, Laos in particular.

Recent development in Laos has led to a situation in which a market economy coexists with a self-sufficient subsistence one. The implications of these recent changes are as yet unclear. The focus of research in this region will be farming villages on the periphery of cities and mountainous villages with the objective of investigating the effects of the ongoing clearance of old forests and introduction of market-oriented agriculture and plantation. Topics for study are loss of traditional ways of life and changes in forest biodiversity, water and particulate matter cycles. One of the most important aims of this workshop was to comprehend these changes.

The workshop consisted of three portions. The first portion focused on society and environment in Mainland Southeast Asia. Both of two speakers in this part, Somkhit BOULIDAM and Sekson YONGVANIT are geographers. The title of the second portion of the workshop is Forestry and Environment. We had two presentations, by Kimihiko HYAKUMURA and Kazuya ITO, both focusing on forests and plantations in Laos. The third portion dealt with agriculture and environment. Kanok RERKASEM was belonging to Faculty of Agriculture, Chang Mai University in northern Thailand. Benjamin SAMSON from the Crop and Environmental Sciences Division of IRRI (International Rice Research Institute) was working in Luang Prabang in northern Laos. We were deeply saddened to learn of Professor Kanok RERKASEM’s passing in 2010.

In the workshop, we had two commentators. The first commentator was Sisavang VONGHACHAC, a vice-director of NAFRI: National Agriculture and Forestry Research Institute, Laos. NAFRI is one of the most active economic institutes Laos. Two Graduate schools of Nagoya University, Graduate School of Environmental Studies and Graduate School of Bioagricultural Sciences, signed the agreement for academic exchange and cooperation on the day before the workshop. The second commentator was Yasuyuki KONO from Center for Southeastern Asian Studies, Kyoto University. Prof. Kono successfully summarized the workshop and cleared the tasks.
of this Global COE program.

We appreciate all of these contributors. Especially, we are deeply grateful that Dr. Hyakumura accepted pleasantly the substitute speaker of the injured even though we asked him only three days before the workshop.

Kohei OKAMOTO
Chisato TAKENAKA
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Good morning ladies and gentlemen. I would especially like to convey my heartfelt welcome to this symposium, held under the auspices of Nagoya University, to all the participants, particularly those from abroad. I would really like to thank you for your participation in this year’s symposium, as well as Prof. Okamoto for the introduction.

We have started the so-called Global COE program entitled “From Earth Science System to Basic and Clinical Environmental Studies”. To briefly introduce this program, I would like to show these photos from the website of Nature magazine from the United Kingdom. You can get the details from this website, which introduces the scientific activities of Nagoya University, where our Global COE program is also included. This program focuses, of course, on environmental studies, particularly in the Asian region. This program is organized by the Graduate School of Environmental Studies and the Graduate School of Bioagricultural Sciences and some other institutes, such as the Hydrospheric Atmospheric Research Center, where I work. Also, this program focuses not only on what is going on in environmental issues in Asia, but also how to manage these environmental issues and how to mitigate or how to improve the environmental issues. So that’s why we say it’s not only about basic environmental sciences, but also how to improve or how to mitigate the problems. That is why we call it Basic and Clinical Environmental Studies, borrowing a concept from medical science.

For example, I’ll show you some photos of different Asian countries. This is a photo of a part of the shifting cultivation fields in Laos. These are the glacial lakes and glaciers in Nepal, and this is an urban view from the sky, which I think is Yokkaichi city. So we focus not only on the issues from the Himalayas, but also on the Southeast Asian countries and also, of course, on the many environmental problems in China or East Asia, including Japan.

As I mentioned, so far we have a lot of fields of environmental science, such as geoscience, ecology, geography, etc. These are fields of science which are included in so-called diagnostic environmental studies, whereas there are other fields of environmental studies, such as engineering, agronomy, economics, etc., which focus on treatment and therapeutic environmental studies. But the problem is how to link these two fields to get a better understanding and better improvement of the environmental issues. So that’s why we are going to establish these two components, by working together from these two sides – the clinical environmental studies and the basic environmental studies. These two components have to collaborate very closely. So it is
important to share environmental issues amongst diagnostic and treatment scientists, to establish clinical environmental studies as well as basic environmental studies, which focus on the generalization and the systematization of wisdom and knowledge, on both a local and a global scale.

I would like to talk about how we proceed with clinical environmental studies. As I mentioned, we are particularly focusing on the Asian region, where we have so many issues, and the environmental problems of East and Northeast Asia and South and Southeast Asia, and of course in Japan. So this symposium is the first international symposium under this Global COE. We will focus on the South and Southeast Asian issues, where the development of industries and economies is growing very rapidly, but at the same time the rich nature and traditional culture and industries are still retained.

How we can harmonize these traditional systems with the development of modernized systems, and how we can make our life sustainable here, is the concern of this symposium, I believe. As Prof. Okamoto mentioned, this is a program not only for educators and researchers, but particularly for educating doctorate program students. In other words, we will focus on how to educate young researchers or engineers, who can work on these environmental studies from various fields.

One method is the so-called On-site Research Training, where the faculty and staff and the doctorate program students work together in the environmental field of the program. That is why we have on-site research training. So, of course, they would have to study on campus, but also we will move out to various countries and locations. And then we have some of the plenary specific field work. Finally, we have a kind of report or recommendation on how to mitigate the environmental issues. In this particular activity, a so-called diagnostic study group and also the therapeutic or treatment study group should work together.

Also on the main campus, we are now planning to have a Seminar for Basic Environmental Studies. Again, these basic environmental studies seminars are a kind of collaboration between the diagnostic studies and the therapeutic or treatment studies. Of course, we will focus on some specific, important issues from global to regional environmental problems, such as global warming and urbanization, water cycle issues, biodiversity and agriculture, and also long-term changes to the environment and society and how to achieve sustainability, etc. This is the main focus of our activity.

For the educational system, we should combine this On-site Research Training off campus with the field and basic environmental studies seminar on campus.

This is a summarized structure for the Global COE program and, particularly as a main part of this activity, we are now preparing for the Integrated Environment Study Course in the Graduate School.
of Environmental Studies and the Graduate School of Bioagricultural Studies in the doctorate program. Of course, we expect many foreign students and scholars for this program. About one-third will be foreign students. As I mentioned, this on-site research training and the basic environmental studies seminar are two major components. Of course, we should collaborate very closely on these components with regard to the various environmental issues. So we expect the students or the researchers to have expertise at a global level for the environmental issues, be internationally focused and have bargaining abilities. Having these abilities is very important for young scientists, particularly for environmental studies.

The development of human resources is a very important objective of the program. This is basically a five year program, but of course we expect to continue this activity permanently as part of the graduate school studies here at Nagoya University. Anyway, we expect to have scientists who can take a leadership role on the global to regional environmental studies.

In this symposium, we expect to have fruitful discussions on the issues, particularly for Southeast Asia. I think I should stop here. Thank you very much.
Global COE Program
From Earth System Science to
Basic and Clinical Environmental Studies

Program Leader: Tetsuzo Yasunari

www.natureasia.com/nagoya-spotlight

Concept & Objective of the GCOE Program
To understand and solve regional environmental issues, in-situ collaboration between diagnostic and therapeutic studies is vital and indispensable.

Clinical Environmental Studies
- Importance of share of in-situ environmental issues by diagnostic & treatment scientists

Basic Environmental Studies
- Generalization & Systematization of wisdom & knowledge from local to global scale

Diagnostit Environ. studies
- geoscience
- ecology
- geography, etc.

Treatment Environ. studies
- engineering
- agronomy
- economics, etc.
Clinical environmental studies (CES)

Plan of Clinical Environmental Study in Asia

Environmental stress under Rapid climate change (warming?) is a common background

Three targeted areas where Stages of economic development differ

- south/southeast Asia under development
- east/northeast Asia under rapid development
- Japan at maturely developed

Strong collaboration with Asian universities & institutions are necessary
ORT: On-site Research Training

Diverse environmental issues
In various regions in Asia

Diagnostic Study group

In-campus pre-study

Plenary Field work

Therapic Study group

Specific Field work

Final report (prescription)

★ RA
● students

Seminar for Basic Environmental Studies (BES)

Diagnostic general themes across regions Therapic study

- Regional medical environmental studies
- Review and discussion, external lecturer invitations
- Collaborate to bring out a textbook review report

Examples of themes Diagnostic view collaboration Therapic view

| Global warming & Urbanization | リモートセンシング環境診断 | 沿海域水害防止・気候対応政策 |
| Water cycle & water resources / utilization | 地球水-物質循環海洋環境変動 | 都市の水・緑環境デザイン・水需要・建築物LC管理 |
| Biodiversity & agriculture | 地球と生命の共進化海洋生態系情報 | 遺伝子産業森林と焼畑 |
| Long-term change of Environment & society | 気候と環境の短長周期変動 | 人間社会の応答と合意形成 |
Educational system
On-site Res. Training (ORT) + Basic Environmental Studies (BES)

- on-site education with clinical environmental study
- cultivation of competent students who can promote both clinical and basic environmental studies

Integrated Environmental Studies Course

Graduate School of Environmental Studies
Doctor Program

Current DP
Foreign: 50
Japanese: 170

Graduate School of Bioagricultural Studies
Doctor Program

Integrated Environmental Studies Course
ORT + BES Seminar
Students #: Foreign 20, Japanese 40

General course
GELP
Foreign: 20
Japanese: 10

Other GS
HyARC
STEL

Other univ. & business society
Foreign countries

协力
Two major programs in special course for 統合環境学

- Expertness
- Broad view
- Internationality
- Bargaining power

On-site Research Training (ORT)

- Field work
- Outside of the campus

Seminar for Basic Environmental Studies (BES)

- Seminar series
- In the campus

Close collaboration between ORT & BES

In-situ experience

Theoretical insights

Cultivation of Human Resources

To play a leading role in global to regional environmental studies

1. leaders for international projects for environmental studies
2. excellent researchers and engineers in international organizations/institutions for environmental studies
3. leaders in environmental management in society
4. environmental specialists in national & regional governments
The Aims of the Workshop

Satoshi YOKOYAMA

Global-COE program member, Nagoya University, Japan

I would like to talk about the aims of the workshop; understanding contemporary environmental matters in Mainland Southeast Asia from the point of view of the relationship between economic development and environmental changes in Laos.

Laos is a landlocked country surrounded by China, Vietnam, Cambodia, Thailand and Myanmar. The population of Laos in 2007 was estimated to be about 6.5 million. Subsistence agriculture still accounts for half of GDP and provides 80% of the total employment. Laos has the lowest percentage of arable land in mainland Southeast Asia because of its mountainous landscape.

Laos is considered a least developed country (LDC) by the criteria of the UN. But the government of Laos has made it a top priority to break away from the LDCs by 2020. The gross national income (GNI) per capita of Laos in 2007 was about US$678, compared with Thailand, which is about US$3,700. According to the UNDP criteria, the LDCs are the countries which have a three-year average GNI per capita of less than US$750. If the country exceeds US$900, it can leave the list. This criterion was defined in 2003; at that time, the GNI of Laos was only US$390. So it has increased 1.7-fold in only four years. Looking at that figure from the viewpoint of GNI, it might be easy for Laos to exit the LDC status by 2020. What is the driving force behind its economic development?

The biggest driving force of economic development is direct foreign investment, especially from China. The 25th SEA Games, or Asia Olympics, is now to be hosted by Laos. The main stadium was constructed at a cost of about 8.6 billion yen, with assistance from the Chinese Government.

The indispensable engine for this economic growth in Laos must be attributed to recent Chinese direct investment. The Asian Times Online on September 19, 2009 explains Chinese investment like this:

“By 2007, China was responsible for nearly 40% of investment projects in Laos… Indeed, through official state aid investment and a growing number of private ventures, China now dominates a large part of the Laotian economy. From mining and hydropower to rubber, retail and hospitality, the Chinese generally have a controlling interest in almost every economic sector.”

Last year, the government of Yunnan completed a blueprint, widely known as the ‘Northern Plan’,
which started operating in 2008 to develop the industrial sectors of northern Laos, from now until 2020. This was handed over to the Laotian government in January, and is expected to be ratified at the Laotian 9th Party Congress in 2010. Setting specific targets for the ‘backbone industries’ of power, agriculture and forestry, tourism and mining, the Northern Plan ‘intends to develop a highly focused and executable roadmap for industrialization’.

I will give you an example from the northern part of Laos. This is a rural village near the Chinese border in Oudomxay province. Local residents had actively practiced shifting cultivation to grow upland rice. In 2004, many households in this village had gotten cash income by selling NTFPs. NTFP means non-timber forest products. In addition to this, the wild plants in the forest play an important role in their daily life. Villagers gather many useful plants from the shifting cultivation fallows. About three years later, in 2007, the local residents set up a contract for farming green pepper, watermelon and tobacco for Chinese firms. There was no shifting cultivation field in the village. Watermelons are grown during the paddy off-season. The others are newly planted and are allocated by local government under the land and forest allocation program, implemented in 2004.

This type of contract farming uses, of course, a lot of chemical fertilizers and pesticides. The benefit of contract farming is that local residents do not need an initial investment at all. They are able to make money easily. So Chinese firms bring seed, pesticides and chemical fertilizer and also agricultural films of mulching from China. So it is rapidly spreading.

By introducing cash crops for export to China, the infrastructure is rapidly being improved at the same time. Route No. 3, or the Asia Highway linking the southern part of China with northern Thailand and Laos, has been constructed with some foreign assistance; it passes through 94 villages in northern Laos, with a total length of 220 km. The total cost of the construction of Route No. 3 in Laos was US$97 million, to which China, Thailand and the ADB, Asia Development Bank, contributed US$30 million each.

The growing of sugarcane and the para-rubber tree plantations are typical agricultural activities along Route No. 3 in the Luang Namtha province in northern Laos. Transportation development plays an important role in introducing such a high growth of economic activities.

Indeed, to introduce new agricultural activities such as cash crops and commercial trees, the development of the infrastructure is absolutely imperative. The landlocked country, Laos, can make strong ties with neighboring countries, and the investments from other countries have increased by activating the flow of commodities, information, technology and money. So it produces a ‘positive spiral of economic development.’

What can cause an increase in investment? It is clear that traditional land-uses are being changed
very much. However, we do not know what type of environmental impact this will have. In addition to this, the traditional eco-knowledge will disappear in the near future. It produces a ‘negative spiral of nature-friendly life.’ Then a question arises; will the cash crops and commercial trees lead Laos to a positive spiral or a negative spiral?

At this juncture, we would like to discuss the next topics. First, we understand the present situation of Laos regarding the environmental degradation caused by changes in socio-economy, forestry and agriculture. Second, we will take account of the lessons learned from neighboring countries such as Thailand. It is very useful to share their experiences with Laos, in order to move Laos in the right direction. Lao people have a lot of indigenous eco-knowledge regarding the use of natural resources, but the economic situation of Laos is still at a low level.

Let’s take a look at the situation in this track and field event. Laos is a leading runner regarding the use of natural resources. However, the economic development level is very low. That is, Laos is a leading runner who is one lap behind. It is necessary to develop Lao’s merits without any loss of the environment. We would like to discuss this.

Thank you very much.
The Aim of the Workshop

Understanding the Contemporary Environmental Matters in Mainland Southeast Asia

Satoshi YOKOYAMA
Department of Geography, Graduate School of Environmental Studies, Nagoya University

Laos: Land-locked country

Source: USGS GTOPO30
Economic situation of Laos at present

The Government of Laos has made it a top priority to “break away from Least Developed Countries (LDCs) by 2020.”

- The Gross National Income (GNI) in 2007: **US$678**

According to UNDP criteria which was defined in 2003, the LDCs are the countries which have 3-year average of GNI per capita less than **US$750**. If the country exceed **US$900**, it can leave the list.

- In 2003, the GNI of Laos was only **US$390**. It increased 1.7-fold in 4 years.
- Looking at that figure from the viewpoint of GNI, it might be easy for Laos to exit LDC status by 2020.

What is the driving force for economic development?

Main stadium for SEA Games in Vientiane
**Chinese investment in Laos**

By 2007, China was responsible for nearly 40% of investment projects in Laos....Indeed, through official aid, state investment and a growing number of private ventures, China now dominates a large part of the Laotian economy. From mining and hydropower to rubber, retail and hospitality, the Chinese generally have a controlling interest in almost every economic sector. ...

Last year, the government of Yunnan completed a blueprint - widely known as the "Northern Plan" - to develop the industrial sectors of northern Laos from now until 2020. This was handed over to the Laotian government in January, and is expected to be ratified at the Laotian 9th Party Congress in 2010. Setting specific targets for the "backbone industries" of power, agriculture and forestry, tourism and mining, the Northern Plan "intends to develop a highly focused and executable roadmap for industrialization".

Asia Times Online (Sep. 19, 2009)
http://www.atimes.com/atimes/Southeast_Asia/K119Ae01.html

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**Shifting cultivation and NTFP gathering (2004)**

In the same village, residents had actively practiced shifting cultivation and also non-timber forest gathering (NTFP) in the fallow forest.
Contract farming of cash crops in northern village (2007)

Local residents made up a contract farming of green pepper and watermelon to Chinese firms.

Asian Highway in Luang Namtha
Sugarcane and para-rubber trees

Sugarcane transportation at Chinese border point
Para-rubber tree plantation in Luang Namtha

Positive spiral or negative spiral?

The infrastructure improvement must be developed by introducing the cash crops for export.

Cash Crops/Commercial Trees
Infrastructure Development

Positive Spiral for Economic Development?

Cash Crops/Commercial Trees
Disappearance Traditional Knowledge

Negative Spiral for Nature-friendly Life?

Traditional eco-knowledge of residents must be disappeared by introducing the cash crops for export.

Will the cash crops and commercial trees lead Laos to positive spiral or negative spiral?
The aim of the workshop

**Understanding the present situation of Laos**
- Socio-economic, Forestry, Agriculture

**Lessen learned from neighboring countries**
- Sharing their experiences with Laos
- Taking Laos in the right direction

1. A lot of indigenous eco-knowledge regarding the natural resource use
2. Low-level of economic situation

Laos is a leading runner who is one lap behind

Country B, Country A, Laos
Vulnerability and Adaptation of Rainfed-Rice Farmers to Impact of Climate Variability in Laos

Somkhit BOULIDAM

National University of Laos, Laos

Good morning, ladies and gentlemen. I am very happy to be here today. As Professor Okamoto informed you, I am a lecturer in the Geography Department, Faculty of Social Science, National University of Laos. I have been working on my Ph.D. in the Agricultural Engineering and Water Management Program at the University of Natural Resources and Applied Life Sciences in Vienna, Austria.

Today, I would like to present on the vulnerability and adaptation of rain-fed rice farmers to climate variability in the Songkhone district of Savanakhet Province. This is part of my thesis for my master’s degree at Mahidol University, Thailand, conducted from 2003 to 2005 under Dr. Sansanee Choowaew (core supervisor), supported by SEASTART.

Introduction:
I will start with a brief general introduction of Laos. As Professor Satoshi mentioned, Laos is a landlocked country. The total population was estimated at 6.5 million in 2009, with a density of 29 persons per square kilometer, classified into 47 ethnic groups, with a literacy rate around 34%. In 2008, the GDP was estimated at US$765 in the capital, with an import-export imbalance over $200 billion.

Laos is an agriculture-based country. In 2002, 85% of the population and 50% of the GDP were based on agriculture, but the GDP from agriculture has dropped to 29%, according to a 2008 estimate. Natural resources are essential to economic stability and human well-being, particularly in Laos, as we have been engaged with natural resources for many generations. As we know, farmers rely heavily on non-timber forest products. Now we face environmental issues, particularly mining, dam construction, land use changes, and climate change.

Climate has a significant influence on agriculture, particularly rice farming without irrigation. In this area, climate variability and climate change are global issues. Over the past three decades, greenhouse gas, carbon dioxide, and sulfur have increasingly effected changes in temperature, rainfall, and agricultural systems. The average global surface temperature is projected to increase by 1.4° to 5.8°C between 1990 and 2100. Climate variability occurs as a result of extreme climatic events; for example, floods, droughts, and increased temperatures are major concerns in Asian regions.
Savannakhet Province is the largest agricultural area in which climate variability has damaged rice production. For example, from 1976 to 2002, several climatic factors affected rice production: severe dry spells in 1977 and 1988, floods and dry spells in 1991 and 1993, dry spells in 2000 and 2001, and a very serious flood in 2008. The Songkhone district has about 25,900 ha, of which 23,500 ha or almost 91% are dedicated to rain-fed rice cultivation. The Songkhone district has 142 villages, and about 14,000 households are farmers. Four villages in the district — Lahakhok, Sebangnuane Tai, Dongkhamphou, and Koudhi — have already been negatively affected by climate variability and extreme climatic events. These four villages have thus been chosen for this study of the vulnerability and adaptation options of rain-fed rice farmers.

The objectives of the study are to assess the vulnerability of rain-fed rice farmers to climate variability, to identify characteristics of vulnerable rain-fed rice farmers, and to explore adaptation options.

Research questions: How do we assess the vulnerability of rain-fed rice farmers to climate variability in the four villages? What are the characteristics of these vulnerable groups of rain-fed rice farmers? How did these vulnerable rain-fed rice farmers adapt to climate variability in the past? What are the adaptation options for vulnerable rain-fed rice farmers?

Scope of study: This research assessed the vulnerability of rain-fed rice farmers, analyzed their adaptive capacity, and explored their options for coping with the impacts of climate variability. The study comprised four villages and sampled heads of households whose major occupation was rain-fed rice cultivation. Characteristics of and adaptation options for rain-fed rice farmers vulnerable to climate stress were observed over 10 years, from 1992 to 2002, and analysis of vulnerability to climate impact was based on multiple criteria. Two types of adaptation options were explored: self-adaptation and collective adaptation.

Study area: The total study area was 1,851 ha. Total rice farming area was 1,000 ha and 434 households, comprising over 2,000 people. Of these, 160 households were selected for sampling, with a total farming area of about 850 ha.

Conceptual framework: Climate variability was observed and recorded over 30 years, 1973–2002; the Ministry of Agriculture and Forestry recorded data on the impact of climate variability on rice production; CCAM has provided climate model simulation; and the CERES-Rice model enables us to review the impact of climate change on rice production in Laos. These are the four main issues in the literature review. These are followed by proxy selection of climate impact production at different levels — 30% and 50% — and the assessment of vulnerability of rain-fed rice farmers to climate impact using three criteria and nine indexes. Finally, the study analyzes current
adaptation options, develops potential adaptation options, and suggests an adaptation strategy to cope with climate variability.

Expected output: Options for adaptation to climate variability that might be applicable to and useful for vulnerable rain-fed farmers in the future; a preliminary study that could be used by policymakers in preparation for the reduction of the vulnerability of farmers and that could serve as a guideline for the assessment of vulnerability in other sectors.

Literature review: Although this figure is unclear, we can see that it shows temperatures over the last 30 years. The graph shows a slight upward shift.

This is the amount of rainfall over the last 30 years, 1973–2002. We can also see an increase in temperature and the amount of rainfall.

This shows rainfall fluctuation over the last 30 years. We can also see the impact on rice production.

The impact of climate variability on rice production in Savannakhet Province: Floods, dry spells, and decreased rice productivity were recorded in 1977, 1980, and until 2000. In 2000, about 59,000 ha of rice were destroyed. This was recorded by the Department of Meteorology and Hydrology of the Ministry of Agriculture and Forestry.

This is the second model scenario created by Mr. Wirod, a research assistant. This figure shows a future climate scenario in relation to carbon dioxide. We can see that if carbon dioxide increases, the amount of rainfall also increases.

This is a crop model created by Mr. Thavone Inthavong of NAFRI. We can see that the highest concentration of carbon dioxide in this slide is 360 ppm; if increased to 540 ppm, the rice production will decrease slightly.

I have selected four villages — Sebangnuane Tai, Lahakhok, Koudhi, and Dong Khamphou. I interviewed about 160 households, or about 77% of the total number of households in the study area. These are the key issues I observed.

Study results: In farming practice, the 160 households had a total area of about 490 ha. Most of them were rice fields; only 5% were planted with other crops. Most of the households, about 99%, had their own land, and only 1% had no land. The average per capita rice farming area of 0.4 ha was higher than the average farming area per capita, 0.24 ha. Average rice production was lower in Savannakhet, according to the data: 2 ton/ha, but only 1.4 ton/ha in observation. Average rice farming experience was about 26 years, with a maximum of 60 years. They had enough
experience to provide information. The crop calendar organizes farming activities by climate or seasons, that is, from May until the beginning of December. The mountain seed variety, in particular, meets between traditional and land area suggested. Here, there are about 17 seed varieties, but local people have an additional 18 seed varieties, so in certain areas there are about 25 seed varieties.

Economic conditions: Average income was US$185 per capita. In 2002, the national average was US$330. The income of farmers in the study area was lower than the national average. However, the average number of people per household is seven, so if annual household income was $1,293 and expenditures totaled $924, and every two members of the household got about $53 per capita, the average surplus would be $369. However, 35 households had a deficit of about $187 per household. Total household savings averaged $1,000, but 11 households, or 70%, had no household savings at all. They had some debt.

This shows the impact of climate on four villages. We can see that floods and dry spells affected about 19%, floods 15%, and dry spells 44%; about 22% were non-impact.

The average frequency of climate variability over a period of 10 years, 1992–2002, is about 60% is less than or equal to 30% and frequency of occurrence is once every four years; a 40% decline in rice production has a 30%–50% chance of occurring once every six years; and a 29% decline in rice production has more than a 50% chance of occurring once every eight years.

Our assessment of vulnerability is based on three countries and nine indexes, including household economy, rice dependency, and electric capacity. We can see that currently, 31% are low vulnerability, 55% moderate, and 14% high.

In a comparison of total annual household income in three vulnerable groups, we can see that rice production is higher in the low-vulnerability group than in the other groups, as is off-farm income. This is significant, particularly the off-farm income, which helps to maintain the household economy and might lower the impact of climate on rice production. In comparison, in higher-vulnerability groups, we can see that rice production is lower and off-farm income is very limited. So if climate causes rice production to decrease, these groups will have a limited capacity and will be more vulnerable to climate impact.

This comparison of vulnerable groups between current year and rice production lost shows that, in particular, the moderate-vulnerability group grows in number and the low-vulnerability group shrinks when rice production loss is at 30%; and when rice production loss is at 50%, the high-vulnerability group increases in number and stabilized about the moderate-vulnerability group when the low-vulnerability group changed to moderate and moderate changed to high.
Following are adaptation options based on farming experience. There are two types of adaptation: self-adaptation and collective adaptation. In self-adaptation, farmers know the environmental conditions very well, and they use their knowledge and experience to observe phenomena and predict climate. For example, they observe frogs laying eggs on the grass by the pond; if the frogs lay their eggs at a high level, it means that that year may get a lot of rainfall and there may be floods. On the other hand, if the frogs lay their eggs at a lower level, it means that they will get little rainfall or possibly drought. They also observe monitor lizards. This figure shows the end of the tail. This year, they will get more rainfall and floods may occur because the monitor lizard’s tail is dark in color, whereas if the tail turns white, they will get a small amount of rainfall and may have drought. They also have other methods of natural observation. However, they also follow the weather on TV and radio, then decide how to apply the seed varieties on their farms.

Self-adaptation farming is quite limited in practice, for example, the upland planting method we called “sakloung.” Sakloung uses sharp wood to dig or to plant rice without water and employs shifting soil preparation. Off-farm adaptation seeks income from other crops, particularly vegetables, watermelon, corn, sweet potato, cotton, etc. Earning income from livestock is very important because most farming households have livestock such as buffalos, cows, pigs, etc. They sell them when money is needed or there is not enough rice for consumption. They may seek income from off-farm jobs, for example, if they have to earn income in the case of rice production loss. Seeking income from natural resources is very important for Lao farmers. Although they do not feel the impact of climate, they still use many products from the natural ecosystem. In terms of climate impact, they use non-timber forest products for daily food consumption and also to supplement income.

Collective adaptation: Farmers conserve their culture by helping their relatives when they have problems. The government and village also help to find a solution, for example, providing training in rice cultivation, suggesting seed varieties, and providing rice and food when rice production is limited.

This is a very good lesson to learn from the village of Lahakhok. They have established a rice bank with yearly contributions from village members. They have practiced this for over 20 years. Every household has to contribute about 20 kg of rice per year, and they can collect about 1.7 tons of rice per year. This system provides for those who do not have enough rice for consumption, particularly households that do not have enough income, do not have husbands, or have limited labor. If every household has enough rice for consumption in a given year, they sell rice to build schools or to rebuild temples. In addition, they have a fishpond that belongs to all village members, and they serve the fish at festivals or other special events.

This section discusses the tolerance of rain-fed rice farmers to climate impact. We can see the effects of decline in rice production over three years: When rice production loss was at 30%,
about 34% of interviewees remained farmers; even when rice production loss was at 80%, 3% of the interviewees remained farmers. I also asked why, when rice production decreased over three years, they continued to farm, and they answered that it was their habit. They did not want to change jobs, or they did not have the knowledge to do other jobs.

In conclusion, the assessment of vulnerability of rain-fed rice farmers to climate variability shows that in the current situation, 31% are low vulnerability, 55% moderate, and 14% high. When rice production decreases, the low-vulnerability group will decrease in number, but the moderate- and high-vulnerability groups will increase, especially when rice production loss reaches 50%, in which case the high-vulnerability group increased to 28% of total interviewees.

Adaptation options for rain-fed rice farmers to climate impact: Self-adaptation has an influence on rain-fed rice farmers. Farmers’ ability to adjust farming practices and off-farm adaptation led to an adaptive capacity to maintain their livelihood when rice production decreased. Collective adaptation was more difficult than self-adaptation but could be improved in the future through external financial support and irrigation systems.

Here, I would like to discuss with our audience two key points. First, how to find a mechanism to support farming practice. This may concern the Ministry of Agriculture and Forestry. The problems are limited funding to support irrigation, inadequate farming training, and a lack of seeds. Second, how can farmers maintain natural resources for sustainable farming to avoid rice production loss due to climate impact in the future? The problems include changes in natural resources due to climate impact, the conversion of forests for other land use, population increase, and so on.

Here, I have two recommendations, including an option to improve household economic conditions by increasing opportunities to earn off-farm income, such as developing factories and the commercial sector in order to promote local products. In the study area, when farmers plant a crop (for example, watermelon) and have a limited market, they lose their investment. One way to improve the area’s adaptive capacity is to expand the period of rice growing to two seasons. Because they have no irrigation right now, they plant once a year. Improving natural ecosystems is a very important issue, as are rice bank promotion and the promotion of fishponds, as in Lahakhok.

This concludes my presentation. Thank you very much for your attention.
Questions and Answers

(Question) Just a small question. How do you distinguish climate variability and climate change?

(Somkhit Boulidam) Thank you for your question. According to collected data and observations, temperature and rainfall variability are increasing. Yes, maybe the distinction between these two is not clear, but they might occur in the future, as well. Climate variability has already been observed in the study area.

(Question) Mr. Chairman, to my mind, farmers are always faced with climate variability. Now, if we can distinguish the cause — whether it is due to variability or to the change — then we can analyze in more detail how to tell the farmers to cope with the changes. Otherwise, we will be confused by all of the variability and changes.

(Somkhit Boulidam) Thank you. This is a comment, right? I will consider it in the future. I will keep working on this topic as part of my Ph.D. Thank you very much.

(Question) Thank you very much for the wonderful lecture. I would like to ask you about improving natural ecosystems, which you recommended. What do you mean by that?

(Somkhit Boulidam) Thank you for your question. Natural resources provide many foods for household consumption and household income. There is competition for natural resources, so awareness of natural resources is necessary in order to set guidelines for protecting or improving the natural ecosystem. Of course, local people cannot arrange it by themselves. There is a need for outside help.

(Question) Thank you very much for your exciting presentation. You have presented data on variability over the last 30 years and shown that rainfall fluctuation and climate variability are risks for farmers. I would like to know if there have been any signs that risks have increased in the last 30 years, or if risk has been continuous for the last three years. That’s the first question I would like to ask.

(Somkhit Boulidam) Climate variability and rainfall fluctuation have hurt farmers in the past, and climate change scenario projections show potential risks as well. My research covered only 10 years, so as to whether risk increased or decreased over the last 30 years, we will have to study more.

(Question) So the current trend, the problem for farmers, is that it is difficult for them to predict when the rainy season will start, and sometimes a dry spell occurs during the rainy season; and
they do not know when the rainy season stops and the dry season starts? Is that the current trend for farmers?

(Somkhit Boulidam) Yes, of course. They don’t know about fluctuation or whether rainfall will come early or stop early. They don’t know exactly. They just simply go, “Oh, this year maybe we won’t get rain,” or something like that. Because we have no climate warning system. All they can do is follow news, reports, or their own experience, so they don’t know exactly when the rain will come, late or early in the year, they don’t know.

(Question) One of the recommendations that you indicated in your slides is to have cropping in two seasons in one year. Is that right? Oh, yes. But for agriculture, agronomy and agronomists, it is going to be more difficult to do that. How could the cropping system be improved, and what are the varieties that are tolerant to both drought and flooding? Is there any kind of program that could help the farmers to adopt that kind of recommendation in Laos?

(Somkhit Boulidam) Here, I recommend promoting more seasons for rice cultivation in certain areas where people have no irrigation system. So if they can plant rice in two seasons, maybe they can reduce their vulnerability. As for the rice seed varieties, I don’t know exactly which seed variety is suitable for these areas; it’s up to the experts. Thank you.

(Benjamin Samson) I’m not asking a question. I’m going qualify a little bit and add some more information to this, because a lot of things have happened, I guess, since you did this research. The comment about having two growing seasons — the suggestion behind that is to have an irrigation system started this year …..these communities so that there will be a reliable water source.

The question about what systems to put in has received a lot of attention recently, especially in Southern Laos. There is a huge World Bank project, I guess, being implemented to produce quality seeds, and that involves both infrastructure and the procurement of inputs. So some of those issues will be addressed in a few months or in a couple of years.

The other thing about what to do in terms of climate-proofing the rice systems in the lowlands against too much water or too little water, a lot of things have also happened in there in terms of the kinds of rice genotypes that are available now. For flooded areas, the submergence gene is available now and has been incorporated in materials that are grown in Laos as well as in other countries, such as Thailand, India, and Bangladesh. So there is that alternative. What this gene does is allow the rice plants to survive 7–14 days of submergence and then, after the water has gone, the rice plant recovers quickly and produces a good crop. That is mainly what happens. On the other hand, in terms of drought, there has been some progress there, as well. So the field is coming up with appropriate treatment.
Vulnerability and Adaptation of Rainfed-Rice Farmers to Impact of Climate Variability in Songkhone District, Savanakhet Province, Lao PDR

By Somkhit BOULIDAM
Main Advisor: Prof. Sansanee Choowaew, Ph.D
Supported by Southeast Asia SysTem for Analysis, Research and Training Regional Centre (SEA START)

Introduction

Total area: 236,800 km²
Pop: 6.8 million (est 2009)
Density: 29 persons/km²
 Classified to 47 ethnic grps
Literate rate: 33.6%
GDP: $765/capital (est 2008)

Exports: $1.033 billion,
Imports: $1.278 billion
(2008 est.)

http://www.state.gov/r/pa/ei/bgn/2770.htm
Introduction cont’

- Lao PDR is an agricultural based country with 84.7% of population, 50% of GDP 2002 (Committee for Planning and Cooperation, 2003) and 39.3% of GDP in 2008 est (http://www.state.gov/r/pa/ei/bgn/2770.htm)
- Natural resources are essential for economic stability and human well being (Ravaioli. C., 1995).
- Lao society engage with natural resources for long time a go...
- Challenging of environment issues (impact of mining, dam construction, land use change, climate change...)
- Climate has a significant influence on agriculture

Background

- Climate variability and climate change are current issues facing ...(UNEP, 2001).
- Over past three decades, GHG such as CO2, SO2 have increased affecting change in temperature, rainfall system, and agriculture system
- The global average surface temperature is projected to increase by 1.4° C to 5.8° C over the period 1990 to 2100 (IPCC, 2001).
- Climate variability occurs of extreme climatic events e.g flood, drought and temperature rise are major concern in the Asian region (Shukla et al., 2003).
- In Savannakhet the climate variability damaged rice production (Schiller et al., 2002)
Justification

- 1976 – 2002, rice production in Savannakhet was affected by climate impact (MAF reported)
- Severe dry spell in 1977 and 1988
- Flood and dry spell occurred in 1991 and 1993, 2000 and 2001 were severe impact
- Songkhone district has about 25,900 ha of which 23,500 ha or almost 90.73% are rainfed rice cultivation (D A F, Savannakhet province 2003)
- Songkhone district has 142 villages and 13,919 households. Most households are rice-farmers

Justification cont’

- Four villages (Lahakhok, Sebangnuane tai, Dongkhamphou and Koudhi Village of Songkhone) have already been affected by climate variability and extreme climatic events and have been experiencing negative impact from climate variability
- These 4 villages are thus chosen for this study in the assessment of the vulnerability and to explore adaptation options of rainfed-rice farmer
Objectives

- To assess the vulnerability of rainfed-rice farmer to climate variability.
- To identify characteristics of vulnerable groups of rainfed-rice farmer.
- To explore adaptation options of rainfed-rice farmer to climate stress.

Research Questions

- How to assess vulnerability of rainfed-rice farmer from negative impact of climate variability in four villages?
- What are the characteristics of rainfed-rice farmers groups, who are vulnerable in different degree to the climate impact?
- How did those vulnerable rainfed-rice farmer adapt to impact of climate variability in the past?
- What are adaptation options of vulnerable rainfed-rice farmers to climate stress?
Scope of study

✔ This research assessed the vulnerability of rainfed-rice farmer, analysed their adaptive capacity, and explored their adaptation options to cope with impact of climate variability.
✔ The study area was 4 villages.
✔ Target sampled population were heads of the households whose major occupation were rainfed rice cultivation.

Scope of study

✔ Analysis of vulnerability to climate impact was based on multiple criteria.
✔ Two types of adaptation options were explored: self-adaptation and collective adaptation.
**Study area**

- Total area of study is 1,851 ha
- Total rice farming area was 1,007.3 ha
- 434 households and 2,490 people
- 160 households was selected for sampling had a total farming area of 846.98 ha

**Conceptual framework**

- Observed data record (C V) from Meteorology department (1973 - 2002)
- Climate model simulation (CCAM)
- Summary impact of C V to rice production data record from M A F
- Review impact C C on rice production (CERES – Rice Model)
- Selection proxy of climate impact rice production at different levels 30% and 50%
- Assessment on vulnerability of rainfed-rice farmer to climate impact by 3 criteria and 9 indices
- Analysis current adaptation options, and develops future potential adaptation options
- Suggestion: Adaptation strategy to cope with climate impact
**Expected outputs**

- Adaptation options to climate variability which might be applicable and useful for vulnerable farmers to cope with future climate change.
- Potential adaptation options of rainfed-rice farmer to climate change in the future.
- Pre-liminary information that could be used by policy makers in the preparation of future reduction of vulnerability of farmers, and guidelines for the assessment of vulnerability in other sectors.

**Literature Review**

The average minimum and maximum temperature ranged from 21.1 - 31.4 °C in 30 years (1973-2002).

Source: Department of Meteorology and Hydrology, 2004.
Average of rainfall from 1973 – 2002 is 1,469 mm (max 1,920 mm in 1996, min 1,011 mm in 1973)
Source : Department of Meteorology and Hydrology, 2004

The rainfall pattern extremely fluctuation

Source : Department of Meteorology and Hydrology, 2004
Impact of climate variability on rice production in Savannakhet province


Climate scenario by using Conformal-Cubic global Atmospheric Model (CCAM) model

By Mr Laongmanee, Wirod. 2005
**Simulated climate condition at different atmospheric CO2 concentration**

<table>
<thead>
<tr>
<th>CO2 Concentration</th>
<th>Min (Kg / ha)</th>
<th>Max (Kg / ha)</th>
<th>Average (Kg / ha)</th>
<th>Comparative average rice yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>360 ppm</td>
<td>919.65</td>
<td>5974.62</td>
<td>2497.4</td>
<td></td>
</tr>
<tr>
<td>540 ppm</td>
<td>866.25</td>
<td>5470.0</td>
<td>2355.0</td>
<td>-4.9%</td>
</tr>
<tr>
<td>720 ppm</td>
<td>1021.8</td>
<td>5877.4</td>
<td>2493.3</td>
<td>-0.16%</td>
</tr>
</tbody>
</table>

By Mr Thavone Inthavong, 2004

**Methodologies**

- Site selection
- Target population and sampling size (Srisaat Bounxom, 1992).

<table>
<thead>
<tr>
<th>Villages</th>
<th>Number of population</th>
<th>Number of households</th>
<th>Sampling size (households)</th>
<th>Percentage of sampling size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sebangnuane Tai</td>
<td>546</td>
<td>96</td>
<td>38</td>
<td>39</td>
</tr>
<tr>
<td>Lahakhok</td>
<td>1,055</td>
<td>182</td>
<td>71</td>
<td>39</td>
</tr>
<tr>
<td>Koudhi</td>
<td>715</td>
<td>122</td>
<td>38</td>
<td>31</td>
</tr>
<tr>
<td>Doung Khamphou</td>
<td>174</td>
<td>34</td>
<td>13</td>
<td>38</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>2,490</strong></td>
<td><strong>434</strong></td>
<td><strong>160</strong></td>
<td><strong>36.75</strong></td>
</tr>
</tbody>
</table>
Methodologies cont’

- Field visit and observation
- Household survey
- Structured questionnaire
  - (1) General information about interviewees
  - (2) Household economic conditions
  - (3) Rainfed rice farming systems
  - (4) Impacts of past climate variability on rainfed rice production
  - (5) Adaptive capacity and adaptation options
  - (6) Coping capacity

- Secondary data collection and review
- Data management and data analysis

Result

- **Farming practice**
  - Total farm area of 160 hh was 486.98 ha (rice field 95%, other crop 5%)
  - Most of the households (98.75%) had their own land. Only 1.25% had no land ownership.
  - The average rice farming area was 0.4 ha / capita, was higher than the average farming area per capita of Lao PDR (0.24 ha / capita) (Steering Committee for the Agricultural Census Office, 2000)
  - The average rice productivity was 1.4 ton / ha. The average rice productivity of Savannakhet was 2 ton / ha (Ministry of Agriculture and Forestry, 2002)
  - Rice farming experience > 20 years was 66%, in average is 26 years (min was 3 years, max was 60 years)
  - Farming activities (crop calendar)
  - Rice verities
Result

Economic condition

- Average income was US $185/capita, (GDP US $330, in 2002). Annual household income was US $1,293 (http://www.regeringen.se/content/1/c6/01/39/77/1d6de37c.pdf)
- Total annual household expense was US $924
- The average total annual household income surplus was US $369 (or US $53/capita). However, 35 households deficit was US $187/household.
- The total household saving average was US $1,036. And 11 households of total household interviewed (or 7%) had no household saving.

Result

Number of climate impact in four villages (households)

<table>
<thead>
<tr>
<th>Villages and households</th>
<th>Flood and dry spell</th>
<th>Flood only</th>
<th>Dry spell</th>
<th>Non impacted</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBN Tai (38 hhs)</td>
<td>26</td>
<td>3</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Lahakhok (71 hhs)</td>
<td>0</td>
<td>2</td>
<td>49</td>
<td>20</td>
</tr>
<tr>
<td>Koudhi (38 hhs)</td>
<td>2</td>
<td>19</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>D Kh P (13 hhs)</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Total 160 (100%)</td>
<td>30 (19%)</td>
<td>25(15%)</td>
<td>70(44%)</td>
<td>35(22%)</td>
</tr>
</tbody>
</table>
### Result

#### Average frequency of climate variability impacted and levels of rice production lost during period 1992 – 2002

<table>
<thead>
<tr>
<th>Number households affected from climate impact</th>
<th>% of rice production lost</th>
<th>Average frequency of climate impacted occurrences</th>
</tr>
</thead>
<tbody>
<tr>
<td>95 (59%)</td>
<td>&lt;=30%</td>
<td>Once in four ys</td>
</tr>
<tr>
<td>64 (40%)</td>
<td>30- 50%</td>
<td>Once in six ys</td>
</tr>
<tr>
<td>47 (29%)</td>
<td>&gt;50%</td>
<td>Once in eight ys</td>
</tr>
</tbody>
</table>

### Result

#### Levels of vulnerable groups to climate variability in 4 villages

<table>
<thead>
<tr>
<th>Villages</th>
<th>No (hh)</th>
<th>Levels of vulnerability</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sebangnuan Tai</td>
<td>38</td>
<td></td>
<td>8 (21%)</td>
<td>20 (53%)</td>
<td>10 (26%)</td>
</tr>
<tr>
<td>Lahakhok</td>
<td>71</td>
<td></td>
<td>27 (38%)</td>
<td>35 (49%)</td>
<td>9 (13%)</td>
</tr>
<tr>
<td>Koudhi</td>
<td>38</td>
<td></td>
<td>10 (26%)</td>
<td>26 (69%)</td>
<td>2 (5%)</td>
</tr>
<tr>
<td>Dong khamphou</td>
<td>13</td>
<td></td>
<td>4 (31%)</td>
<td>7 (54%)</td>
<td>2 (15%)</td>
</tr>
<tr>
<td><strong>Total household</strong></td>
<td><strong>160</strong></td>
<td></td>
<td><strong>49</strong></td>
<td><strong>88</strong></td>
<td><strong>23</strong></td>
</tr>
</tbody>
</table>

#### Percentage

<table>
<thead>
<tr>
<th></th>
<th>100%</th>
<th>31%</th>
<th>55%</th>
<th>14%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Score range</strong></td>
<td>17 - 45</td>
<td>17 -26</td>
<td>&gt;26-36</td>
<td>&gt;36-45</td>
</tr>
</tbody>
</table>
Result

Comparative structure of total annual household income of three vulnerable groups

![Bar chart showing income distribution for low, moderate, and high vulnerability groups.]

Result

Comparative number of vulnerable groups between current year and rice production lost

![Bar chart showing number of household farmers for low, moderate, and high vulnerability groups under different rice production loss scenarios.]
Result

✓ Adaptation options from faming experience
  
  – **Self adaptation**

  • Indigenous knowledge
  • Farming practice adjustment
  • Off-farm adaptation
  • Seeking income from other crops
  • Seeking income from natural ecosystems

  – **Collective adaptation**

  ✓ Self adaptation

  ✓ Observation phenomenon to predict climate
  (the frogs lay eggs, the tail of monitor lizard …)
Self adaptation cont’

✔ Farming practice adjustment adaptation (31%)
   could adjust farming practice
   – Using upland planting method “Sakloung”
   – Shifting soil preparation

✔ Off-farm adaptation
   – Seeking income from other crops (vegetable, watermelon, corn, sweet potato, cotton etc)
   – Earning income from livestock
   – Seeking income from off-farm job
   – Seeking income from natural ecosystems

Collective adaptation

✔ To support from relatives, from village, and from government...

✔ Lahakhok village has established rice bank
   with contribution from village members
   every year for over 20 years (about 1.7 ton / year)....
Tolerance of rain-fed rice farmers to climate impact

<table>
<thead>
<tr>
<th>Level of decline in rice production: 3 consecutive years</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount Accept interviewee (households)</td>
<td>10</td>
<td>14</td>
<td>55</td>
<td>26</td>
<td>26</td>
<td>20</td>
<td>5</td>
<td>4</td>
<td>160</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage accept (%)</td>
<td>6</td>
<td>9</td>
<td>34</td>
<td>16</td>
<td>16</td>
<td>13</td>
<td>3</td>
<td>3</td>
<td>100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Conclusion

Assessment vulnerability of rainfed-rice farmers to climate variability (rice production loss 30% and 50%)

<table>
<thead>
<tr>
<th>Levels</th>
<th>Current Situation</th>
<th>Rice production loss 30%</th>
<th>Rice production loss 50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>31%</td>
<td>19%</td>
<td>14%</td>
</tr>
<tr>
<td>Moderate</td>
<td>55%</td>
<td>58%</td>
<td>58%</td>
</tr>
<tr>
<td>High</td>
<td>14%</td>
<td>23%</td>
<td>28%</td>
</tr>
<tr>
<td>Total</td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>
Conclusion cont’

- Adaptation options of rainfed-rice farmers to climate impact
  - Self-adaptation had influence on rainfed-rice farmers. Ability to adjust farming practice and off-farm adaptation led to adjustment in adaptive capacity to support their livelihood when rice production lost.
  - Collective adaptation was still less possible than self-adaptation, but could be improved in the future, such as external financial support, irrigation system.

Discussion

- How to find technique, mechanism to support farming practice?
  - The problems are limited fund to support irrigation system, farming training, seed provided…

- How farmers maintain natural resources for sustainable using instead of rice production loss in term of climate impact in the future?
  - The problems: natural resource change in term of climate change itself, forest convert to other land use, population increase …
Recommendation

- **Alternatives to improve household economic conditions to** Improve off-farm income such as factories and commercial sectors…

- **Alternatives to improve adaptive capacity for adaptation**
  - Expanding rice growing to two seasons
  - Improving natural ecosystems
  - Rice bank, promoting fish ponds (Lahakhok)

Thank you
Good morning, professors. Good morning, presenters, ladies and gentlemen. I would like to thank
the Graduate School of Environmental Studies, Nagoya University, for giving me the opportunity
to present my research and share my experience with all of you.

My presentation concerns driving forces of social and environmental change in Northeast Thailand:
a case study of the Dong Mun Forest. The driving forces behind social and environmental change
include migration, cash crops, government policy, and globalization.

Dong Mun Forest is in Northeast Thailand, bordered by Laos PDR. Northeast Thailand is covered
by sediment stone formed in the Jurassic period and sandy, low-fertility soil. The average rainfall is
1,200 mm/year, with a four-month dry season. Vegetation formation is tropical savanna and
dipterocarpacaeae forest. This is the poorest area in Thailand.

Dong Mun Forest is located 50 km from Khon Kaen Province. I researched this area in 1988 with
respect to social forestry; in 1990 with respect to ethno-botany with Hawaii University; in 2004
with respect to the migration of people with Prof. Nakagawa from Kobe University; and, lastly, in
2008 with respect to the impact of globalization.

Around 1830, 200 years ago, the first group of people migrated from Laos PDR to Dong Mun
Forest. Later, in 1930, other groups from the provinces of Khon Kaen, Udonthani, Kalasin, Roi Et,
Ubon Ratchathani, Sakonnakorn, and Mukdahan came to mix and settle with the first group.

People migrated to Dong Mun Forest because it was a very dense forest with fertile soil. They
came to claim new land for agriculture; some came to hunt and gather forest products. Moreover,
due to pressures from population growth, droughts, and floods in many provinces, groups migrated
continuously to this area.

In terms of subsistence farming, people planted rice, chilies, cotton, tobacco, and eggplant. They
also gathered honey, mushrooms, bamboo, wild vegetables, and firewood and hunted deer and wild
pigs for self-consumption or trade. In the lower land, it was possible to plant wet rice.
Some families raised cattle in the forest area, and some owned more than 100 cows or buffalo. The Nai Hoi were traders by profession; they sold cows and buffalo to central Thailand.

In 1942, more and more people migrated to this area. They planted jute and corn because the soil was fertile, and the crop yield was very high. The farmers expanded their land to the forest to plant jute and corn to sell at markets. This was the first step in planting cash crops for sale, which was a big change in this area. Although the jute and corn prices were not very high, farmers were satisfied because this was the only source of cash.

But not many farmers could maintain large-scale farms; only a few of them had large plots of land. Most of them planted jute and corn at the corner of the rice plot. In terms of agricultural activities, the main crops were still upland rice, cotton, chilies, tobacco, and eggplant. Hunting and gathering were very important economic activities in this area.

In 1963, Professor Lert Chunttanapath reported that Dong Mun was a very dense forest and one of the best dipterocarpaceae forests in Thailand. At that time, there were many animals, such as wild pigs, deer, monkeys, and so on.

In 1952, a forest company got a concession from the government to cut down trees in the northern part of Dong Mun Forest. In 1961 and 1963, Nam Pong Company also got a 30-year concession to cut down trees in the southern and eastern parts. So the Nam Pong Company constructed a road into the center of Dong Mun Forest to transport timber. Thereafter, Dong Mun was divided into three parts. Villagers migrated into Dong Mun using the timber-transport road and occupied more land for agriculture.

In 1963, Lam Pao Dam was constructed, and people living in the lowland migrated to Dong Mun Forest. Due to population growth, drought, and poverty, more people migrated to the center of Dong Mun Forest to occupy roadside land for agriculture.
Sandy soil with heavy erosion: In the rainy season, fertile soil was flushed away.

House, chilies drying and a chili plot, tobacco plot, house under construction (what we call a “never-finished house” because they carry timber from the mountains to build a house while waiting for people from the city to buy the woods).

Silkworm cultivation and weaving.

Chili plot, preparing to plant rice, jute, and a boy responsible for cattle feeding.

Cassava planting, soil erosion, and cassava harvesting.

This is a cassava store; the farmers sell their cassavas here.

From 1960 to 1970, the company cut trees for trade and constructed the road. Farmers cut trees for housing and sold timber using the transport route. The farmers expanded their agricultural lands through more cutting and burning to make room for cash crops. During that period, more and more people migrated to Dong Mun Forest. The forest area was decreased and eventually depleted.

What did the government do? The government declared this area Dong Mun Forest Reserve, protecting 60,000 hectares as national forest area.

The government provided land for farmers, so-called illegal settlers, by allocating four land-rights programs; each forest village was given 2 hectares of land, a land rights program, and a cooperative village. Agricultural villages were given 8 hectares of land, but most of the farmers occupied larger areas of land than what the government provided.

To protect forestland from illegal migrants, the Royal Forestry Department established a forest protection office, Dong Mun Forest Development Offices 1 and 2, two fire stations, and a guard station.

This is Dong Mun Forest Reserve, showing the location of four land-rights programs and five forest protection offices.

From 1971 to 1981, the Communist Party of Thailand controlled this area, so the forest company could no longer be active. However, the number of settlements in Dong Mun Forest Reserve increased to 50 because people came from other provinces, even those that were far away, having heard that the government provided land for landless people. This information spread very slowly among villages, so landless people migrated to Dong Mun Forest gradually and continuously; the
process took about 10 years after the allocation of land. When the last groups arrived, there was no land available, so they had to invade the forest area to claim it for agricultural use.

(Map) These are the 50 villages in Dong Mun Forest Reserve.

In 1967, cassava was introduced as the new cash crop. This is very important. Cassava was planted in the southern part of Dong Mun Forest and sold in the Nampong district. Cassava grows very well and produces higher yields than jute. It is easier to care for than jute or corn. So farmers expanded their plots, which explains why the two hectares of land from the land-rights program were not enough for them to live on.

This is a comparison of the planting processes for jute, corn, and cassava. For jute, we have to plant it, harvest it, and lay it underwater for three to four weeks, peel it, and pack it for sale. Corn is not as good, because it is easily damaged by pests, and its yield decreased. In the 70s and 80s, cassava was the most popular crop in this area.

Sugar cane was introduced in 1971. Harvesting sugar cane and transporting it to factories required high investments and high costs. Many farmers could not afford to invest in sugar cane plantations.

Thus, the traditional crops — rice, upland rice, chili, tobacco, and cotton — continued to be planted, but jute and corn decreased. New plantings in this area were cassava and sugar cane. Cassava planting expanded because its yield and price were higher than those of other crops. Sugar cane must be planted near the main road and on a small scale due to the high investment and transportation costs.

(Chart 1, 2, 3) I am a geographer, so I would like to present on the settlement patterns in this area. You can see that villagers claimed new land and established new settlements until around 1990, when there was no more land available.

To protect Dong Mun Forest, the Royal Forestry Department worked with government agencies, universities, and NGOs to organize social groups, women’s groups, and youth groups, including tree-planting groups and fire-protection groups, by providing training and seminars on tree planting and nurseries. At that time, Dong Mun Forest Offices 1 and 2 were responsible for reforestation with eucalyptus trees.

In 1987, the Green Isan Policy was introduced to protect the forests in Northeast Thailand and Thailand as a whole. What did the government do? The government banned logging concessions in Thailand in 1989.

(Picture) Many agencies organized discussions, training, and seminars for social groups.
Training, seminars for fire-protection groups, pupils, and local leaders.

Reforestation with eucalyptus, but in dry season, it burned. Planting rattan: Rattan shoot is not only for food but is also sold as material for making chairs or furniture.

Cassava grew mostly on the slopes of hilly areas. For sugar cane, farmers got financial support from a sugar factory, so the planting of sugar cane increased. Rice was planted in the lowland, in the southern part of Dong Mun Forest. In 1995, the rubber tree was introduced by the Agricultural Extension Division.

Overall, the farmers earned most of their income from cash crops. Nevertheless, more and more people went to work in big cities in the dry season. In fact, they have been emigrating from Dong Mun Forest since 1980.

This table shows villages’ dependency on the forest. Villagers were happy to go to the forest to gather vegetables for food, herbs, plywood, and timber; some went to hunt; and some participated in community forest activities.

Planting and harvesting sugar cane.

This is a small tractor, one of the driving forces of cattle cultivation.

Rubber trees.

I would like to tell you about the price of cassava. Twenty to thirty years ago, the price of cassava was much lower than one baht per kilo. As of 2009, the price had increased about 20%.

Twenty to thirty years ago, the price of sugar cane was 300–400 baht per ton, but the price in 2009 had almost doubled to 700 baht. The reason is that in that year, the EU stopped subsidizing sugar beet farming.

Later, in 2003, the Royal Forest Department closed four forest protection offices. Only the mountain area remained under protection. The government cut all budgets, and there were no activities. Only one station, at Phu Phra, is still active.

What is happening now? The forest covers only the mountainous area, and 30% has been reforested with eucalyptus and teak. The Phu Phra Forest Protection Station is still operating. Rubber plantations dominate the hilly areas, covering more than 60% of those areas. Sugar cane has
expanded on the lower slope because the price is increasing. Cassava is diminishing. These are the changes so far.

As for forest conservation, in 2009 there were 33 temples on the mountainous area, most of which had not registered with the Religion Department. The temples covered more than 2,000 hectares. Only four temples were established before 1945, and 40 years later, five temples had been established. Between 1986 and 2009, 24 temples were established. These temples play a significant role in forest conservation because Buddhist temples need a place for meditation, and forests are the best. Monks have supported the villagers in cultivating nurseries and planting trees. Altogether, the temples have planted more than 500,000 trees.

(Map) These are the temples around Dong Mun Forest. Most of the temples are located on the hillside to protect the forest. It is not easy for farmers to go into the forest because they have to pass the temple area.

(Picture) This is one of the biggest forest temples, responsible for planting more than 80,000 trees. The monks have expended a lot of effort and money planting trees and protecting them from wildfires.

Not only that, but the villages have also established a community forest group to conserve 400 hectares for food gathering, firewood for cremation, cattle husbandry, and so on. There are 25 villages supporting the community forest group, collaborating with forest temples to set regulations. Cutting down trees is prohibited; villagers may gather bamboo and mushrooms for self-consumption. The important thing is to prevent and control wildfires.

Youths, after finishing high school, go to Bangkok or Chonburi to work. When you walk in the village, you will meet mostly elderly people and children. Middle-aged people work in big cities. In our study of 31 villages, we found that 25 people worked abroad, and 70 women married foreigners. This is a new social phenomenon. They live in the United States, England, Germany, Sweden, Japan, Norway, Italy, and so on.

(Chart) I will conclude with a timeline. Immigration lasted from 1800 to 1980, and then people began to migrate out of the forest. Now some people go abroad to work or to live. They still gather edible plants from the forest because they taste better than vegetables from public markets. But hunting is becoming less and less popular. In terms of agriculture, there is no more jute and corn, less cassava, and an increase in sugar cane; the rubber tree is now the dominant plant. Population growth is declining. Natural resources are decreasing. Temples, monks, and villagers work together to conserve the forest.

(Picture) Picture from 2006: sandy soil.
I’m sure you thought this was a bush. It is a cattle farm.

We interviewed farmers here. This woman owns cattle. She has three daughters. One lives in Japan, married to a Japanese man; one lives in Sweden; and the last lives in England. She has been to England and prefers to live here, feeding cattle.

This woman is married to an American and has two daughters. He comes here for three months every year.

Sugar cane harvesting: Sugar cane is burned before cutting and banding.

Sugar transported in trucks; a sugar cane factory.

These are rubber trees and rubber sheets.

This is the Kra Nuan district; 150 years ago, it was a small village, and now it is the center of the area.

These pictures show houses, cars, and rubber trees. Some houses are very large.

Thank you for your attention.
(Question) I think natural forests are rapidly increasing in your country. So the protection of natural forests is a very important issue for your country. I would like to know if there are any precious plants, such as medicinal plants, in the remaining natural forests in this area.

(Sekson Yongvanit) In this mountainous area, there are lots of herbal plants that are very precious and important; they are not easy to find in other places. There are 16 men, we call them medicine men, who know a great deal about herbs. But this knowledge remains only in men in the older generation. In our study, we surveyed young people. They have no such knowledge. Even the plants that they eat, they do not know the names. This is a very serious situation.

(Question) Any oaks?

(Sekson Yongvanit) Yes, but not many. These are more dipterocarp.

(Question) As you mentioned, I think the team conserving the natural forest and biological diversity is important, as are other resources such as precious plants and medical plants for local use. So maintaining and keeping the natural forest intact — this is my comment.

(Sekson Yongvanit) Yes, thank you. The Royal Forestry is more concerned about the national park, and this is a natural reserved forest. It is possible to protect the forest as a national park or wildlife sanctuary. So there is only one forest protection station left in Dong Mun. Luckily, the temples and local people know the value of their natural resources. I think it is good that local people participate willingly in many activities to conserve their forest. The situation is different than it was in 1980, when we went to the villages and tried to mobilize people to come and participate and so on. Because we came from a university, they said, “Okay, I’ll work with you.” But they have to survive. They have no money.

(Question) I am not familiar with forest temples, but you said the forest temples are illegal.

(Sekson Yongvanit) Yes.

(Question) Thank you very much.

(Sekson Yongvanit) Professor, there are about four forest temples that are registered with the Religion Department. Registering with the Religion Department is a complicated process, because they have to survey all biodiversity in that area. We tell them to do that and send the information to the Religion Department, and the Religion Department sends it to the Royal Forestry Department,
and then to other ministries, and so on. So this is a very long process. Illegal — that means from the viewpoint of the government.

(Question) Thank you very much for the interesting presentation. I see that in 20 years, there will be no places like this, integrating knowledge of natural resources and vanishing forests and introducing various cash crops. I want to ask one question: What was the trigger for introducing new cash crops? For example, cassava and corn and sugar cane. Was it the local villagers’ decision or introduced by a middleman or a government policy? I want to know the trigger.

(Sekson Yongvanit) Jute and corn came with the migrants; they brought them. But cassava was introduced by local politicians into this area. Cassava was planted in Eastern Thailand, Chonburi, and surroundings according to policy; local politicians introduced it to Northeast Thailand and it came to Dong Mun. But we always said that when cassava came, the forest was depleted. When the sugar cane came to this area, it destroyed everything. Because of sugar cane, they used tractors to plow the shrub forest.

Another reason for planting sugar cane is that they moved the sugar factory from central Thailand to Northeast Thailand. What we are facing now is moving the factory to Savannakhet, in Laos. So the people have money from cash crops. Farmers were paid to plant sugar cane through a contract-farming system.

The rubber tree is in luck, because the price for rubber juice is increasing. Some farmers also cut rubber trees to sell as timber. The tree grows very quickly. After 30 years, a rubber tree can sell for around 2,000 baht. It is a capital investment for farmers: When the price is really low or they need money, they sell the trees. Rubber timber is very good for furniture. I heard they sell it to IKEA.

(Question) Okay, thank you very much. I’d just like to follow up on what Satoshi said. What I see you saying is that these marketing costs are a major driver of the changes in cattle.

(Sekson Yongvanit) The market?

(Question) The market cost is the driver of land use in this village, particularly for cash crops — changing from jute to rubber, or whatever. What I would like to point out is this: Now that jute has gone, there is rubber, and it is called a long-term investment. Of course, I accept what you say, but then all of those cash crops are good for short-term benefits, and they need them because they are poor people. Why would they shift from a short-term benefit to a long-term benefit? When shifting to rubber, in the early years, at the beginning, there will be nothing. Could you kindly comment on this?
There is also a push for out-migration, because income from cash crops depends on market price and climate. A rubber tree takes 6–7 years to harvest, but in the same period, a farmer plants cassava in between the rubber trees. The yield from cassava is not so high, but it is better than waiting for rubber juice. Rubber tree bark is separated into three parts, and the farmer peels the bark to collect rubber juice; each part takes five years. So peeling all the bark of a rubber tree takes 15 years, and then he returns to the first part.

Also important is cash from outside the village. Most villagers depend on this money to survive. From our study — I would like to say — money from out-migration is very important to the local economy. And there is a rural-family system — everyone sends money to his or her parents. There are some farmers still planting only cassava or sugar cane because they cannot afford to change. So what my idea is, I think you may know better than I do, because we also do research on migration and I have assigned a student to study the village economy.

I’m sure you mean agroforestry.

Yes, agroforestry. There is also agroforestry in that area.

Thank you very much for the presentation. My question concerns how you understand international marriage. You said that there are 70 people in your village who are married to foreigners, and I think that this is a big number. Is it related to something about . . .?

Sorry, just 70.

Seventy?

Seventy people?

Seventy people married to foreigners?

Seventy people from the area we studied — 31 villages.

Yes. So it’s not so big, you mean?

It’s big, it’s big. I thought you said 70%. If 70% of women marry foreigners, I’ll have no chance of getting married.

But anyway, a substantive number of people in this village, mostly women, are getting married to foreigners. Is this related to the environmental degradation of this village or its natural resources? What kind of causes do you suppose are behind it?
Because of family backgrounds and the cash crop, villagers could not survive with 3–4 hectares of land. Most of them migrated elsewhere to work in factories, restaurants, or the tourist sector. They went to meet people. They are just trying to survive, but the number is increasing. For our study with Professor Nakagawa, in Khon Kaen, we interviewed more than 200 young people who had a contract via the Internet with foreigners from Mexico, South Africa, or countries that I had never heard of — many of them were nurses. Nurses work hard. Maybe they are not happy working here. These young people, most of them have good jobs and have graduated from university. It is a big change.

Last week, I attended a wedding. We asked the couple how they knew each other. They’d met via Internet. We old men were shocked. What’s happening? But more and more, young villagers in Northeast Thailand are getting a partner this way.
Nagaya University Global COE Program
“From Earth System Science to Basic and Clinical Environmental Studies”

5th December 2009
Graduate School of Environmental Studies
NAGOYA UNIVERSITY

Driving Force to Social and Environmental Change in Northeastern Thailand

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Paper presented at Nagaya Global COE Program, Nagaya University, Japan.
Focus on International workshop on Contemporary Environmental Matters in Mainland Southeast Asia.
Driving Force to Social and Environmental Change in Northeastern Thailand

Presentation Topic:

Study site: Dong Mun Forest area

Driving Forces:
- Migration
- Cash Crop
- Government’s Policy
- Globalization

Dong Mun Reserved Forest Area

Northeastern Thailand: Dong Mun
- Sediment Stone,
- Lower middle Jurassic
- Sandy Soil, Low fertility
- Rainfall average: 1,200 mm/y
- Dry period: 4-5 months
- Tropical Savanna
- Dipterocarp Forest
- The poorest area

Map from Khon Kaen strategic plan
The development of Land use
Year 1800 – 1900 - 1930
Migration to Dong Mun Forest Area

Dong Mun Reserved Forest Area: 1800-1930

Driving Forces for Migration
Population Growth, Drought and Flooded
New Land for the agriculture
For Hunting and Gathering
**Year 1800 – 1900 – 1930**

**Subsistence Economy:**
self-consumption and exchange goods / products

**Gathering and hunting:** Honey, Mushroom, Bamboos, wild vegetable, fire wood oil, Deer, Wild Pigs ..........

**Agriculture Activities:**
Upland Rice, Cotton, Chilies, Tobacco, Egg plant and Gathering and Hunting
Village at the low land –planting rice (wet-rice)

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**Year 1800 – 1900 – 1930**

**Cattle cultivation/feeding:**

Some families had Buffaloes and Cows more than100 and feed it from wild grass – forest area.

And sell Buffaloes and cow to Nai Hoi who buy and sell these animals in central Thailand
Migration
More people from surrounding area Migration to Dong Mun Forest – to claim land and the land is very fertile

Driving Forces for Migration are
Population Growth, drought and flooding
Claim new Land for the agriculture
To hunting and gathering

Year 1942 – Cash Crop

New Plant: Cash Corp / JUTE and CORN
Some farmers planted Jute and Corn and the yield was very good.

The farmer expanded their land – into the forest area to planted Jute and Corn for sell to the market

Although the Jute’s price was very low BUT the farmer was satisfied with this price because the farmer did not have change to earn money

Jute was just only crop that they can sell for cash.
Year 1942 – Cash Crop

Corn could not sell every year BUT the farmer could eat it and kept it as seed for next year.

They were some farmers who planted Jute and Corn in a large scale

Most of the farmer just planted Jute and Corn at the corner of rice plot

Main activities still were:
Upland Rice, Cotton, Chilies, Tobacco, Egg plant and Gathering and Hunting

Year 1950 - 1960

Research from Lert Chuntatanapath, 1963

Lert Chuntatanapath reported:

Dong Mun Forest was dense forest and it is one of the best dipterocarpaceae Forest (hard wood) in Thailand

There were many wild animals such as wild pigs, deer, monkey and so on....
**Forest Concession**

**Year 1952**
Forest Company got permission to cut trees at northern part of Dong Mun Forest

1961 and 1963 Nam Pong Company got **concession for 30 years to cut trees** at southern and eastern part of Dong Mun Forest

Nam Pong Company: Constructed road for transport the timber out of the forest.

Dong Mun Forest Area war divided into 3 parts – Phu No, Phu Phra, and South Phu No
Year 1963: Constructed Lam Pao dam, near Dong Mun Forest Area

People in Lam Pao Plain, flooded area, moved to Dong Mun Forest Area

Because of Population growth with 3,4
Drought and Poverty – to have land for agriculture

More and more people moved to the center of Dong Mun Forest Area by followed the timber-road.
Deforestation during year 1985

Timber prepared

Timber transport route

Hunting at Ban Sai Thong

Deforestation method
Gathering Forest Bamboo

Poor road

Soil / Sandy Soil and Erosion

Soil / Sandy Soil and Erosion

Soil / Sandy Soil and Erosion
**Dong Mun Forest Area, Year 1960-70**

The Company cut the trees, constructed the road. The farmer cut trees for housing, and sell by using the Timber-transportation road. The farmer expanded their Agriculture land by burning And planted cash crop.

More and more people migrate to Dong Mun Forest

**Dong Mun Forest Area decreased and depleted**
Tools (Policy) Protect Dong Mun Forest

To protect the Forest Area between 1968-1980

1. The Government announced the area around Phu No and Phu Phra mountain to be Dong Mun National Reserved Forest Area with 58,937 hectares.
2. The Government provided Land for illegal settler by allocate Land Right Program:
   - 1. Forest Village
   - 2. Land Right for the Farmer Program (STK Village)
   - 3. Cooperative Villages
   - 4. Land Development for Agriculture Villages

Tools (Policy) Protect Dong Mun Forest

3. Royal Forestry Department (RFD) established Forest Protection Office
   - 1. Dong Mun Forest Development I
   - 2. Dong Mun Forest Development 2
   - 3. DM Forest-fire protection
   - 4. Phu Phra Forest-fire protection
   - 5. Phu Phra Forest Protection Station

To Protect the Forest land from illegal migrant to claim the forest land.
Dong Mun National Reserved Forest 1968 and 1975

National Reserved Forest
Land Right Program (Villages)
Royal Forestry Department

The company have to stop making wood because of the threat of the communist terrorist.

But the settlement grew up!
There are 50 Villages in the National Reserved Forest Area
Because the people heard that Government provided land for the poor!!!
Migration to Dung Mun......
New Cash Crop: Cassava or Tapioca

Year 1967, New Cash crop was introduced to Dong Mun, is cassava. Cassava was planted at southern part of Dong Mun forest. All the production was sold at Nampong District.

Cassava could grow very well and yield was higher than Jute and Corn, very good price.

So, more and more farmer expanded cassava planting into upland area.
New Cash Crop: Cassava or Tapioca

To compare with Jute Planting: have to plant, harvest, laid it underwater for 3-4 weeks, peeled it and packed for sell.

And for Corn, at first the product was very good after many year- planting, became more pest and yield was decreased

Cassava is popular and expand to all up-land area

New Cash Crop: Sugar Cane

Sugar Cane was introduced to Dong Mun area in year 1971

But to plant Sugar Cane need high investment (Compare with Cassava) and cost for transportation to Sugar Factory

So many farmers did not invest in Sugar Cane.
Agriculture Activities in Dong Mun, Year 1990

Traditional crop: rice, upland rice, chilies, tobacco, cotton - (corn and jute)

New Cash Crop: Cassava and Sugar Cane.

Cassava
Cassava produced high yield and selling price was very good -- the expanded of cassava planting was very fast – It means more land for agriculture.

Year 1991-1998
Cassava covered most of upland area
Sugar Cane planted near the main road and small area

The settlement pattern

Nong Mai Tai 1807
Kok Khuer 1872
Huai Yang Dong 1927

Nong Kae 1941
Kam Khan 1889
Nong Kob 1972
Kok Klang 1972

Non Sri Sawat 1975
RachaKhue 1990
Nampong Patana 1975
Sai Thong 1982

Nampong Patana 1975
Non Sadao 1973
To protect the Forest Area between 1981 – 2000

Dong Mun Forest Protection Office mobilized villager to protected the forest by working with Government agencies, Universities, NGOs to organized social groups: Women Groups, Youth Group, Tree planting Groups, Fire-protection Group by training, seminar, and planting trees, nursery tree to conservation the forest

And Dong Mun Forest Office (I and II and ...... )
Reforestation with Eucalyptus-tree on mountain

Year 1987: Green Isan Policy – To protect forest in Northeastern Thailand

Year 1989 The government ban the logging concession in Thailand and Regional Forest division take responsibility for this area

Year 1989 Ban the logging concession
Dong Mun Forest Development Office

Seminar to protect the forest

Villager participatory

Seminar to protect the forest

Forest-fire Protection Group

Study Tour for pupils

Forest-fire Protection Group

Seminar for Local Leaders
Agriculture Activities in Dong Mun, Year 1995

Cassava covered mostly on the slope, upland, hilly area.

Sugar Cane: Farmer got financial support from Sugar factory (Contract Farm); increasing......

Rice planted at the low land, mostly in the southern part of DM

Introduced Rubber Tree in this area by Agricultural Extension Division

The farmer earned income form Cash Crop and in the dry season went to work in another provinces. Begin Out-migration to work in Central Thailand
### Year 2000: Forest dependency

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<tr>
<th>Village</th>
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<tr>
<td>Kong Kao</td>
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<tr>
<td>Sang Kwao</td>
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<td>Ban Kerg</td>
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</table>

- **Land for Sugar Cane Plantation**
- **Sugar Cane Plantation**
- **Sugar Cane / Harvest / Burn**
- **Sugar Cane / Harvest**
## Cassava Price from year 1987-2009

<table>
<thead>
<tr>
<th>Year</th>
<th>Price/ Kilo Baht</th>
<th>Price/ Kilo US$</th>
<th>Year</th>
<th>Price/ Kilo Baht</th>
<th>Price/ Kilo US$</th>
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<tbody>
<tr>
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<td>0.84</td>
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<td>1999</td>
<td>0.83</td>
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</tr>
<tr>
<td>1988</td>
<td>0.58</td>
<td>0.017</td>
<td>2000</td>
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<tr>
<td>1989</td>
<td>0.54</td>
<td>0.015</td>
<td>2001</td>
<td>0.77</td>
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</tr>
<tr>
<td>1990</td>
<td>0.71</td>
<td>0.020</td>
<td>2002</td>
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<td>1991</td>
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<td>2003</td>
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<tr>
<td>1992</td>
<td>0.77</td>
<td>0.025</td>
<td>2004</td>
<td>0.88</td>
<td>0.025</td>
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<tr>
<td>1993</td>
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<td>2005</td>
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<tr>
<td>1994</td>
<td>0.71</td>
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<td>1997</td>
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<td>2009</td>
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<td>1998</td>
<td>1.30</td>
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<td>Average 0.94 Baht</td>
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</table>

## Sugar Cane Price from year 1987-2009

<table>
<thead>
<tr>
<th>Year</th>
<th>Price/ Ton Baht</th>
<th>Price/ Ton US$</th>
<th>Year</th>
<th>Price/ Ton Baht</th>
<th>Price/ Ton US$</th>
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<tr>
<td>1989</td>
<td>351</td>
<td>10.03</td>
<td>2001</td>
<td>496</td>
<td>14.17</td>
</tr>
<tr>
<td>1990</td>
<td>412</td>
<td>11.77</td>
<td>2002</td>
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<td>2003</td>
<td>445</td>
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<td>1996</td>
<td>393</td>
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<td>2008</td>
<td>615</td>
<td>17.57</td>
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<td>1997</td>
<td>440</td>
<td>12.57</td>
<td>2009</td>
<td>706</td>
<td>20.17</td>
</tr>
</tbody>
</table>
**Tools (Policy) Protect Dong Mun Forest**

Year 2003: Royal Forestry Department (RFD) closed Forest Protection Office

1. Dong Mun Forest Development I
2. Dong Mun Forest Development 2
3. DM Forest-fire protection
4. Phu Phra Forest-fire protection
5. Phu Phra Forest Protection Station

---

**Dong Mun, Year 2009**

The forest covers only on the mountain sites and 30% are reforestation with Eucalyptus and Teak.

Phu Phra Forest Protection Station is still operate

**Rubber Plantation** is the dominant in the hilly area and slope, more than 60% of total area

**Sugar Cane** find at the lower slope, expanding.... Because the price is increasing.....

**Cassava** covered less than 10% of total area
There were 33 temples on the mountain, Phu No, Phu Phra and... – most of them did not register by Religion Department. They are illegal temples.

All the temples covered 1,930 hectares

Before 1945: There are 4 Temples established.
Year 1946-1985: There are 5 temples more
Year 1986-2009: There are 24 Temples setting up

The temples play a big role for forest conservation, with support from villager to participate many activities such as plant nursery, reforestation, forest fire protection and planted more than 500,000 trees.
Dong Mun, Year 2009 - Conservation

Villages around the mountain established Community Forest to conservation their forest around the villages = 359 hectares with the purpose for cattle feeding, fire wood for bury, for food gathering- Bamboo / Mushroom / Insect ..... 

There are 25 Villages support Forest conservation groups to participate with Forest Temples. They set a regulation, not allow to cut the tree, gathering Bamboos, mushroom and ... for self-consumption, not allow to hunting and ..... To controll forest-fire .....
Dong Mun, Year 2009 / Out-migration

After 9th to 12th Grade, most of the young people went to work in the province, Bangkok, Chonburi, ……

From Prof. Nakagawa survey: 31 villages in Dong Mun found that ……

There are 25 persons Work-aboard

There are 70 persons (Women) married with foreigner
There are 59 persons live in aboard
There are 11 persons lives in Thailand

Marry with: USA (7), England (6), Germany (5), Sweden (5), Japan (4), Norway (3), Italy (3), Switzerland (2), Taiwan (2), France, Finland, Denmark, Netherland, Korea, Malaysia, Hong Kong, Saudi Arabia

Conclusion

<table>
<thead>
<tr>
<th>Time</th>
<th>Immigration</th>
<th>Out-migration</th>
<th>Gathering</th>
<th>Hunting</th>
<th>Jute &amp; Corn</th>
<th>Cassava</th>
<th>Sugar Cane</th>
<th>Rubber Tree</th>
<th>Population Growth</th>
<th>Policy</th>
<th>Natural Resources</th>
<th>People Participatory Forest Conservation</th>
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<td>2001-2009</td>
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</tbody>
</table>
Year 2006, Rain fed – Rice field

Picture from Prof. Satoshi NAKAGAWA, Kobe University

Year 2006

Picture from Prof. Satoshi NAKAGAWA, Kobe University
Year 2006 – Interview

Picture from Prof. Satoshi NAKAGAWA, Kobe University

Year 2006 - Interview

Picture from Prof. Satoshi NAKAGAWA, Kobe University
Year 2009 – Sugar Plantation

Year 2009 – Sugar Cane Transportation
Year 2009 – Sugar Cane Transportation

Year 2006 – Alley Crop / Cassava and Rubber Plantation

Picture from Prof. Satoshi NAKAGAWA, Kobe University
Year 2006 – Rubber Tree plantation

Year 2006 - Rubber
Year 2009 - Rubber

Silk worm cultivation

Weaving
Chilies Plot

Rice Field

Jute Planting in Dong Mun

Cattle Boy

Cattle Cultivation/feeding in Dong Mun

Prepare for Planting

Rice Field

Rice Field
Cassava harvesting

Cassava Store

Soil erosion / Cassava

Cassava

Cassava harvesting

Cassava Store
Year 2009 – Villager House in Dong Mun Area

Year 2009 – Foreigner House in Dong Mun Area
THANK YOU
SAWASDEE
My name is Kimihiko Hyakumura. I am from the Institute for Global Environmental Strategies in Japan. I am from the Kanagawa Prefecture. So as the moderator explained to you, I am just a pinch hitter for the presentation and we only prepared the presentations last night. So I may supplement my presentation with additional resources.

My presentation is a visualization of forest resources in Laos. Sorry I moved my reading notes – sometimes I will have to refer to them. Recently, Laos has undergone rapid economic development and its economic growth rate is still high, in spite of the global economic crisis. In this situation, the role of the forest has drastically changed. After globalization, forests are being thought about for their economic or conservation values.

The objectives of my presentation are twofold. One is to describe the visualization of forest resources as a result of external factors. The second one is to discuss the visualization of land use change, such as plantation and cash crop introduction in Laos.

When did the visualization of forest resources happen? It happened when forest resources were recognized and given a value by certain players. That means that the value of forest resources was recognized in terms of the economic value of the plantation, and the cash crops and environmental values in the protected area.

And what has happened after this visualization? Basically it was decided which people should be involved for each territory and forest resource use regulations were established.

Which parties visualized the forest resources? At the stage involving only usage by the local people for their livelihood, the main actors are the local people, an internal actor. In this presentation, local people equate to an internal factor. Local people also use the forest resources for their livelihood. But when the global community - the government or investors - were included as resources, the visualization of forest resources increased drastically. Visualization by external parties has been introduced since the 1990s to 2000s in Laos.

I categorize three kinds of forest resources as visualizations. The first one is the recognition of forest products; the second one is the recognition of conservation; and the third one is the recognition of land or land use.
The first one is the recognition of forest products, such as timber and non-timber forest products. For the local people, forest resources can mainly be used for their own livelihood and their income generation. Both timber and NTFP are very important for the livelihood of the local rural population. Some estimates - the calculations are on the slide there.

With regard to the external parties, they use the timber and NTFP for selling and marketing. And between the 1990s and 2000, the demand for timber and NTFP began to drastically increase, due to factors concerning supply and requirements.

Next is the recognition of conservation. From a local perspective, most of the local people have cemetery forests and spiritual forests in the rural area of Laos. The local people sometimes established protection forests, such as for watershed management. These conservation efforts are initiatives of the local people. But on the other hand, from a global perspective, protected areas have been established in Laos. This development is not a local requirement but a global requirement. The total area which is protected is now 14% of the total land area of Laos. It’s a very big area to be protected.

Here is a history of the protected areas in Laos. The Government basically follows the global standard. For example, it was decided at the World National Park Congress in 1992 that each country would establish a protected area of at least 10% of the total land area. In the case of Laos, 14% of the total land area is now protected. And regulations also follow the IUCN standard, which is the international standard.

The third category is the recognition of land. Mostly, local people used to collect NTFP or to cultivate their own crops. At the stage of recognition by only the local people, fallow land, the shifting cultivation area and potential agricultural land were occupied by individuals or groups of local people. And each forest in the villages is also used by local people. Most local people are used to collecting NTFP. For economic purposes, the forest is not recognized as a forest, but as land for the cultivation of fast growing species or cash crops and so on, through concessions belonging to foreign and local investment. And land use by the local people corresponds with the change to cash crops and the plantation boom.

Next, I’d like to describe the plantation and cash crop movement in Laos. This table shows the visualization of the forest through the plantation initiatives. Since the 1990s, the government has accelerated plantation. In the middle of the 1990s teak plantation was a boom, and in the late 1990s, ADB plantation, and now it is the biggest plantation being carried out in the economic plantation initiative.

This figure was as of 2007, and is a little old. But we can understand when a plantation movement
has increased. Mainly, there are three big growers here. The first one is a teak plantation in the North, from 1994 to 1997. The second movement is the ADB plantation in the late 1990s to the late 2000s. The third one is the current plantation movement. This current one is the biggest wave.

At the global level, reforestation is needed for environmental conservation and the mitigation of global warming. For example, the APEC congress decided to promote the reforestation of 20 million hectares by 2020.

At the national level of Laos, there are two needs here. The first one is the need for industrial plantation. That is, for economic development and the demand for pulp and timber. The second one is the need for environmental conservation.

The triggers for the plantation in Laos are mainly twofold. The first one is from the Lao government. The government has promoted plantations for the purposes of economic development and poverty alleviation. The second one is the demand side, such as foreign and local investment. They need raw materials for rubber or paper and, for some of them, it is an investment gamble.

This slide is also not recent data, but we can recognize the total planted forest area, which will be almost 400,000 hectares by 2010. On the other hand, the Government of Laos has established a reforestation target of 500,000 hectares by 2020. If all of the planting is carried out, the government target will almost be reached in 2010. In reality, none of these reforestation plans have been carried out yet. But we can recognize the rapid investment in reforestation in Laos.

And this figure mentions the land concessions of several private investments, both for forest plantations and cash crops. This is only a requirement base. I think some of them may not be implemented. But we can see that there are attempts to occupy much of the land all over Laos by other concessions, particularly in Khammouane province. 57% of the total land in Khammouane Province is occupied as a concession, according to this data. You can appreciate that many private investments want to seek land concessions.

Finally, I would like to describe the historical changes to the forest area in Laos. This table shows the official government data of the historical changes to the forest area in Laos. In 1982, 49% was forest land and now it is only 41.5%. So we can see that forestry has decreased year by year according to this data.

This figure describes the historical forest change in Laos and other Asian countries. The data at the top is the same as in the previous information, and the middle line is the data for submission to the FAO. With regard to the differentials, there are very different forestry rates between these two
sets of data. The data at the top shows the forest cover is 41.5%, as of 2002. But in the data below, it is 71.6%. Why is there a difference in the canopy density? At the top, the canopy density is 20%, but below the canopy density is 10%. Lao applied the 20% canopy density in the official data. On the other hand, FAO, including many other countries, follow 10% for the canopy density. When we compare the 10% canopy density in the data from Laos with other countries, for example Cambodia is 59.1% and Bhutan is 68%, and Laos is almost 70% higher compared to this.

The line below is the remaining forest, at 30.1%. This data mentions a canopy density of between 10 to 20%. This forest is recognized mainly as a secondary forest. So in Laos, there are a lot of secondary forests that are not calculated in the forest data. This 30% of forest area cannot be included in the forest statistics, but the local people still use these forest areas.

If Laos applies a 10% canopy density, this country has the highest forest cover rate in Asia. During the last 20 years, the deforestation movement in Lao has been much bigger than the reforestation efforts, according to the data. The reason for the plantation with a high forest rate has to do with economic development factors. Laos itself has a high level of economic growth compared to other countries. And recently Laos’ economic growth rate has been very high. In this situation, the evaluation and monitoring of plantation in Laos is crucial for the reforestation process, caused either by economic developments or to secure the forests in a sustainable way. Thank you very much.
Questions and Answers

(Questioner) Thank you very much. I have just two small questions on your lecture. The first one is that I would like to ask you about the spiritual forests and cemetery forests. I’m not familiar with this type of forest. Like the temple forest, you mentioned the *Gunma* forest area. In Japan, there is the Shinto shrine forest, this type of forest. The second question, you described Table 4, what kind of trees, please give me short information.

(Kimihiko Hyakumura) With regard to your first question, the meaning of the cemetery forest and the spiritual forest, maybe the people from Laos can give a better explanation than me, but I will try to explain. Can you say something...?

(Questioner) Like the type of forest…

(Male) This temple forest is another kind. It’s the temples that are the conserved forest.

(Kimihiko Hyakumura) The cemetery forest means cemetery or grave forest. Meaning a dead person was buried here and the spiritual forest is not different. The spiritual forest means they have local…

(Female) For the spirits’ forest in Laos, we don’t buy any soil. But normally in the temple itself suddenly bird or somebody. Then we also have some spirits that the local people pray to as well. Yes we have.

(Male) Natural forest or plantation forest?

(Female) In natural forests, mostly. Thank you.

(Male) May I add something about Thailand? Spiritual forests are forests that the village, when there are sent to the village, the “pee” in the forest and we call this “Pah-poo-taa”. “Pah-poo-taa” is a father and mother forest. They keep it there and it’s a rule that the people do not go to cut anything there. Every year they have some rituals to ask that the rain will come for something, and then you’ll be with what they call spiritual men in the village. This is the village where we live. It’s the same thing there, because it is like an export village, because the people come from another place and they do not understand each other, which is another problem. For a temple, the temple is inside and they have a village. They have the forest there and they conserve this forest for many days and it’s for a cemetery forest. The tradition is that they do not bury the people who have passed away in the village. So they have the so-called cemetery forest for them and they burn them there. Then they conserve this forest to have enough wood for burning, because at that time the burning is done in the open, so we need not be discreet.
(Kohei Okamoto) Other questions?

(Questioner) I just want to get some clarification. When you say 10 or 20% canopy density, that I guess determines what kind of percentage cover there is. What does that exactly mean? What is 10 or 20% canopy density?

(Kimihiko Hyakumura) Canopy density is the calculation of forest cover in the forest area. When we see the forest from above, if the canopy of the forest covers more than 10% of the land, this can be recognized as a forest. That is the standard.

(Questioner) If you have a hundred square meters of land and 20% is covered by canopy, it’s considered a forest?

(Kimihiko Hyakumura) Yeah, that is a forest. Yes. That’s right.

(Questioner) Regarding this question, I want to ask about the forest canopy density. So you said that that was the secondary forest. I did not catch the meaning because that is the area per unit 05 hectares and then the canopy has to occupy 20% of the area. But this one is growing…

(Kimihiko Hyakumura) Actually, we cannot - I don’t know the details of that. How the type of forest is changing in this data. But my estimation or my prediction compared with the growth of forestation, in the database, I’m sorry I cannot get any clearer information to give you an impression.

(Male) Actually, this issue about forest cover is very sensitive in Laos because it affects not only the forestry cycle but it also affects agriculture, because there are policies in place which are linked to forest cover in the country, and I’ll talk a little bit about that later on.

(Questioner) Thank you very much for the nice presentation. You showed some data concerning recent reforestation, three kinds of data. First is Table 3. According to these figures, in recent years, the plantation area is around 30,000 hectares. Then there was Table 4. According to this, during the five years from 2006 to 2010, the proposed reforestation, by pouring investment in, is 400,000; 30,000 annually. This would take about 15 years. There seems to be a gap between these two.

This is the proposed concession area for private investment. Again, in the total, it is nearly two million hectares. Again, the figures between Tables 4 and 5. Could you clarify a little bit what these gaps mean?
Kimihiko Hyakumura: I’d like to explain this one by one. Given Table 3, this data is a calculation of the rate in the year 2007. So at the end of 2007, most likely there should be a bigger increase.

Questioner: That means the area will increase to…

Kimihiko Hyakumura: Yeah. It should be.

Questioner: 40,000 or 50,000 annually.

Kimihiko Hyakumura: That’s right. It reminds me that this one…

Questioner: And the kind of trees is something…

Kimihiko Hyakumura: Yes. That works also only for the…

Questioner: Majority of the crops and eucalyptus.

Kimihiko Hyakumura: Yeah. But this data is the proposed base data, since many of the activities are not implemented yet.

Questioner: Yes, but what is your expectation? What are the majority of the planted species and tree species?

Kimihiko Hyakumura: The tree species for planting are rubber and eucalyptus. This very huge area can be covered by the concessioned plantation area. But this data is the proposed base data at this stage. As you can see, in the case of Khammouane province, 57% of the total area will be recovered. It is not impossible for ordinary activities.

Questioner: So you’re saying that this is just on paper?

Kimihiko Hyakumura: Yeah, at this stage. But we should recognize that such movement will be caused by economic reasons.

Questioner: What would be the proposed tree species? Is it rubber or eucalyptus?

Kimihiko Hyakumura: This data included not only the tree species you mentioned but also cash crops.

Questioner: What kinds of cash crop are proposed to be planted?
(Kimihiko Hyakumura) I will have to check.

(Questioner) In your presentation title, you use the word “visualization”. The key point is who is visualized? Who visualizes who or what? Can you explain the main factor, the main subject clearly, central government?

(Kimihiko Hyakumura) There are various factors ... In my presentation, I discussed when things happened and what happened and which actor was visualized, as described here. The forest could be visualized for several reasons. For example, if the investment in cash crops was introduced, the forest can be described as a visualization at the time of introducing the cash crops. But before that, they didn’t recognize the value of the land. When the forest is recognized as a useful resource by some parties, visualization occurs.
Visualization of Forest Resources in Laos

Institute for Global Environmental Strategies

HYAKUMURA Kimihiko

Background

□ Recently, role of forest in Laos has been drastically changed under the economic development and the poverty alleviation strategies.

□ Forest has been visualized for putting economic and/or conservation values by the global society, governments and investments
Objective

- To describe the visualization of forest resources by external actors (such as global society, government and investments...).

- To discuss the visualization of land use change including plantation and cash crop development recently developed.

- When visualization of forest resources is happened?
  - When the forest resources take notice and put values by actors.

- What is happened after the visualization?
  - Decide the territory and establish the regulation of forest resources use.

- Which actors visualized forest resources?
  - At the stage of only local livelihood use, local people (Internal actor) who rely on the forest resources use.
  - At the stage of taking notice of the global society, government and investments (External actor), visualization of forest resources drastically increased.
  - Visualization was increased since 1990s to 2000s in Laos.
Three categories of visualization of forest resources

1. As a recognition of forest products

2. As a recognition of conservation

3. As a recognition of land (use)

1. As a recognition of forest products such as timber and NTFP
From local people (Internal actors)

- For securing local livelihood (house consumption as well as income generation)
  - **Timber**: 68 million m³/year (Gold 2004)
  - **Firewood and charcoal**: 710 million m³/year (GoL 2004)
  - **House consumption for NTFP**: 224 million USD (280 USD × 800,000HH) (FSIP 2007)
  - **Income for NTFP**: 49% (of total) (Luang phabang) (Yokoyama 2003)
    - 41% (of total) (Khammuane) (Foppe and Ketphan)
    - 8% (of total) (Sekong) (Rosales et al. 2003)

External actors for industry and trade

- Timber and valuable NTFP
  - **Timber harvesting**: 300-450 thousand m³/year (FSIP 2007)
    - cf. Timber for local consumption: 680 thousand m³ (timber)、7.1 million m³ (firewood and charcoal)

- After accelerating of economic globalization, quantity and species was changed
  - Demand for specific NTFP species from China, Vietnam etc…
  - Demand for timber and illegal logging issues
2. As a recognition of conservation

- For local people
  - Protection forest for watershed management
  - Establishment of Spiritual forest and cemetery forest

- Requirement from global society, establishment of protected area for biodiversity conservation and valuable mammal

- Protected area established by the government (Total area 3.4 million ha).

Fig. 1: Protected Area in Laos
### Table 1: Brief History of protected area in Laos

<table>
<thead>
<tr>
<th>Year</th>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>French colonial era</td>
<td>Establishment of conservation forest (For timber harvesting)</td>
</tr>
<tr>
<td>Late 1980s</td>
<td>Investigation of proposed protected area by IUCN</td>
</tr>
<tr>
<td>1992</td>
<td>World National Park Congress: 「more than 10% of total land will be protected area in all countries」 (Global standard)</td>
</tr>
<tr>
<td>1993</td>
<td>Establishment of protected area (18 sites) (prime minister decree)</td>
</tr>
<tr>
<td>1995-6</td>
<td>Add two site for protected area</td>
</tr>
<tr>
<td>1996</td>
<td>Protected area (conservation forest) under the forestry Law</td>
</tr>
<tr>
<td>1996〜</td>
<td>Determining territory and regulation of protected area at village level under the land and forest allocation regulation.</td>
</tr>
<tr>
<td>2000</td>
<td>Add corridor are (Area of total protected area: 3.4 million ha: 14% of total land)</td>
</tr>
<tr>
<td>2000s</td>
<td>Promoting conservation forest at provincial and district level (Area of total conservation forest: 5.3 million ha: 22% of total land)</td>
</tr>
<tr>
<td>2003</td>
<td>Minister degree on protected are and wildlife conservation (putting on IUCN standards and For CITES) (Global standard)</td>
</tr>
</tbody>
</table>

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### 3. As a recognition of land (use)

![Image of a map and people]
At the stage of recognition by local people
- Secondary forest for fallow land, swidden area and potential agricultural land (Chapchon area) was occupied by individual local people.
- Community forest for village use

Into the economic purpose
- Forest area sometimes dose not recognized as a forest, but as a land for cultivation of fast growing species or cash crop.
  - Concession by foreign investment and land enclosure by domestic investment etc
  - Land use change by local people corresponding cash crop / tree boom

plantation and cash crop program and its promotion
### Table 2: Trend on visualization of forest by reforestation initiatives

<table>
<thead>
<tr>
<th>Year</th>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>The first forestry conference (Promoting plantation)</td>
</tr>
<tr>
<td>1993</td>
<td>Establishment of plantation section in the DOF</td>
</tr>
<tr>
<td>Middle 1990s</td>
<td><strong>Teak plantation movement in northern Laos</strong> (mainly individually)</td>
</tr>
<tr>
<td>1994</td>
<td><strong>Industrial Tree Plantation Programme by ADB (by 2003)(mainly individual)</strong></td>
</tr>
<tr>
<td>1996</td>
<td>Promoting plantation under the forestry law</td>
</tr>
<tr>
<td></td>
<td><strong>Land and forest allocation programme: plantation in the degraded land</strong></td>
</tr>
<tr>
<td>2004</td>
<td>NGEPS: Promoting poverty alleviation and economic development</td>
</tr>
<tr>
<td>2004</td>
<td><strong>Revised foreign investment law:</strong> promoting foreign investment</td>
</tr>
</tbody>
</table>
| 2005     | Forestry Strategies 2020 | 500 thousand ha for reforestation
          | 2.5 million ha for natural regeneration                               |
| 2006     | NSEDP                                                                 |

### Table 3: Trend of reforestation area in Laos

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.4</td>
<td>1.3</td>
<td>1.4</td>
<td>0.9</td>
<td>2.2</td>
<td>3.4</td>
<td>11.9</td>
<td>12.3</td>
<td>9.9</td>
<td>6.6</td>
<td>15.2</td>
<td>15.5</td>
<td>17.2</td>
<td>18.6</td>
<td>25.8</td>
<td></td>
</tr>
</tbody>
</table>

**Source:** FSIP 2007
Justification of reforestation programme and its justification

- **At global level**
  - Reforestation needs from environmental conservation and mitigation of global warming
    - By 2020, 20 million ha reforestation in APEC has been promoted (2007. Sep APEC Summit)

- **At national level (Laos)**
  - Needs for industrial plantation
    - Way for Poverty alleviation and economic development
    - Demand for pulp and timber
  - Needs for environment conservation
    - Protection for water and natural disaster as well as forest rate recovering

---

Background of the third boom plantation in Laos

- **Plantation promotion as policy**
  - 500 thousand reforestation by 2020 under Forestry Strategies
  - Cash crop and tree plantation for poverty alleviation and alternative livelihood

- **Demand for foreign countries**
  - China and Vietnam: rubber demand
  - Finland, India, Japan investment: paper materials

- **Plantation boom in Laos**
  - Rubber plantation in northern part
  - Fast growing and rubber plantation in the south
Table 4: Proposed reforestation area by foreign investment (2006-2010)

<table>
<thead>
<tr>
<th>species</th>
<th>Planned reforestation area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rubber</td>
<td>227,910</td>
</tr>
<tr>
<td>Fast growing species (Eucalyptus and Acacia)</td>
<td>151,050</td>
</tr>
<tr>
<td>Teak</td>
<td>51,200</td>
</tr>
<tr>
<td>Eaglewood</td>
<td>5,980</td>
</tr>
<tr>
<td>Others</td>
<td>1,900</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>438,040</strong></td>
</tr>
</tbody>
</table>

Source: FSIP(2007)

- c.f 500 thousand ha reforestation (Forestry strategies 2020)

---

Table 5: Proposed concession area by private investment

<table>
<thead>
<tr>
<th>province</th>
<th>Number of companies</th>
<th>Proposed area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponsali</td>
<td>2</td>
<td>?</td>
</tr>
<tr>
<td>Luang Namtha</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Oudomsay</td>
<td>9</td>
<td>50</td>
</tr>
<tr>
<td>Bokeo</td>
<td>4</td>
<td>29,155</td>
</tr>
<tr>
<td>Luang Prabang</td>
<td>7</td>
<td>67,100</td>
</tr>
<tr>
<td>Houaphanh</td>
<td>5</td>
<td>760</td>
</tr>
<tr>
<td>Sayabuly</td>
<td>9</td>
<td>50,800</td>
</tr>
<tr>
<td>Xiengkouang</td>
<td>9</td>
<td>20,619</td>
</tr>
<tr>
<td>Saysomboun S.Z</td>
<td>27</td>
<td>115,482</td>
</tr>
<tr>
<td>Vientiane Prov.</td>
<td>8</td>
<td>61,258</td>
</tr>
<tr>
<td>Vientiane Mun.</td>
<td>11</td>
<td>70,386</td>
</tr>
<tr>
<td>Bolikhhamxay</td>
<td>12</td>
<td>932,300</td>
</tr>
<tr>
<td>Khammouane</td>
<td>24</td>
<td>439,967</td>
</tr>
<tr>
<td>Savannakhet</td>
<td>15</td>
<td>19,018</td>
</tr>
<tr>
<td>Champasack</td>
<td>16</td>
<td>14,165</td>
</tr>
<tr>
<td>Sekong</td>
<td>17</td>
<td>15,000</td>
</tr>
<tr>
<td>Attapeu</td>
<td>18</td>
<td>24,797</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>159</strong></td>
<td><strong>1,860,857</strong></td>
</tr>
</tbody>
</table>

- 57% of total
- 20% of total
Historical change of forest area in Laos

<table>
<thead>
<tr>
<th>Land use</th>
<th>1982</th>
<th>1992</th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current forest (canopy density more than 20%)</td>
<td>11,637(49.1%)</td>
<td>11,168(47.2%)</td>
<td>9,825(41.3%)</td>
</tr>
<tr>
<td>Potential forest (canopy density 0-20%)</td>
<td>8,554(36.1%)</td>
<td>8,949(37.8%)</td>
<td>10,152(47.1%)</td>
</tr>
<tr>
<td>Sub-total</td>
<td>20,191(85.2%)</td>
<td>20,117(85.0%)</td>
<td>20,977(88.6%)</td>
</tr>
<tr>
<td>Bush etc</td>
<td>1,545(6.5%)</td>
<td>1,444(6.1%)</td>
<td>286(1.2%)</td>
</tr>
<tr>
<td>Agriculture land</td>
<td>709(3.0%)</td>
<td>850(3.6%)</td>
<td>1,200(5.1%)</td>
</tr>
<tr>
<td>others</td>
<td>1,235(5.2%)</td>
<td>1,270(5.4%)</td>
<td>1,217(5.1%)</td>
</tr>
<tr>
<td>合計</td>
<td>23,680(100.0%)</td>
<td>23,680(100.0%)</td>
<td>23,680(100.0%)</td>
</tr>
</tbody>
</table>

Closing

- Under 10% of canopy cover,
  - Laos is highest forest cover rate in Asia.
  - During past 20 years: forest degradation > deforestation.

- The meaning of reforestation program under 70% of forest cover
  - As industrial promotion for alternative livelihood and economic development

- Slowing down rapid plantation and cash crop development by government and rapid economic growth
  
  Economic growth rate: Laos +5.0%.  
  Cf. world average -1.74%, Japan -5.3% (WB 2009)

- Laos will follow same way to other SE Asia or more sustainable way(?)

Thank you
Good afternoon, ladies and gentlemen. My name is Kazuya Ito. I am a general manager at Oji Paper’s Forestry Research Institute. Thank you for giving me this opportunity to present our plantation activities under the title “Hardwood Plantation Project for Pulpwood in Laos.”

Today, I will present you with four topics. The first is an outline of Oji Paper’s plantation projects. I’ll explain plantation projects throughout the world and also the characteristics of eucalyptus and acacia as pulpwood. The second topic is related to concerns about the effect of hardwood plantation on the environment. Some people here are concerned about water consumption and nutrient usage by fast-growing trees like eucalyptus, and I will also mention some effects on biodiversity. The third topic is an introduction of the plantation project in Laos. The last topic concerns issues with and approaches to expanding hardwood plantation in Laos, from the viewpoint of the breeding and development of silviculture.

This figure shows our overseas plantation projects. We have eight chip export businesses right here, and also three pulpwood production projects. We prefer eucalyptus as pulpwood. The SPFL business is located in the southern part of South Island in New Zealand, a very cold place. In winter, temperatures are as low as -10°C. *E. nitens* can still grow. Also, we have three plantation projects in Australia — APFL, GPFL, and EPFL. These are in temperate regions. We have planted *E. globulus*. This is the best species of eucalyptus as hardwood for pulp. Also, we have another four projects in areas including Southeast Asia. We have planted hybrid clones of acacia in Vietnam. This project here, QPFL, has started to plant *Eucalyptus camaldulensis* and *Acacia mangium*, but both species cannot grow very well. So we have changed our mind and planted clones of a hybrid of *Acacia mangium* and *A. auriculiformis*. Also, we have included some acacia in the last project shown in the table, LPFL. We have planted clones of eucalyptus hybrids and acacia hybrids. Our target is 300,000 hectares of plantation by 2010. If these projects come to an end, we have already achieved 220,000 hectares, but we still need 80,000 hectares to meet our goal.

I will show you the characteristics of eucalyptus used as pulp. There are several species suitable for tropical/subtropical regions. Two species, *urophylla* and *grandis*, are very popular in Brazil. Brazil was the first country in the world to establish eucalypt plantations. For temperate regions, we prefer *globulus*, and we have also imported some natural species of *regnans, delegatensis*, and *obliqua* from Tasmania.
I will also explain the advantages of eucalyptus. It grows quickly and has a higher basic density, with more than 400 kg per cubic meter; also, eucalyptus has a straight stem and characteristics of self-pruning. Self-pruning means that the lower branches fall off naturally. This is very good for us at harvest. But there are some disadvantages to eucalyptus. Eucalyptus needs intensive weeding, especially in the early stages of growth. If weeding is not done properly in the early stages, the rate of growth is cut in half. Another disadvantage of eucalyptus is that fewer species can adapt to the tropics. Therefore, we have selected acacia as the other target species for pulp production in the tropics.

Acacia seems to be a newcomer to our industry. Fewer species are used for pulp production only because of acacia’s short history of utilization for this purpose. Acacia has the great advantage of fixing nitrogen in the air. In Vietnam, QPFL doesn’t use nitrogen as a fertilizer. Also, acacia can compete with weeds. Even if we do not weed properly, Acacia can grow quickly. On the other hand, acacia is high in fatty acids, which causes some problems when making paper.

This slide shows the characteristics of species during the digestion process. The horizontal axis shows ease of cooking to produce pulp from chips. A lower value means it is easier to cook. The vertical axis shows the pulp yield. The analyzed samples have been classified into four categories. Numbers 1 and 2 are *globulus* from Australia or Chile, classified into category I, which has better digestibility and a higher pulp yield. In comparison with *globulus*, *camaldulensis*, numbers 6, 7, and 8, falls into category IV. This group is somewhat difficult to cook and has a lower pulp yield. The acacia, *mangium* from Papua New Guinea and *auriculiformis* from Vietnam, are classified as category III, which has a higher pulp yield but lower digestibility. We have planted both eucalypt and acacia in Southeast Asia. It is difficult to select species for plantation in Southeast Asia, including Laos, because we must base the decision on several considerations, including ease of cocking, pulp yield, ease of making paper, growth habitats, and so on.

There are three major concerns to consider as we enlarge our plantation area. Firstly, as eucalyptus can grow quickly and produce more biomass material, it may utilize more water, causing water depletion and related problems. Secondly, as eucalyptus may absorb more nutrients from the land, it may create wastelands with low soil fertility. Also, large-scale plantation may affect biodiversity. In spite of these concerns, eucalyptus plantation has been expanding throughout the world. Here are some reasons: As there are many species of eucalyptus, suitable species can be selected for target areas with varying conditions. Eucalyptus can grow in wastelands with low soil fertility. Also, eucalyptus wood is versatile and can be utilized for pulp, construction, fuel, and other uses.

Although there have been issues with the utilization of water by eucalypt throughout the world, many of them have been settled scientifically. Let me introduce some figures related to efficient water usage, according to FAO. This figure shows water use efficiency, including crops. Eucalyptus can use 510 liters of water to produce one kilogram of biomass. Eucalyptus can use water very
efficiently. But because eucalyptus can so quickly produce biomass, it requires large volumes of water. If eucalyptus is to be planted in a low-rainfall area, say, less than 500 millimeters per year, care should be taken to avoid water deficiency in that area. I will show you a case study of our plantation project in Laos, very briefly. The average rainfall is 1,750 millimeters. The growth rate is 12.5 bone dry tons per hectare per year. Water required is less than 10,000 cubic meters per hectare per year. Recharge by rainfall is more than 10,000 cubic meters per hectare per year. This is enough for the production of eucalypt. So there seems to be no concern about water efficiency in regard to eucalypt plantation in Laos.

Let me introduce sustainable plantation in Brazil. Cenibra, our sister company in Brazil, was established in 1973 to plant eucalyptus for pulp production. Their plantation area is 137,000 hectare so far. The target species are mainly clones of a eucalypt hybrid of \textit{urophylla} and \textit{grandis}. Annual rainfall is 1,100 to 1,300 mm. Annual mean temperature is 21°–25°C. The rotation cycle is seven years, on average. Currently, their plantation area is coming into its fifth or sixth rotation cycle. The growth rate is increasing. At the moment, 40 cubic meters per hectare per year may be the highest figure in the world.

I will give you other data on the consumption of water by eucalypt plantations at Scott River, in Western Australia. It is located 250 kilometers south of Perth. Annual rainfall is 1,100 millimeters. The planted species is \textit{globulus}. In this area, plantations of \textit{globulus} were started in 1996 and thinned and fertilized in 1998. Researchers have surveyed the water deficit in the soil since late 1998. This figure shows the soil water deficit. The dotted line represents soil without fertilizer. Low-stocked, medium, and unthinned comprise 300, 600, and 1,200 trees per hectare, respectively. No fertilizer means that growth is not so good. There are significant seasonal variations. This one here is in the dry period, summer. The deficit gradually expanded toward the end of rotation cycle, but soon after harvest in 2006, the water level recovered quickly. So there seems to be less concern about water deficits in areas with more than 1,000 millimeters of rainfall.

The second concern is the removal of nutrients from the land as a result of eucalypt plantation. As shown in the table, eucalyptus utilizes fewer nutrients per unit weight of biomass products in comparison with most crops, such as paddy rice and maize. In a seven-year rotation, 77 kg of nitrogen, 7 kg of phosphate, and 84 kg of potassium may be removed at harvest. At least the same amount of nutrients should be fertilized for one rotation. We should sustain soil fertility. In our plantation projects throughout the world, we apply fertilizer several times per rotation cycle.

Our last concern is related to effects of hardwood plantation on biodiversity. In this slide, I want to emphasize that not only eucalyptus but almost all crops that are not native to Laos or other countries may have adverse effects on local biodiversity. Uncontrolled invasion by introduced species may have negative impacts on native plants and animals in the area. Even if eucalypt seeds are dispersed from plantation areas naturally, they cannot survive in densely vegetated areas like...
Laos, as they need light to grow. This shows that there is not much concern about eucalypt plantation in Laos. Also, Oji observes the laws and attempts to produce as much wood as possible in a limited space, thus maintaining or increasing the level of biodiversity in Laos.

Lao Plantation Forest Company, LPFL, was founded in 2005 as a joint venture with the government of Laos. The government’s share is 15%. On the Japanese side, we have 11 companies involved in this plantation scheme. LPFL creates hardwood plantations for pulpwood, with rotation cycles of seven years. The target site is degraded forestland or barren land. The species for plantation are eucalyptus and acacia. Also, we promote clonal plantation to improve the productivity of the plantation area.

In 2007, we changed our plan to plant both eucalyptus and acacia. The planting ratio is around fifty-fifty. The area for acacia is expanding year by year, expected to reach about 7,000 out of about 18,000 hectares by the end of 2008. We will reach 25,000 hectares of eucalyptus and acacia in Laos by the end of 2009.

Our predecessor, BGA, a New Zealand-based company, planted only *Eucalyptus camaldulensis*. This is one of best clones of camaldulensis, BGA25. Because BGA25 is susceptible to some leaf diseases, we have conducted several trials to obtain new clones. K7 was originally imported from Thailand and has performed much better than BGA25.

K7 is a hybrid clone of *Eucalyptus deglupta* and *E. camaldulensis*. *E. camaldulensis*, which originated in Australia, is suitable for tropical and subtropical areas, drought tolerant but susceptible to leaf diseases in Thailand and also in Laos. Another species, *E. deglupta*, naturally originated in the northern part of Australia, Papua New Guinea, and Indonesia. This species is suitable for tropical areas and grows very quickly, but its density is very low, maybe 300-something kilograms per cubic meter. This figure shows the wood quality of K7. The basic density is 490 kilograms per cubic meter, which is lower than *camaldulensis* imported from Vietnam, but other characteristics are the same as *camaldulensis*. Thus, K7 has turned out to be our main eucalyptus clone.

We have imported several hybrid clones of acacia from the subsidiary company, QPFL, in Vietnam. They have performed well so far. The average height was around 10 meters after two years. Although we do not have any data on older acacia, growth at age two was right on the growth curve, which was taken from the data collected at better sites in Vietnam. Growth of hybrid clones is anticipated to be good in Laos.

Let me briefly talk about the improvement of acacia hybrid clones in Vietnam. Though growth performance improved greatly after the introduction of hybrid clones of acacia, we had a problem of lower basic density, shown by the pink triangle, very close to 400 kilograms per cubic meter.
Therefore, we have selected superior trees with good performance both in growth and in wood quality. We obtained samples from all of the selected trees and analyzed them in our pulp and paper research laboratory. The red squares in this figure show the basic density of selected trees. They are heavier than the original clone by 10%–20% and digest more easily than another LAC2, which encompasses acacia trees imported from several countries.

Efforts are being made to address a couple of issues related to advancing hardwood plantation in Laos. The first is improving the productivity of the plantation. The promotion of clonal forests seems to be the appropriate solution to this issue.

Cenibra has a long history of clonal plantation. As I mentioned before, their plantation is in its fifth or sixth cycle. Clonal plantation started in 1990. At this stage, 10% of their area was planted with clones. They used clones mainly of a hybrid of *urophylla* and *grandis*, which grows very quickly in Brazil. The clonal plantation area has increased year by year. They have been planting only clones since 2001.

This figure shows the improvement of the growth rate. Mean annual increment (MAI) at harvest in 1990 was 23 cubic meters per hectare per year. The plantation harvested in 1990 was planted from seedlings in 1983. The plantation harvested in 2007 was mainly clonal. MAI grew to 40 cubic meters per hectare per year, an almost 70% increase. Thus, clonal plantation is a very powerful tool for increasing productivity and became very popular for both eucalyptus and acacia.

I will explain the process of clonal plantation with newly acquired clones. First of all, we must acquire clones. The quickest way to do this is to acquire them from other organizations. Another way, which takes a bit longer, is to select trees at plantation and hybridize them to get the new clone. During the mass propagation of clones, we must assess the growth performance of the clone. About half of a rotation cycle is required to assess growth performance. So it takes 3–5 years to start commercial planting with newly acquired clones.

The second issue is the threat of pests and diseases. Production loss by pests and diseases may be offset by expansion of the plantation area, especially in clonal forests. There may be less genetic variation compared with plantation from seeds, so we should develop as many new clones as possible.

I will explain the present situation regarding clones of eucalyptus and acacia in Laos. For eucalyptus, we have only one clone, K7. It grows very quickly and is very tolerant of pests and diseases, but we have only one clone. For acacia, several clones have been imported from QPFL. They have performed well so far, but we still need other clones.

This figure shows the acquisition of new eucalyptus clones. In 2006, we brought hybrid clones of
urophylla and grandis from China. These three clones are commercial clones from CPFL, a subsidiary in the south of China. Trials are still being conducted. We do not have concrete results so far. Also, we have conducted several trials with new clones from China and Thailand. We obtained three from Thailand as well as some natural hybrids of pellita and brassiana from Vietnam in 2009.

As I mentioned above, the decision to use commercial clones from China has not been made yet. DH3213 from China performed very well in the first year, but in the second year, it got a disease. It lost many leaves, in contrast to K7, which is very healthy. Hybrids from China seem to be unsuitable for Laos. Thus, acquired plants should be carefully evaluated for adaptability to the site, especially in higher-rainfall regions.

We have other good candidates for new clones. The Research Center for Forest Tree Improvement, located in Vietnam, obtained many clones of a natural hybrid of pellita and brassiana. Researchers selected higher-performance clones and have already conducted trials in Vietnam. This figure shows the rainfall pattern in Laos and Vietnam. The quantity of rainfall is different, but the pattern is quite similar in both countries, as are edaphic conditions and mean annual temperature. These natural hybrid clones should perform well in Laos.

We have established a species trial to get more suitable species for pulp. The survival rates of brassiana and camaldulensis are relatively higher than pellita, but pellita grows better, as the figure clearly shows. As pellita can grow even after four years of planting, hybrids of pellita and brassiana or camaldulensis should perform well in Laos.

Let me explain how to create superior hybrids of camaldulensis and pellita. We have already selected superior clones of camaldulensis, shown in this photograph. This is the selected tree; the height is over 23 meters, and the diameter at chest height is about 20 centimeters, which makes it a good clone. Now we are making grafted clones, and then we will add some chemicals to promote flowering. After flowering, we will do some hybridization work with pellita to select good clones from the offspring of the hybrid seeds.

This photograph shows the performance of a natural hybrid of pellita and brassiana, selected in Indonesia. These logs were taken from five-year-old trees. You can see that the growth performance of the hybrid is much better than that of the original species.

We have done some trials with acacia hybrid clones from QPFL. As these clones have performed well so far, we have decided to expand those areas of hybrid. In 2008, we have already planted over 1,000 hectares. Also in 2008, we have obtained other hybrid clones and clones of auriculiformis from QPFL and the Forestry Science Institute of Vietnam for testing.

Matching clones with sites is a very important factor in maximizing pulpwood productivity per area
unit. Our plantation area in Laos is roughly separated into two types — loamy and sandy.

This figure shows the growth performance of K7 and *Acacia mangium* in both soil types. While K7 grows better at sandy sites, *Acacia mangium* grows better at loamy sites.

The third issue is the sustainability of soil nutrition. Generally speaking, our target sites are less rich in nutrients, and there are some symptoms of nutrient disorder, especially in boron.

This table shows the macro-element level of leaves, which reflects the soil nutrient level. There are adequate levels of nitrogen, phosphate, and potassium. Also, there are shortages of micro-elements in zinc and boron.

The figure shows boron deficiency in eucalyptus. A–C are for *grandis urophylla* hybrids. D–G are for K7. There are changes in pigmentation in the young leaves shown in A, D, and F; developing leaves may be malformed, with missing sectors, as shown in B. Boron deficiency severely impairs the growth of the shoot tip and causes stem forking and twisting due to slowed growth.

This photograph shows you some symptoms in an acacia hybrid plant. Yellowing extends from the edge over the whole blade, and developing leaves are malformed, with missing sectors. Shoot tips are likely to die, and this may cause multiple shoots. We have established several trials to elucidate adequate levels of macro- and micronutrients.

The last issue is the challenge of plantation in areas with severe conditions. There are a lot of waterlogged sites along Mekong and major roads. We have started to plant trees in the waterlogged sites due to the shortage of land for hardwood plantation in Laos. In Laos, the main rainy season starts in May and ends in September. The risky period for waterlogged areas is from July to September. As the waterlogged areas are basically very flat, it is very easy to conduct plantation activities such as preparation, planting, weeding, and fertilizing; however, we expect disturbed growth.

We have conducted a soil survey in the waterlogged area. There are some layers that are rich in iron or clay, which may cause trouble for water drainage. Several measures should be undertaken. We should select species or clones that are tolerant of a shortage of oxygen in the soil and also undertake civil engineering projects, such as building water channels to improve drainage.

This is my last slide, which shows another example of planting materials for a waterlogged site. *Acacia peregrinalis*, which is quite new to the pulp industry, and K7 can survive under waterlogged conditions. Though we have planted *Acacia crassicarpa*, which is very popular in waterlogged areas in Indonesia, almost all of them were missed. The provenance of *A. crassicarpa* may be important. Growth performance should be carefully monitored for the next 2–3 years. It is very
risky but challenging.

Thank you very much for your attention.

Questions and Answers

(Question) Thank you very much for your explanation of eucalyptus clones. I am sure that you made good clones. I do not know the history of disturbance in Laos, but hedging against pests and diseases is very important. I am concerned about the risk of forest fires and the need to improve our methods of dealing with them. What is your opinion?

(Kazuya Ito) As we have not had many problems with fires in Laos, I have not considered developing clones with a tolerance to forest fire. Generally speaking, Eucalyptus can tolerate forest fire. Even if a eucalyptus plantation is damaged by fire, significant numbers of eucalyptus can survive and grow again. It is very difficult to obtain clones tolerant to fire.

(Question): In the case of pine trees, I assume tolerance to forest fire is low.

(Kazuya Ito) In the case of Australia, native forests of eucalyptus have come in contact with many fires, and occasionally big ones. But plantations do not get big fires because there is less fuel on the ground.

(Question) Thank you very much for the informative talk. You said that tree plantation projects in Laos are facing some criticism regarding the environment, and you explained the major concerns. I totally agree with your ideas, but as I understand it, most of the concerns are problems of scale. As you know, in Asian countries, the landscape is very small; roads are narrow and houses are tiny. If large areas of land are occupied, that may be of great concern to local people and their local government. Standardized management should be more economic; I understand that. But now may be the time for private sectors to decentralize this management because, in the case of Thailand, most eucalyptus plantations are contract-based with its whole partners. This would mean direct management of plantations by the private sectors. I sincerely respect your efforts in Laos, but this may be something to consider. What do you think?

(Kazuya Ito) This is a tough question for me. This slide shows our plantation sites, which are very scattered. It is true that we don’t have large-scale lands for plantation, except in Brazil. In Brazil, we have a large plantation area around a pulp mill. In all of our other plantation projects
around the world, our plantation sites are on a very small scale. Now, we will have planted 18,000 hectares in Laos by the end of this year. We have around 200 plantation sites, so each site is around 80 hectares. Also, we have already put some farmer plantation schemes into action.

(Question) So 80 hectares is not so large. Does it incur high management costs for the company?

(Kazuya Ito) Yes.

(Question) I see. But you are still promoting it.

(Kazuya Ito) Yes. It is very difficult to get large areas of land in Laos or other countries, except Brazil.

(Question) Thank you.

(Question) I have a question about your arguments about water availability under the plantation system. There is an idea that in any ecosystem, the structure and function should go together, so that the main arguments for plantation are being counted as far as the functionality perform the same thing as natural forest. In terms of water, I am curious, because the data you showed is based on water use within your plantation. Regarding water that is coming out of the system or water availability outside your forests, what is the situation there? Is less water available now in surrounding areas, compared to when there was original vegetation or original land use?

(Kazuya Ito) This is another tough question. At this stage, we do not have enough information on water consumption in large plantation areas. I’ll talk to you later, one on one.

(Question) The reason I asked the question is that one of the basic things that natural forests are supposed to do is soak up water and release it gradually or use it in other places. What I want to know is whether plantation systems do the same thing.
Hardwood Plantation Project for Pulpwood in Laos

Oji Paper Co., Ltd
Research & Development Division
Forestry Research Institute

KAZUYA ITO

Contents

1. Outline of the plantation projects in Oji Paper
   • Projects in the world
   • Characteristics of Eucalyptus & Acacia as pulpwood

2. Some concerns for environment by plantation
   • Water/ nutrient usage/ biodiversity

3. Introduction of the plantation project in Laos
   • Review of plantation activities

4. Issues & approaches on expanding hardwood plantations in Laos
   • Breeding
   • Silviculture
1. Overseas plantation projects in Oji Paper

<table>
<thead>
<tr>
<th>Country</th>
<th>Region</th>
<th>Company</th>
<th>Species</th>
<th>Target (ha)</th>
<th>Planted* (ha)</th>
<th>Harvest cycle (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Zealand</td>
<td>South Island</td>
<td>SPFL</td>
<td>E. nitens</td>
<td>10,000</td>
<td>10,083</td>
<td>12</td>
</tr>
<tr>
<td>Australia</td>
<td>Western Australia</td>
<td>APFL</td>
<td>E. globulus</td>
<td>24,000</td>
<td>23,898</td>
<td>10</td>
</tr>
<tr>
<td>Australia</td>
<td>Victoria</td>
<td>GPFL</td>
<td></td>
<td>6,500</td>
<td>6,548</td>
<td>10</td>
</tr>
<tr>
<td>Vietnam</td>
<td>Binh Dinh Province</td>
<td>QPFL</td>
<td>A. mangium x A. agriliformis</td>
<td>13,000</td>
<td>11,056</td>
<td>7</td>
</tr>
<tr>
<td>China</td>
<td>Guangxi</td>
<td>CPFL</td>
<td>E. urophylla x E. grandis</td>
<td>6,500</td>
<td>6,361</td>
<td>6</td>
</tr>
<tr>
<td>Guangdong</td>
<td>KPFL</td>
<td></td>
<td></td>
<td>25,000</td>
<td>23,424</td>
<td>5</td>
</tr>
<tr>
<td>Laos</td>
<td>Celal Lao</td>
<td>LPFL</td>
<td>Eucalyptus hybrids</td>
<td>50,000</td>
<td>18,600</td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>Minas Gerais</td>
<td>GENIBRA*2</td>
<td>E. urophylla x E. grandis</td>
<td>43,450</td>
<td>57,155</td>
<td></td>
</tr>
<tr>
<td>New Zealand</td>
<td>North Island</td>
<td>PANPAC</td>
<td>Radiata pine</td>
<td>30,000</td>
<td>32,765</td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>Alberta</td>
<td>APFI</td>
<td>Populus</td>
<td>7,500</td>
<td>1,971</td>
<td>~25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td>218,750</td>
<td>194,523</td>
<td></td>
</tr>
</tbody>
</table>

*1: The total area planted is 200,000 ha as of the end of December 2008 for OPIF APFL, Genibra ANFL, and as of the end of March 2009 for the others.

1) Characteristics of Eucalyptus for pulp

### Eucalyptus

- **Main species for pulpwood**
  - Tropical / Subtropical: urophylla, grandis, camaldulensis, dunnii, saligna
  - Temperate: globulus, regnans, delegatensis, obliqua, nitens

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Advantage: better growth, heavier basic density (&gt;400kg/m3), straight stem, self pruning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Disadvantage: intense weeding in the early stage, less species for tropics</td>
</tr>
</tbody>
</table>
2) Characteristics of Acacia for pulp

<table>
<thead>
<tr>
<th>Acacia</th>
<th>Tropical / Subtropical</th>
<th>Temperate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main species</td>
<td>mangium, auriculiformis, crassicarpa</td>
<td>meransii</td>
</tr>
<tr>
<td>for pulpwood</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Advantage:**
better growth, nitrogen fixation, less weeding

**Disadvantage:**
less heavier basic density than Eucalyptus, large crown, high fatty acids content, less usage for pulpwood

3) Characteristics of species in digestion process

<table>
<thead>
<tr>
<th>Pulp yield (%)</th>
<th>Digestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>35 (Kapper value) 10</td>
</tr>
</tbody>
</table>

**LE3:** ①E.globulus (Australia), ②E.globulus (Chile), ③, ④E.grandis (South Africa)
**LE2:** ⑤Natural Eucalyptus (Australia)
**LE1:** ⑥E.camaldulensis (Thailand), ⑦E.camaldulensis (Vietnam), ⑧Eucalyptus (China)
**LAC1:** ⑨A.mearnsii (South Africa)
**LAC2:** ⑩A.mangium (Papua New Guinea), ⑪A.auriculiformis (Vietnam)
2. Concerns on expansion of plantations

Concerns
• As Eucalyptus can grow fast and produce more biomass materials, it utilizes more water and may cause water depletion and other related problems.
• As Eucalyptus may absorb more nutrition from the land, it may increase waste lands with low soil fertility.
• Large plantation may affect biodiversity.

Characteristics of Eucalyptus
• As there are many species in Eucalyptus, suitable species can be selected for target areas with different conditions.
• Eucalyptus can grow on waste lands with low soil fertility.
• Logs of eucalypt are versatile materials for pulp, construction, fuel and other uses.

Expansion of Eucalyptus plantation in the world

1)-① Does Eucalyptus utilize excessive water?

• Eucalyptus utilizes less water per unit weight of biomass
• Volume of water is dependent on volume of biomass produced

<table>
<thead>
<tr>
<th>Species</th>
<th>Water use per total biomass (litres/kg)</th>
<th>Harvest index</th>
<th>Water use per harvested biomass (litres/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coffee/Banana</td>
<td>3.200</td>
<td>0.25</td>
<td>800</td>
</tr>
<tr>
<td>Sunflower</td>
<td>2.400</td>
<td>0.25</td>
<td>600</td>
</tr>
<tr>
<td>Paddy rice</td>
<td>2.000</td>
<td>0.30</td>
<td>600</td>
</tr>
<tr>
<td>Pine</td>
<td>1.538</td>
<td>0.65</td>
<td>1.000</td>
</tr>
<tr>
<td>Soybean</td>
<td>1.430</td>
<td>0.35</td>
<td>500</td>
</tr>
<tr>
<td>Acacia</td>
<td>1.323</td>
<td>0.65</td>
<td>860</td>
</tr>
<tr>
<td>White potato</td>
<td>1.000</td>
<td>0.60</td>
<td>600</td>
</tr>
<tr>
<td>Sofghum</td>
<td>1.000</td>
<td>0.25</td>
<td>250</td>
</tr>
<tr>
<td>Albizia</td>
<td>967</td>
<td>0.60</td>
<td>580</td>
</tr>
<tr>
<td>Eucalyptus</td>
<td>785</td>
<td>0.65</td>
<td>510</td>
</tr>
<tr>
<td>Finger Millet</td>
<td>592</td>
<td>0.40</td>
<td>240</td>
</tr>
</tbody>
</table>

Source: FAO(1993)

Ex): LPFL Rainfall 1,750mm(include S-LPFL), MAI 25(12.5 BDT/ha/year)
Water required* 12.5x785 = 9,812.5m³/ha/year
Recharge (Rain) 100x100x1.75 = 17,500.0m³/ha/year

* Much of water taken by plants are then transpired into the air, thus the water circulation follows (good for the environment).
② Sustainable plantation of Eucalypt in Brazil

Cenibra: Established in 1973 & owned by Japan Brazil Pulp & Paper Resources Development (Oji’s share:39.84%)

<table>
<thead>
<tr>
<th>Plantation area</th>
<th>137,000ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target species</td>
<td>Eucalyptus(mainly hybrid)</td>
</tr>
<tr>
<td>Annual rainfall</td>
<td>1,100～1,300 mm</td>
</tr>
<tr>
<td>Annual mean temperature</td>
<td>21～25°C</td>
</tr>
<tr>
<td>Rotation cycle</td>
<td>seven years in average</td>
</tr>
<tr>
<td>Growth rate</td>
<td>40m³/ha/year (increasing)</td>
</tr>
</tbody>
</table>

Consumption of water by eucalypt plantation in WA

- Scott river
- Annual rainfall: 1,100mm
- Species: E.globulus

Planted in 1996 and thinned & fertilized in 1998

Soil moisture is declined gradually in accordance with growth period. But condition of soil moisture is restored soon after harvest of trees. It may be less concern about soil moisture at the area with certain level of annual precipitation.
2) Does Eucalyptus utilize more nutrients?

- Eucalyptus utilizes less nutrients per unit weight of biomass
- Although Eucalyptus removes nutrients at every harvest, plantation sites are fertilized enough to conduct sustainable forestry.

![Uptake and removal of nutrients](image)

If rotation is seven years, 77kg of N, 7kg of P and 84kg of K may be removed at harvest. At least the same amounts of nutrients should be fertilized for one rotation.

3) Does Eucalyptus have adverse effects on biodiversity?

Not only Eucalyptus but also almost all of crops are exotic. They may have some adverse effects on biodiversity.

1. Concern on biodiversity is invasion of introduced species by self-propagation to cause negative impacts on native plants and animals in the area. If eucalypt seeds disperse from plantation area, they cannot survive in densely vegetated areas.
   ⇒ Not much concerns

2. Large plantation of any species including crops may have some adverse effects on biodiversity.

3. Oji observe the laws and attempts to produce as much wood as possible in limited space, thus allowing the level of biodiversity to stay the same or increase in other types of lands.
3. Outlines of hardwood plantation in Laos

Lao Plantation Forest Company (LPFL) has been founded in 2005 under the joint venture scheme with Laos government.

LPFL

15% Government of Laos
85% Oji Lao Plantation Holdings

Oji Paper(73.33%), Kokusai Pulp & Paper(5%), Shueisha(5%), Mitsui S.K.Lines(5%), Senshukai(5%), Recruit(5%), others(5 companies, 1.67%)

1. Hardwood plantation for pulpwood with rotation cycle of seven years.
2. Target site: degraded forest land or barren land
3. Species for plantation: Eucalyptus & Acacia
4. Clonal plantation

1) Plantation area & species

Original plan: Eucalyptus 100% ⇒ 2007~  Eucalyptus : Acacia = 50:50
• Acacia can grow fast just like K7(eucalypt best clone in Laos)
• Slopes/long distance : Acacia
2)-① Planting clones in Eucalyptus

A hybrid clone K7 performed better.

Growth performance in clonal trials (mainly E.camaldulensis) at age 4 years

![Growth Index Chart]

② Analysis for wood properties in K7

<table>
<thead>
<tr>
<th>Species</th>
<th>Origin</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>E.camaldulensis</td>
<td>Australia</td>
<td>suitable for tropical &amp; subtropical area, drought tolerant</td>
</tr>
<tr>
<td>E.deglupta</td>
<td>Papua New Guiana</td>
<td>suitable for tropical area, fast growth, light basic density, construction wood</td>
</tr>
</tbody>
</table>

Wood quality of K7 similar to LE1 from Vietnam

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>K7</td>
<td>LE1</td>
</tr>
<tr>
<td>E.camaldulensis (Vietnam, QPFL)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Property</th>
<th>K7</th>
<th>LE1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic density (Kg/m³)</td>
<td>490</td>
<td>511</td>
</tr>
<tr>
<td>Length of fiber (mm)</td>
<td>0.62</td>
<td>0.59</td>
</tr>
<tr>
<td>Width of fiber (μm)</td>
<td>15.0</td>
<td>14.7</td>
</tr>
<tr>
<td>Thickness of fiber (μm)</td>
<td>4.5</td>
<td>4.4</td>
</tr>
</tbody>
</table>
3) Planting clones in Acacia

Acacia hybrid clones (QPFL) performed better.

- Average height: 9.7m

Enlargement of the area

\[
\begin{align*}
\text{Wood volume} & \quad \text{m}^3/\text{ha} \\
0 & \quad 20 \quad 40 \quad 60 \quad 80 \quad 100 \quad 120 \quad 140 \\
0 & \quad 1 \quad 2 \quad 3 \quad 4 \quad 5 \quad 6
\end{align*}
\]

② Hybrid clones with heavier basic density

Improvement of basic density is one of our targets for getting pulp from a unit area as much as possible

- Selection of clones: Growth and wood quality
- Identification of clones by DNA markers

Five clones have been selected for heavier basic density with better digestibility

Basic density and cocking ability of Acacia hybrids and LAC2 chips

(Active alkali 20%)
4. Issues & efforts on advancing hardwood plantation

1. Improvement on productivity of plantation

Promotion of clonal forest

1) Effect of promoting clonal plantation in Brazil

Cenibra has long history of clonal plantation. Clonal plantation has been started in 1990. Rotation cycle is seven years.

Seed: E. grandis  Clone: urophylla x grandis

Growth rate has been increased by almost 70% to 40m³/ha/year in 2007.
2. Outline of clonal plantation

Acquisition of clones

- Short term: acquisition from other organizations
- Long term: selection of plus trees at plantations
  → hybridization between plus trees

Propagation

Propagation of mother trees for mass production

Confirmation

1. Growth performance of the clone should be confirmed at target lands
2. About half of rotation cycle will be required for confirmation

Commercial

It will take three to five years to start commercial planting with a newly acquired clone.

4. Issues & efforts on advancing hardwood plantation

1. Improvement on productivity of plantation
   ➞ Promotion of clonal forest

2. Risk hedge against pests & diseases
   ➞ Development of new clones

(Present status)
1) Eucalyptus: No clones available except K7
2) Acacia: Imported hybrid clones perform better so far
### 1) Acquisition of new clones in Eucalyptus

<table>
<thead>
<tr>
<th>Year / Source</th>
<th>Clone No.</th>
<th>Species</th>
<th>Planted area</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006 / China</td>
<td>DH3213</td>
<td>urophylla x grandis</td>
<td>2006: 60ha 2007: 23ha</td>
<td>CPFL (commercial)</td>
</tr>
<tr>
<td></td>
<td>DH3226</td>
<td>&quot;</td>
<td></td>
<td>&quot;</td>
</tr>
<tr>
<td></td>
<td>DH3327</td>
<td>&quot;</td>
<td></td>
<td>&quot;</td>
</tr>
<tr>
<td>2008 / China</td>
<td>GLGU9</td>
<td>&quot;</td>
<td>Trial in a small scale</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GLWC3</td>
<td>camaldulensis x urophylla</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008 / Thailand</td>
<td>H1</td>
<td>camaldulensis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>H3</td>
<td>&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>H4</td>
<td>camaldulensis x urophylla</td>
<td>High pulp yield</td>
<td></td>
</tr>
<tr>
<td>2009 / Thailand</td>
<td>K51</td>
<td>camaldulensis</td>
<td>Trial scheduled</td>
<td></td>
</tr>
<tr>
<td></td>
<td>K58</td>
<td>unknown</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>K62</td>
<td>&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009 / Vietnam</td>
<td>U6</td>
<td>urophylla</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>pellita (natural hybrids)</td>
<td>40 clones</td>
<td></td>
</tr>
</tbody>
</table>

### 2) Susceptibility of the clones to disease

Acquired clones should be carefully evaluated for adaptability to the sites especially in higher rainfall region.

DH3213 from China (one year old)  
Left: DH3213, Right: K7
③ Natural hybrid clones in Vietnam

Research center for Forest Tree Improvement (Vietnam)
1. There are many clones of hybrid between E.pellita and E.brassiana (Natural hybrids)
2. Selection has been conducted for growth.
3. Trials of selected trees is in progress. Performance is good so far.
4. Climate condition seems to be very similar in Laos.

2)-① Development of new clones: Species trial

① Survival rate : E.brassiana/E.camaldulensis > E.pellita
② Growth : E.pellita >> E.brassiana/E.camaldulensis

Hybrids between E.pellita and E.brassiana or E.camaldulensis should be good in Laos
2) Selection & Pollination

Creation of hybrids with high survival rate and good growth performance by hybridization between E.camaldulensis and E.pellita

- Selection in E.camaldulensis

Selected tree
(Age: seven years old)
H: 23.4m, DBH: 19.6cm

Process for creating superior clones

Grafting & promoting to flower

Hybridization

Selection

E.pellita

5 years old

4) Acquisition of new clones in Acacia

<table>
<thead>
<tr>
<th>Year / Source</th>
<th>Clone No.</th>
<th>Species</th>
<th>Planted area</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005 / QPFL</td>
<td>QPFL No.1</td>
<td>hybrid (mangium x auriculiformis)</td>
<td>2006: 12ha</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot; No.2</td>
<td></td>
<td>2007: 92ha</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot; No.21</td>
<td></td>
<td>2008: 1,025ha</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot; No.32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot; No.40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Higher pulpwood productivity</td>
</tr>
<tr>
<td>2008 / FSIV &amp; QPFL</td>
<td>&quot; No.27</td>
<td></td>
<td>Trial in a small scale</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot; No.28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&quot; No.49</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TB11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>AH1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>AH7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>AA7</td>
<td>auriculiformis</td>
<td>Higher pulpwood productivity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AA9</td>
<td></td>
<td></td>
<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>Straight</td>
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</tbody>
</table>
5) Policy for enlargement of plantation area

Matching of clones and sites is a very important factor to maximize pulp wood productivity per unit area.

- **K7**
- **Acacia mangium**

4. Issues & efforts on advancing hardwood plantation

1. **Improvement on productivity of plantation**
   - Promotion of clonal forest

2. **Risk hedge against pests & diseases**
   - Development of new clones

3. **Management of soil nutrition**
   - Fertilization of microelements

(Present status)
1. Less nutrients in our target sites
2. Symptoms of nutrient disorder, especially in Boron
1) Leaf analysis for nutrient level of soil

Soils in our plantation sites seems to contain less nutrients especially in macro elements.

<table>
<thead>
<tr>
<th>No. sample</th>
<th>Species</th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>S</th>
<th>Ca</th>
<th>Mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>K7</td>
<td>Mean</td>
<td>13.8</td>
<td>0.9</td>
<td>9.9</td>
<td>1.1</td>
<td>4.0</td>
</tr>
<tr>
<td>8</td>
<td>G X U</td>
<td>Mean</td>
<td>15.1</td>
<td>0.8</td>
<td>7.3</td>
<td>1.2</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Adequate

Min. 18 1.2 9 1.2 2.1 1.1
Max. 29 1.6 15 2.9 7.5 3.6

Summary of leaf nutrient level in LPFL plantations (micro elements)

<table>
<thead>
<tr>
<th>No. sample</th>
<th>Species</th>
<th>Fe</th>
<th>Zn</th>
<th>Mn</th>
<th>Cu</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>K7</td>
<td>Mean</td>
<td>66.0</td>
<td>12.6</td>
<td>374.1</td>
<td>5.9</td>
</tr>
<tr>
<td>8</td>
<td>G X U</td>
<td>Mean</td>
<td>83.5</td>
<td>11.9</td>
<td>795.3</td>
<td>6.5</td>
</tr>
</tbody>
</table>

Adequate

Min. 40 13 130 3.5 13
Max. 100 29 2300 13.4 30

2) Boron deficiency in Eucalyptus

E. grandis x E. urophylla (china)

A: The emerging severe B deficiency in new leaves of GxU in dry season
B: Early phase of B deficiency – leaf cupping
C: Severe prolonged B deficiency – stem twist and forking

K7

D: The emerging severe B deficiency in new leaves of K7
E: Severe prolonged B deficiency – stem forking
F: the early onset of B deficiency – purple color of young leaves
G: normal leaves in a age gradient
Boron deficiency in Acacia

Acacia hybrid

The same symptoms as in Eucalyptus

1. Leaf: yellowing can extend from the margin over the whole blade, developing leaves may be malformed with missing sectors
2. Stem: shoot tip death, multiple shoots from axillary buds

Several trials have been established to elucidate adequate levels of macro and micro elements

Issues & efforts on advancing hardwood plantation

1. Improvement on productivity of plantation
   - Promotion of clonal forest
2. Risk hedge against pests & diseases
   - Development of new clones
3. Management of soil nutrition
   - Fertilization of microelements
4. Challenge to environmental issues
   - Selection of species/clones for waterlogged sites
1) Plantation in waterlogged area

- There is a significant level of waterlogged area mainly along major roads in Laos.
- Main rainy season: May ~ September
- Risk period for waterlogged: July ~ September

As waterlogged area is basically very flat, it is very easy to operate plantation activities. But, high risk of disturbing growth will be expected.

### Plantation area at waterlogged sites in 2008

<table>
<thead>
<tr>
<th>Water depth (m)</th>
<th>Period for waterlogged (ha)</th>
<th>~1 weak</th>
<th>~2 weeks</th>
<th>~1 month</th>
<th>~2 months</th>
<th>2 months ~</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5~</td>
<td></td>
<td>722</td>
<td>79</td>
<td>846</td>
<td></td>
<td></td>
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<tr>
<td>~1.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>~1.0</td>
<td></td>
<td>33</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>~0.5</td>
<td></td>
<td>712</td>
<td>109</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>0</td>
<td></td>
<td>4,091</td>
<td></td>
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</table>

Total (Waterlogged area) 6,592 (1,680)

2) Soil survey in the waterlogged area

- There are some layers with iron rich or clay rich which may cause trouble to drain water

Measures below should be required
1. Tolerant species or clones to shortage of oxygen
2. Improvement of drainage

Red spots means shortage of oxygen in the soil periodically.
### 3) Adaptable clones and species

**Higher survival rate: K7 and Acacia peregrinalis**

<table>
<thead>
<tr>
<th></th>
<th>6 months after planting</th>
<th>11 months after planting</th>
<th>18 months after planting</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. peregrinalis</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>left: A. crassicarpa</td>
<td>left: A. crassicarpa</td>
<td>left: A. crassicarpa</td>
</tr>
<tr>
<td></td>
<td>right: A. peregrinalis</td>
<td>right: A. peregrinalis</td>
<td>right: A. peregrinalis</td>
</tr>
<tr>
<td>K7</td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>left: A. crassicarpa</td>
<td>left: A. crassicarpa</td>
<td>left: K7</td>
</tr>
</tbody>
</table>

Growth performance should be carefully monitored for the next two to three years. It is very risky but challengeable!
Agriculture and Environment: Shifting Cultivation in the Mountainous Mainland of Southeast Asia: The search for appropriate and sustainable land use, and its contribution

Kanok RERKASEM

Chiang Mai University, Thailand

Now I think as part of these sessions, we will turn to look at the issue of agriculture and the environment. My talk will concentrate on the system of agriculture called shifting cultivation. I will look at it in terms of land use, land use changes, with particular emphasis on a sustainable form of land use, and links to improvements in rural livelihood. The following are three of the main points that I will be focusing on: the changes in land use under shifting cultivation, government policies and the implementation of alternative land use, and the farmers’ management of sustainable land use and improvement of livelihoods.

Why are we planning these lectures? These are some of the questions that came to my mind and helped me prepare for this lecture. I asked myself, what went wrong and how did it happen in the past? What are the key factors and the trends? What are the problems on the ground? We will not just look at the secondary data, but look at the trends and the problems on the ground. What sorts of attempt have been made so far to solve the problem? How do people cope with the changes and also the uncertainties? These are the types of question. I may not be able to answer in full, but the structure of the talk will be about these kinds of question that I have in my mind.

Before we start, I just want to clarify what we mean by the Mountainous Mainland of Southeast Asia, or as we call it the MMSEA. These are areas of the country’s portions of the mountainous area of Southeast Asia. Basically, these are the areas that we’ll be talking about. I think one part extends even to Assam, on the Indian side, next to Myanmar. But this is basically the area which covers Myanmar right to the southwest of China, including Sipsonpanna. This area’s agriculture is basically centered on rice domestication. From our point of view, this is also the area that has been some sort of social and cultural link between people right through the region. For example, during the land civilization of over a hundred years ago, these cities - Chiang Mai, Chiang Rai and Chiang Saen, Chiang Tung and Chiang Rung - were limited areas which were part of the same popular system, through common ethnic minority groups of populations, Thai Lue people who lived in the city. This linkage also extended from Lanna to Lang Xang in Laos, for example. They have some sort of know-how and social linkage in this affected area, too.

Ecology – they share some of the common ecological or biophysical setting and they also imported it. Many areas at this level of the country represent the upper watershed, like the mountainous
Thailand represents the critical watershed of the Chao Phraya River basin, which is the rice bowl of Thailand that world rice exports come from.

This is the typical type of landscape in the hilly mountainous areas, and then you can look through the varied landscape. You find that the major agriculture of some groups exists in the form of shifting cultivation. This particular picture deals with upland rice and growing seeds.

I’ll give you some idea. One can read, just from the literature, the extent of the shifting cultivation. But I have no idea what type of agriculture has arisen, nor the type of food. But at this level they provide us some sort of sense of the extent of all the external shifting cultivation in Southeast Asia. That is, the number of minorities or the ethnic groups that exist within these regions in Cambodia, Laos, Myanmar, Thailand, Vietnam and Yunnan. This represents something like 180 ethnic groups, and the majority of them also practice shifting cultivation. The number of shifting cultivators in this particular region also varies tremendously. We have published that kind of data somewhere else. Maybe people could look at it later. But in particular, in our case, where I come from, but not in Thailand, we have about seven or nine ethnic groups but we can categorize them into two different types of shifting cultivation. According to Conklin’s classifications, the pioneer types are Hmong, Lisu, Lahu, Akha and Yao. These are the groups that have recently come here, having migrated a few decades ago into Northern Thailand, particularly from Laos, and some directly from China or even from the Myanmar side. These are the rotational types of group. The Karen have maybe lived in northern Thailand for many hundreds of years or even a thousand years. But what I’d like to point out is that this kind of classification seemed to be very clear to promotional people. When you look at their practices, they are something in between. So the types of shifting cultivation from pioneer to rotational types or established types give you some sort of idea of the extremes of the continuum. I think I will explain that later on. This gives you some sort of idea of those who do not apply variable shifting cultivation. At the landscape level, this is one of the areas of traditional shifting cultivation where the use of shifting cultivation is developed around the villages. This is the upland rice. So the people are planting crops at present, which will be developed this year. Last year maybe they developed these few, but the year before maybe those over there, and so on and so forth. Across the landscape, you can see different steps to solve this shifting cultivation problem, from active fields to fallow fields, and the different maturity of forest land.

Importantly, it’s not just rice that they derive from shifting cultivation. Even in the fallow areas and natural forests, there are some varieties of the range of the products that they can derive in the fallow forest. This is from the fallow forest and forest fields, and probably from the cropping fields. I focus on showing different groups of people. This is the Karen group and this is the Hmong group. Many people believe that the Hmong are the pioneer group. They are more environmentally and ecologically destructive to the ecosystem compared to the Karen, who practice the rotational type of cultivation. But maybe it is not true, because both sets of women
behave in exactly the same way to conserve biodiversity, particularly agro-biodiversity in the traditional shifting cultivation fields. If one minority group is interviewed and you can find somebody to go out and conduct a survey, then as you might expect, all of the groups would be occupied with this or would utilize species diversity in the different and old landscapes; they do not just have shifting cultivation fields, but also paddy fields. Incidentally, we tend to see in the shifting cultivation communities not just this type of land use, but in fact the farmers and the landscape, they think of many types of land use as a whole package. This is an example of biodiversity, but I am not going into detail about that.

In conclusion, it is very confusing. These are some of the lists of the main crops that we have generalized in this particular region. For subsistence, they grow upland rice, maize, cassava and probably other root crops like taro. To make more money, opium poppy would be grown. This clearly has been a problem because opium has become an illegal crop. Two governments in the region have a policy of suppression, or they have in fact implemented this suppression policy, to eliminate opium throughout the region. I think it started in 1947 in Yunnan, and then later on in Thailand, Laos, Vietnam, and Myanmar. These are quite common policies that are actually practiced. But in our case, I don’t know very much about other cases, but in our case, they are also not only eliminating opium cultivation, but at the same time on the hidden agenda of the government policy is to reduce or to stop shifting cultivation. So they stop it by promoting all of these new cash crops. The reason for stopping shifting cultivation is also to prevent people moving anymore. They will settle down permanently, with permanent active land, exploiting everything with cash crops. This gives you some sort of factual pattern of our own policy, implemented with regard to shifting cultivation.

I just put this slide in the sequence to remind us about this guy in Myanmar in the ‘70s and ‘80s; his name is Khun Sa. He was the most influential person in opium smuggling. He used to deal with the US and was the most wanted man in the United States at that time. He just passed away two years ago but I didn’t have the chance to meet him. As a result of the government efforts, in the case of Thailand, there has been a significant decline in opium production during this 30 year period. From 2000, and even up to now, the amount of opium production has been somewhat insignificant. We are now importing opium from overseas for local consumption. And the pattern is similar in other regions. After the suppression in Thailand, the UN agencies have been extended to those regions excluding Thailand, with successful opium suppression in Myanmar, Laos and Vietnam in 1989 to 1990, and even up to now. One of the points I just mentioned briefly, the rate of suppression in Thailand keeps going. But as they go into Laos and Vietnam, the raids are becoming less and less. It doesn’t mean they are more efficient or they are more experienced, but maybe there is more enforcement among them. Even in the case of Thailand, we know that the suppression is due to the development of law enforcement. Law enforcement means that the Army has cut down the opium. But the worst case that we see is in Vietnam, where suppression has taken only three years to make everything disappear. For the shifting cultivators to be
producing, they reportedly have to comply with the new system within a very short period of time. How do they do that? So those, I think, are just very quick thoughts, a 30-year history, or more than a 50-year history, which I have made very short, and people can track what happened in this part of the world. Now, I will focus more on crops within this key point. What are the drivers? What are the government policies that have been determined, the consequences and then some remarks later on?

The following are four main drivers in this particular region: population, land tenure, commercialization and government policies. I made a little bit of a comment on these major drivers in the land use changes. When we look at the population, the migration of people has been dealt with. I call it the myth of the population and environment nexus. This has not become very common. It is the pressure on the land and the surrounding natural forest. It focuses more on the internal population increase. But less emphasis, I put less emphasis on this issue of migration. We have also viewed it as a component of the population called the regional community. But in our case, in the mainland of Southeast Asia, it is sometimes due to the migrants in the lowlands. This is sometimes encouraged by the government in many countries, except Thailand probably. Many governments in the region, as in China, have planned the migration of the Han people. During the start of the problems with rubber plantation, because the minority did not like rubber, they had to import everything from the Han Chinese. And in Vietnam, I think since the French colonization, they have had this system of moving people up the hill because of land scarcity in the lowlands, for example. Even nowadays, I think that this still happens. Spontaneous migration, I suppose, happens everywhere. But recently, over the past 10 or 20 years, this cross-border migration is also another critical type of issue that has been in and around this migration. So these are the types, I think, and we would truly like to understand this type of migration and its contribution to the impact of population on land use.

These are examples of a resettlement policy, the mass migration in the lowlands in Vietnam. So these are examples. Decree 327 of the Vietnamese Government of the lowlands; this is the fixed cultivation and sedentarization policy; the movement of the Han Chinese; the relocation of a large development dam. I think probably this is the most significant, probably in Thailand and in Laos, I’m not quite sure but these are likely to happen.

Land Tenure; people tend to see, particularly in western thinking, that the lack of land tenure often leads to misuse of land; land use conflict leads to whatever. Insecurity of land and land use causes illegal encroachment, and so on and so forth. But those are the kinds of issue that are not beautiful. Thailand is probably the worst in terms of land tenure because we do not allow people to live in the forest nowadays. But other countries probably permit it, in Vietnam, China and such like. They even have a formal arrangement of land. We shall see that later on. But before leaving this slide, I think much of the literature has been dealing with this issue, the legal or the formal arrangement issue. But traditional arrangement issues, we believe not many people have
the problem. How do farmers adopt and use these customary rules and regulations to manage the system? How can the government introduce a land use permit or land use system so that it can be incorporated into and effectively promote sustainable land use of the local system. We don’t know very much and then we tend to say, okay we will introduce these legal things and everything will fix it. And that, I think, is one of the problems.

Commercialization; I think this is very big in the integration of countries. There has been, for the past 10 or 15 years, a big push from the government and private sectors – a very big push. Road construction, you see it everywhere. I have been travelling to Southern China through Luang Namtha, from Thailand. It was very fast; it doesn’t take more than 4 hours. Apart from the road, there is also the installation of other kinds of infrastructure—the dams, electricity, and other things. This road construction also tremendously increases access to the external market, as well as being prestigious, and everyone here more or less gets support and subsidies, and then higher inputs, better prices and so on and so forth. These are the kinds of push that really speed up the shift from shifting cultivation.

I have talked about opium policies and mentioned a little bit about these policies against shifting cultivation. I think all of them believe that shifting cultivation is a bad practice. It is primitive. It is a destructive form of cultivation. Governments never recognize different forms of shifting cultivation. As far as I can see from the policy documents, Laos is beginning to differentiate different types of shifting cultivation. But the rest, no. With that in mind, this is the consequence of what happened on the ground with the promotion of cash crops. All of this, of course, has been done under the policy of opium suppression, which we have also reviewed. In fact I have it here. Good practices, they said new cash crops are very good for you. It also represents, they said, not a primitive form of agriculture but a modernized form of agriculture. It is a very good alternative income to opium and will help you to develop permanent land use and sedentarization. As in past lectures that I mentioned here, I would just like to give people an impression here. This is the infrastructure of MMSEA, with support from ADB and local government to link everything in this Greater Mekong Sub-region. These are the lines of the entire infrastructure. Most of these roads have been done. Now you can travel from Vietnam, from Laos, to cities in the southwest; there are many ways to go to Laos and many ways to Thailand. When I had just graduated with my bachelor’s degree, this was the infrastructure in Northern Thailand that we had. This is in 1971-72. We couldn’t even go to Chiang Rai from Chiang Mai. There were no roads. This was just constructed the year I graduated. We couldn’t go to Mea Hong Son unless you went down to Mea Sarieng. So now you can imagine all of those tribal people who lived along this area. No way that they had access but, on the other hand, it was an ideal place for them so that they could still grow opium in the past.

This is an example of the results in the region. We didn’t solve all those things that I was talking about here, especially the rubber development in China. Now the extent is not just the Han
Chinese. All the ethnic minorities have now converted to this rubber plantation. I am not saying it’s good or bad, but this is the landscape where they are putting pressure on shifting cultivation. It is exactly what the government needs; pertinent agriculture, sedentarization, and so on and so forth.

In China, if one travels in that part of the world, what can be seen are some sort of tourist things that have been supported by the government in the past. But it is not very successful, in fact, if you look at this support, as other areas still do not look very nice with respect to land use. These are other crops, like maize in Lancang and then sugarcane and tea in Simao.

In Vietnam, where I visited in the beginning, when they implemented this opium suppression in the 1990s, I have observed the development of alternative upland crops, of maize production in this area. This is a lot of erosion, because of the beginning of the rainy season. There were fewer alternatives at that time, but I could find cash crops, and it is the local crop, but it had a really good market at that time, or even now, if they devoted all the forest area in part of Vietnam very quickly, because of poverty.

I even travelled in Laos; I am taking this as a side matter. I worked with my colleagues. In Laos, this is in Luang Pabang. You see the beautiful landscape and shifting cultivation is appealing and they don’t see a lot of forest. You go to the fields; you see teak plantations everywhere, particularly in the northern area near Luang Pabang. The development of teak is in different stages of development. At the beginning, it was complemented by rice, where the teak covers and went out of business, and then the people had to buy somewhere else. But they owned teak in this particular case. I didn’t fully understand and then I was trying to get a full understanding of how the local people had shifted their system into teak plantation. It is not really clear in the literature that is available. I visited these areas before, in 1990-something, and the government tried to promote teak, but nothing happened. There was some shifting cultivation done by the Khmu ethnic group, but now they all grow teak in this particular area. I think some Lao colleagues are studying this to work it out pretty soon now. That is enough of some examples in the regions.

Another issue is that these kinds of development were actually restricted within their own country. They have to cross borders and transfer technology. Here is one example when I visited Pang Sang, the Wa Army Territory many years ago, maybe 20 years ago. But even at that time, the Chinese had broken away to promote alternative cash crops to opium because they didn’t want opium to get into Simao, Yunnan. So these are the rubber plantations that they have successfully introduced, and the Wa people liked the plantation crops, and then they could do what they wanted to do. Recently, you will find the same situation being developed in Luang Namtha in Laos, which I call the rubber plantation blueprint; the Chinese blueprints really had some sort of copy everywhere. I think that rubber tends to break up biodiversity and causes land degradation. But people are now saying that it is not that bad, but we will soon get the complete picture. But they
are not expecting any biodiversity. This is probably less, compared with shifting cultivation. In our case in northern Thailand, the plantation crop is maize for the livestock industry. And now in this particular area, you see nothing but maize, and then other forms of land use.

With regard to alternative land use, it is not only happening with the opium growing groups, it has also been extended to the non-growing groups, like Karen in our case. The differentiation of ethnic groups, the good aspects of shifting cultivation and the changes, this is not ethnicity. These things do not attach to ethnic groups. That group conserves natural resources and this group doesn’t conserve them - I don’t think it is true. It is dependent on other conditions with which the community group copes well and adapts to. A farmer’s shifting cultivation fields gradually cause deterioration of the forests. These are some of the examples of the deterioration of fallow forests. In the past, this was covered by a young forest, but then it became a jungle. When the rotation period becomes shorter, it can be declared finally. I took this particular case from the Lua people in the mountainous area of Thailand. According to Kunstadter’s report, they were one of the best shifting cultivators in the world. But they have now operated seven years fallow with this kind of regeneration forest because of the land pressure. And then I asked them, “Is that okay?” They said, “Yeah, it is okay, because our ancestors said we should practice this.” When I asked, “Do you have enough rice to eat?” they said, “No.” That means they are getting into a very bad situation. So people get used to this kind of degraded forest for shifting cultivation in some cases. This gives us some confirmation and some sort of confusion about what the consequences are of alternatives. So these are the kinds of reasonable consequence; the threat to the forest ecosystem, in terms of sustainability and degradation. But I think there is also the increasing use of resources and the conflicts. We must respect not only the forest but land and water as well, and everyone who lives within the community, and so on and so forth.

With regard to that point, at that time, these land use conflicts had been trying to solve the problems through this new paradigm that is coming up. The mountain development paradigm in the 1990s, this development project is coming up – it involves people participation and bottom up planning, grass roots planning, good practices, farmer coping ability, community empowerment. These are the kinds of things that actually utilize some sort of development strategy, some sort of major change, but giving some sort of more credible implementation, like this example of attempts to help the local people to resolve conflict. It’s a community based land use planning system, where outsiders can both cross-link to local people to identify any conflicts and discuss how to solve these kinds of conflict; things can be brought up not only about the community itself, but between the community and officials. And in the process at that time, often one of the solutions, we said this was one of the solutions, was that if we could develop this kind of paddy, then there would be no need to do shifting cultivation, and then people would have more rice to eat. The government tends to see this as a model for future development. So there have been a lot of tests of the highland paddy on the slopes. But it can be very dangerous because water gets a hold on the soil. It cannot tolerate floods and it collapses the resources. And even in many cases where
there was no connection with the upper watershed, no irrigation is carried out for the paddy, and that would not be very common, and so on and so forth.

Briefly, this is a simple example of the implementation of participation which is encouraged, given the government document for forest ownership in Vietnam, and this has been done.

Now, okay, something has been done, but so far we still cannot solve everything or look at a bright future or an alternative to shifting cultivation. What about the government’s point of view? This is a kind of patchwork. When you visit a village like this, you may wonder why these villages maintain forests up in the hills. Then if you look at the landscape, you will begin to understand why this kind of village can keep the forest, together with intensive land use.

These are some of the interfaces between agriculture and the forest landscape. Through this irrigation, the farmer got the idea after the government introduced this for domestic use, but there is potential for the development of this one, and if they get water there is the need to conserve this kind of forest for their water resources.

So I will go through this very quickly, not too detailed. If you look at the farmers in the landscape, you may find this sort of forest. This is the Hmong village. But this is the same because it has some sort of social and ecological function. I call this agroforestry of the forest patches within the agricultural landscape. The patches are sometimes managed ably by this particular individual, and this gives you agro-diversity land management, and so on and so forth.

Importantly, this particular person also managed this kind of forest patch with the introduction of this wild bamboo, where he has the skill to make this traditional pipe. He sells this pipe. While other people go into the forest patches, this farmer just has income from this pipe. He was selling them at that time for about 3,000 baht each, so making quite enough money to even buy opium – he is still smoking opium, which is very expensive. This is the product of that kind of forest.

I think this kind of agroforestry system and the local management of agroforestry systems may be extended all over the place. Here, like in Luang Pabang, there is the management of *Posa*, which is now getting into the tourist industry.

Also the farmers manage wild species like *Macaranga* to enrich their degraded shifting cultivation fields, or fallow fields in this particular case. So this attempt by farmers can actually help to restore the dense fallows, the dense *Macaranga*, which gives you three times the yield, compared with sparsely populated *Macaranga*. What lies behind *Macaranga* is this association with mycorrhiza, which I don’t think I have time to go into detail, but there’s some sort of association, and we get our students to carry out tests and whatever.
So this gives you some idea of the trends, as this will be the trend for the future. From my point of view, I think the important thing is just the land use problem. Agriculture will be increasing. This forest land and the resources will continue to decline, despite what they wanted to do, because inappropriate practices continue to expand. So the sustainability of livelihood is probably decreasing and then there will be more conflict.

So the question now for us is what are the appropriate land use alternatives that work? I have shown some of them that we have been studying. But to do it on a very large scale, not national but also on a regional or sub-regional scale, what are the appropriate alternatives that work? Not just appropriate land use, but the alternatives that work for the mountain communities. When do they work? Where, why and how?

These are the final remarks from my presentation. Thank you very much.
Questions and Answers

(Question)  You skipped the second slide.  Please explain.

(Kanok Rerkasem)  What I’m trying to present here is, apart from those cash cropping areas, there are still some areas that practice traditional shifting cultivation, but under tremendous stress because the rotational period has been tremendously reduced.  So in this particular village that we work with, there are only seven pieces of land that are available for rotation.  So their production has been decreased.  The soil is so bad; very, very acid; very, very poor soil with low phosphorus.  These are the pictures of the village.  But the village has been able to find this particular tree – the Macaranga.  *Macaranga* has been incorporated into the shifting cultivation fields right at the beginning of the rice growing season. So they get at least one year of cropping in the 7-year’s rotation.  By the time they reach the eighth year, they can chop them down and then they can grow rice again.

By clarifying this kind of practice, we conducted a survey to determine productivity and make a comparison between the densely populated *Macaranga* areas and the sparsely populated areas.  It’s mostly *Macaranga*.  You look at the yield differences of between one ton to three tons per hectare, and this gives you the range.  So this is from eight fields and six farms.  So they have been able to restore some of their productivity under this degraded system.

One of the things that we put a student to work on is to see what is actually behind this *Macaranga*.  They’re beginning to find some sort of endomycorrhiza that is associated with the root of the *Macaranga*, and some of the 30 species have been identified, and these are some of the examples.  We then put a student to work on this *Macaranga*.  We fertilized the soil and then inoculated the soil in the village where the mycorrhiza had already contaminated it.  Then in the first row, that is inoculation with different species.  So this one is not inoculated.  This is Glomus something and this is another thing, and the last one is a mix of these things.  This is phosphorus; this is a phosphorus application varying from zero, 25 up to 150 kgP per hectare.  You look at the compensation effects of *Macaranga* and the phosphorus.  With the infected one, you can get that.

So those are the kinds of land use, of problems that local people have been able to sort of help themselves with, to sustain the day to day shifting cultivation.  So I have presented pictures of the permanent agriculture, pictures of the process of changing shifting cultivation in the process, and also comparing those that were impacted by government policy.

(Question)  Thank you very much, Professor Kanok.  I would like to ask you one thing, I mean two things.  Today you presented a lot of experiences during your fieldwork in Southeast Asia and you had many chances to talk to the local people there.  Could you please tell me how some villages are very successful and sometimes some villages have some failures?  Have you seen a
sustainable way of life or something? So what is the way to provide good methods and give hope to the local villages or identify the ways in which they are failing?

The next point is, how do you formulate your role as a researcher in such cases?

(Kanok Rerkasem) What is the second one?

(Question) I want to know how you behave, whether you contribute to the local villages.

(Kanok Rerkasem) Maybe it is very little. Okay, the first question. That’s really difficult to give a good answer because we don’t really fully understand the human behavior. It’s just a question of why these people conserve but we do not conserve, we’re destructive. I think it’s really a psychological one. Then, because of these difficulties, I will rephrase my questions. I will rephrase my question: do we actually understand all these forms of positive land use? Yes, a farm will have abilities; a farm will have those and those. But this local knowledge tends to be some kind of specific local knowledge. It is really difficult to transfer, except you know for a fact that, behind that knowledge, is a systematic study and the study of Macaranga. I think we are beginning to see that generalization will not help the farmer to get sustainable land, I think. You need some sort of specific knowledge that will enable you to overcome the variance of the transfer of these good practices. So that is the way I am thinking, because we encounter one question.

I used to work 10, 20 years ago. I was thinking like this, why is this a concern? But then we will say, okay, if we understand this a little bit, then the issue is how can we transfer the knowledge of people who conserve to those who do not conserve? Then you get into what kind of knowledge, you know. You cannot just say, this is significant also, this is good, take it. One of our NGOs did that. They took Macaranga and they spread it to other places. No germination took place because there was no knowledge, none whatsoever, no knowledge of seed biology. Now we know that this is a big concern, and so on and so forth.

So that is my contribution to the local people. I have, like I said, made very little contribution. But the way I work with farmers, I work with them as a partner. They don’t like me because I’m not presenting myself as someone from the government or from a development project. Those people give them gifts. They asked me for a road; I said I cannot give you a road. I don’t have a road and I don’t have money for road construction. So they hated me. They almost kicked me out in one of the villages we worked at. But then I said I am ajan (professor) from the university. I have to teach my students. My students are urban people. They don’t know about shifting cultivation. I am ajan, I don’t know about it either because I don’t practice it, but I have worked with you for many years. So I said, can you be ajan and teach my students so that then we will have knowledge? And in the future they may be your sons, or whatever, and we can work together. Without this communication, there would be a breakdown.
So those are the kinds of things. But at the same time, in our areas, we have a lot of conflicts here. I work with maps, I work with satisfying data; I work with the information. All the information, I give it back to the farmers. They use it on the projects with the government in order to stay in the forest. The map has been very helpful. So in the process, we were not happy but I think we supported this movement or whatever. Sometimes the government people, they hate me. Sometimes they cannot afford to hate because I also give them information. Everything I do just has to be very apparent, nothing hidden. I think too much.
Shifting Cultivation in the Mountainous Mainland Southeast Asia:
The search for appropriate and sustainable land use, and its contribution to the improvement of rural livelihoods

Kanok Rerkasem

Focus

• Changes in land use under shifting cultivation

• Government policy and implementation for alternative land use

• Farmers’ management of sustainable land use and improved livelihoods
Questions

- What went “wrong” and how did it happen?
- What are the key factors and trends in land use?
- What are the problems on the ground?
- What sort of attempts have been made so far to solve the problems?
- How do people cope with the changes and uncertainties?

Background of the Mountainous Mainland Southeast Asia: the MMSEA
Cultural Connectedness during the Lanna Civilization with 5 Centres: Chiang Mai, Chiang Rai, Chiang Saen, Chiang Tung and Chiang Rung

A typical feature of the mountainous mainland Southeast Asia (MMSEA): the biophysical setting and priority area for national and international watershed protection
Table 1. Extent of land under shifting cultivation in mountainous areas of mainland Southeast Asia region.

<table>
<thead>
<tr>
<th>Country</th>
<th>Total Land Area (10^3 ha)</th>
<th>Total Forest Area (10^3 ha)</th>
<th>Shifting Cultivation Area</th>
<th>% Forest under Shifting Cultivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cambodia</td>
<td>17,652</td>
<td>12,163</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Laos</td>
<td>23,080</td>
<td>13,173</td>
<td>400</td>
<td>3.04</td>
</tr>
<tr>
<td>Myanmar</td>
<td>65,774</td>
<td>28,856</td>
<td>181</td>
<td>0.63</td>
</tr>
<tr>
<td>Thailand - Northern</td>
<td>16,966</td>
<td>7,523</td>
<td>400</td>
<td>5.32</td>
</tr>
<tr>
<td>Vietnam</td>
<td>32,536</td>
<td>8,312</td>
<td>3,500</td>
<td>42.11</td>
</tr>
<tr>
<td>China (Yunnan Province)</td>
<td>39,410</td>
<td>9,533</td>
<td>130</td>
<td>1.36</td>
</tr>
<tr>
<td>Total</td>
<td>229,629</td>
<td>84,772</td>
<td>&gt; 4,611</td>
<td>5.44</td>
</tr>
</tbody>
</table>


Table 2. Ethnic diversity and population of the MMSEA member countries.

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of Ethnic Groups</th>
<th>Population (10^6 persons)</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ethnic Minority</td>
<td>Total</td>
</tr>
<tr>
<td>Cambodia</td>
<td>36</td>
<td>0.31</td>
<td>9.45</td>
</tr>
<tr>
<td>Laos</td>
<td>47</td>
<td>2.01</td>
<td>4.88</td>
</tr>
<tr>
<td>Myanmar</td>
<td>&gt;12</td>
<td>&gt;6.8</td>
<td>46.55</td>
</tr>
<tr>
<td>Thailand</td>
<td>10</td>
<td>0.79</td>
<td>58.27</td>
</tr>
<tr>
<td>Vietnam</td>
<td>53</td>
<td>9.88</td>
<td>73.81</td>
</tr>
<tr>
<td>Yunnan</td>
<td>18</td>
<td>8.68</td>
<td>39.90</td>
</tr>
<tr>
<td>Total</td>
<td>176</td>
<td>28.47</td>
<td>192.96</td>
</tr>
</tbody>
</table>

Sources: Data taken from Kampe (1997), WRI (1994) and Yin (1989)
Traditional Shifting Cultivation in Northern Thailand by ethnic minority groups

I. Pioneer Type:
   Slashing and burning of primary forests and plots used exhaustively before moving to a new site.

   1. Hmong
   2. Lisu
   3. Lahu
   4. Akha
   5. Yao

II. Rotational Type (Established Swidden):
   Farming in secondary forests on rotational basis. Fixed cultivation within village territories.

   6. Karen
   7. Lua
   8. Khamu
   9. H’tin

Shifting Cultivation: the dominant land use in the mountainous landscape
Table 1. Species diversity in different land use by ethnic groups.

<table>
<thead>
<tr>
<th>Ethnic Groups/Cultivation Area</th>
<th>Home Garden</th>
<th>Hill Farms</th>
<th>Paddy Fields</th>
<th>Forest Patches</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haw</td>
<td>60</td>
<td>59</td>
<td>4</td>
<td>15</td>
<td>56</td>
</tr>
<tr>
<td>Hmong</td>
<td>27</td>
<td>43</td>
<td>24</td>
<td>39</td>
<td>105</td>
</tr>
<tr>
<td>Lisu</td>
<td>55</td>
<td>69</td>
<td>-</td>
<td>22</td>
<td>110</td>
</tr>
<tr>
<td>Yao</td>
<td>21</td>
<td>54</td>
<td>-</td>
<td>44</td>
<td>92</td>
</tr>
<tr>
<td>Ahka</td>
<td>23</td>
<td>34</td>
<td>9</td>
<td>65</td>
<td>108</td>
</tr>
<tr>
<td>Black Lahu</td>
<td>20</td>
<td>51</td>
<td>-</td>
<td>12</td>
<td>61</td>
</tr>
<tr>
<td>Red Lahu</td>
<td>32</td>
<td>45</td>
<td>-</td>
<td>28</td>
<td>80</td>
</tr>
<tr>
<td>Karen</td>
<td>106</td>
<td>65</td>
<td>45</td>
<td>58</td>
<td>369</td>
</tr>
<tr>
<td>Red Karen</td>
<td>15</td>
<td>6</td>
<td>4</td>
<td>21</td>
<td>62</td>
</tr>
<tr>
<td>Lawa</td>
<td>7</td>
<td>25</td>
<td>1</td>
<td>13</td>
<td>52</td>
</tr>
<tr>
<td>Tai Yai</td>
<td>32</td>
<td>18</td>
<td>3</td>
<td>5</td>
<td>49</td>
</tr>
<tr>
<td>Khon Muang</td>
<td>166</td>
<td>42</td>
<td>22</td>
<td>56</td>
<td>286</td>
</tr>
</tbody>
</table>

Table 2. Varietal diversity of rice and some swidden crop by ethnic groups in Northern Thailand.

<table>
<thead>
<tr>
<th>Ethnic Groups</th>
<th>Rice</th>
<th>Sticky Rice</th>
<th>Maize</th>
<th>Bean</th>
<th>Sesame</th>
<th>Wax/Ash Gourds</th>
<th>Eggplants</th>
<th>Chilli Pepper</th>
<th>Sugar Cane</th>
<th>Taro</th>
<th>Yam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hmong</td>
<td>7</td>
<td>5</td>
<td>9</td>
<td>10</td>
<td>2</td>
<td>4</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Lisu</td>
<td>6</td>
<td>2</td>
<td>4</td>
<td>10</td>
<td>2</td>
<td>-</td>
<td>10</td>
<td>3</td>
<td>3</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Yao</td>
<td>6</td>
<td>5</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Khamu</td>
<td>4</td>
<td>20</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Karen</td>
<td>15</td>
<td>11</td>
<td>6</td>
<td>7</td>
<td>3</td>
<td>2</td>
<td>8</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
Some Main Crops in the Traditional Shifting Cultivation Systems

1. For Subsistence:
   - **Upland rice** (*Oryza sativa*), more than 200 landraces or cultivars of non-glutinous type. Rice is the most preferred grain for staple food crop.
   - **Maize** (*Zea mays*), many types for food and animal feeds
   - **Cassava** (*Manihot esculenta*), diverse types from staple food (mixed with rice) to animal feed (pigs)
   - **Taro** (*Colocasia antiquorum*)

2. For cash
   - **Opium Poppy** (*Papaver somniferum*)

---

Government policy on illicit crop cultivation

- Eliminate opium growing and stop/suppress shifting cultivation
- Promote alternative (cash) crops to replace opium and shifting cultivation
- Stop village movement and promote permanent farming with dominant cash crops; annuals, perennials, fruit trees and plantations

**National and international campaign to eradicate opium**
Drug (opium and opiates) smugglers and trafficking in the “Golden Triangle”

<table>
<thead>
<tr>
<th>Area (ha)</th>
<th>Production (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,000</td>
<td>18,000</td>
</tr>
<tr>
<td>15,000</td>
<td>30</td>
</tr>
<tr>
<td>12,000</td>
<td>60</td>
</tr>
<tr>
<td>9,000</td>
<td>90</td>
</tr>
<tr>
<td>6,000</td>
<td>120</td>
</tr>
<tr>
<td>3,000</td>
<td>150</td>
</tr>
</tbody>
</table>

**Figure 1.** Changes in opium growing area and production in Thailand.

**Sources:** Department of Public Welfare (1962), United Nations Survey Team 1967 and ONCB.
Outline of Presentation

- Drivers of land use change
- Government Policies
- Some consequences and trends
- Concluding remarks
Major Drivers

- Population
- Land Tenure
- Commercialization
- Government policies

Population

The myth of population-environment nexus: pressure on land and the surrounding natural forests

- Internal Population Increase

Migration

- Migrants from the lowlands
  - Planned migration (resettlement): Vietnam and Yunnan of China
  - Spontaneous migration (everywhere in the sub-region)
- Cross-border migration (critical issue on border security in N. Thailand)
Resettlement policy

- Mass migration of lowland population
- Amelioration of population pressure in the lowlands
- Capturing unused resources and biophysical advantages of the highlands and village relocation

Examples:
1. Decree 327 of Vietnamese government (issuing September 15, 1992):
   - Fixed Cultivation and sedentarization of ethnic minorities
   - Restoration of barren hills
   - Resettlement goal for ameliorating population pressures in the lowlands
2. Movement of Han Chinese to State Rubber Plantation in Yunnan of China
3. Relocation of people out of large scale development project (dam, mining etc) or conservation areas in Laos and Thailand

Land Tenure

The lack of tenure often leads to land use conflicts and land disputes at all levels

Insecurity of land and/or use permit (the formal arrangement)
- Illegal encroachment
- Leasing arrangements (inconsistent and terms of leasing, taxing and etc)
- Subsidies and supports (amount, conditions and continuity)

Customary rights (the traditional arrangement)
- Traditional tenure systems
- Customary rules and regulations on land use and land allocation, e.g., communal management of swidden fields, community and conservation forests in the village
Big pushes from the government and the private sectors:

- road construction
- installation of other infrastructures
- access to external markets and credits
- Supports and subsidies, e.g., inputs, prices, transportation and so on.

Commercialization

Government Policies that are common to governments in MMSEA)

Against traditional shifting cultivation
- “Bad” practice
- Primitive
- Destructive

Promotion of cash crops
- “Good” practice
- Modernization
- Alternative to illicit opium poppy
- Permanent land use
- Sedentarization
Infrastructure Development Mainland Southeast Asia

Northern Thailand in 1970s

Large scale plantation of cash perennial crop: Rubber in China
Government Support to Stop Shifting Cultivation in Simao, Yunnan province of China

Large scale transformation of shifting cultivation in Simao and Lancang of Yunnan province in southwest China

Maize in Lancang

Sugarcane and tea in Simao
Rapid transformation of swidden in Vietnam due to opium eradication and fixed cultivation and sedentary settlement policies in 1994.

Maize in Moc Chau

Canna edulis in Mai Chau

Transformation of shifting cultivation to teak plantation in Luang Prabang, Laos.
A cross border transfer of Chinese rubber plantation (“blueprint”) to Wa territory in Myanmar and Udomxay and Luang Namtha in Lao PDR

Meng La

Pang Sang, Wa Army Territory

Luang Namtha, Lao PDR

Large scale expansion of cash crop in a former opium growing area:

Maize in Mae Chaem

site for livestock feed industry in Thailand and the neighbouring countries
Transformation of former opium fields to patchworks of cash and subsistence crops in northern Thailand

Intensive Systems with High Inputs and Increasing Cost of Production
Degradation process of shifting cultivation in MMSEA

Threats to Forest Ecosystems: Sustainability and degradation
- Monoculture of large scale farming and diverse systems of dominant cash crops by smallholders
- Forest and watershed destruction
- Loss of ecosystem integrity (structure, organization and functions) and biodiversity (domesticated and wild species)

Increasing resource use and conflicts: Strong competition for natural resources
- Land
- Water
- Forests (both natural and community managed systems)
Paradigm shift in mountain development activity since 1990s

- People participation and bottom up planning
- Grass-root planning and stakeholder analysis
- Recognition of “Good” practices” from local innovations and traditional knowledge
- Support farmers’ coping ability
- Community empowerment

Land Use Conflict Resolutions

Alternative Cash Crops in Mae Tho and Community-Based Land Use Planning and Local Watershed Management

Land use conflict and disputes:
- Expansion of cash crop area
- Declaring areas under strictly protected forests
- Encroachment into community forests and village conservation areas
Development of highland paddy as alternative land use and reduce pressure on the natural forests: physical limitations, e.g., soils, water and steep slopes

Decree 327: Policy initiative in the restoration of Barren Hills in the Midlands of North Vietnam during early 1990s
Farmers’ management of sustainable land use and improvement of their livelihoods

Patchworks of agrobiodiversity in diverse village landscapes

Pah Poo Chom in Chiang Mai, Thailand

Baihualing, Gaoligongshan in Baoshan, China
Interface between agriculture and forest lands in a village landscape

Gravity-fed sprinkler irrigation for dry season cash crops

Comparative advantages:
- Lower elevation as comparing to other major cabbage production sites
- Possible to delay planting until late September for higher prices
- Taming *Mimosa invisa*, an invasive species for green manure crop in the wet season
**Spiny Mimosa:** The live mulching system in Pah Poo Chom village

*Total Amount of Nitrogen = 67 kgN/ha*
- From Spiny Mimosa = 47 kgN/ha
- From Corn Trashes = 20 kgN/ha

**Forest patches in agricultural landscape:** the Hmong traditional systems for production, conservation and other services
A complex AF edge managed by Mr. Sao-phang Saetao of Pah Poo Chom

- Highest species richness (114) vs. other edges (38)
- Highest utility (firewood, food, construction material and making tools)
- Conservation of headwater for production of cash crops

Management of Agroforest plots in Pah Poo Chom Project site
# Biodiversity assessment of AF edges

<table>
<thead>
<tr>
<th>Names of responsible persons who manage the AF edges</th>
<th>Total Individuals</th>
<th>Species Richness</th>
<th>Shannon Index</th>
<th>Margalef Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local expert: Saophang Saetao</td>
<td>717</td>
<td>114</td>
<td>2.77</td>
<td>17.19</td>
</tr>
<tr>
<td>Non-experts: (average)</td>
<td>315</td>
<td>38</td>
<td>2.35</td>
<td>6.39</td>
</tr>
<tr>
<td>- Juk Saehang</td>
<td>332</td>
<td>33</td>
<td>2.29</td>
<td>5.51</td>
</tr>
<tr>
<td>- Joint managed by Chao/Chang Seng</td>
<td>315</td>
<td>18</td>
<td>1.54</td>
<td>2.96</td>
</tr>
<tr>
<td>- Unidentified person</td>
<td>300</td>
<td>62</td>
<td>3.24</td>
<td>10.69</td>
</tr>
</tbody>
</table>

## Utilization of tree species in AF edge managed by local expert in *Pah Poo Chom*.

<table>
<thead>
<tr>
<th>Utilization</th>
<th>Number of Species</th>
<th>Herbs/Spices</th>
<th>Construction</th>
<th>Farm Tools</th>
<th>Firewood</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>25</td>
<td>1</td>
<td>6</td>
<td>6</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>Herbs/Spices</td>
<td>16</td>
<td></td>
<td></td>
<td>1</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Construction</td>
<td>24</td>
<td></td>
<td></td>
<td>8</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Farm Tools</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>Firewood</td>
<td>78</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>
Reintroducing bambo for making *Hmong* pipe in AF edge, managed by Saophang Saetao of *Pah Poo Chom* village

Products from wild banana for cash income of the poor households sold in Chiang Mai markets (Kaad Muang Mai)
Products from agricultural fields with high demand in the city markets

Management of Posa (mulberry paper: *Broussonetia papyrifera* Vent.) agroforest in Ban Ta Hae of Luang Prabang, Lao PDR
Shifting cultivation and fallow fields in Tee Cha Village, Sop Moei District, Mae Hong Son Province

Managing forest species in agricultural landscape: Local innovation to restore productivity of reduced rotation in traditional shifting cultivation in Tee Cha Village, Sop Moei District, Mae Hong Son Province
Management of a pioneer tree species, *Pada* (*Macaranga denticulata*).

<table>
<thead>
<tr>
<th>Pada in fallow</th>
<th>Dense</th>
<th>Sparse</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean yield</strong></td>
<td><strong>3.04</strong></td>
<td><strong>1.15</strong></td>
</tr>
<tr>
<td><em>(8 fields, 6 farms)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>2.48-4.53</td>
<td>0.71-1.56</td>
</tr>
<tr>
<td>SD</td>
<td>0.71</td>
<td>0.33</td>
</tr>
</tbody>
</table>

Source: Narit Yimyam et al 2003
Diversity of arbuscular mycorrhizal fungi in the rhizosphere of *M. denticulata*

<table>
<thead>
<tr>
<th>Genus</th>
<th>Number of species found</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acaulospora</td>
<td>6</td>
</tr>
<tr>
<td>Archaeospora</td>
<td>1</td>
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<tr>
<td>Gigaspora</td>
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</tr>
<tr>
<td>Glomus</td>
<td>18</td>
</tr>
<tr>
<td>Paraglomus</td>
<td>1</td>
</tr>
<tr>
<td>Scutellospora</td>
<td>2</td>
</tr>
</tbody>
</table>

 Responses to arbuscular fungi in *Macaranga denticulata*

Inoculation Treatments:
- Uninoculated
- *Glomus fasciculatum*
- *Glomus* spp.
- *Acaulospora* spp
- Mixed species

Uninoculated: 1 2 3 4 5
Glomus fasciculatum: P0 P25 P50 P75 P100 P150
Trends in Land Use

- Intensity of land use with permanent agriculture is increasing and encouraged
- Forest land and resources will continue to decline
- Inappropriate practice with unsustainable forms of land use will be expanding as long as policy perception remains unchanged
- Sustainability of rural livelihoods is decreasing
- Land disputes and land use conflicts are extending on a larger scale
  - Between local upland communities
  - Between upland and lowland communities
  - Between community and government agency

Remaining questions

- What are the appropriate land use alternatives that work for the mountain communities?
- When do they work? Where, why and how?
Final remarks

1. Farmers and communities have capacity to manage land on sustainable basis as long as local knowledge, traditions, customary rules and regulations are effectively functioning.

2. Sustainable land management can be seen in many ways at different levels and different scales.

3. Better understanding of “best practices” in sustainable land management is urgently needed in order to promote the systems with wider scales and overcome site specific problem relating to the best practices.

Thank You for Your Attention
Good afternoon. My name is Ben Samson. I work with the International Rice Research Institute (IRRI). The work I am going to talk about is a collaboration between several institutions. We receive funding from the Swiss Agency for International Development and Cooperation (SDC); the Challenge Program for Water and Food (CPWF), which is a project within the Consultative Group on International Agricultural Research (CGIAR); and the International Fund for Agricultural Development (IFAD). We work with the National Agriculture and Forestry Research Institute (NAFRI) and the University of California at Davis.

Before I continue, I want to thank all the other speakers who came before me, because they have made my job easier by giving a good background and macro-perspective on the situation in Laos and the Greater Mekong Subregion. They talked about some of the major issues, particularly the upsurge of forest and rubber plantations and the drive toward the cultivation of cash crops in Laos, especially in the northern uplands. What I want to do now is focus and talk about the northern uplands of Laos.

I will talk about the conditions of this area, including the geographical and socioeconomic state of this region. I will talk about the crops grown and common agricultural activities/practices in Northern Laos. I will briefly go over the conceptual framework that guides the rice landscape management project that IRRI is implementing in collaboration with NAFRI. Embedded within this project are efforts to screen and select rice germplasm, the sustainable management of crops and fields, and natural resources management. Toward the end of my talk, I will address interactions between uplands and lowlands via the flow of water through these ecosystems.

You may have seen this map before. It emphasizes the geographic positions of our sites of concern. Laos is a landlocked country. It is surrounded by China to the north, Vietnam to the east, Thailand to the south, and Myanmar to the west.

The work I will describe is concentrated mainly in Northern Laos, which has similar physical characteristics to Southern China (Yunnan Province) and Northern Vietnam. As Dr. Kanok said, the main physical feature that characterizes these areas is that they are hilly and mountainous.

This is a closer view of Northern Laos. The project covers the provinces of Luang Prabang,
Oudomxay, Louang Namtha, and Sayaburi.

These are views of the rice landscapes of Northern Laos. Rice can be grown in purely upland areas or a mixture of sloping uplands, terraces, and lowland areas such as valley bottoms and riverbeds.

This slide describes the economic situation in Northern Laos. Industry accounts for 10% of the economy of the North; this is just a third of the national average of 37%. Agriculture is the major economic activity, employing about 70% of the total population. The service sector accounts for 20% of the economy of Northern Laos, compared to 26% in the rest of the country. High levels of poverty persist in Northern Laos, as in the uplands of other countries in the GMS and elsewhere.

Land elevation in Northern Laos ranges from 250 to 1,500 meters. Total rainfall ordinarily ranges from 1,200 to 2,000 millimeters per year. Soil is poor because the soil parent material is uplifted sediment that has undergone extensive erosion by rainfall. Soil in sloping areas is also unstable and prone to erosion and landslides. Soil on valley bottoms and riverbeds is composed of sediments deposited by runoff water from the slopes.

Access to sites is difficult. Road systems have just recently been established. Most of the population in Northern Laos is made up of ethnic minorities. Population density is low, but population is growing rapidly, at about 2.5% per year.

About 80% of farmers in the North are engaged in subsistence farming. The major trading partners of Northern Laos are China, Thailand, and Vietnam. The commodities traded include maize, rice, sugarcane, and rubber.

Investment in rubber plantations is being pushed by investors from China, Thailand, and Vietnam. Traders and trading companies get incentives from the government to encourage long-term investments, including land concessions on highly favorable terms. These investments have had a negative impact on traditional land-tenure arrangements and food security for small farmers whose land has been turned over to investors. Household supplies of rice, which used to be grown on designated rubber plantations, have to be purchased, or grown farther away from communities, leading to increased local demand for rice and higher prices. These external investments have had a major impact on the trajectory of agricultural and economic development of the North.

One of the four Lao policies governing the uplands involves putting a stop to slash-and-burn cultivation and stabilizing shifting agriculture. This is similar to measures taken by the governments of China and Vietnam in their uplands. Laos aims to have 70% forest cover by the year 2020. The rice landscape management project is actively testing alternatives to shifting agriculture.
The Lao government has implemented several strategies to stop slash-and-burn agriculture. The relocation of far-off communities to areas near road systems aims to reduce pressure on forests in the uplands. It benefits members of the community by facilitating the delivery of social services such as education and health services. Greater accessibility to markets and easy contact with investors increases economic opportunities for farm households, including raising cash crops and livestock for consumers elsewhere. Relocation, however, takes households away from their crop production sites. Part of the relocation program is the land allocation system, in which relocated households are allotted parcels of land to be used for sedentary agriculture. For example, a family of four or five may receive three parcels of land, equivalent to about three hectares. The household may cultivate one parcel a year and go through the three parcels in three years. In three years, the first plot will have lain fallow for two years. This short fallow period is not sufficient to renew soil fertility. Then, too, newly arrived households are allocated the poorest land around a village.

What crops are grown in our target sites? Rubber is extensively grown in the provinces of Luang Namtha and Sayaburi. The area planted is increasing in Luang Prabang. Job’s Tears, or *Coix lachryma-jobi*, is usually grown after rice. Maize is grown in place of Job’s Tears where there is market demand — mainly in Oudomxay Province, to provide raw materials for feed mills in Yunnan and Northern Vietnam. Maize production is contract-grown for investors who provide seed and agricultural chemicals and buy the produce at harvest. Maize is usually grown on sloping uplands. There is data showing that soil erosion is higher in maize cover than in upland rice.

Minor crops grown with rice and in rotation with rain-fed lowland rice are small grain legumes, spices, and fruits.

Rice is grown in both lowland/wetland and upland/dry land conditions. Farmers sow, transplant, and care for the rice crop and, finally, harvest it. The reward for all these efforts is good-quality rice for consumption by members of the household.

In Northern Laos, households say that they go through a hunger period when there is no rice to eat. Energy needs are met with cassava or other root crops as substitutes for rice. Not having rice to eat is perceived as hunger, even if calorie intake is sufficient. Households in some districts of Northern Laos still report 3–4 months of hunger.

Rice plays a central role in Lao culture and life. Rice is the major offering made to Buddhist monks to earn merit. Its centrality in the Lao psyche is reflected in the common greeting among friends, who ask each other whether they have eaten rice yet.

Let me shift gears and talk about how we were approached the issue of rice productivity in Laos. I will talk about the vicious and virtuous cycles of crop productivity, the use of natural resources, and management and household well-being in the uplands of Laos.
This is a conceptual framework for what we think is going on in the northern uplands. The intensive cultivation of fragile land, the sloping uplands, leads to land degradation and low food production. Households are not able to produce enough food and hence are food insecure. This prevents households from focusing on options for cash crop production. Limited cash crop production means that households have little income from their agricultural activities. This vicious cycle may be transformed into a virtuous one by increasing food productivity. We think that increasing food productivity will improve food security and encourage households to go into cash crop production and increase their incomes. Achievement of food security and higher incomes may move households toward more appropriate use of the different land forms and protect the environment.

In summary, factors that impinge on rice-based agricultural systems in Northern Laos include markets, local and national government regulations and policies, national institutions, and externalities such as changing economic trends in neighboring countries. The arrows represent the flows of information, materials, energy, and funds.

The objectives of the rice landscape management project are to improve the productivity of rotational upland systems, develop stable and permanent land use systems in both uplands and lowlands, and conduct policy analysis and dialogues for policy reform. The first two objectives cover the agronomic and biophysical aspects of our research. The third objective recognizes that all of our research does not amount to much if our results are not made known to policymakers and translated to appropriate policies or the reform of existing policies.

These are the organizations that participate in the rice landscape management program. We receive financial support from the Challenge Program on Water and Food (CPWF) and technical cooperation from the Yunnan Academy of Agricultural Sciences (YAAS) and the Consortium for Unfavorable Rice Environments (CURE). The International Fund for Agricultural Development (IFAD) provided financial support to the project for three years. IFAD support gave the project a platform to extend its findings through a requirement that the project have technical assistance linkages with IFAD loan projects. Lessons and technologies from the project were shared with IFAD for adaptation in loan projects. We work closely with the provincial and district agriculture and forestry offices (PAFO and DAFO). Our main partner is NAFRI, through the Northern Agriculture and Forestry Research Center (NAFReC).

The rice landscape management project is investigating component technologies to improve productivity as well as develop stable agricultural systems. Rice germplasm improvement in the upland project consists of a two-pronged approach: work on traditional cultivars and improved rice varieties. There is also ongoing work on field and crop management research and cropping systems. We are also investigating upland and lowland interactions through water flows. I will show a
sampling of the work we have done in these areas.

This is picture of some of the researchers on the research project at NAFReC. It is composed of dedicated and talented young people.

Let me talk about the project’s germplasm work. As I said before, we have a two-pronged approach to rice germplasm improvement in Northern Laos: a focus on traditional rice landraces and improved rice germplasm. The idea with traditional rice cultivars is to use cultivars that farmers are already growing and stream them into the screening and selection process to identify the best-performing cultivars for the range of environments in the uplands. We have also used growth duration as a germplasm selection criterion. We have been able to identify several traditional cultivars of short and medium growth duration. In addition, our work in this area identified cultivars suited for sites with short fallow periods or no fallow period between rice growing seasons.

The average yield for upland rice on sloping areas is about 1.5 tons per hectare. We have been able to double this yield with traditional cultivars. There is a wide variation in minimum and maximum grain yields. Coupled with screening for yields is the identification of application domains, the conditions/environments where rice cultivars have high yields.

The other prong of our germplasm work is the screening and selection of improved rice germplasm materials originating from outside of Laos. We have been successful in identifying lines and varieties from the International Network for Genetic Evaluation of Rice (INGER). INGER is a program within IRRI that collects best-performing rice and promising germplasm materials from its member countries and organizes these materials into nurseries, which are then disseminated to partners and institutions for testing and evaluation. INGER nurseries are organized to address specific abiotic and biotic stresses. Hence, there are INGER nurseries for poor soil, aerobic growing conditions, tungro, and planthopper. The project also tests materials from the Yunnan Academy of Agricultural Sciences (YAAS). One of our best-performing rice lines is B6144F-MR-6, which came from YAAS. It is a line that was originally developed in Indonesia. IR55432 is a line that was developed at IRRI. The average yield of these lines is about 0.5 tons better than the best-performing traditional cultivars in the North. Added fertilizer doubles their grain yield.

The acid test for our work is whether farmers are adopting the lines and cultivars we have identified through on-station and on-farm research. This is an illustration of farmer uptake of the traditional cultivar Khao Laboun, which was selected and purified at NAFReC. The cultivar was initially disseminated as one kilogram of seed to two farmers in one village in 2006. By 2008, there were 20 farmers using the cultivar, and the total seed planted had increased to 800 kilograms. B6144 dissemination began as 2.5 kilograms of seed distributed to five farmers in five villages. By 2007, farmers in 18 villages — 8 in the uplands and 10 in the lowlands — were using the line in
I will shift gears now and talk about our work to improve agricultural production in sloping uplands. Dr. Kanok touched on the regeneration process in the uplands; we have done work in this area, as well. The problem we addressed was shortening fallow periods, which adversely affected soil fertility regeneration. Our approach was to try to enrich the fallow to restore soil fertility at a faster pace. Fallow enrichment with legumes may raise soil nitrogen levels over a short period. Raising soil nitrogen levels is critical for crop production, as nitrogen is the essential macronutrient element deficient in upland soils. The scheme we devised involves establishing the legume even before the rice crop is harvested. This scheme uses residual soil moisture from the rice crop and ensures that the legume crop is in the ground for a longer period to improve soil fertility. Different species have been tried: stylo (*Stylosanthes guianensis*), pigeonpea (*Cajanus cajan*), paper mulberry, rice bean, leucaena (*Leucaena leucocephala*), gliricidia (*Gliricidia sepium*), and crotalaria (*Crotolaria sp.*). Each of these species has specific advantages, but we have found that stylo and pigeonpea are best suited for this scheme in sloping uplands.

This slide shows data comparing traditional and improved fallows, with stylo as the fallow enrichment species. Note that the stylo-enriched fallow yielded about 0.6 ton more grain per hectare than plain fallow. In a dry fallow season, stylo-enriched plots yielded 0.4 ton more grain per hectare than natural fallow. Rice productivity was similar in plots that had three years of paper mulberry fallow and natural fallow. The advantage of the paper mulberry fallow is that farmers can harvest its bark and sell it.

This is an illustration of one year’s worth of data, in which we compared the stylo line-seeded to stylo broadcasted into the rice stand. The data shows that line-seeded stylo germinated and produced more biomass than broadcasted stylo, due to less competition for light with rice. Broadcast-seeded stylo were shaded out by the rice plants.

One of the major weed species in the uplands is *Imperata cylindrica*. *Imperata* is a noxious and persistent weed. It has underground rhizomes where carbohydrates are stored, hence the difficulty of ridding the land of this species. Cutting and burning does not kill this weed but actually encourages its growth. This weed takes land away from cultivation.

We wanted find a methodology to bring *Imperata*-infested land back into crop production. The method we developed involved a one-time application of glyphosate in combination with rapidly growing, highly competitive species that would shade out the *Imperata*. This figure shows the number of new *Imperata* shoots in control plots, glyphosate-treated plots, and plots that were sprayed with glyphosate and planted with pigeonpea as the shade species.

Glyphosate application at the beginning of the season kills the *Imperata* shoots and allows rice and
pigeonpea to be established, resulting in a higher rice yield than treatment with glyphosate alone. This is an illustration of a pigeonpea bush and the sticklac insect that lives on pigeonpea. This is sticklac, produced by the sticklac insect, a product that we think is going to serve as a profitable incentive to use pigeonpea as a means of enriching fallows and eradicating *Imperata cylindrica* from the uplands. Sticklac fetches a good price in the international market. Farmers growing pigeonpea to culture the sticklac insects and produce sticklac also improve soil fertility and rid the uplands of *Imperata cylindrica*.

Farmers spend a lot of their time weeding their upland fields, especially after the first year of cropping. Weeding accounts for more than 50% of the labor that goes into the cultivation of upland rice. We were interested in finding out what part of the rice yield is lost due to weeds. We set up an experiment in which we compared rice productivity in fields that were relatively weed-free and those that were managed according to usual farming practices. We found almost a 20% difference in yield, which means that farmers’ fields were losing about 20% of their yields because of weeds.

Much of the program’s work in rain-fed lowlands is concentrated on rice germplasm improvement and maintaining/improving the soil fertility in rice fields. Farmers in Laos apply little or no fertilizer to their fields. A key concern was how to maintain or increase soil fertility through the use of alternatives to inorganic fertilizers. The easy method of soil fertility maintenance/improvement would be to apply inorganic fertilizers; however, most Lao farmers do not have the capacity to buy them.

Our strategy was to investigate the use of locally available, abundant organic manures. We compared the effects of pig manure, chromolaena (*Chromolaena odorata*) green manure, and inorganic fertilizer on rice productivity in rain-fed montane lowlands. Rice grain yield in plots with 25 t/ha of *Chromolaena* green manure was not significantly different from plots treated with 60 kg/ha N, 30 kg/ha P, and 30 kg/ha K. Questions remain about chromolaena green manuring: where to source the biomass needed, labor requirements, soil fertility changes in the sites where the green manures are harvested, etc.

As I stated at the beginning of this talk, the upland project is investigating interactions between upland and lowland systems. Water flow through these systems is an obvious linkage, hence hydrology and flow of water across the systems is an active research area in the rice landscape program. A graduate student from UC Davis is doing his dissertation research in this area, using the programs research sites. The elucidation of the impacts on livelihoods and the characterization of water availability and rice production through the integrated assessment of land use options in terms of the biophysical resource bases of linked upland and lowland systems are the broad objectives of this work.
The analytical approach involves the use of GIS techniques and dynamic simulation modeling to look at watershed hydrology. The expectation is that the biophysical model can be linked to an economic model to enable the quantification of the consequences of land use changes in the uplands and the lowlands in terms of water availability and monetary flows to communities/farmers.

Some of the characteristics of the project’s sites are shown here. The project has activities in one village in each of two districts: Banh Fay in Pak Ou and Banh Silalek in XiengNgeun.

Field methods involve the construction of weirs to facilitate the measurement of water flows through channels, meteorological stations, and automatic water flow measurement devices. Participatory assessments will be conducted on water, land, and resources; resources inventory; and peoples’ perceptions of land and water use. These data are all linked to a GIS mapping exercise. We had thought that the mapping could be done using satellite photos, but we quickly found out that it was much better to go into the field and do manual measurements.

An initial result of this work is the definition of biophysical resource linkages, comprising the different land uses and the water flows, as well as the systems’ crop and livestock components.

We now have a topographical map of the sites, rainfall and evaporation data, and land use and resource maps. We have crop production data from two years of work. The modeling work is ongoing.

Before I end, I would like to review the “take home” messages of this talk. There is high genetic diversity in the uplands of Northern Laos, which remains largely untapped. There is also high physical diversity, which is perceived as physical discontinuities and a wide range of microenvironments. The diversity of microenvironments raises opportunities for mixed strategies for increasing productivity and stabilizing production systems. The sticking point is how to achieve integration of component technologies suited for different rice landscapes. On top of these biological and physical complexities is the socioeconomic matrix of ethnic diversity, poverty, local and national policy directives, and external drivers such as highly focused investments and market demand for Lao products and resources. The rice landscape project focuses on alternative low-input, low-cost technologies that use locally abundant resources.

While there are incredible opportunities to develop ranges of technologies for the diversity of environments in the uplands, it is difficult to arrive at generic solutions. The physical and biological diversity of the uplands requires the development of typologies of environments and technology options for each typology and each situation in the typology. The work we are doing involves scientific research for understanding and development.
We, as researchers, develop options for farmers to choose from and decide which are more appropriate for their environments and economic circumstances. The end user — the farmer — ultimately decides which technologies to implement.

We found that it is not sufficient for technologies to be scientifically valid. They also have to make sense and fit easily into the way farmers do their work. Published or publishable technology research does not always translate into usable technologies by end users. Technologies need to be economically viable and socially acceptable to farmers.

Scientific research alone is not enough. Research results and technologies must be made known and explained to policymakers and end users. These are necessary steps for correct policies to be formulated and for change to occur.

Externalities play a big role in all these things. Changing economic and social demands mean that the context of the problems and their solutions changes as well, hence it is important not only to engage with present day issues, but also to look ahead and foresee future needs.

With that, I leave you. Thank you for your attention.
Questions and Answers

(Question) Thank you very much for the excellent presentation. I am wondering why farmers do not use herbicide to control weeds. You probably know that weeds are very aggressive plants. So farmers could use herbicide, or insecticide to protect rice plants from insect attacks.

(Benjamin Samson) The use of agricultural chemicals in lowland fields would, under certain conditions, be recommended. IRRI is a proponent of integrated pest management. Using insecticides on a schedule is not something that we do or recommend.

In the uplands of Laos, the economic status of farmers largely precludes the use of agricultural chemicals. What I showed here about the use of glyphosate, a systemic herbicide, is an effort on our part to introduce a technology that uses minimal amounts of chemicals in concert with a biological approach to control *Imperata* infestation in upland areas. Glyphosate is utilized as a one-time-use herbicide in our scheme. The effect of glyphosate wears out over time, but before it becomes ineffective and *Imperata* shoots start growing again, pigeonpea will have had time to be established and physically overtop *Imperata* and shade it out. We have similar a scheme for controlling weeds in lowland rice: manipulating the density and the planting times of rice, planting them closer or planting them wider apart, to manipulate timing of canopy closure and the amount of light that passes through the crop canopy.

(Question) I am concerned about the socioeconomic drivers. As you mentioned in your presentation, it is said in Japan that the green revolution introduced by IRRI in 1968 resulted from the wide economic gap between rich farmers and poor farmers, due to the lack of consciousness about the social condition of the farmers. What do you at IRRI think about that?

(Benjamin Samson) IRRI launched what we call the second green revolution. It is a greener green revolution, meaning that this green revolution is more environmentally friendly. Now, to address your question about the disparity of adoption between rich and poor farmers, and in terms of taking advantage of research and technological developments, I don’t think it is farfetched for us to think about it in terms of the risks that are involved when farmers adopt new things. For a rich farmer, changing the way he or she does cultivation, any kind of crop cultivation, presents little risk because they have something to fall back on. Poor farmers, especially subsistence farmers, find it much more difficult to adopt these changes. Crop failure impacts the food that a farmer’s family will consume for the rest of the year, the money that is needed to send the children to school, the money needed to buy clothes, etc. We think of this in relation to how much risk farmers are able to tolerate. Poor farmers tolerate smaller risks. Our project does not emphasize technology packaging, because packaging implies that users have to employ all the component technologies in an ordered manner. Our approach is to expose farmers to technologies that will increase crop productivity and let farmers choose those they are comfortable with. The thinking here is that farmers will take
pieces of technology they are happy with. Eventually, they may try other technologies and adopt those, as well. So we think of this as an incremental process. It is slow, but hopefully the changes will be effective and long-lasting.
Managing Rice Landscapes: Experiences and Lessons from Northern Laos

Benjamin K. Samson
International Rice Research Institute
Luang Prabang, Lao PDR

• Setting
• Crops
• Conceptual framework
• Rice Landscapes Management Program
• Approaches
  • Germplasm
  • Crop and field management
  • Natural resources management
• Upland – lowland interactions
  • Water flows
Northern Laos

• **Economic setting**
  – Industry: 10% (National: 26.6%)
  – Agriculture: 70% (47.2 %)
  – Services: 20% (26.2 %)
  – High levels of persistent poverty

• **Physical setting**
  – Elevation: 250 to 1,500 m
  – Annual: 1,200 to 2,000 mm;
  – Soils: slopes, valleys, river beds

• **Access** is difficult
• **Ethnic minorities;** rapid growth (2.5%)
• **Subsistence farming** (80%)
Trade

Investments and trade
• China, Thailand, Vietnam

Commodities
• rice, sugarcane, rubber
• land concessions
  • land values
  • crop prices

Trajectories of agricultural development

Policy setting

– Stop slash and burn agriculture in uplands
  – stabilize shifting cultivation
  – 70% forest cover by the year 2020
  – alternatives to shifting agriculture

– Strategies
  • Relocation near road systems
    – Access to markets / flow of investments
    – Delivery of social services/ education

  • Land allocation system
    – Cultivation of parcels in rotation – Shortened fallows
    – Intensive agriculture for market oriented crops
    – Consequences on soil fertility, weed incidence, crop productivity
Crops

Rubber

Job's tears (Coix lachryma-jobi)

Maize (Zea mays)
Small grain legumes (soybean, cowpea, mungbean), spices, fruit
Rice is central to Lao life and culture
“Vicious” and “Virtuous” Cycles
In the Uplands

- Low food productivity
- Food insecurity
- Limited cash cropping
- Intensive cultivation of fragile land
- Land degradation
- Low income
Objectives

- Improve the **productivity** of rotational upland systems
- Develop **stable permanent land use systems** in uplands and lowlands
- Conduct **policy analyses and dialogues** for policy reforms
Approaches

- Component technologies
  - Germplasm improvement
    • Traditional cultivars
    • Improved rice lines and cultivars
  - Field and crop management research
- Cropping systems
- Integration
  - Upland-lowland interactions
Grain yield (t/ha) of traditional and modern upland rice varieties.

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<th>Max. Yield</th>
<th>Ave. Yield</th>
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<td></td>
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<td>Makhinsoung</td>
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<td>Laboun</td>
<td>0.2</td>
<td>4.0</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Grain yield (t/ha) of aerobic rice varieties.

<table>
<thead>
<tr>
<th>Line</th>
<th>Number of sites</th>
<th>Ave. Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low input</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IR55432-01</td>
<td>10</td>
<td>1.9</td>
</tr>
<tr>
<td>B6144-MR-6</td>
<td>10</td>
<td>2.0</td>
</tr>
<tr>
<td>Local check</td>
<td></td>
<td>1.3</td>
</tr>
<tr>
<td><strong>Fertilized</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IR55432-01</td>
<td>6</td>
<td>3.0</td>
</tr>
<tr>
<td>B6144-MR-6</td>
<td>7</td>
<td>3.0</td>
</tr>
<tr>
<td>Local check</td>
<td></td>
<td>1.8</td>
</tr>
</tbody>
</table>
Adoption of Laboun through farmer to farmer exchange (Luang Prabang)

2006
- Upland: 1 villages, 2 farmers, 1 kg

2007
- Upland: 1 villages, 10 farmers, 100 kg

2008
- Upland: 1 villages, 20 farmers, 800 kg

Adoption of B6144F-MR-6 through farmer to farmer exchange (Sayabouri)

2006
- Upland: 5 villages, 5 farmers, 2.5 kg

2007
- Upland: 8 villages, 26 farmers, 380 kg
- Lowland: 10 villages, 24 farmers, 520 kg
Rice - Enhanced fallow systems

<table>
<thead>
<tr>
<th>Traditional systems</th>
<th>Rice</th>
<th>Fallow</th>
<th>Rice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved fallow systems</td>
<td>Rice</td>
<td>Fallow crops</td>
<td>Rice</td>
</tr>
<tr>
<td>Fallow crops</td>
<td>stylosanthes, pigeon pea, paper mulberry, rice bean, <em>Leucaena leucocephala</em>, <em>Gliricidia sepium</em>, <em>Crotolaria anagyroides</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Traditional system</th>
<th>Improved system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1-yr natural fallow</td>
<td>1-yr stylosanthes fallow</td>
</tr>
<tr>
<td>Grain yield (t/ha)</td>
<td>0.4</td>
<td>1.0 **</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Traditional system</th>
<th>Improved system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dry season natural fallow</td>
<td>Dry season stylosanthes fallow</td>
</tr>
<tr>
<td>Grain yield (t/ha)</td>
<td>0.9</td>
<td>1.3 **</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Traditional system</th>
<th>Improved system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Natural fallow (3 years)</td>
<td>Paper mulberry fallow (3 years)</td>
</tr>
<tr>
<td>Grain yield (t/ha)</td>
<td>1.7</td>
<td>1.8</td>
</tr>
</tbody>
</table>

From: Saito, 2005
Upland rice + *Stylosanthes* sp.

![Bar graph showing grain yield (kg/ha) for different treatments: Rice, Rice + Stylosanthes (Line planted), Rice + Stylosanthes (Broadcast).](image)
## Labor input for land preparation, sowing and weeding of upland rice.

<table>
<thead>
<tr>
<th>Farmer</th>
<th>Sowing date</th>
<th>Harvest date</th>
<th>Labor input (d/ha)</th>
<th>Land preparation</th>
<th>Sowing</th>
<th>1st weeding</th>
<th>2nd weeding</th>
<th>3rd weeding</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vanhthong</td>
<td>10-Jun</td>
<td>12-Oct</td>
<td>23 25 19 18 18 18 18 102</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thitchanthone</td>
<td>16-Jun</td>
<td>15-Oct</td>
<td>28 23 23 19 19 19 19 112</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ping</td>
<td>27-May</td>
<td>01-Sep</td>
<td>28 29 32 34 27 150</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thea</td>
<td>03-Jun</td>
<td>15-Oct</td>
<td>30 35 39 44 30 178</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maipeng</td>
<td>08-May</td>
<td>14-Oct</td>
<td>60 40 40 40 35 205</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main</td>
<td>06-May</td>
<td>10-Sep</td>
<td>68 30 30 28 25 150</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phone</td>
<td>04-May</td>
<td>13-Oct</td>
<td>30 25 30 40 25 150</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td></td>
<td>38 28 30 32 25 154</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Yield gap due to weeds in sloping uplands.

<table>
<thead>
<tr>
<th>Weeding</th>
<th>Grain yield (g m⁻²)</th>
<th>Yield gap (g m⁻²)</th>
<th>Yield gap (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Banh Silalek</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Researcher weeded</td>
<td>257</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmer weeded</td>
<td>219</td>
<td>38</td>
<td>17.4</td>
</tr>
<tr>
<td><strong>Banh Fay</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Researcher weeded</td>
<td>362</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmer weeded</td>
<td>295</td>
<td>67</td>
<td>22.7</td>
</tr>
</tbody>
</table>
Comparison of local farmer practice, pig manure, *Chromolaena odorata* green manure and inorganic fertilizer on rainfed lowland rice growth and grain yield.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant height (cm)</th>
<th>Grain Yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>80</td>
<td>2.7</td>
</tr>
<tr>
<td>Pig manure (5 t/ha)</td>
<td>80</td>
<td>2.6</td>
</tr>
<tr>
<td><em>Chromolaena odorata</em> green manure (25 t/ha)</td>
<td>92</td>
<td>3.5</td>
</tr>
<tr>
<td>Inorganic fertilizer (60-30-30)</td>
<td>85</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Comparison of local farmer practice, pig manure, *Chromolaena odorata* green manure and inorganic fertilizer on rainfed lowland rice growth and grain yield.
Goal: Assess impacts to livelihoods, water availability, and rice production through integrated assessment of land use options on biophysical resource base of target sites.
Analytical Approach

Framework Characteristics:
- Distributed approach designed to capture spatiotemporal aspects of integrated biophysical resource flows
- Enables direct linkage with socioeconomics

Scenarios:
- Base case
- Paddy expansion
- Upland land use mosaics & dry season paddy
- Alternative water management
- Alternative cropping systems

Land / Water System Characterization

Track 1: Resource Linkage Appraisal
- Both villages
- Comprehensive qualitative assessment of BP resource base

Track 2: Land / Water Resource Characterization
- Houay Hom watershed (3.8 km²)
- Quantitative, detailed description of L/W resources

Goals:
1) A priori analysis
2) Model development
3) Model input data set
4) Identification of extrapolation domains
Methodology

Field Hydrology

Hydrology infrastructure:
- Three climate stations
- Six stream gauging stations
- Two paddy study sites

Detailed topographic / land use surveys

Participatory Assessments

Initial Results: BP Resource Linkages

System characterization: components, products, and linkages.
## Initial Results: Land & Water Characterization

### Land:
- Detailed topography
- Land uses for 2007
- Production zoning with qualitative descriptions

### Water:
- Rainfall, evapotranspiration
- Stream flows
- Paddy water levels
- Spring locations

## Lessons 1

- Harness high genetic diversity
- High biophysical diversity
  - Discontinuities and micro-environments
  - Mixed strategies
  - Find points of integration
- High socioeconomic diversity
  - Low ability and propensity to pay
  - Work with available abundant resources
- Difficult to come up with generic solutions
  - Research for understanding
  - Research for adaptation of validated technologies
  - Research for development
Lessons 2

• Options, not pat solutions
  – End user/ farmer decides

• Biologically and technologically sound solutions are not sufficient
  – Economic viability (profitability) and social acceptability are major concerns

• Science alone is not enough
  – Political will, policy and action

• Externalities
Good evening everyone. First of all, I would like to thank Global Centre of Excellence Program for giving me the opportunity to be here and attend this very important workshop for environment management in the future. At the same time, this is a very exciting that me and you, all of us are here together and to talk to you as a commentator. Today we mainly focused on the situation of Lao PDR and some conditions in the natural resource management and some socioeconomic development. I don’t have much knowledge or experience about this but I am very happy that I could join the lessons on all the session today. At the same time, we have also learned some experience from the neighboring countries and Thailand that they have experience in how to manage environment and natural resources especially from Dr. Sekson from Khon Kaen University and Dr. Kanok from Chang Mai University about the shifting cultivation. Because in the northern part of Thailand and Laos is quite similar, so it were very good lessons for both countries to continue to practice shifting cultivation operation.

Yesterday, we have signed MOU with Nagoya University especially with the Graduate School of Environmental Studies and with Global Centre of Excellence Program. We have many activities like we have the agreement on academic actions in Laos and we also have activities to train researchers, to provide information and especially the activities to give students opportunity to learn in Nagoya University, one person per year.

Up until now I think everyone knows very well about Laos because most of the presentations today concern about Laos’ situation. Today, I want to repeat some points about National Development Forum like Lao PDR now is taking measures of poverty and food security because we have been on the list of the least developed countries and now try to break out from the list in 2020. At the same time, the Ministry of Agriculture to eliminate this poverty and food security has yet to been considered in the next few years up to 2010 like food security with rice approximately 500kg per hectare per year and for community production to contribute one-third of total export about one billion and shifting cultivation stabilization by year 2010.

Now, there is remaining about less than 10,000 hectare of shifting cultivation, not upland cultivation. The fourth is the sustenance on forest management. The policy of the government has been on how to make the forest cover up to 70% in the year 2000 by forest management system in three categories by conservation forest. Up to now, we have 21 sites of conservation forest with 3.4 hectare. The second one is the protection forest, approximately 6.5 million hectares and production forest 4.5 million hectares. As reforestation tree plantation will be approximately...
500,000 hectares by year 2020. You can see Lao situation and development in Lao PDR on this hand-out which Dr. Linkham usually brings for his workshop but he could not join us today.

I want to introduce you a little bit about my institution, about NAFRI and its role. Sorry, I have no slides to present because I was asked to give commentary a day before I came here so I did not have enough time to prepare.

NAFRI: National Agriculture and Forestry Research Institute is an organization under the Ministry of Agriculture and Forestry established in 1999. In this December, we will commemorate the 10th anniversary of the establishment of NAFRI.

Our role is to undertake the development of researches. We do original researches in the area of rice, cash crop, livestock, fishery, forestry and related policy, not like academic research in universities. Our main function is forming functions like land use spending, land use zoning and land management. That is the first main function. The second one is the research of improving the production and seeds' variety. The third one is the research for development of effective and demand-driven technology, new technology. We deliver modern system for forestry production. The fourth one is offering new jobs and providing accommodation to the policymaker.

The capacity of NAFRI is very limited compared to the other organizations. Now, we have approximately 300 staffs in total. We have also the infrastructure and facilities for researches like laboratory and also the budget is very limited and then we are supported by donations, I can say 80 to 90 % of our operation cost is supported by donations. That is the present situation of capacity.

We put research programs in the next few years up to 2015. The first is maximizing the yearly benefit from forestry production to efficient land and labor use. That is the first area of research program. The second is the improvement of the land use spending and land management which would be mainly related to environment management and so on. The third is to improve techniques and mechanism to increase productivity. The fourth one is to meet requirement for the quality of commodity production. Fifth is to achieve in biodiversity conservation and utilization and sixth is to get sustainable natural resources to increase benefit.

Why do we need assistance from donors? From the past, we have been having partners who joined to NAFRI such as SEARAP and FEO as the international partners and also regional partners from China, Vietnam, Thailand, Philippines and also from Japan, especially from Kyoto University and now Nagoya University has joined us. We also have national partners.

I am very pleased that we have the MOU yesterday with Nagoya University. I hope in next five years, we can find a way that we can follow on environment management as the other countries.
think we have to follow the developed countries.

Thank you very much for your attention.
First of all, I would like to express my sincere thanks to the organizing committee, particularly to Prof. Yasunari, Prof. Okamoto and Dr. Yokoyama, who are chairing the Global COE Program and organizing this workshop. I would also like to extend my congratulations to the six speakers today. I enjoyed all of them.

As far as I understand, my assignment today is to connect six presentations with the aim of the workshop, this being the much broader topic of the Global COE Program. Actually, it is the first time for me to be part of the activities of this Global COE Program. My understanding of the Global COE Program may not be enough. I tried to catch up and actually, as you know, the Global COE is a priority program, so when we initiate or when we research projects, we spend a lot of time on discussions, expanding ideas and collaborating ideas. I tried to catch up with the ideas in this program. I did this during the whole day today, but I am not sure whether my understanding is sufficient. But anyway, I will start.

I will briefly review each of your presentations today. First, Ms. Somkhit, who talked about climatic variability and the vulnerability of a rice-based livelihood, using case studies from Savannakhet. Prof. Sekson talked about the case of forests in Kohn Kaen, Northeast Thailand, and discussed the conversion process since the 19th century, a 200 year history of a conversion process from forest to agricultural land. I will talk about this slide later, but first I will just give an overview of the six papers. The third presentation was by Dr Hyakumura. He also tried to focus on the various kinds of forests in Laos, including the spiritual forest, cremation forest or plantation forestry. The major message from his talk was maybe that forest resources are gradually becoming commercialized. That was the point he wanted to explain, I guess. This was followed by Mr. Ito’s presentation. He is from the Oji paper and pulp company. Anyway, he introduced how private sectors get along with tree plantation enterprises, not only in Laos but also in other countries like Brazil. The next presentation was by Prof. Kanok. He talked a lot about many things, including the transformation of shifting cultivation in the mountainous regions of Mainland Southeast Asia. Finally, Dr. Benjamin also presented Lao IRRI’s recent achievement in rice planting systems. He emphasized changing the virtuous cycle, food insecurity, the increasing cultivation of fragile land, and land rotation with low productivity to a virtuous cycle, including food productivity.
I will go back to the first presentation today, the one by Dr. Yokoyama. As far as I understand, he explained the aim of this workshop. There seem to be two spirals simultaneously going on in present-day Laos. One is a spiral of economic development through modernization or through the spread of a market economy, which is more modern, and this has been going on since the 1990s. The second spiral is one regarding nature-friendly life through traditional knowledge, which is kind of the foundation of Laos. According to his work, his point is that these spirals are confronting the aforementioned, becoming bigger and bigger and eroding this spiral. I thought this was aimed at telling us how we should cope with this situation. That is what he explained as the aim of the workshop.

As for questions, I think today’s presentations, particularly the questions at two presentations this morning, were answered clearly. Ms. Somkhit is studying rice farming in Savannakhet. She measures the vulnerability of the climate and she illustrates its data. Apparently, income diversification is a major strategy or provides measures to cope with vulnerability, in order to enhance resilience in Laos. What is income diversification? It can be the production of vegetables or livestock or fishery or aquaculture, but one of the biggest ones is off-farm income, and now they can find a job. So farmers can become factory workers.

Prof. Sekson also presented a discussion on ‘international marriage’. He said that cash comes from outside and that money may be invested in forest temples. Villagers donated money for forest temples and forest temples can protect the forests. Anyway, now, villagers’ lives are heavily dependent on cash from outside and that makes them less vulnerable. So, it is not an alternative but it must co-exist, in a synchronized way. The two spirals must be synchronized. There are no other options. We cannot have only one of them, we should go with both, but in a synchronized way.

Going back again to Prof. Yasunari’s presentation about the global symposium, From Earth Sciences to Basic and Clinical Environmental Studies, as far as I understand, so far the diagnostic environmental studies are moving towards treatment environmental studies. For this, we need two components, one is clinical environmental studies and the other is environmental studies. So far, it is a little bit difficult for me to understand the difference between these two, so I will just focus on one.

When I listened to Prof. Yasunari’s presentation, a question came into my mind as a first impression. If we have to care for the environment, we have to support an ideally healthy condition. What are the healthiest conditions for the environment? We first have to know what should be done to care for the environment. But it depends on the definition of the health condition of the environment. That determines the necessity for environmental studies. These two questions arose when I listened to Prof. Yasunari’s talk this morning. To some extent, I found answers to these two questions throughout today’s talks. Very simply speaking, there seem to be two kinds of clinical
studies. One is a clinical study in a narrow sense, and the other is a clinical study in a broader sense. What are they? Prof. Ito’s presentation was very clear. The tropics, that is a good place for tree biomass production. Tree plantation will be much more developed in the future. But so far, we do not have good cultivars or good varieties that are suited to a tropical environment. We should fix the land in order to maximize production there, then look at what kind of variety we need, how to do it, what kind of soil treatment we have to do. That is what he talked about. I am sure that this is one of the clinical environment studies. I believe Prof. Hyakumura’s studies are also clinical studies, but his study has a rather broader perspective. He is looking at the transformation of forests and also of some official forest institutions and local institutions, but in his conclusion, there is a very big difference between official forests and informal forests, which could cause problems.

Dr Benjamin’s study is also a very clinical study. The upland rice shifting cultivation in the northern part of Laos is facing problems. Food insecurity causes degradation of the environment and lowers food quality. He tried to develop technology to increase not only the production but also the whole cycle. So it is a typical clinical study, I think, and it also applies modern technology. But from what Prof. Kanok said, I think he has a will to develop and care for the area to make the region better, but food insecurity or land failure often lead to land use conflict. Yes it’s true. There is a wide number of indigenous minorities, and the people are selecting adoptive management. They have several options in adoptive management, depending on the situation. We cannot say there is only one solution; there are always several solutions.

I think that Prof. Ito’s and Prof. Benjamin’s studies are a clinical study in a narrow sense. Dr. Hyakumura’s and Prof. Kanok’s studies are clinical studies in a broader sense. In the case of the narrow sense, their target is very specific and goal-oriented, but they try to rush to the goal and it is driven by technology or science. We can see this type of development in many domains, but in the case of environmental studies, we have to also consider the clinical studies that Dr Hyakumura or Prof. Kanok proposed. The targets or drivers are not clear. But what we seem to know at this moment is that the process of change does not seem to be much more important than the goal itself. I think that that is what Prof. Kanok emphasized finally in his talk about participatory development, and I think that adaptive management is also one of the process oriented measures. The most important thing is that we have to do address the issues in both ways. I sincerely expect that we should do both.

In addition, in environmental studies, we have to concern ourselves with complexities, and complexity is not only about ecosystems but also about livelihood, and there are many, many cases today, for example income diversification, job diversification, agro-bio-diversification. We use the term diversification many times, and this is what the regional characteristics of Asian society and nature are like. There is one point about change, how we should consider change.
In clinical studies, we have to assume some kind of timescale, and actually it is a kind of contemporary issue, but the area itself or the system itself is changing very rapidly. I have myself been working for Thailand and Laos, maybe 20 years now, but still the changes are beyond all my expectations. So we cannot presume how things will be many years later, 20 years later, and we should not miss this point.

Thank you very much.
Questions and Answers

(Tetsuzo Yasunari)  Prof. Kono, thank you very much for a very nice comment about our program. I really learned a lot from your comments. You mentioned the clinical environment studies in a narrow sense and a broader sense, but you have also raised the question of the analogy of medical science with environmental science, is this okay or not. We also had very similar questions from the beginning, and of course medical science may provide treatment to recover health or from other illnesses, etc. So we can see the condition of body health more clearly than that of the environment. But as far as our environment is concerned, what is the illness in the environment? It is really a tough issue, as you pointed out. You showed that there are proper diagnostic studies for the various kinds of treatment study. One way, I think, when we proposed this, is that there should be a kind of two-way dialogue, and that is maybe the role of basic environmental studies, which you didn’t mention as being important. Within basic environmental studies, we should think about what is a good environment for human beings, for the environment in the ecosystem. This is what we should think about.

Within basic medical sciences, sometimes there are scientists who discuss what life is. In the same sense, we should think about our world environment or the human population, including local people and minorities in some areas, but anyway, that’s why we really need to kind of have the two way introduction between the clinical and basic environmental studies. That’s why we proposed not only the clinical environmental studies, but also the basic environmental studies. What is important for us? Then, of course, human beings have been involved in the life-long history of the social system and organization. What is good for human beings? That is what we should all consider. It is very important. Then we have to go back to treatment. That is why we propose these two. These are my comments. I am not sure whether you . . .

(Kono Yasuyuki)  Thank you very much. At that point, my understanding was not sufficient, but just one additional comment or idea. When we discussed what the healthiest environment is, it may not be the answer to the question, but the process to develop the idea, and so that may be much more important than the final outcome.

(Tetsuzo Yasunari)  Yeah, I agree with you.
Today’s Presentations: Society and Environment

Ms. Somkhit Boulidam
- Climatic variability and vulnerability of rice-based livelihood
- Income diversification is the strategy for villagers to cope with the vulnerability of their livelihood.

Prof. Sekson Yongvanit
- Conversion process from forest to agricultural lands
- In addition to population, market and policies, we have to consider much wider range of factors including religion.
- Cash comes from outside, which enhance the resilience of rural livelihood.
Today’s Presentations: Forestry and Environment

Dr. Hyakumura Kimihiko
• Commercialization of forest resources
• There is a big gap between forestry policies, official forestry institutions and the reality.

Dr. Ito Kazuya
• Tree plantation enterprise by the private sector
• Forestry for the global market by the advanced technology including clone plantation and soil and water management

Today’s Presentations: Agriculture and Environment

Prof. Kanok Rerkasem
• Transformation of shifting cultivation in the mountain region of mainland Southeast Asia
• Insecurity of land tenure often leads to land use conflicts.
• A wide range of indigenous knowledge, alternative adaptive management, no unique solution

Dr. Benjamin K. Samson
• Changing the vicious cycle of Food insecurity, intensive cultivation of fragile land, land degradation, low food productivity to virtuous cycle using food productivity as the entry point.
• Applying the modern technology to shifting cultivation development
Aim of the Workshop
(by Dr. Yokoyama)

A spiral for economic development through commercialization

A spiral for nature-friendly life through traditional knowledge
From earth science to basic and clinical environmental studies
(by Prof. Yasunari)

Clinical environmental studies
Diagnostic environmental studies
Earth Science
Basic environmental studies
Treatment Environmental studies

Questions

• What is the most healthy condition of the environment?

• What are the necessary scope for environmental studies
**Clinical studies**

**Clinical study in a narrow sense**
- Target-specific
- Technology/Science-driven
- Goal-oriented

**Clinical study in a broader sense**
- Target not clear
- Driver not clear
- Process-oriented

---

**In addition,**

- Complexity in ecosystem and livelihood systems is an indispensable characteristics of Asian nature and society.

- Livelihood system can be transformed beyond the imagination of scholars.